

Reliability



可靠性 Confiabilidade

موثوقية Fiabilité Affidabilità

信賴性 Αξιοπιστία Zuverlässigkeit

Confiabilidad Niezawodność Надежность

USER'S GUIDE

Reliability

SYNTHESIS

Elements®

User's Guide



RBI

Version 9

ReliaSoft®



Tucson 🌐 São Paulo 🌐 Warsaw 🌐 Chennai 🌐 Singapore

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Introduction

1

ReliaSoft's RBI software facilitates risk based inspection (RBI) analysis for the oil & gas, chemical and power plants in adherence to the principles and guidelines presented in the American Petroleum Institute's recommendations in the API RP 580 and RP 581 publications, as well as the American Society of Mechanical Engineers' recommendations in the ASME PCC-3-2007 publication.

Full-featured Reliability Centered Maintenance (RCM) and FMEA / FMECA functionality is also included.

RBI has been integrated into the ground-breaking new Synthesis Platform®, which offers reliability practitioners the best of both worlds: analysis tools that are optimized to fully meet the individual user's needs for a particular set of reliability engineering methodologies, plus integration into a shared repository (database) that is accessible by multiple users throughout the organization and facilitates integration between all Synthesis applications. This powerful new platform makes it feasible to more effectively leverage and integrate the information from different types of reliability activities throughout the organization.

This chapter provides a wealth of information to help you learn how to use the software to its maximum potential. Before starting we recommend reading the following sections:

- Technical Support - Section 1.1 (p. 2)
- ReliaSoft Consulting - Section 1.2 (p. 2)
- Minimum System Requirements - Section 1.3 (p. 3)
- Installing Synthesis - Section 1.4 (p. 5)
- License Registration & Activation - Section 1.5 (p. 6)
- Internet Connectivity - Section 1.6 (p. 13)
- Region and Language Settings - Section 1.7 (p. 13)
- Product Features
 - Introduction to the Synthesis Platform - Section 1.8 (p. 16)
 - RBI Features Overview- Section 1.9 (p. 18)

For information about how to use the software to perform risk based inspection analysis, you may wish to jump directly to RBI Analysis (*see Chapter 12*). To focus on the reliability centered maintenance analysis capabilities, *see Chapter 13*. And for information about FMEA and related analyses, start from FMEA Analysis, *see Chapter 14*.

1.1 Technical Support

ReliaSoft's reliability software products are renowned for their ease of use and unparalleled after sale support. For standard shrink-wrap software, we provide free technical support for software-related issues via an established (and growing) network of regional offices and partners/distributors throughout the world.

(See <http://Support.Reliasoft.com> for details and exclusions.) You can request assistance directly from within the software by choosing **File > Help > E-mail Support**. This option creates an e-mail message that is pre-populated with information about your license and operating system, which the technical support representative will need for troubleshooting the issue.

You can also contact us directly via phone, fax, e-mail, mail or live chat. To find the office that serves your region, choose **File > Help > Contact Global Support Center** or visit <http://www.Reliasoft.com/help.htm>. Note. Alternatively, and regardless of your region, you can always request assistance from ReliaSoft's Corporate Headquarters in Tucson, Arizona. For details, choose **File > Help > Contact Reliasoft USA**.

1.1.1 When Requesting Support

When you contact ReliaSoft to request technical support, please be prepared to provide the following information:

- Your phone number and e-mail address.
- The product name and the Compile Release Version number of your application.¹
- Your product license key.
 - To determine the license for the application on your computer, you can choose **File > Application Setup** and look on the User page of the Application Setup window.
- The operating system (e.g., Windows 7), RAM and hard disk space on your computer.
- Describe what you were doing when the problem occurred and exactly what happened. Please include the specific wording of any message(s) that appeared.

Note: ReliaSoft's technical support representatives are not reliability consultants, and their assistance is limited to technical issues that you may encounter with the software tools. To get assistance with your analysis from a subject matter expert, please contact ReliaSoft Consulting Services. ReliaSoft also offers a comprehensive selection of training courses that cover both the underlying principles and theory, as well as the applicable software tools. For details, visit <http://Seminars.Reliasoft.com>.

1.2 ReliaSoft Consulting

If your organization does not have sufficient time, expertise or objectivity in-house to accomplish specific reliability goals, turning to ReliaSoft's expert reliability consultants can prove to be the most effective and economical solution. Whether you need a quick statistical analysis, a complete assessment of your reliability program plan or something in between, ReliaSoft Consulting Services (RCS) is ready to help.

- Our reliability consulting services team has combined expertise in almost **all areas of reliability and quality engineering** with experience that spans **a broad spectrum of product types**, from micro-electronics and appliances to advanced weapons systems and off-shore oil well drilling equipment.
- Unlike engaging a consultant who works independently, RCS consultants have **direct access to all of Reliasoft's global resources, expertise and contacts**.

¹. To determine the Compile Release Version (CRV) of the application on your computer, choose **File > Help**. The CRV is displayed in the **About** area. Note that the CRV will also indicate whether you are running the 32-Bit version or the 64-Bit version of the software.

- Our **team-based approach to consulting**, combined with ReliaSoft's global reliability engineering organization, allows us to provide you with reliability consultants who understand your culture and speak your language while ensuring that the appropriate reliability expertise can be applied to each and every project.
- RCS is structured to **accommodate requests of any size or complexity**, from short telephone consultations to multiple experts at a client's site for an extended time period.

Please visit <http://Consulting.ReliaSoft.com> for a published list of commonly requested services, answers to frequently asked questions, and other useful information about this service.

1.3 Minimum System Requirements

This section describes the minimum system requirements for all Synthesis applications.

ReliaSoft provides a tool that can help you determine whether you should install the 32-bit or 64-bit version of the Synthesis Platform. The tool will also tell you whether your computer and Internet connection meet the requirements for running and activating the Synthesis Platform. To download the tool, refer to Technical Support Document RS40025.

System Hardware Requirements	
CPU Speed	1.5 GHz or higher
Processor	Intel Pentium or higher
Memory/RAM	2 GB or higher (32-bit) 8 GB or higher (64-bit)
Display Properties	24-bit color depth
Screen Resolution	1024 x 768 or higher at normal size (96 dpi)
Swap Space	Determined by the operating system, 500 MB or higher
Disk Space	1 GB for installing the Platform and Synthesis applications
Video/Graphics Adapter	64 MB RAM or higher
Internet Access	Internet access is required for the License Manager and optional for using the Internet-enabled features in the software interface. <i>See Section 1.6 on page 13.</i>
Operating Systems Supported	
Microsoft Windows	XP - 32-bit (Service Pack 3 or higher). <i>The 64-bit version of Windows XP is not supported.</i>
	Vista - 32-bit and 64-bit (Service Pack 1 or higher)
	Windows 7 - 32-bit and 64-bit
	Windows 8 - 32-bit and 64-bit
Microsoft Windows Server (Requires a license that specifically allows server installations/deployments.)	2003 R2
	2008 - 32-bit and 64-bit (Service Pack 2 or higher)
	2008 R2
	SBS (Small Business Server) 2011

Microsoft Office Integration			
Microsoft Office 2000 or higher (Excel, Word and Outlook) are required for automated exports, report generation and e-mail/calendar integration. ReliaSoft recommends Microsoft Office 2010.			
IMPORTANT NOTE: 32-bit and 64-bit Versions			
As shown in the following table, you can choose which version of Synthesis to install if you have a 64-bit version of Windows and any version of Microsoft Office except Office 2010 (32-bit). When the installation program gives you a choice, the decision should be based on the capabilities of your computer (processor and RAM) and how you plan to use the software.			
		Microsoft Office Version	
Windows Version	32-Bit	32	
	64-Bit	32 or 64†*	32 or 64*
[See our 32-bit vs. 64-bit FAQ at http://www.Reliasoft.com/synthesis/installation.htm for more details.]			
† If you have Microsoft Office 2010 (32-bit), you must install the 32-bit version of Synthesis.			
* If you plan to use the optional Synthesis API (Application Programming Interface) to call Synthesis functions from a Microsoft Office application (e.g., use VBA in Excel to call the Weibull++ calculation engines), you must have the same version of Office and Synthesis (i.e., 32-32 or 64-64).			
Enterprise Database Platforms			
Microsoft SQL Server	2005, 2008 and 2012 32-bit and 64-bit versions		
Microsoft SQL Server Express Edition	2005, 2008 and 2012 32-bit and 64-bit versions		
Oracle	10g and 11g 32-bit and 64-bit versions		
Oracle Express	11g 32-bit and 64-bit versions		

1.3.1 A Note About Enterprise Database Servers

Although the enterprise database platform (Microsoft SQL Server or Oracle) could be installed on the same computer where the Synthesis applications reside, most organizations will choose to set up a separate server to host the database. Both the 32-bit and 64-bit versions of the Synthesis applications will work with either the 32-bit or 64-bit versions of a back-end database/server. The minimum hardware/software requirements for each server hosting the database should be obtained directly from the selected database vendor (i.e., Microsoft or Oracle). In general, ReliaSoft recommends a minimum CPU speed of 2 GHz and 4 GB of RAM.

Tip: If you're considering the option to use the free "Express" edition of Microsoft SQL Server, the http://www.Reliasoft.com/synthesis/sql_express.htm file provides some information that may help you to get started.

1.4 Installing Synthesis

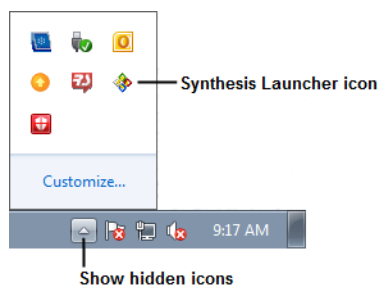
To install Synthesis, open the installation program (e.g., “Synthesis9.exe”) and follow the prompts. This single *.exe will install all Synthesis applications and then you can choose which application(s) to activate on your computer. Please note the following:

- Before running the installation program, make sure your computer meets the **minimum system requirements** for Synthesis. *See Section 1.3 on page 3.*
- To perform the installation, you must be logged in with a user account that has **administrative rights**.
- It is strongly recommended that you **close all other applications** during the installation.
- After the installation, all Synthesis applications will be located in the same application directory and available for activation. *See Section 1.5 on page 6.* Depending on your preferences, the applications that you choose to activate can be accessible via the Windows Start menu, via shortcut icons on the desktop and from the Synthesis Launcher.

Deactivation and/or Uninstall

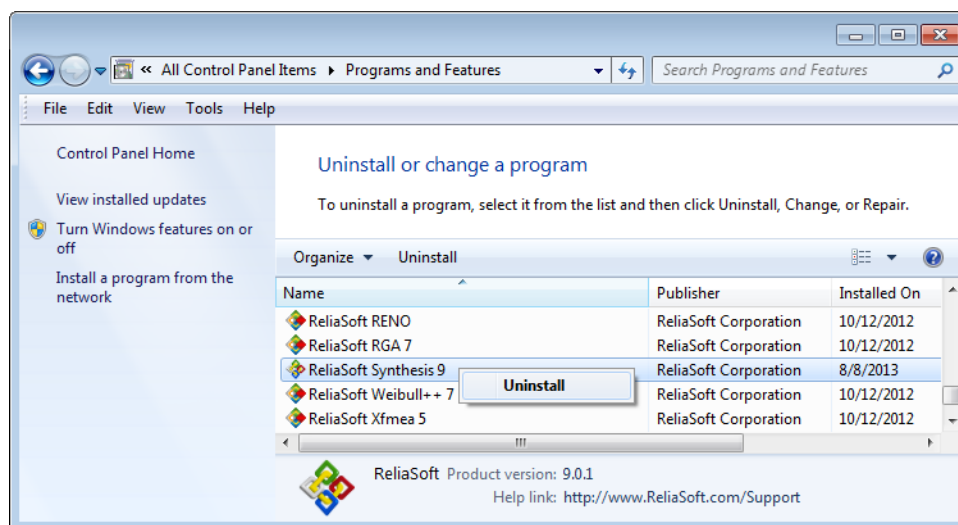
If you wish to stop using some or all of the Synthesis applications on this computer, you have two options:

- **Deactivate Without Uninstall.** This will free up the specified activation(s) for your product license key so you can activate on another computer or for another user. However, you can continue to use any other Synthesis applications that remain activated on this computer. If you decide to start using the deactivated application(s) again, you will not need to reinstall (as long as the new activation would not exceed the limits of your license key). Simply launch the application and follow the prompts to activate again. *For details see Section 1.5.2 on page 12.*
- **Full Uninstall.** This will completely uninstall all Synthesis applications from your computer. If you have a network connection to ReliaSoft’s License Server, you will be able to deactivate all applications at the same time. If you are not able to complete the deactivations during uninstall, you will need to contact ReliaSoft Technical Support for assistance to make the license available for later activation with another computer/user. To perform the uninstall, do the following:
 1. Make sure you do not have any Synthesis applications currently open.
 2. Make sure the Synthesis Launcher is not currently running. To check this, click **Show hidden icons** in the Windows notification area (i.e., the “system tray” located next to the clock in the Windows taskbar) and look to see if the Synthesis Launcher icon appears. If it does, click the icon and choose **Exit Synthesis Launcher**.



3. Open the Windows Control Panel and click **Programs and Features** (or use the search box in the Windows Start menu to find and select **Add or Remove Programs**).

4. In the Uninstall or change a program window, double-click **ReliaSoft Synthesis 9** and follow the prompts.



1.5 License Registration & Activation

The first time you run each Synthesis application, you will be prompted to register and activate the product on your computer. The License Manager wizard will guide you through the steps to provide your registration details and product license key. If you have an active Internet connection, you can complete the activation automatically via the wizard. If you do not currently have an active Internet connection, you can choose to implement the free 7-day trial or you can request an activation code from ReliaSoft and enter it manually when prompted by the wizard. *For details, see Section 1.5.1 on page 6.*

When the activation process is complete, you will receive a confirmation e-mail that includes your ReliaSoft ID and password. Please store this information in a safe place. It may be required if you later need to update your registration details or manage the products that are currently activated for your computer. If you are unable to locate this information when you attempt to use the License Manager, you can request to have the ID and password sent to the e-mail address on file for your registration.

If you do not plan to continue to use a Synthesis application on a particular computer, it is very important to deactivate it. ReliaSoft's License Server will prohibit future activations that would exceed the limits of your license key. *For details, see Section 1.5.2 on page 12.*

1.5.1 Activating Synthesis Applications

Activation is a required process that associates your ReliaSoft products with the computer(s) on which they're installed. The process helps you maintain better control of your software assets (through activation and deactivation on different computers that you may use over time). It also allows you to recover lost keys and licenses, prevents unauthorized use and copying of the software, and protects you against the risks of counterfeit software. This is usually a quick and simple automated process done through our secure server at <https://Validate.ReliaSoft.org> (ReliaSoft License Server).²

². Specifically, the information transmitted to the ReliaSoft License Server is your ReliaSoft ID (e-mail address) and Product License Key. If this is your first time registering, your name and the basic contact information will also be transmitted. The information is encrypted by our software first and then transmitted using SSL to the secure server. We do not sell or provide your information to any third parties (see <http://www.ReliaSoft.com/privacy.htm>). The information sent back is simply a code that tells the software that it is now authorized to run on that computer.

If the computer has an active Internet connection and your firewall allows the software to access the ReliaSoft License Server, only a few simple steps are required. If you are unable to connect to the server, several alternative options are available. This document contains the following information:

- Basic instructions when the activation wizard can communicate directly with the server - Section 1.5.1.1 (p. 7)
- General tips to address problems communicating with the server - Section 1.5.1.2 (p. 7)
- Other ways to activate the application if the wizard cannot communicate directly with the server - Section 1.5.1.3 (p. 8)

1.5.1.1 Basic Instructions with Direct Communication to the License Server

1. The first time you launch an application, the activation wizard will appear. On the first page, select whether you want to activate a license or start with the free expiring demo.

Note that if you choose to start with the demo first, it will be easy to upgrade to the full license when you're ready — no further downloads or installs required! The next time you launch the application after the demo expires, you will be prompted to repeat this process so you can enter the license key that you received from ReliaSoft.

2. On the next page, enter a valid e-mail address to serve as your **ReliaSoft ID**. This is the e-mail address where you will receive confirmation e-mails from the ReliaSoft License Server. It will also identify all of the products registered to you.
 - **One-Time Registration:** If this is the first time that you have registered a Synthesis application on this computer with this e-mail address, the next page will request your name and basic contact information.
3. If you are activating a product license key provided by ReliaSoft, you will be prompted to enter it on the next page. *Tip: If you are able to copy the key from a product delivery e-mail, the Paste icon saves time by automatically entering each section into the appropriate input box.*
 - **For Unlimited User Licenses:** If you have an [Unlimited User License](#) (e.g., a site-wide, division-wide, corporate-wide or corporate partner license), the wizard must confirm that your ReliaSoft ID matches one of the e-mail domains that have been authorized for the license (e.g., a corporate-wide license for ReliaSoft might be configured to allow access by any user with an e-mail account on @ReliaSoft.com or @weibull.com, etc.). If it meets the requirements, the next page requires you to copy/paste a code that you will receive from ReliaSoft via e-mail. *Tip: If the e-mail does not appear in your Inbox within a few minutes, check your Junk mail or SPAM folders.*
 - **Activate Multiple Applications:** If your license key includes other Synthesis applications that have not yet been activated on this computer, the next page gives you the opportunity to activate any or all of them at the same time.
4. When you see the “Your product has been activated” message, click **Finish** to start using the software.

For Concurrent Network Licenses: If your organization has a [Concurrent Network License](#), your access to the application at any given time depends on how many other users who share the license are accessing the application at the same time. After the initial activation (i.e., the steps described above), the software will automatically check the server each time you try to access the application. Therefore, the computer must have an active Internet connection and must be able to access the ReliaSoft License Server whenever you wish to use the software. You may need to adjust your Internet and/or firewall settings and/or set the server as a trusted location in order to use the application. To determine whether your computer will be able to connect with the ReliaSoft License Server each time you use the application, you can download a test application from <http://www.ReliaSoft.com/support/rs40025.htm>.

1.5.1.2 Problems Communicating with the Server

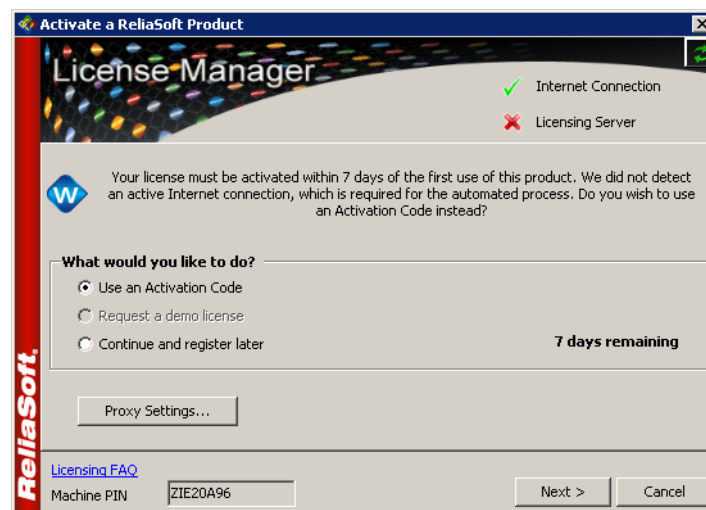
The software must communicate with the ReliaSoft License Server at <https://Validate.ReliaSoft.org> each time you activate a particular application on a particular computer. For Concurrent Network Licenses, the software must also connect each time you attempt to access and use the software. Personal or corporate firewalls can block this communication.

Possible Solutions:

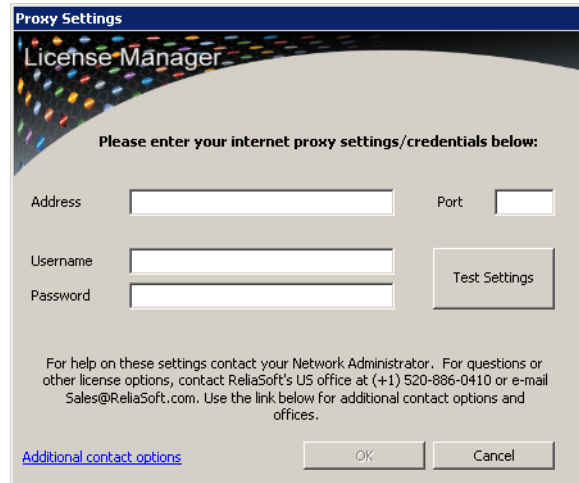
- Personal firewalls (Norton Firewall, ZoneAlarm, BlackIce, Outpost, McAfee Firewall, etc.) need to be configured to allow the software to communicate with the server. Generally, these products will ask for your authorization when the software first tries to establish communication with the server (e.g., “BlockSim.exe is attempting to access the Internet. Do you wish to authorize it?” or something similar). You should authorize this and also make this authorization permanent if possible.
- Some firewall configurations block all new programs without any warning. To activate the software, it will be necessary to manually add the software name to the authorized list. Provide for unlimited access for the software.
- If all of this still fails, try to deactivate the firewall temporarily until the software has been activated. The majority of firewalls have an option to suspend their action. If not, you will have to terminate the firewall. Activate the software and then reboot your machine to restore firewall action.
- For network or corporate firewalls, you may need to ask the network manager to make the required settings to allow the software to communicate with the ReliaSoft License Server and/or add this domain to a trusted list.

1.5.1.3 Multiple Ways to Activate

1. The software will first attempt to communicate with the ReliaSoft License Server directly. At this time, it checks both your network connection and the ability to connect to our server. In the image below, the connection is detected (green check mark) but it is unable to communicate with our server (red X). (Note that some licenses require additional information, such as a Confirmation Key, password, user or seat information, etc. In such cases, you will not be able to obtain an Activation Code automatically. If you have trouble with the automatic process, you can refer to step 3 for instructions on obtaining a code manually.)



- In the case that the server connection fails but the software detects network access, the wizard will first prompt you to indicate whether a proxy server is being used. If you choose to configure the software to communicate through a proxy, the Proxy Settings window looks like the one shown next. Enter the information required (you may need the assistance of your network administrator to complete this) and click **Test Settings**. The **OK** button will become enabled if the test is successful.



Proxy Settings

License Manager

Please enter your internet proxy settings/credentials below:

Address Port

Username

Password

Test Settings

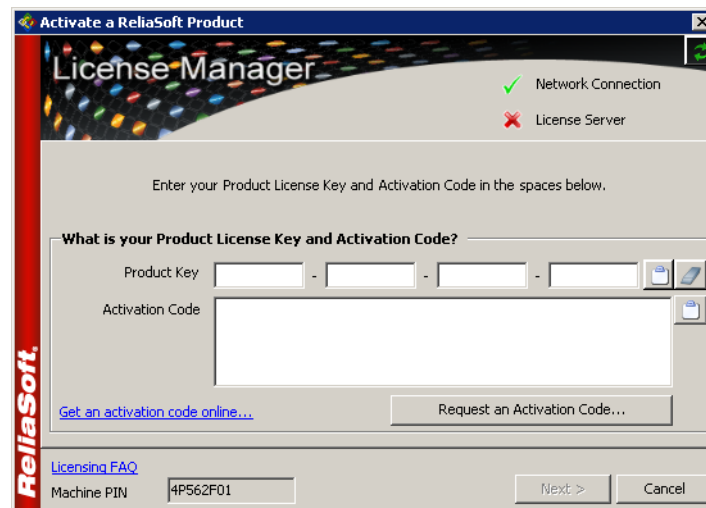
For help on these settings contact your Network Administrator. For questions or other license options, contact ReliaSoft's US office at (+1) 520-886-0410 or e-mail Sales@ReliaSoft.com. Use the link below for additional contact options and offices.

[Additional contact options](#)

OK **Cancel**

Once a proxy is successfully set, you can continue with the automated process. If the proxy fails, you may want to try again and confirm that the entries are valid. If the test is still not successful, you can exit the window using the **Cancel** button and then try one of the two methods for requesting an Activation Code: from within the wizard or from a web form. Both methods are described next.

- To request the Activation Code from within the wizard, choose **Use an Activation Code** and continue until you reach the screen shown next.



Activate a ReliaSoft Product

License Manager

✓ Network Connection
✗ License Server

Enter your Product License Key and Activation Code in the spaces below.

What is your Product License Key and Activation Code?

Product Key - - -

Activation Code

[Get an activation code online...](#)

Request an Activation Code...

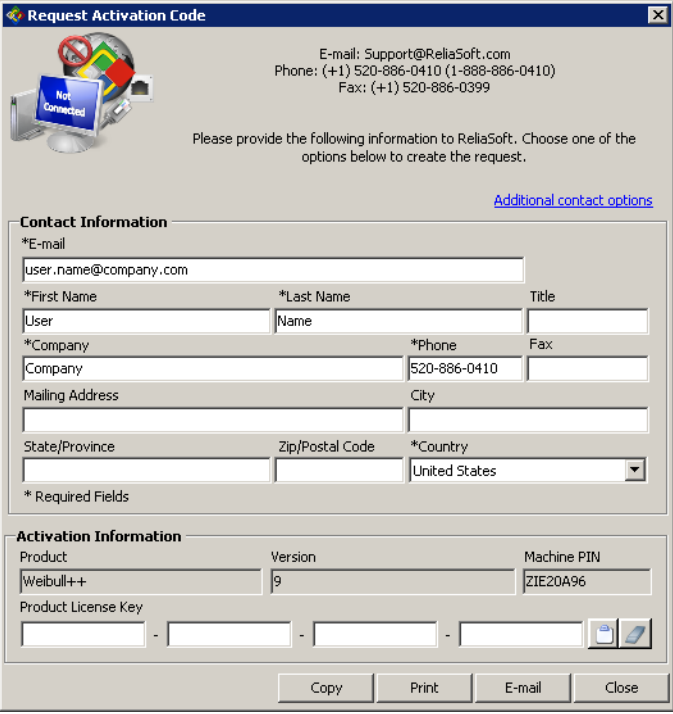
ReliaSoft.

[Licensing FAQ](#)

Machine PIN

Next > **Cancel**

If you click **Request an Activation Code**, the window shown next will appear.



The "Request Activation Code" window features a title bar with a close button. On the left is an icon of a computer with a "Not Connected" message. The top right displays contact information: E-mail: Support@ReliaSoft.com, Phone: (+1) 520-886-0410 (1-888-886-0410), and Fax: (+1) 520-886-0399. A central instruction reads: "Please provide the following information to ReliaSoft. Choose one of the options below to create the request." Below this is a link for "Additional contact options".

The form is divided into two main sections:

- Contact Information:** Includes fields for *E-mail (pre-filled with "user.name@company.com"), *First Name (pre-filled with "User"), *Last Name (pre-filled with "Name"), Title, *Company (pre-filled with "Company"), *Phone (pre-filled with "520-886-0410"), Fax, Mailing Address, City, State/Province, Zip/Postal Code, and *Country (a dropdown menu currently showing "United States"). A note indicates "* Required Fields".
- Activation Information:** Includes fields for Product (pre-filled with "Weibull++"), Version (pre-filled with "9"), Machine PIN (pre-filled with "ZIE20A96"), and Product License Key (four empty boxes separated by hyphens). There are also icons for saving and printing the license key.

At the bottom are four buttons: "Copy", "Print", "E-mail", and "Close".

Once you enter the required information, you have the following options:

- A. Send an e-mail to our server (if you have an e-mail connection).
- B. Print a form to fax or mail to us.
- C. Copy the information to a text file so you can submit it to ReliaSoft at a later time via e-mail, mail or phone.

If you have an e-mail connection, the best option is to click the **E-mail** button. This will activate your e-mail client and automatically create an e-mail formatted so that it can be read by our server. Please do not alter any of the text in this e-mail; simply send the message exactly as it is.

DO NOT MODIFY BELOW THIS LINE

Contact Information
 E-mail: user.name@company.com
 First Name: User
 Last Name: Name
 Title:
 Company: Company
 Phone: 520-886-0410
 Fax:
 Mailing Address:
 City:
 State/Province:
 Zip/Postal Code:
 Country: United States

Activation Information
 Product: Weibull++
 Version: 9
 Machine PIN: ZIE20A96
 Product License Key: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DO NOT MODIFY ABOVE THIS LINE

When this is received by our server, the server will automatically reply with a block of text that you need to copy and paste in the Activation Code area of the wizard (i.e., below your Product License Key).

4. To request the Activation Code from the web form, go to <https://Validate.ReliaSoft.org/UserManagement/ActivationCode.aspx>, enter the required fields and click **E-mail Activation Code**.

Customer Information (Items in RED are required)

First Name Last Name

Company Title Mail Stop

Mailing Address

City State/Province Country Zip/Postal Code

Phone Fax E-Mail

Product & License Key

Which product are you activating?

What product version?

What is your Product Key? - - -

What is the Machine PIN (from activation wizard)?

If your license is eligible for activation in this manner, the server will send an e-mail with a block of text that you need to copy and paste in the Activation Code area of the wizard (i.e., below your Product License Key).

5. Lastly, if all else fails, you can contact ReliaSoft via, phone, e-mail and/or fax to obtain an Activation Code. In cases where an automated activation is not possible, you can select the **Continue and register later** option on the first page of the License Manager wizard to continue without activating during a seven-day grace period; this allows you sufficient time to activate via alternative methods.

1.5.2 Deactivating Synthesis Applications

Unless you have an Unlimited User License, there will be a limit to the number of computers and users for which a Synthesis application can be activated at the same time with the same license key. (To review these limits for different license types, see http://www.ReliaSoft.com/license_compare.htm.)

Therefore, if you do not plan to continue to use a Synthesis application on a particular computer (or for a particular user), **it is very important to deactivate it**. The License Server will prohibit future activations that would exceed the license key's limits. If you do not free up activations that are no longer being used, the license may be unavailable for later activation on other computers and/or for other users.

For example, a Standard Network License permits each named user to activate the application on one computer at any given time. If you need to change computers, you must deactivate from the old computer before you will be able to activate on the new one.

There are three ways to deactivate Synthesis applications:

1. **Upon Uninstall:** When you uninstall Synthesis, you will be prompted to deactivate all applications for all users on that computer. If you are not able to complete the deactivation at that time (e.g., because you do not have a network connection to ReliaSoft's License Server), you will need to contact ReliaSoft Technical Support for assistance. *See Section 1.1 on page 2.*
2. **Deactivation Without Uninstall:**
 - From within the application you wish to deactivate, choose **File > Help** and click the **License Manager** link.
 - Enter your password or click **Cancel** to proceed without it. (A password is not required for deactivation.)
 - Click the **Deactivate** button in the center of the License Manager window.
 - You will be prompted to confirm. When you do, the application will immediately close and you will not be able to run it on this computer without activating again.
 - Repeat the process for any other applications that require deactivation.
3. **Contact ReliaSoft:** If you were unable to deactivate during the uninstall, or if you did not uninstall and no longer have access to the computer, you will need to contact ReliaSoft Technical Support for assistance.

1.6 Internet Connectivity

One of the many new enhancements for applications that are built on the Synthesis Platform is the ability to take advantage of an active Internet connection to obtain the most up-to-date announcements, documentation and examples. Internet access is not required to use the Synthesis applications, but once you have registered and activated the software on your computer, an active Internet connection will allow you to take advantage of several useful new features, including:

- **ReliaSoft Online:** When you are using any page in the Backstage view (accessed by clicking the File tab on the Ribbon), the ReliaSoft Online pane is displayed on the right side of the MDI. When you have an active Internet connection, this panel provides a variety of useful information, updated in real time so you always have access to the latest information. This includes quick tips for using the software, upcoming training seminars and other recent announcements.
- **Reliability Web Notes:** The Reliability Web Notes page of the My Portal window provides access to information about the tool that you are currently working with. This usually includes a brief description of the item, as well as links to examples and theory articles.
- **Help Center:** When you are using the new Help Center in the Backstage view (accessed by clicking **File > Help**), you will have quick access to a variety of support tools. Many of the tools require Internet access, such as the ability to download software updates and the option to generate an e-mail with the technical details about your computer that may be needed for support.
- **Latest Help File:** We will always install a copy of the help file on your computer so you can access it any time, even when you're working offline. But when you have an active Internet connection, the help topics that you see when you press **F1** or choose **File > Help > Help File Contents** will always be the most up-to-date versions available. This allows us to keep updating the product documentation to provide the information that users are looking for, and it ensures that you will always have access to the latest information about the software.

1.7 Region and Language Settings

The Region and Language settings for your particular computer will have some impact on the way information is displayed in Synthesis applications. Specifically, they will affect:

- Which language is selected by default when you install the software.
- How dates and times will be entered and displayed.
- How decimal values and currency will be entered and displayed.

Users with different regional and language settings can work together on the same analysis projects because, in most cases, the basic information is stored in the database and the software simply displays it in the format preferred by each user. For example, if the date September 25, 2012 is stored in the database, User A might see it as “9/25/2012” while User B might see “25-Sep-12.”

This section first explains how to view or change the Region and Language settings on your computer and then discusses some specific considerations for Synthesis applications.

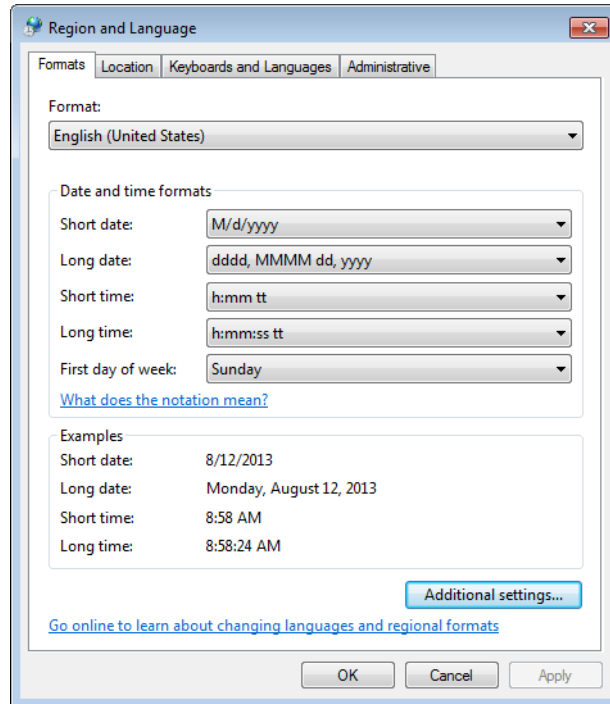
1.7.1 Viewing/Changing the Region and Language Settings for Your Computer

To open the Region and Language window, do the following:

- In Windows 8, move the pointer over the lower-left corner of the desktop, then right-click and choose **Control Panel**. Click the **Clock, Language, and Region** option then click the **Region** link.
- In Windows 7, choose **Start > Control Panel** and then click the **Region and Language** link.

- In Windows Vista, choose **Start > Control Panel** and then under **Languages and Region**, click the **Change Display Options** link.
- In Windows XP, choose **Start > Control Panel** and then click the **Regional and Language Options** link.

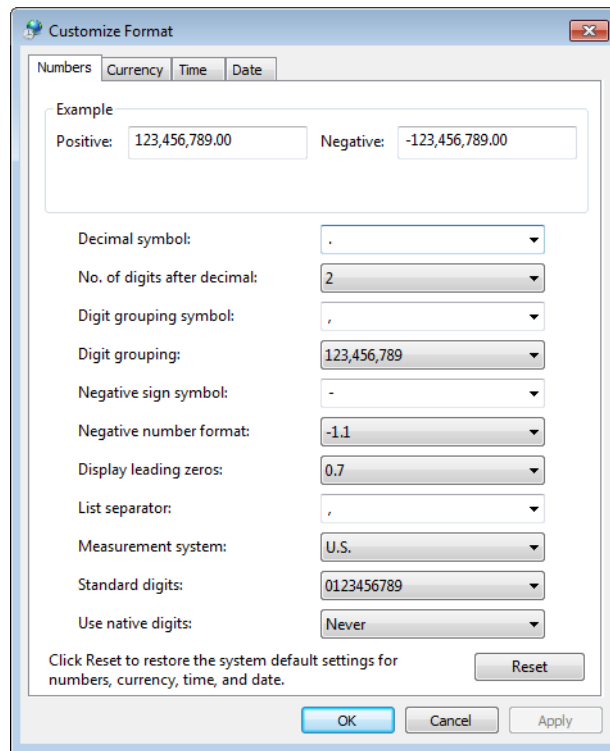
As an example, the Windows 7 interface is shown here. The Windows 8, Windows Vista and Windows XP versions look different but function similarly.



Other relevant settings are managed via the Customize Format window:

- In Windows 8, click the **Additional settings** button.
- In Windows 7, click the **Additional settings** button.
- In Windows Vista, click the **Customize Format** button.
- In Windows XP, click the **Customize** button.

As an example, the Windows 7 interface is shown next.



Note: To see the changed settings in the Synthesis application, you must close the application, and then restart it.

1.7.2 Setting the Default Language When You Install the Software

The user interface for Synthesis applications is available in several languages. You can change this language at any time by opening the Synthesis Setup window (**File > Synthesis Setup**) and selecting an option from the **Language** drop-down list.

When you first install the software, it will check your computer's current language as it is set in the **Format** field in the Windows Region and Language window. If that language is supported in Synthesis, Synthesis will use those settings; however, if that language is not supported, Synthesis will use the default setting of English.

1.7.3 Defining Date and Time Formats

Dates and times appear frequently throughout the Synthesis interface, including (but not limited to):

- The dates in the plot legend area of a plot in all Synthesis applications.
- The Created and Modified dates in many diagrams and in resources in all Synthesis applications.
- The History area of the record and item properties in Xfmea, RCM++, RBI and MPC.
- The dates in the worksheet view and in the record properties windows in Xfmea, RCM++, RBI and MPC.
- The dates in the “dates of failure” format and “usage” format of the Weibull++ warranty folios.

The **Short date** field from the Windows Region and Language window determines how dates are displayed. You can select any standard format (e.g., M/d/yyyy, dd/MMM/yy, yy/MM/dd) or you can create your own format using the available date notations.

The **Short time** field determines how times are displayed. You can select any standard format (e.g., h:mm tt, HH:mm, HH'h'mm) or you can create your own format using the available time notations.

The Windows settings do not apply to the following items:

- Dates and times in spreadsheet utilities (e.g., analysis workbooks, general spreadsheets, etc.) are defined by the functions within the report.
- Dates and times displayed in the Weibull++ event log folio are created by the folio and are not affected by the computer's settings.

1.7.4 Changing the Decimal Symbol and the List Separator

How decimal values are displayed depends on the value of the Decimal symbol field in the Windows Customized Format window, which determines which character is used to indicate the decimal portion of a number (e.g., 85.25 or 85,25). In addition, the character used to separate the arguments in a list depends on the value of the **List separator** field. These settings affect how you enter functions in analysis workbooks and in general spreadsheets, either manually or by using the Function Wizard. For example, if the decimal symbol value is a comma, and the list separator value is a semicolon, you would enter a function like this: =RELIABILITY("Folio1!Data 1";500;100;0,9)). Whereas, if the decimal symbol is a period and the list separator is a comma, it would be =RELIABILITY("Folio1!Data 1",500,100,0.9)).

1.7.5 Setting the Measurement System in the Page Setup

On the Margins tab of any Synthesis application's Page Setup window (**Home > Print > Page Setup**), the **Units** field determines which unit of measure (inches [U.S.] or centimeters [Metric]) is used for the page margins on print output. The field includes the **System's default** option. Selecting this option means that the measurement system used is determined by the value of the Windows Customize Format window's **Measurement system** field, and it will change if the computer's settings change.

Tip: If you want the page margins to always be the same, you can select a specific unit of measure and not use the **System's default** option.

1.8 Introduction to the Synthesis Platform

This section provides a brief introduction to the Synthesis Platform as it relates to using RBI.

You can also review an overview of the main features in RBI (*see Section 1.9 on page 18*).

1.8.1 Centralized Data Storage and Flexible Permissions

All Synthesis applications offer centralized data storage that allows multiple users to work cooperatively on analysis projects. As described in the "Working in Synthesis" chapter, you can choose which type of database will provide the back-end data storage for each Synthesis repository.

- A **Standard Repository** (*.rsr9) is easy to create and maintain without any special IT infrastructure or support, but there are limitations to the amount of data it can store and the number of users who can access the database simultaneously.
- An **Enterprise Repository** requires implementation of Microsoft SQL Server or Oracle (which requires separate licensing, support and maintenance), but it is a more robust platform that can store much more analysis information in the same database and supports access by many more simultaneous users.

For all enterprise databases, and when you have enabled login security for standard databases, authorized users will be able to create and maintain user accounts that determine which analyses and capabilities each individual user has permission to access. You can use the basic security groups that have been predefined in the software or customize the access permissions to meet the specific needs of your organization.

Tip: Working with a database-driven, multi-user application such as RBI is a bit different from working with other types of software that you may be familiar with (such as Microsoft Excel). For example, changes are saved automatically while you are updating the analysis (e.g., whenever you click **OK** or navigate away from a cell in a table or worksheet). In addition, you must be diligent about storing backups and performing adequate database maintenance to guard against data loss or corruption. *Specific recommendations are provided on page 67 in Chapter 2.*

1.8.2 Integration with Other Synthesis Applications

The Synthesis Platform offers a unique solution to the problem of integrating different types of reliability information without sacrificing the power and flexibility of each individual analysis tool. From the individual user's perspective, your interaction with each application will be similar to your experience with previous versions — a full-featured tool that has been expertly designed to meet your needs for all aspects of the analysis methodology. However, from the overall reliability program perspective, multiple users will now have the ability to access the same centralized data repository from any Synthesis application and thereby share commonly needed resources between applications and analyses (such as the model that describes a component's failure behavior, the description of a particular maintenance strategy or the reliability-wise configuration of a system).

As described in the “Working in Synthesis” chapter, this integration is facilitated primarily through Synthesis resources that can be published from one type of analysis and utilized in other analyses where they may be relevant. When a resource needs to be updated in response to new information, the change can be reflected automatically in all analyses that rely upon it. Specifically for RBI, the Synthesis Platform gives you the ability to:

- Use *models* and *universal reliability definitions* (URDs) that were created in Weibull++, ALTA or BlockSim to define the reliability characteristics of the records in your RBI analysis. *For more information about models and URDs, see the “Resources” chapter.*
- Share the system configuration and failure mode data from your RBI analysis as reliability block diagrams (RBDs) or fault trees in BlockSim. This allows you to move beyond the simple assumption of a series reliability-wise configuration in order to obtain a more realistic system model and perform more complex analyses to explore the system reliability, maintainability, throughput, life cycle costs, etc.

1.8.3 Messages and Action Tracking

One of the many benefits of having multiple users working from the same centralized data repository is the opportunity to use a common interface for posting announcements and tracking the completion of assigned actions.

All Synthesis applications offer the **My Portal** interface, which facilitates the dissemination of messages directed either to all system users or only to specific users/groups. My Portal can also be used to display the Actions that you are involved with, either as the person responsible for completing the assignment, the person who created the record or a person who simply needs to be kept informed about the progress.

If desired, the Synthesis repository can be configured to enable **E-mail Notifications** that serve to alert members of the team when a message or action that they're involved with is created or updated. Now in the Synthesis version, you also have the option to send actions to your calendar in Microsoft Outlook.

1.8.4 Take Advantage of Internet Connectivity

One of the many new enhancements in the Synthesis Platform is the ability to take advantage of an active Internet connection to obtain the most up-to-date announcements, documentation and examples. Once you have registered and activated the application on your computer, Internet access is not required — you can still perform all of your

analysis activities while working offline — but an Internet connection allows you to take advantage of several useful new features, including:

ReliaSoft Online for up-to-date tips and announcements.

Reliability Web Notes for context-sensitive access to theoretical background information for the feature you're currently working with.

Help Center for access to a variety of support tools – including the ability to download software updates and generate an e-mail with the details needed for technical support.

Online Help File for access to all of the latest updates that provide new information users have been looking for. (Of course we will always install a static version for the times when you're working offline.)

1.9 RBI Features Overview

This section provides a brief overview of the major analysis, data management and reporting capabilities provided by RBI. This includes the features that facilitate:

- Risk Based Inspection (RBI) - Section 1.9.1 (p. 18)
- Reliability Centered Maintenance (RCM) - Section 1.9.2 (p. 19)
- FMEA and Related Analyses - Section 1.9.3 (p. 20)

The Customization, Data Management and Reporting features are applicable for all analysis types - Section 1.9.4 (p. 21).

For information about the software's capabilities for multi-user access and intelligent integration, you can also review an introduction to the Synthesis Platform (*see Section 1.8 on page 16*).

1.9.1 Risk Based Inspection (RBI)

As described in Chapter 12, the software provides flexible support for each step in performing a risk based inspection analysis based on the API RP 580 and RP 581 publications.

Risk Category Customization

RBI allows you to define the risk categories that reflect the specific risk tolerances (failure probability, area consequences and financial consequences) that your organization is willing to take. You can also define how each rating is displayed in your analyses. *See page 270 in Chapter 12.*

Management Score

RBI also allows you to set the Management Systems Score for each project, which is an adjustment factor that accounts for the management influence of a given plant's supervisors and management on the mechanical integrity of the plant equipment. This factor helps to measure how likely it will be that management finds issues related to the plant's mechanical integrity. The factor is calculated based on a Management Score Survey that evaluates the facility's management systems and their effect on a given plant's risk. *See page 271 in Chapter 12.*

Qualitative RBI Analysis

You can configure the risk discovery ratings feature to provide a quick qualitative RBI analysis that can save time and effort by estimating an asset's importance in terms of risk. If the asset is found to be of low risk, then less time (possibly none) should be spent on it in the future as compared to an asset that is found to be of high risk during the assessment. By doing this quick assessment, you can focus your limited resources (both time and money) on those assets that pose the greatest risk, both physically and financially. *See page 259 in Chapter 10.*

Support for All API Equipment and Components

RBI includes all of the equipment and components listed in the American Petroleum Institute's RP 581 document for risk-based inspection technology. This includes compressors, heat exchangers, pipes, tubes, tanks, HEXTUBEs and pressure relief devices.

When adding a component, RBI provides a wizard that guides you through the steps of defining the general properties and selecting the applicable damage factors. You can then enter the relevant damage factor properties and consequence properties and finally generate the results. (*For more information, see page 274 in Chapter 12.*)

1.9.2 Flexible Capabilities for RCM Analysis

As described in Chapter 13, the software provides flexible support for each aspect of your RCM analysis project, from selecting the equipment to creating the final maintenance plan.

- **Equipment Selection:** In order to focus resources where they can provide the greatest benefit, RBI supports two configurable methods for selecting the equipment that will be analyzed with RCM techniques. The first option allows you to answer a series of yes/no questions and the second option allows you to assign ratings for a variety of different factors and then calculate an overall criticality value for each item. *See Chapter 10.*
- **Functional Failure Analysis:** The Analysis panel offers three complementary views of the information in your functional failure analyses. It is easy to switch back and forth between the views so you can choose the display that is best suited for each specific task. *See page 297 in Chapter 13.*
 - The **hierarchy view**, which displays the analysis records in a hierarchical tree, tends to be good for viewing a lot of information in a small amount of space. It can be especially useful when copying and pasting data or when scanning the analysis to find a particular section. *See page 346 in Chapter 14.*
 - The **worksheet view**, which follows the traditional tabular reporting format that most RCM and FMEA practitioners are familiar with, allows you to type directly into the worksheet cells and tab through the analysis as you would in a spreadsheet application, such as Microsoft Excel. *See page 348 in Chapter 14.*
 - The **filtered view** presents a sortable list of all records of a particular type. For example, you may wish to see all task records sorted by type. This view allows you to generate these lists on-the-fly as you work on the analysis. *See page 351 in Chapter 14.*
- **Failure Effect Categorization and Maintenance Task Selection:** RBI supports the failure effect categorization (FEC) (*see page 298 in Chapter 13*) and maintenance task selection logic charts (*see page 300 in Chapter 13*) in the major industry RCM standards and also provides the ability to customize the questions, categories and task types to fit your own specific analysis procedures.
- **Comparing Maintenance Strategies Based on Cost and Availability:** Even when you choose to use the predefined decision logic diagrams employed by traditional RCM methods, those guidelines still require the analysis team to utilize their knowledge of the equipment's failure behavior when making decisions about the appropriate maintenance strategy. The software allows you to:
 - **Choose from a Variety of Statistical Distributions to Describe the Failure Behavior:** When you use an MTBF or failure rate to describe the equipment's failure behavior, you are assuming that failures occur at a constant rate regardless of the age of the equipment (i.e., an exponential distribution). Other statistical distributions are more appropriate for situations where the failure behavior varies with time, as in the case of infant mortality or wearout. RBI allows you to more accurately describe the probability of failure by providing a choice of ten distributions (including, but not limited to, the lognormal, exponential and all forms of the Weibull distribution).
 - **Use Simulation to Calculate the Average Availability, Cost per Uptime and Total Operating Cost:** When a failure mode does not involve hazardous consequences that require a conservative prevention strategy, the analysis team may wish to choose the maintenance approach that will provide adequate availability with the lowest operational costs.

- **Calculate the Optimum Replacement Interval:** RBI provides a utility to automatically calculate the optimum replacement interval that will minimize the corrective and preventive maintenance costs. You now have the option to calculate the optimum time for a individual item, or calculate a time that will be optimum for a specified group of items. *See page 324 in Chapter 13.*
- **Scheduled Task Packaging:** RBI makes it easy to group individual tasks into packages based on factors such as interval or labor crew. You can manually assign a task to the appropriate maintenance package or allow the software to automatically group tasks based on the criteria that you have specified for each package. Greatly expanded and enhanced in the Synthesis version, this tool now makes it easier to experiment with different intervals and provides a graphical chart to help you visualize the packages that are under consideration. *See page 326 in Chapter 13.*

1.9.3 Support for FMEA and Related Analyses

RBI also provides a complete set of features for FMEA and related analyses, which can be used independently (e.g., use RCM for some equipment and FMEA for other equipment) or integrated with any RCM analysis (e.g., incorporate the RPN method as an additional tool for evaluating risk).

- **DFR Planner:** This flexible tool allows you to track and manage the stages in the Design for Reliability (DFR) process for a particular system, assembly or component. You can configure the plan templates to fit particular processes and needs. You can also utilize RBI's powerful action management capabilities to keep track of the DFR activities that need to be performed by different members of the team. *See Chapter 9.*
- **Risk Priority Numbers (RPNs):** RBI automatically calculates RPNs and also supports related metrics, including SxO (Severity x Occurrence), SOD (Severity, Occurrence, Detection) and SD (Severity, Detection). In addition, the flexible Priority Highlights feature can be configured to categorize issues based on criteria established by your organization and then highlight issues based on this prioritization. RBI is shipped with an extensive array of predefined rating scales for Severity, Occurrence and Detection and also allows you to create and manage your own rating scales. *See Chapter 15.*
- **Criticality Analysis:** RBI provides full support for quantitative criticality analysis or qualitative criticality analysis patterned after MIL-STD-1629A. *See Chapter 16.*
- **Tracking the Completion of Recommended Actions:** One of the most costly mistakes among FMEA practitioners is the failure to properly follow up and track the completion of recommended actions. As described in Chapter 14, RBI provides multiple features that will help to ensure that your organization implements the actions identified during the FMEA project so that you can achieve the benefits that come from improving the design and reducing the risk. This includes the ability to send notification e-mails to the person who is responsible for completing an action and others who may need to stay informed about the progress. In addition, the **My Portal** window also displays a list of actions that may be of interest to the user and makes it easy to open and edit these records with a simple double-click. *See page 98 in Chapter 3.*
- **Design Verification Plan and Report (DVP&R):** The DVP&R tab in the Analysis panel provides a configurable worksheet for design verification plans and reports (DVP&Rs). You can create each plan from scratch or transfer data from the FMEA that has been defined for the same item. For example, you may wish to transfer the controls (and perhaps some recommended actions) from the design FMEA (DFMEA) to be the starting point for the new DVP&R. *See Chapter 18.*
- **Transfer Design FMEA to Process FMEA:** You can leverage existing knowledge by automatically transferring relevant data from the design FMEA (DFMEA) to provide the starting point for a new process FMEA (PFMEA). For example, the causes of failure that have been identified for your design can be transferred as failure modes to consider when analyzing the manufacturing process. RBI's flexible Transfer Projects utility allows you to specify what information will be transferred and how it will be "mapped" to the new analysis. *See page 368 in Chapter 14.*
- **Process Flow Diagram (PFD) Worksheet:** A process flow diagram (PFD) provides a logical, visual depiction of the process that is being analyzed. As described in Chapter 19, the Synthesis version now allows you to integrate the diagram into a worksheet that captures more specific details about each step in the process. This worksheet

records the specific operations that are performed and also starts to identify the key product/process characteristics that need to be kept under control during manufacturing. RBI makes it easy to automatically transfer relevant data to the process FMEA (PFMEA) and process control plan (PCP). *See Chapter 19.*

- **Process Control Plan (PCP):** The Control Plan tab in the Analysis panel provides a configurable worksheet for process control plans (PCPs). You can create each plan from scratch or transfer data from the FMEA that has been defined for the same item. For example, you may wish to transfer the process steps (i.e., items or functions) and current controls from the process FMEA (PFMEA) to be the starting point for the new process control plan. *See Chapter 20.*
- **Design Review Based on Failure Mode (DRBFM):** The DRBFM tab in the Analysis panel provides a configurable worksheet for design reviews based on failure mode (DRBFMs). Developed within Toyota Motor Corporation, this methodology uses a modified version of the FMEA worksheet to evaluate proposed changes to an existing design. RBI's DRBFM worksheet provides two views of the analysis, one for the design engineer to prepare the initial draft of the analysis and one for the entire review team to expand on the initial draft and identify appropriate corrective actions. The software also provides the option to import selected functions from the FMEA that has been defined for the same item and also allows you to transfer selected data from the DRBFM to append to the existing FMEA. *See Chapter 21.*
- **FMEA Block Diagram (or Boundary Diagram):** These diagrams can help to define the scope of a particular analysis project and also may provide additional information that will be useful to the analysis team when they attempt to identify potential failure modes. If you don't have existing diagram files that you wish to attach to the project, RBI provides a utility that allows you to build these diagrams and store them together with your RCM and FMEA analyses. *See page 483 in Chapter 28.*

1.9.4 Customization, Data Management and Reporting Features

Analysis Plans

The Analysis Plan utility allows you to keep track of team members, ground rules, estimated completion dates, scheduled work sessions and other details that will help you to plan and manage your analysis projects. The software makes it easy to generate a high-level overview of all pending analysis projects and also to generate a report for each individual project plan. *See Chapter 11.*

Extensive Customization Options

As described in Chapter 2 on page 67, RBI provides predefined profiles for all major FMEA and RCM reporting standards, which makes it easy to configure the analysis workspace to fit any of the supported standards. In addition, the software offers flexible capabilities to customize any of the sample profiles or create your own profiles to meet the specific needs of your organization. Some of the configuration options include the ability to:

- Define the data fields you want to capture and display.
- Set the classifications, categories and other drop-down lists throughout the software.
- Define the logic that will be used for RCM equipment selection, failure effect categorization and maintenance task selection.
- Determine the rating scales and other criteria that will be used for risk assessment.

Flexible Tools to Facilitate Data Entry and Management

RBI's unparalleled capabilities for finding and using data from existing analyses, templates or phrase libraries can help to speed up and improve the quality of your analyses. These flexible ways to utilize existing data can save time on data entry and help to ensure consistency among analyses. They also provide a powerful brainstorming tool. Some of the most useful features for data entry and management include:

- **Cut/Copy/Paste or Drag and Drop:** RBI makes it easy to copy or move data within and between analyses. *See page 212 in Chapter 7.*

- **Import/Export via Excel:** You can define your own custom templates for importing and exporting data via Microsoft Excel® files. *See Chapter 22.*
- **Import from Database or Template:** You can browse for data from an existing analysis or predefined template and then automatically import selected records. *See page 216 in Chapter 7.*
- **Import Existing:** You can use up to three search terms to query for data from existing analyses or predefined templates and then automatically import selected records. For example, the utility can provide a list of failure modes that have been associated with a functional failure that contains the word “leak.” *See page 217 in Chapter 7.*
- **Select Existing:** For any text field within the software, RBI provides easy access to a list of existing descriptions from specified data sources. Each list can be sorted automatically or filtered to match specific search criteria. For example, the utility can provide a list of failure modes that contain the word “fatigue.” *See page 113 in Chapter 3.*
- **Find and Replace:** The flexible Find and Replace utility provides a quick and easy way to find and update specific text, dates, numbers or selections from drop-down lists. *See page 115 in Chapter 3.*
- **Links and Attachments:** The ability to link or attach independent files to any record in your analysis makes it easy to keep related information (such as flowcharts, design drawings, reliability analysis files, procedure instructions, etc.) together with the rest of the analysis. *See page 124 in Chapter 3.*

Support for Large Multi-Level System Configurations

RBI’s flexible system hierarchy interface allows you to manage large, multi-level system configurations with as many levels as you need (and any number of items per level). You can fully define the properties for each item (e.g., supplier, part number, expected operating environment, etc.) and perform RCM, FMEA and related analyses at any level within the system configuration (e.g., system, subsystem and/or component).

You have the option to import system configuration data from an outside file (e.g., Bill of Materials) or use built-in features to build the configuration “from scratch” within the software.

Change Log

When an authorized user activates the change log for a particular RCM analysis, FMEA or DVP&R analysis, the software records a history of the specific changes that were made in each tracked revision to the analysis since the log was activated. Depending on your selections, the log can record the date/time of the change, the user who made the change, the property that was changed, the value before, the value after and the reason (or justification) that the user provided at the time of the change. If desired, this utility also can be used to store an electronic record of the users who have reviewed and approved each version of the analysis. *See Chapter 17.*

Queries, Reports and Charts

Of course, RBI makes it easy to generate report output in the tabular worksheet format that is commonly used for RCMs, FMEAs and related analyses. However, since all of the analysis information is stored in a relational database, RBI is able to go beyond these basic worksheets to provide a complete range of options for presenting the data in ways that will effectively communicate results and facilitate decision-making.

The **Reports window** provides a set of predefined report forms and also allows you to build and manage your own report templates. You can use this flexible tool to build a complete report document that will be generated in Microsoft Word or Excel. *See Chapter 23.*

The **Query Utility** allows you to search the project or database for the records that meet your specific search criteria. Since you also have the option to specify which data fields will be included in the tabular results and the order of the columns, this utility also functions as another flexible custom reporting tool. Query results can be exported directly to Microsoft Excel and you can also integrate saved queries into the documents that you create via the Reports window. *See Chapter 24.*

The **Plot Viewer** provides an array of flexible options for you to create attractive graphical charts based on analysis data. These charts can be saved or copied as graphic files (*.wmf, *.jpg, *.gif or *.png) that can be inserted into other document files. *See Chapter 25.*

Failure Modes and Reliability Analysis (FMRA)

You can use failure modes and reliability analysis (FMRA) to integrate statistical reliability analysis calculations into your RCM and FMEA activities. *See Chapter 8.* Specifically, this view can be used to:

- Display all of the FMEA records that could have an impact on system reliability/maintainability in a single hierarchical tree, and use this view to define the relevant reliability characteristics.
- Calculate the probabilities of failure required for a quantitative criticality analysis.
- Use the occurrence ratings that have been defined in the FMEA to generate a preliminary baseline reliability estimate for the system that can be improved later when actual failure data becomes available.
- Integrate with BlockSim's reliability block diagrams (RBDs) or fault trees, which facilitate more realistic system modeling (e.g., consider redundancy, common cause failures, etc.).

Working in Synthesis

2

With the Synthesis Platform, ReliaSoft's software tools have transitioned from a standalone document/file format, to a multi-user, database-driven approach. This offers enormous potential to integrate reliability program activities and tools, while simultaneously facilitating effective information sharing and cooperation between engineering teams of any size.

The experience of working in a database-driven, multi-user environment will be a bit different than using prior versions of ReliaSoft's applications (Version 7 or older) and other document-centered applications such as Microsoft Excel. For example, your organization (or team) will need to choose the most appropriate database type and security, implement shared settings that will effectively facilitate project management, and establish adequate backups and database maintenance to protect against data loss. In addition, individual users must be aware that changes are saved automatically as they work, and become familiar with the features that facilitate simultaneous access by multiple users.

This chapter addresses a variety of topics that will help you configure and use the Synthesis Platform to meet your particular needs. As a supplement to this information, we have also compiled some targeted tips and FAQs at <http://Synthesis.Reliasoft.com/tips/>.

- The two types of Synthesis repositories- Section 2.1 (p. 26).
- Creating and managing projects - Section 2.2 (p. 34).
- Implementing repository security - Section 2.3 (p. 44).
- Repository settings - Section 2.4 (p. 60), including:
 - Using e-mail notifications to keep users up to date on the progress made in completing assigned actions.
 - Configuring settings that affect analyses in all projects throughout the database, including time units, default naming conventions, global identifiers, project categories and more.
- Protecting against data loss and corruption by establishing adequate backups and database maintenance and creating restore points - Section 2.5 (p. 67).
- Importing and exporting information - Section 2.6 (p. 70).
- Using the Reliability Data Warehouse to access XFRACAS data, and using the Dashboard Viewer to view Synthesis data in graphical form - Section 2.7 (p. 86).

2.1 Synthesis Repositories

Synthesis applications offer two types of databases for storing projects and analysis data. The type of database you choose will depend on the requirements of your organization.



Standard repositories (*.rsr9) are basic database files for single- or multi-user environments. Implementation of a database server is not required; however, there are limits on the amount of data and the number of simultaneous users.



Enterprise repositories (*.rserp) require implementation and support of Oracle or Microsoft SQL Server, but they are a more robust platform that can store much more analysis information in the same database and support access by many more simultaneous users. Synthesis applications are compatible with Microsoft SQL Server 2005 or later and Oracle 10g or later (including the free Express editions of all of these).

2.1.1 Standard Repositories

A standard repository is a basic database file for single- or multi-user environments. Implementation of a database server is not required; however, there are limits on the amount of data and the number of simultaneous users. (*If you prefer to use a more robust Oracle or SQL Server database, see Section 2.1.2 on page 27.*)

Creating a New Standard Repository

To create a new standard database, choose **File > New > Create a new standard repository**.



In the **Repository name** field, specify the filename for the new *.rsr9 file. The path where the file will be saved is shown below this field; to change the location, click the browse icon in the field.

The following options are available when you create a new standard database:

- Select the **Restricted Access** check box if you want the new database to be login secure. You can then select the **Immediately go to security window** check box if you want to add user accounts as part of the database creation process. (*To learn more about secure databases, see Section 2.3 on page 44.*)

Note that you cannot automatically remove security from a database once it has been enabled. However, you can create a new non-secure database and use the **Import from existing repository** check box to automatically import all of the data from the secure database to the non-secure one.

- Select the **Import from existing repository** check box if you want to import entire projects and other data from an existing database, after the new database is created.

Opening an Existing Standard Repository

If you have opened the file recently, choose **File > Recent** and then select the file in the Recent Repositories list.

Otherwise, choose **File > Open Repository** and then browse for the *.rsr9 file.

Tip: If you usually work with the same repository, you can configure the Synthesis applications to attempt to connect with it automatically each time you start the application. Choose **File > New** and then select the **Always start by connecting with the last repository** check box.

If the repository has login security enabled and you are unable to connect, you may be encountering one of the following issues:

- **No access to the repository.** If you have not been given access to the repository, you will see a message stating that your account in the repository is not active or not assigned to at least one security group. You will need assistance from someone who can create and update user accounts (*see Section 2.3.3 on page 48*).
- **Windows authentication failed.** If your Windows login (domain and username) is different from what was specified for your user account, you will see a message to connect using alternative credentials. You will need assistance from someone who can enable the use of alternative credentials for your user account (*see Section 2.3.3.2 on page 50*).

2.1.2 Enterprise Repositories

Unlike standard repositories, enterprise repositories require an established database server with Oracle or Microsoft SQL Server. This allows you to store more analysis information in the same repository and support access by many more simultaneous users. Synthesis applications are compatible with Microsoft SQL Server 2005 or later and Oracle 10g or later (including the free Express editions of all of these).

To establish a database server, you will need to purchase an appropriate license package from Oracle or Microsoft. The license, as well the IT maintenance and support needed to establish the database server, is separate from the ReliaSoft license agreement and must be negotiated directly with Oracle or Microsoft.

As an alternative, you may choose to use the free versions of Oracle or SQL Server if the expected load for the database fits within the limited capabilities of the Express edition (as specified by Oracle/Microsoft). With the free editions, you can establish a functioning enterprise database on your own without making a large investment of time and resources. If your organization's needs grow beyond the capabilities of the Express edition, you can then upgrade to a more robust version with the appropriate IT infrastructure and support.

Tip: Although ReliaSoft cannot provide full documentation and support for third-party database platforms, we do provide a limited number of resources as a convenience for users who wish to explore the possibilities of an enterprise database implementation. For resources on SQL Server (including instructions for configuring the Express edition), see http://Synthesis.Reliasoft.com/sql_server.htm. For resources on Oracle, see <http://Synthesis.Reliasoft.com/oracle.htm>.

The following topics will be of interest to database administrators:

- Creating a new enterprise repository on an established database server - Section 2.1.2.1 (p. 28).
- Three ways that Synthesis user accounts may be recognized by SQL Server (individual logins, group logins or Windows impersonation) - Section 2.1.2.3 (p. 30).
- Upgrading an enterprise repository from Version 8 - Section 2.1.2.5 (p. 33).

The following topics will be of interest to all enterprise repository users:

- Creating and using an enterprise repository connection file (*.rserp) to connect to an existing repository - Section 2.1.2.2 (p. 28).
- Monitoring the enterprise repository connection speed - Section 2.1.2.4 (p. 33).

2.1.2.1 Creating a New Enterprise Repository

If your organization already has established a database server with Oracle or Microsoft SQL Server and you have the permissions necessary to create databases on the server, you can create a new Synthesis enterprise repository by choosing **File > Manage Repository > Repository Creation**.



You can choose to create the new database in either Oracle or Microsoft SQL Server.

If you choose **SQL Server**, you will be required to enter:

- **Server Name:** The name of the Microsoft SQL Server implementation where the new database will be created. Note that if you are using SQL Server Express, the server name is usually your login for that computer followed by \SQLEXPRESS (e.g., Username\SQLEXPRESS).
- **Database Name:** The name of the new database that will be created.

If you choose **Oracle**, you will be required to enter:

- **Port, Host and Service** identifiers for the Oracle server where the new database will be created.
- The **Schema** of the new Enterprise database.
- The **Password** for the new enterprise database schema.
- The administrative username and password for the Oracle server (entered in the **Admin Information** area).

For either server type, select the **Import from existing repository** check box if you want to import entire projects and other data from an existing database.

Click **OK** to create the database. The database will not open automatically; you must connect to it (see the next section).

2.1.2.2 Connecting to an Existing Enterprise Repository

If your organization already has created an enterprise database on Oracle or Microsoft SQL Server and you have an active user account, you can use an enterprise repository connection file (*.rserp) to connect with it. You can create this file yourself or use a file that has been created by someone else. Once this file is created, it can be used to connect to the database and to import from or export to the database.

Creating a Connection File

To create a connection file, choose **File > New > Create a new enterprise repository connection file**.



This command creates a Synthesis repository connection file (*.rserp) that is stored locally on your computer; the file contains all of the necessary information for connecting to the enterprise database.

Enter a name for the connection file, then choose the database type and version (i.e., Microsoft SQL Server 2005 or 2008, or Oracle 10 or 11).

- For SQL Server databases, enter the server name and database name. Select the **Use impersonation** check box if you want the new connection file to impersonate a Windows user account with a SQL Server login that can be shared by multiple users. This connection file can then be distributed to any user who does not have his/her own individual SQL Server login and is not part of an Active Directory group that has a login. *See Section 2.1.2.3 on page 30.*
- For Oracle databases, enter the port, host and service identifiers and the database schema. Your Oracle schema owner and password credentials are used for access to the database.

Using an *.rserp File to Connect to an Enterprise Repository

If you have used the connection file recently, choose **File > Recent** and then select the file in the Recent Repositories list.

Otherwise, choose **File > Open Repository** and then browse for the *.rserp file.

Tip: If you usually work with the same repository, you can configure the Synthesis applications to attempt to connect with it automatically each time you start the application. Choose **File > New** and then select the **Always start by connecting with the last repository** check box.

If you are unable to connect to an enterprise repository, you may be encountering any of the following issues:

- **No access to the repository.** If you have not been given access to the repository, you will see a message stating that your account in the repository is not active or not assigned to at least one security group. You will need assistance from someone who can create and update user accounts (*see Section 2.3.3 on page 48*).
- **Windows authentication failed.** If your Windows login (domain and username) is different from what was specified for your user account, you will see a message to connect using alternative credentials. You will need assistance from someone who can enable the use of alternative credentials for your user account (*see Section 2.3.3.2 on page 50*).
- **Cannot connect to the server or login failed.** Server-related issues may occur for several reasons, and you may see various messages pertaining to the situation. Common issues are:
 - You do not have a network connection or you may have entered the incorrect database name (i.e., Synthesis repository name) or server name in the connection file.
 - The server may not be configured to allow remote connections, has certain firewall settings or is experiencing other issues. In this case, you will need to contact the IT support group responsible for the server.
 - In SQL Server databases, a login issue may occur if your username is not associated with a SQL Server Login. *See Section 2.1.2.3 on page 30.*

2.1.2.3 SQL Server Logins or Using Windows Impersonation

Connecting with a SQL Server database via Windows authentication requires a “SQL Server login” that allows the database platform to recognize the user and gives access to the Synthesis repository. There are three ways that a Synthesis user account may be recognized by SQL Server:

- **Individual Login:** The user has an individual SQL Server login that is associated directly with his/her Windows username.
- **Group Login:** The user belongs to an Active Directory group that has a SQL Server login shared by all members of the group.
- **Use Impersonation for Connection File:** The user does not have an individual or group login but he/she connects to the database with an enterprise connection file (*.rserp) that impersonates another Windows user account that does have a SQL Server login.

Your organization may choose to use any or all of these methods for your Synthesis implementation (e.g., some users may have their own individual logins, while other users connect using Windows identity impersonation). The following sections provide overviews of all three options.

Option 1: Creating Individual SQL Server Logins

If you choose to create individual SQL Server logins for some or all of the Synthesis user accounts, you have two options:

1. A database administrator for SQL Server can create SQL Server logins in advance for every potential user and give the logins access to the application database (at least the db_datareader and db_datawriter roles are required). This would be performed directly in SQL Server (not via one of the Synthesis applications).
2. A database administrator for SQL Server can grant the appropriate level of database authority for creating SQL Server logins and database roles (e.g., securityadmin or sysadmin) to any user who has the ability to create user accounts in the Synthesis repository. The additional authority would be added directly in SQL Server. Then, when any of these administrative users creates a new user account via the Synthesis application, the required SQL Server login can be created and the application database roles can be assigned automatically at the same time.

The web page at http://www.ReliaSoft.com/synthesis/sql_server.htm provides links to instructions for performing certain tasks in SQL Server. This includes a link to an FAQ that discusses these two options in more detail and provides specific instructions for the actions that must be performed in the SQL Server Management Studio.

If you are using the first approach, you can clear the **Create SQL Server login** check box that is displayed when you are adding or importing a user account. If you are using the second approach, you must select this check box.

Tip: If the user already has a SQL Server login and access to the application database, it does not matter whether you select or clear the **Create SQL Server login** check box because the application attempts to create the login only if one does not already exist.

Furthermore, if the user who is creating the user account does not have the necessary level of database authority in SQL Server, the login will not be created even if the check box is selected.

Option 2: Using a Group Login

If the user belongs to an Active Directory group that has a SQL Server login shared by all members of the group and that group has access to the application database, you can clear the **Create SQL Server login** check box that is displayed when you are adding or importing a user account.

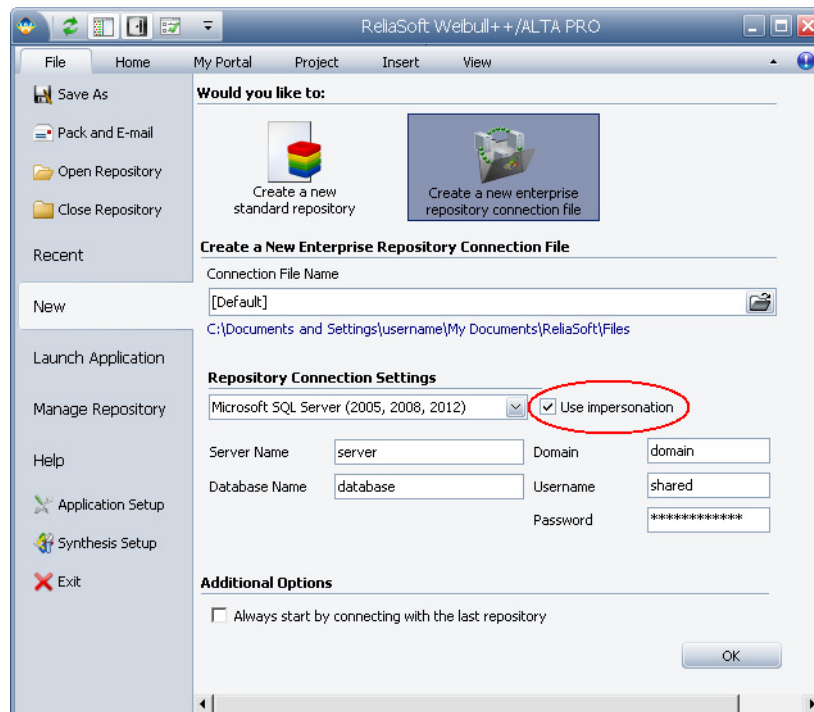
For example, base installations of Microsoft SQL Server Express 2005 and 2008 include the “Builtin\Users” Active Directory group as a SQL Server login by default. This means all users with a Windows account for that domain will be able to log in to the enterprise database with no need to create individual SQL Server logins in SQL Server Express. However, it will still be necessary to grant access for this group login to the application database (at least the db_datareader and db_datawriter roles are required).

Option 3: Using Windows Impersonation for the Connection File

If you choose to have some (or all) users connect to the SQL Server database with a connection file that impersonates a shared Windows user account that has a SQL Server login, you must do the following:

- A Windows network administrator must establish the shared user account on Windows.
- A database administrator for SQL Server must create a SQL Server login for the shared Windows user account and grant this login access to the application database (at least the db_datareader and db_datawriter roles are required).

- A Synthesis user must create an enterprise repository connection file that impersonates the shared Windows user account:
 1. Choose **File > New** then click **Create a new enterprise repository connection file**.
 2. Under **Repository Connection Settings**, select **Microsoft SQL Server (2005, 2008)** from the drop-down list and then select the **Use impersonation** check box.
 3. Enter the server and database name for the SQL Server database, then enter the domain, username and password for the shared Windows account that users will need to impersonate.
 4. Click **OK** to create the connection file (*.rserp). It will be stored in the location specified under **Connection File Name**. Note that the default filename will be “SQL_(Server Name)_(Database Name),” but you can assign any name that fits the process your organization will use for distributing the file to users. (Note that while the window shown next is for Weibull++, the settings are the same for all Synthesis applications.)



Once you have created a connection file that impersonates the shared Windows user account, you can distribute the file to any Synthesis user who needs it. To connect to the repository using this file, the user can:

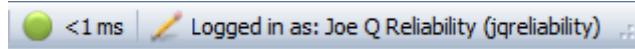
1. Choose **File > Open Repository** and browse for the connection file.
2. Click **Open** to connect with the repository.

After the first connection, this *.rserp file will be saved in the list of recent repositories, which can be accessed by choosing **File > Recent**.

Note: For the purpose of being recognized by SQL Server and accessing the application database, the user will be impersonating the shared Windows login. For the purpose of performing actions via the Synthesis applications, the user's actions will be governed by his/her own user account in Synthesis. In other words, multiple users can connect with the database using the same enterprise connection file, but their activities within the Synthesis applications will be governed by the permissions established in their own individual Synthesis user accounts, and any changes made to the analysis data will be recorded in Synthesis under their own usernames.

2.1.2.4 Enterprise Repository Connection Speed

If the Synthesis application is exhibiting slow performance when you're connected to an enterprise repository, the issue may be related to your network connection. The MDI status bar displays a connection speed indicator.



The following icons are used to indicate the connection speed. In cases of poor network performance, you will need to request assistance from the IT support group responsible for the server.

-  < 30 ms: Good (acceptable performance)
-  30 - 70 ms: OK (may exhibit some delays in operations, opening/closing windows, etc.)
-  70 - 110 ms: Slow (will exhibit some delays in operations, opening/closing windows, etc.)
-  110 - 150 ms: Very slow (will exhibit significant delays in operations, opening/closing windows, etc.)
-  > 150 ms: Extremely slow (will result in unacceptable performance and usability)

2.1.2.5 Upgrading an Enterprise Repository from Version 8

If you have an existing enterprise database that was created with any of the Version 8 Synthesis applications, an administrative user can transfer all of the existing data into a new database that is compatible with the Version 9 applications.

To open the Upgrade Version 8 Enterprise Repository window from any Version 9 application, choose **File > Manage Repository > Upgrade Repository**.



Synthesis 8 Repository to Be Upgraded

Use the left side of the window to specify the Version 8 enterprise database that you wish to upgrade. Note that you must have Admin level permissions in this database in order to be able to transfer all of the data. If you do not have sufficient permissions in the selected database, a message will be displayed when you attempt to perform the upgrade process.

Synthesis 9 Repository to Be Created

Use the right side of the window to define the new Version 9 enterprise database that the existing data will be transferred into. All of the same requirements for creating a new enterprise database apply here (e.g., you must have an established database server and the necessary permissions to create a database on the server).

You can choose to create the new database in either Oracle or Microsoft SQL Server, even if the existing Version 8 database resides in the other database platform. (In other words, it is possible to upgrade a database from SQL Server to Oracle, or from Oracle to SQL Server, if desired.)

If you choose **SQL Server**, you will be required to enter:

- **Server Name:** The name of the Microsoft SQL Server implementation where the new database will be created. Note that if you are using SQL Server Express, the server name is usually your login for that computer followed by \SQLEXPRESS (e.g., Username\SQLEXPRESS).
- **Database Name:** The name of the new database that will be created.

If you choose **Oracle**, you will be required to enter:

- **Port**, **Host** and **Service** identifiers for the Oracle server where the new database will be created.
- The **Schema** of the new Enterprise database.
- The **Password** for the new enterprise database schema.
- The administrative username and password for the Oracle server (entered in the **Admin Information** area).

Click **OK** to start the upgrade. When the process completes, the prior Version 8 database will remain unchanged and there will be a new Version 9 database that contains all of the existing data.

IMPORTANT for SQL Server Databases: The username must be associated with a "SQL Server Login" that allows the database platform to recognize the user and give access to the application database. This can be accomplished with an individual login, a group login or Windows impersonation. See *Section 2.1.2.3 on page 30*.

2.2 Projects

In Synthesis repositories, projects serve as a way to keep related analyses together. Each project can contain analyses (e.g., folios, diagrams, plots, FMEAs, etc.), resources that can be shared between analyses (e.g., models, tasks, actions, etc.) and attachments.

Any project can be opened in any Synthesis application; however, application-specific analyses (e.g., folios in Weibull++, diagrams in BlockSim, etc.) are visible only in the application(s) that can edit them.

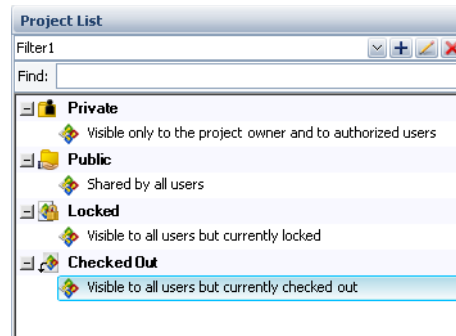
The following sections describe:

- How to create and manage projects - Section 2.2.1 (p. 35).
- Using project properties to view/edit a project's name, category, security settings (for secure databases) and other settings - Section 2.2.2 (p. 36).
- Assigning an owner to a project - Section 2.2.3 (p. 38).
- Working with private and public projects - Section 2.2.4 (p. 39).
- Working with locked and unlocked projects - Section 2.2.5 (p. 40).
- Working with checked in and checked out projects - Section 2.2.6 (p. 40).
- Using the Manage Projects window to perform administrative tasks on several projects - Section 2.2.7 (p. 42).
- Using the recycle bin to temporarily store deleted projects - Section 2.2.8 (p. 43).

2.2.1 Creating and Managing Projects

There are two interfaces you can use to view and manage the projects in a database:

- The project list (**View > Project Manager > Show Project Manager**) provides a list of the projects that are accessible to you (based on your permissions in the database and any security that has been defined at the project level). There are two types of projects you can create: private or public. In addition, a project may be locked or checked out at any given time. Each type of project is displayed under the appropriate heading.



- The Manage Projects window (**Project > Management > Manage Projects**) allows you to perform administrative tasks for multiple projects all at once. In a secure database, only users with the “Manage all projects” permission can access this window.

Creating a New Project

To add a new project to an existing database, go to the project list, right-click the heading of the desired project type (i.e., private or public), and then choose the **Create Project** command on the shortcut menu. Alternatively, you can select the heading and choose **Project > Management > Create Project**.



The Project Properties window opens, allowing you to specify the project name, category, security settings (if applicable) and other settings. *See Section 2.2.2 on page 36.*

Tip: If you later need to change the project type, select the project and choose **Project > Security > [Make Private or Make Public]**. The same commands are also available in the Manage Projects window.

Duplicating Projects

To duplicate an existing project, select it and choose **Project > Management > Duplicate Project**.



This command will create an exact duplicate of the original project with a name that contains an increment number (e.g., Project_1, Project_2, etc.). Note that duplicate projects do not retain the security settings of the original project.

Deleting Projects

To delete a project, select it and press **DELETE** or choose **Project > Management > Delete Project**.



To make sure that your analysis information is not deleted by mistake, you will always be prompted to confirm before proceeding. By default, the project will be moved to the recycle bin, which will give you a chance to recover it later if needed. If you want to permanently delete the project now (no way to undo unless you have a backup or restore point), clear the **Send project to recycle bin** check box in the confirmation window.

2.2.2 Project Properties

The Project Properties window will be displayed when you create a new project or when you choose **Project > Management > Edit Project Properties**.



The options available in this window will vary depending on which application you are using and whether the database has login security enabled. For MPC, see Section 2.2.2.1 on page 37. For all other applications, this may include:

- General Tab
- Global Identifiers Tab
- Security Tab (only if the database is secure and the project is public)
- Configurable Settings Tab (only in Xfmea/RCM++/RBI)

In addition, the status bar at the bottom of the window always displays the following information:

- The user who has been identified as the project owner. In a non-secure database, all users are able to edit the properties for any project. However, in a secure database, the ability to edit the project properties is restricted to the project owner and to users with the “Manage all projects” permission.
- The time and date the project was last changed/updated, and the user who made the change. In Version 9, this now considers any change to any of the analysis data in the project (not just the project properties). This same information is also visible in the Manage Projects window (*see Section 2.2.7 on page 42*), which provides an easy way to determine which projects have been updated recently.

General Tab

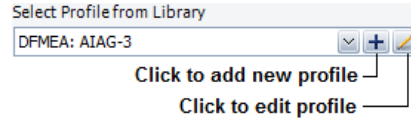
The General tab is available for all Synthesis applications except MPC. It always contains the following options:

- **Name** is the identifier for the project that will appear in the current project explorer and many other windows and reports throughout the software. This field is required and cannot contain any of the following characters: \ / : " * ? < > |.
- **Description** and **Remarks** can contain more detailed notes or information about the project.
- **Proprietary Label** can contain a copyright or distribution statement, if desired. In Xfmea/RCM++/RBI, this label appears in the footer of reports. In MPC, it is displayed in the footer of Standard reports but is not applicable for the Sukhoi or Dassault templates.
- **Project Category** displays a list of the categories that have been defined in the current database. These categories are configurable to meet your particular needs and they can be used to filter the projects displayed in the project list and in many other windows throughout the software. *See Section 2.4.5 on page 65.*

In Xfmea/RCM++/RBI, this tab also contains:

- **FMEA Structure** determines how the software will display the effect and cause records in the FMEA hierarchy. This is applicable only in Xfmea/RCM++/RBI. (See “Choosing the FMEA Structure” in the Xfmea, RCM++ or RBI documentation.)
- **Select Profile from Library** displays a list of all profiles that have been defined in the active library. This is applicable only in Xfmea/RCM++/RBI. When you choose a profile from the list, all of the configurable settings for the project will be set/reset based on the settings that have been predefined for that profile. If you are editing a

project, the current profile is shown in brackets. For users who are authorized to edit the active library, two additional icons will be enabled to the right of this drop-down list, as shown next.



Global Identifiers Tab

The Global Identifiers tab is available for all Synthesis applications except MPC. Identifiers are user-defined fields that can be used to search for certain types of records within the current project. The default names of the identifiers are defined at the database level via the Global Identifiers window; this tab allows you to specify different settings at the project levels. *See Section 2.4.4 on page 64.*

Security Tab

The Security tab is available only when you are working with a public project in a secure database. *For a full discussion on how to use these settings, see Section 2.3.2 on page 45.*

For quick access to the Security tab, you can select the project in the project list and choose **Project > Security > Project Security**.

Configurable Settings Tab

The Configurable Settings tab is available for Xfmea/RCM++/RBI only. It provides access to all of the configurable settings that have been defined for the current project, based on the profile that was selected on the General tab.

This tab allows you to make specific changes that will apply to the current project only. For example, if you are using a predefined profile but want to make a change to the interface style for this particular project only, you could click the **Edit** icon associated with the **Interface Style** drop-down list in the **Interface Settings** area.



Note: For RCM++ and RBI only, in the **Tasks** area, if you have chosen a task selection logic that presents different questions depending on the failure effect categorization, then you must choose a failure effect categorization (FEC) logic with the same number of categories. If the logics do not match, a message will be displayed when you attempt to save the project properties.

It is important to note that any change to the Configurable Settings page will update the settings for the current project, but it will not alter the original profile. If you want the project's current settings to be available as a new profile in the active library, click the **Send Settings to Library** button and then type the name and description for the new profile that will be created.

2.2.2.1 MPC's Project Properties

For users of MPC, the interface has been customized to display only the information that is directly relevant for MSG-3 analyses. This includes all of the same basic properties that are available on the General tab in other applications. In addition, you will be able to define the following:

- **Short Description** appears in the header of the Standard report template. It is not displayed in the Dassault or Sukhoi templates.
- **MSG-3 Guidelines** displays a list of the available MSG-3 guidelines that can be used for the systems and powerplant analysis. In most cases, the version that you select will not have any impact on the MSG-3 logic displayed in the interface and print-ready reports. The only substantive difference occurs when you select MSG-3

Revision 2002.1 because this older version of the guidelines uses slightly different titles for two of the maintenance significant item (MSI) questions, and lists the questions in a different order.

- **Model/Equipment/Effectivity** allows you to enter the information that will appear on the title page of the Dassault and Sukhoi templates.

2.2.3 Project Owner

For each project in a Synthesis repository, one user will be assigned as the *project owner*. By default, the owner will be the user who created the project, but this can be changed when needed.

In a secure database, being the project owner means that you have full permissions over the project. This includes the ability to edit the project properties, add/edit/delete project items and resources, lock and unlock, set security settings, create restore points and delete the project. These permissions are always in effect regardless of the project security settings or item permissions that may be in place. *For more information on security settings, see Section 2.3.2 on page 45.*

Changing the Project Owner

In a non-secure database, any user can assign a different user to be the owner for a selected project. In a secure database, only users with the “Manage all projects” permission can change the project owner.

To change the owner, select the project in the project list and choose **Project > Security > Change Owner**.

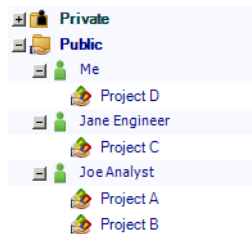


If you want to change the owner for multiple projects simultaneously, use the Manage Projects window (*see Section 2.2.7 on page 42*).

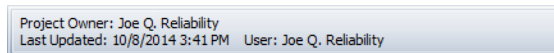
Identifying the Project Owner

There are three ways to identify the current owner of a project:

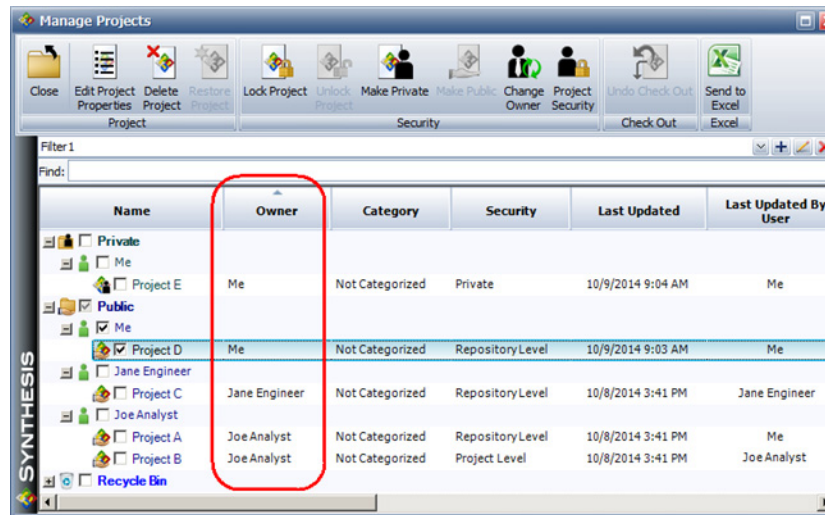
- Use the filters in the project list to filter and/or group projects based on the project owner. For example:



- The Project Properties window (**Project > Management > Edit Project Properties**) displays the name of the current owner in the status bar at the bottom of the window.



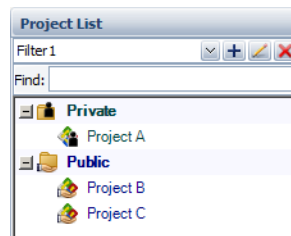
- The Manage Projects window (**Project > Management > Manage Projects**) displays a list of all projects and their owners in a table format. You can use custom filters to filter, sort and/or group the list based on the project owner. (In a secure database, only users with the “Manage all projects” permission can access this window.)



2.2.4 Private and Public Projects

In Synthesis repositories, there are two types of projects you can create: a private or public project. In a non-secure database, both types of projects are accessible to any user who has access to the database. In a secure database, a private project is accessible only to the project owner and to users with the “Manage all projects” permission. No other user can view or edit the project. On the other hand, public projects may be accessible to any user who has access to the database (depending on the security settings that have been implemented). *For more information on security settings, see Section 2.3.2 on page 45.*

In the project list, each type of project is displayed under the appropriate heading, as shown in the following example.



Creating New Private or Public Projects

To add a new project to an existing database, go to the project list, right-click the heading of the desired project type (i.e., private or public), and then choose the **Create Project** command on the shortcut menu. Alternatively, you can select the heading and choose **Project > Management > Create Project**.



The Project Properties window opens, allowing you to specify the project name, category, security settings (if applicable) and other settings. *See Section 2.2.2 on page 36.*

Changing the Project Type

To change the project type, select the project and choose **Project > Security** and then select one of the following options:



Make Private



Make Public

In addition, you can select multiple projects and change them to private or public projects all at once via the Manage Projects window (see Section 2.2.7 on page 42). In a secure database, only users with the “Manage all projects” permission can access this window.

2.2.5 Locked and Unlocked Projects

In all Synthesis repositories, a public project can be *locked* to prevent users from editing the data. If a project is locked, it will be moved from the **Public** heading to the **Locked** heading in the project list and it cannot be edited by any database user unless an authorized user unlocks it again.

In a secure database, a user can lock or unlock a project if he/she a) is the project owner, b) has the “Lock or check out project” permission for the project or c) has the “Manage all projects” permission.

Locking a Project

To lock a project, select it in the project list and choose **Project > Security > Lock Project**.



When a project is locked, all database users (including the user who locked the project) will have read-only access to the project. In addition, a locked project cannot be deleted or have its properties and public/private status edited.

Unlocking a Project

To unlock a project, select it in the project list and choose **Project > Security > Unlock Project**.



Tip: You can select multiple projects and lock or unlock them all at once via the Manage Projects window (see Section 2.2.7 on page 42). In a secure database, only users with the “Manage all projects” permission can access this window.

2.2.6 Check In and Check Out Projects

In all Synthesis repositories, both private and public projects can be *checked out* to temporarily allow one particular user to work on a project independently for a period of time and/or to work on a computer that is not connected to the network where the shared database resides (e.g., if you need to work on the project while you’re out of the office). When a project is checked out, two things happen:

- An editable copy of the project will be saved into a standard database (*.rsr9) in the specified “Checked Out” folder on your local computer. This database will have the same name as the project.
- The original project will be set to read-only and moved under the **Checked Out** heading in the project list. This allows other users who would normally be able to access the project to see that it is currently being edited

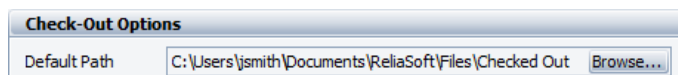
exclusively by one particular user. It also provides read-only access to the latest version of the project at the time it was checked out so those users can query, copy data, etc. while you're editing the project "offline."

You can then edit the project as needed in the standard database and check the project back in when you're finished.

Specifying the "Checked Out" Folder

By default, projects will be checked out to the default Documents folder on your computer (e.g., My Documents\ReliaSoft\Files\Checked Out).

To change this location, open the Synthesis Setup window (**File > Synthesis Setup**) and browse for a new default path under **Check-Out Options**. Keep in mind that anyone who has access to the folder will have full access to the checked out project; however, only the user who has the project checked out will have the ability to check in the project.



Tip: If you need to work on the project from a different computer after it has been checked out to the local folder, you will simply need to make sure that the latest copy of the standard database file is saved back to the exact same check-out location and filename before you check the project back in.

Checking Out a Project

In a secure database, a user can check out a project if he/she a) is the project owner, b) has the "Lock or check out project" permission for the project or c) has the "Manage all projects" permission.

To check out a project, select it in the project list then choose **Project > Management > Check In/Out > Check Out**.



Checking in a Project

To check in a project, select it under the **Checked Out** heading in the project list and choose **Project > Management > Check In/Out > Check In**.



Note that when you check in a project, the software creates a restore point, which is an exact replica (i.e., a backup) of the project before it was checked out. This allows you to restore the project to its prior state when and if needed. The restore point will include a description of the user who checked out the project, as well as the date and time of the check out. *For a discussion on how to use restore points, see Section 2.5.1 on page 68.*

Undo Check Out

In a secure database, a user can undo a check out if he/she a) is the user who checked out the project, b) is the project owner or c) has the "Manage all projects" permission.

To discard changes and restore the project to the state it was in before it was checked out, select the project under the **Checked Out** heading in the project list and choose **Project > Management > Check In/Out > Undo Check Out**.



2.2.7 Manage Projects

The Manage Projects window allows you to perform administrative tasks for multiple projects all at once. In a non-secure database, any user who has access to the database can access the Manage Projects window. In secure databases, only users with the “Manage all projects” permission can access this window.

To open the Manage Project window, choose **Project > Management > Manage Projects**.



This displays a list of all the projects that currently exist for the database. If you have created custom filters in the project list, you can apply those same filters in this window.

Tasks You Can Perform

Some of the tasks you can perform in this window include:

- Change the owner or type (private or public) for multiple projects all at once.
- Apply the same changes to the project properties for multiple projects all at once.
- Review and edit the security settings (if applicable) for multiple projects all at once.
- Delete, restore, lock and unlock, or undo check out for multiple projects all at once.
- Review and sort projects based on the user who made the last change to a project, the date/time of the last change and the last application that was used to make the change.

Tip: The Manage Projects window allows you to edit the properties of a project that is currently open or in use. When you make a change, the user who has the project open will see the change you have made when the database refreshes (the refresh happens automatically whenever the user makes a change, such as closing a window, selecting a different item, etc.).

Tools

The Manage Project window contains the following commands:

Project



Close closes the Manage Projects window.



Edit Project Properties allows you to view and edit the properties of the selected project(s). *See Section 2.2.2 on page 36.*



Delete Project permanently deletes the selected project(s) and bypasses the recycle bin. ***There is no undo for delete*** unless you have a stored backup (*Section 2.5 on page 67*) or restore point (*Section 2.5.1 on page 68*).



Restore Project is available only when you have selected project(s) under the Recycle Bin heading. Each selected project will be recovered from the recycle bin and restored to its original location in the project list.

Security



Lock Project moves the selected project(s) into the Locked heading of the project list. When a project is locked, all database users (including the user who locked the project) will have read-only access to the project.

In addition, a locked project cannot be deleted or have its properties and public/private status edited. To unlock project(s), choose **Unlock Project**. *See Section 2.2.5 on page 40.*



Make Private moves the selected project(s) into the Private heading of the project list. To move private project(s) to the Public heading, choose **Make Public**. *See Section 2.2.4 on page 39.*



Change Owner is available only for public projects in secure databases. It allows you to assign a different database user to be the owner for the selected project(s). *See Section 2.2.3 on page 38.*



Project Security is available only for public projects in secure databases. It opens the Project Properties window with the Security tab active, where you can specify the user accounts that can view/modify the selected project. *For a detailed discussion on how to configure the security setting for the projects in your database, see Section 2.3.2 on page 45.*

Check Out



Undo Check Out discards all changes made to a checked out project and restores it to the state it was at the time it was checked out. *See Section 2.2.6 on page 40.*

Excel



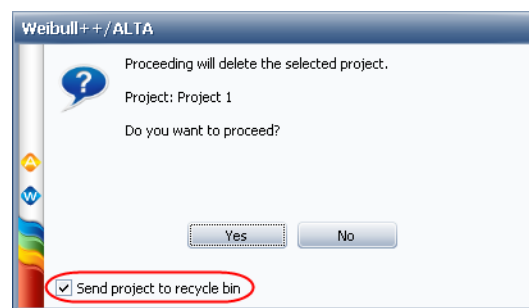
Send to Excel exports the data currently displayed in the Manage Projects window to an Excel spreadsheet.

2.2.8 Recycle Bin

The recycle bin is a temporary storage location for projects that have been deleted. It gives you a chance to restore the deleted project to its original location, if needed. Projects in the recycle bin are stored until you either empty the recycle bin or delete each individual project from the recycle bin.

Sending Projects to the Recycle Bin

Whenever you delete a project from a database, a confirmation window like the one shown next will appear.



If you want to move the project to the recycle bin, make sure the **Send project to recycle bin** check box is selected. If you want to immediately and permanently delete the project (no way to undo unless you have a backup or restore point), clear the check box.

Restoring and Deleting Projects from the Recycle Bin

In order to restore or delete a project from the recycle bin, you must have access to the project and have the permissions that are required to delete the project in general (i.e., for secure databases, you must either be the project

owner, have the project-level “Delete project” permission or have the repository-level “Manage all projects” permission).

To restore a project from the recycle bin, select it and choose **Project > Management > Recycle Bin > Restore Project**.



To permanently delete a project in the recycle bin (no way to undo unless you have a backup or restore point), select it in the recycle bin and choose **Project > Management > Recycle Bin > Delete Project**.



To permanently delete all projects currently in the recycle bin (no way to undo unless you have a backup or restore point), select the Recycle Bin header in the project list and choose **Project > Management > Recycle Bin > Empty Recycle Bin**.



2.3 Security Options

All enterprise databases use *login security*, meaning that the Synthesis applications use Windows authentication (or alternative credentials) to identify each user and control the user’s access via *security groups*. For a standard database, you can choose whether to apply login security; if you don’t, any user who has read/write access to the file will have full permissions throughout the database.

By default, each user in a secure database will have the same set of permissions for every public project in the database (e.g., Jane Engineer has read-write access to all projects, Bill User has read-only access to all projects, and so on). Alternatively, you can configure the database to provide different permissions for different public projects, if desired (e.g., Jane Engineer has read-write access to all of Department A’s projects, but she has read-only access to other projects). With either approach, you also have the option to further limit access for specific project items (e.g., folios, diagrams, system hierarchy items, etc.) if needed.

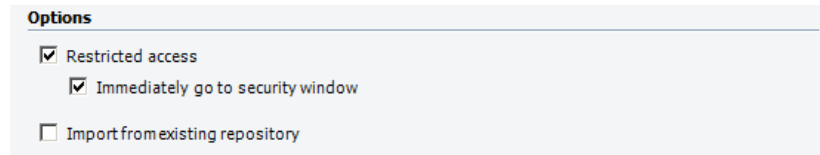
There are many different ways these options can be configured depending on your organization’s particular needs. The following sections discuss:

- Applying login security for a standard database - Section 2.3.1 (p. 45).
- Planning your security approach - Section 2.3.2 (p. 45).
- Managing user accounts - Section 2.3.3 (p. 48), which may also involve:
 - Importing users from Active Directory - Section 2.3.3.1 (p. 49).
 - Creating alternative credentials (if the user needs to log in from a different domain) - Section 2.3.3.2 (p. 50).
 - Editing user login and contact information - Section 2.3.3.3 (p. 51).
- Managing security groups (sets of permissions) - Section 2.3.4 (p. 52).
- Setting item permissions - Section 2.3.5 (p. 56).
- Tools for coordinating access by multiple users, including:
 - Status indicators (“in use” or “restricted access”) - Section 2.3.6 (p. 57).
 - Resetting “in use” flags (if an item is incorrectly locked for editing) - Section 2.3.7 (p. 59).
 - Keeping track of prior logins - Section 2.3.8 (p. 59).

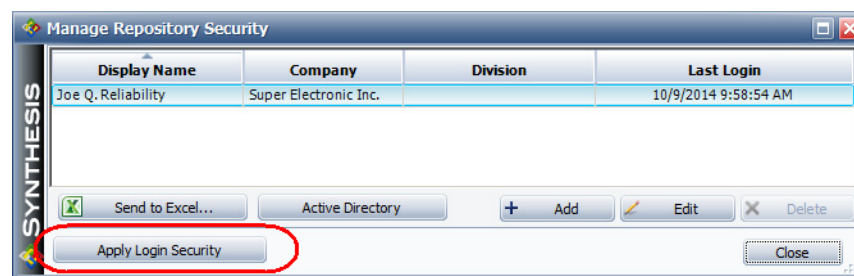
2.3.1 Applying Login Security

All enterprise databases use login security. For a standard database, there are two ways to apply login security if desired:

- Upon creating a new standard database (**File > New**), you can make it login secure by selecting the **Restricted access** check box.



- For an existing standard database, you can apply login security at any time by choosing **File > Manage Repository > Authorized Users** and then clicking the **Apply Login Security** button at the lower left corner of the window.



When you create an enterprise database or apply login security to a standard database, you will automatically be a member of the Admin security group, which has full permissions throughout the database. You can then use the Manage Repository Security window to add/edit/delete other user accounts (*see Section 2.3.3 on page 48*) and assign them to appropriate security groups (*see Section 2.3.4 on page 52*).

Note: You cannot automatically remove security from a database once it has been enabled. However, you can create a new non-secure database and use the **Import from existing repository** check box to automatically import all of the data from the secure database to the non-secure one.

2.3.2 Planning Your Security Approach

In secure databases, there are two basic factors that determine what a typical user can see and do in the database: the security group(s) that the user account belongs to and public project security settings.

This section discusses two general approaches you can use to configure the security groups and project security settings to fit your organization's specific needs:

- Same permissions for all public projects
- Different permissions for different public projects

Tip: In addition to these considerations, it is also important to note the following: a) Users with the "Manage all projects" permission (in any of the security groups that they belong to) will always have full project-level permissions for all public projects in the database; b) The project owner will always have full project-level permissions within that particular project; and c) The item permissions can be used to further limit access to specific items within a project (e.g., folios, diagrams, system hierarchy items, etc.). *See Section 2.3.5 on page 56.*

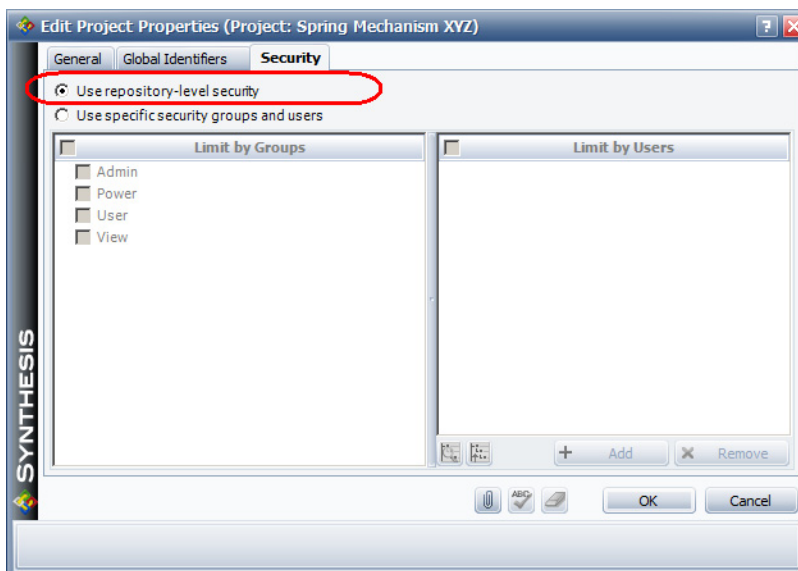
Same Permissions for All Public Projects

If you want each user to have the same set of permissions for all public projects in the database (e.g., Jane Engineer has read-write access to all projects, Bill User has read-only access to all projects, and so on), follow these steps:

1. Assign each user account to an appropriate security group (see Section 2.3.4 on page 52). This can be one of the four security groups that are created by default in each new Synthesis Repository — Admin, Power, User (Read/Write) or View (Read-Only) — or you can configure new or existing security groups to meet your particular needs.



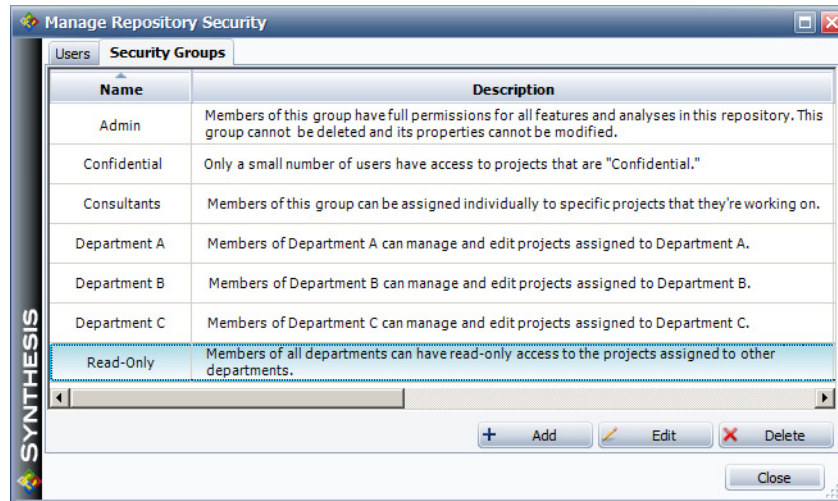
2. Accept the default option on the **Security** tab of the Project Properties for all public projects (**Project > Security > Project Security**). Note that if a user belongs to more than one security group, he/she will have the combined permissions of those groups in any project that is set to repository-level security.



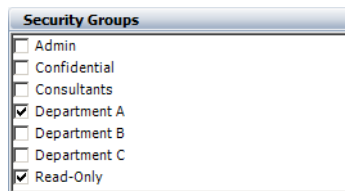
Different Permissions for Different Public Projects

If you want the same user to have different permissions for different public projects (e.g., Jane Engineer has read-write access to all of Department A's projects, but she has read-only access to other projects), you will need to:

1. Create a security group for each distinct type of access that users might need in any particular public project. Here's a simple example:



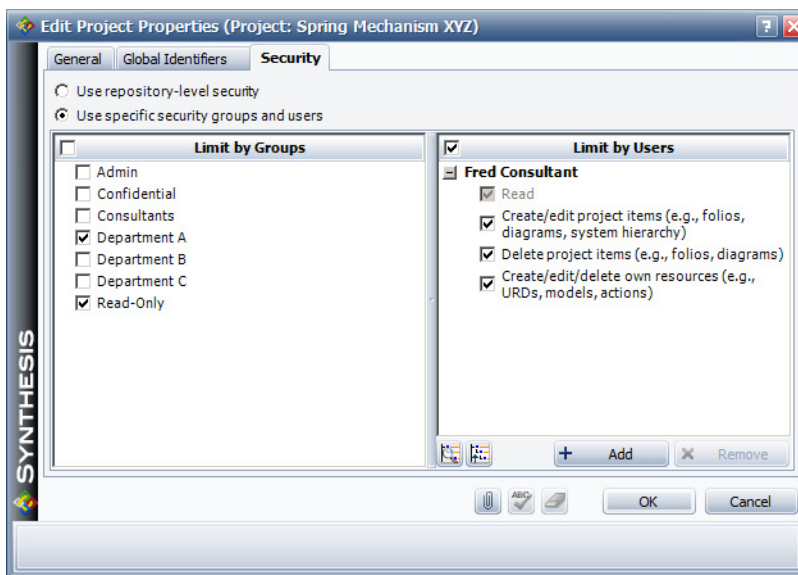
2. Assign the appropriate security group(s) to each user account. For the example shown below, the user will have read/write permissions in projects that are assigned to "Department A," and read-only access in projects that are assigned to "Read-Only."



3. Assign the appropriate security group(s) and/or specific user(s) for every public project in the database.
 - When you assign a security group, every user who belongs to that group will be able to access the project with the permissions that are specified in the group.
 - When you assign a specific user, the combined permissions from all of the security groups that the user belongs to will be displayed. Use the check boxes to select which of those permissions will be in effect for that user in this particular project.

For the example shown below, users from Department A will have read/write access (because they belong to the "Department A" security group), users from Departments B and C will have read-only access (because they belong to

the “Read-Only” security group) and Fred Consultant will have read/write access (because he belongs to the “Consultants” security group and has been specifically assigned to have those permissions in this project).



2.3.3 Managing User Accounts

Every person who will access a Synthesis repository or receive notification e-mails must have a personalized user account in the database.

- In **non-secure databases**, the software automatically creates an account for anyone who opens the file. Every user has full permissions throughout the database, including the ability to create, edit or delete other user accounts (e.g., so you can modify contact information or send notifications to someone who has not yet had an account created automatically).
- In **secure databases**, the accounts must be created and managed by users with the “Manage users and logins” permission. The security group(s) assigned to each account determines what the user can see and do in the database.

To view and manage the user accounts in a database, choose **File > Manage Repository > Authorized Users**.



This section describes how to use the Manage Repository Security window to create, edit or delete/deactivate user accounts. The same window can also be used to apply login security for a standard database (*see Section 2.3.1 on page 45*) and to manage security groups (permissions) for a secure database (*see Section 2.3.4 on page 52*).

Creating and Editing User Accounts

The Users tab of the Manage Repository Security window displays a table of all user accounts that have been created in the database. You can use the **Add** or **Edit** buttons below the table to create or modify individual accounts.

You can also import user accounts from Microsoft Active Directory® by clicking the **Active Directory** button. (*see Section 2.3.3.1 on page 49*).

Keep in mind the following requirements when creating new user accounts for a secure database:

- In order to use Windows authentication, the user must be logged in to a computer with the same domain/username that is defined in the Synthesis user account. If a user needs to connect to a database from a different domain, you can set up alternative credentials that will allow access without domain authentication. *See Section 2.3.3.2 on page 50.*
- In order to access the database, the user account must be assigned to at least one security group. *See Section 2.3.4 on page 52.* (If you simply wish to send notifications to the user, a security group is not required.)
- For SQL Server databases, the username must be associated with a “SQL Server Login” that allows the database platform to recognize the user and give access to the application database. This can be accomplished with an individual login, a group login or Windows impersonation. *See Section 2.1.2.3 on page 30.*

Deleting or Deactivating User Accounts

If an account has never been used and you want to permanently remove it, select the account name from the list and click **Delete**.

In a secure database, you also have the option to *deactivate* the account instead. This can be used if the account has already been logged in at least once, or if you only want to temporarily suspend access. If you attempt to delete an account that has previously been logged in, you will be prompted to deactivate it instead. If you want to manually deactivate an account:

- Select the account name from the list and click **Edit**.
- In the User Login and Contact Information window, clear the **Active** check box at the bottom of the window and click **OK**.
- When you return to the Manage Repository Security window, select the **Show active users only** check box to hide the accounts that are currently inactive.

To reactivate the account again later, return to the User Login and Contact Information window and select the **Active** check box.

2.3.3.1 Importing Users from Active Directory

If your organization uses Microsoft Active Directory, it is easy to import username and contact information from the directory to create new user accounts in the Synthesis repository.

To import users from Active Directory, open the Manage Repository Security window (**File > Manage Repository > Authorized Users**), click the **Active Directory** button, and then follow these steps:

1. Use the **Search Options** to find the user(s) you want to create accounts for. When you enter the criteria and click **Search**, the utility will return only records that a) have the minimum information required to create a Synthesis user account (i.e., username, first name, last name and e-mail address) and b) do not already have a user account in the current database.

The image shows a 'Search Options' dialog box with the following fields:

- Domains:** SuperElectronic
- Sub-Domains:** <All>
- Groups:** <All>
- Filter By:** First Name
- Text Input:** Jane Engineer
- Search Button:** Search

- In the table of results, select the check box for each user you want to create an account for.
- Use the remaining control panel options to set certain properties for the new user account(s) that will be created. This will vary depending on the type of database you're using. The following picture shows all possible options.

The screenshot shows two overlapping dialog boxes. The top box, titled 'Authentication Domain', has a text field containing 'SuperElectronic'. The bottom box, titled 'Import as Members Of', contains a list with four items: 'Admin', 'Power', 'User', and 'View'. The 'User' item is checked. Below this list is a checkbox labeled 'Create SQL Server login', which is also checked.

- In the **Authentication Domain** field, specify the network domain name (i.e., the domain that the user's computer will be logged in to).
 - For secure databases only, use the **Import as Members Of** field to select the security group(s) that will be assigned to the new user account(s). If you skip this option now, you can assign security groups later for each individual account. *See Section 2.3.4 on page 52.*
 - For SQL Server databases only, select the **Create SQL Server login** check box if you want to create an individual SQL Server login for each new Synthesis user account. *See Section 2.1.2.3 on page 30.*
- Click **Import** to create the account(s). After the process completes, the window will remain open to allow you to import additional users, if desired.

2.3.3.2 Creating Alternative Credentials

Secure databases use Windows authentication by default. This means that users must be logged in to a computer using the same domain and username specified for their Synthesis user accounts. You can, however, allow specific users to bypass Windows authentication as needed. This may be useful for situations where:

- A user needs to work on a copy of a secure standard database on a computer that is not connected to the company's network.
- A user needs to connect to an enterprise database from a different domain.

For these situations, you can set up alternative credentials for a user's account that will allow that user to access the database without domain authentication. These credentials must be set in advance, before the user attempts the connection.

If you have the "Manage users and logins" permission, you can create alternative credentials for a user account by following these steps:

- Open the Manage Repository Security window (**File > Manage Repository > Authorized Users**). On the Users tab, select the account name from the list and click **Edit**.
- In the User Login and Contact Information window, click the **Alternative Credentials** tab and then select the check box to enable alternative credentials.
- With the setting enabled, create an alternative username and password for the account. The username and password must be unique within the database, and the password is CaSe SeNsiTiVe.

The screenshot shows the 'Alternative Credentials' tab of a dialog box. It has two sub-tabs: 'User Info' and 'Alternative Credentials'. The 'Alternative Credentials' tab is active. It contains a checkbox labeled 'Allow use of alternative credentials if domain authentication fails', which is checked. Below this are three text fields: 'Username' (containing 'engineer2'), 'Password' (masked with asterisks), and 'Confirm Password' (masked with asterisks).

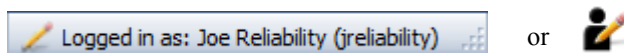
Once you have created the credentials, instruct the user to enter this login whenever the database prompts for it. The database will ask for the alternative credentials whenever the user account cannot be matched based on domain authentication.

Tip: The first time you connect to a database using alternative credentials, the application will automatically remember the login information on your computer. If you wish to clear the saved login, you can click the **Forget Alternative Login** button on the Synthesis Setup window (**File > Synthesis Setup**).

2.3.3.3 User Login and Contact Information

The User Login and Contact Information window allows you to view and edit the contact information for your own user account. If you have the “Manage users and logins” permission, you can also edit the information for any user account.

To view or edit your own user account, double-click your user name in the MDI status bar or choose **My Portal > Users > My Profile**.



In the User Login and Contact Information window, you can edit the following information:

- **User information.** At minimum, you must supply your first name, last name, display name and e-mail address. Your display name will appear in all projects, analyses and plots you create or modify in the database. Click the **Active Directory** button if you wish to update your contact details based on information stored in Microsoft Active Directory for your account.
- **User image.** You can associate a profile photo with your user account. Saved images are resized to 100 x 100 pixels.

If you have the “Manage users and logins” permission, you can also edit the following information for any user account. To edit an account, open the Manage Repository Security window (**File > Manage Repository > Authorized Users**) and then double-click the account name.

- **Domain and Username.** Windows authentication uses an account’s domain and username to identify the user and give him/her access to the database.
- **Security groups(s).** Security groups control the user's access to the database. *See Section 2.3.4 on page 52.*
- **Alternative credentials.** Select the check box on the Alternative Credentials tab to allow the user to bypass Windows authentication and connect to the database using an alternative username and password. *See Section 2.3.3.2 on page 50.*
- **Deactivate or Activate** the account. Clear or select the **Active** check box to deactivate or activate the account. A deactivated account will not have access to the database.

2.3.4 Managing Security Groups

In a secure database, security groups control what users can see and do in the database. By default, the software includes four predefined security groups: Admin, Power, User and View. The Admin group, which has full permissions throughout the database, can neither be deleted nor have its permissions modified. For the other predefined groups, you can edit their permissions or replace them with new groups that fit the specific way the database will be used. As discussed in Section 2.3.2 on page 45, there are two basic approaches you can use:

- **Same permissions for all public projects** – each user account is assigned to one security group and all public projects use the default security option (repository-level security).
- **Different permissions for different public projects** – each user account may be assigned to multiple security groups and each public project may be accessed only by specific security groups and/or users.

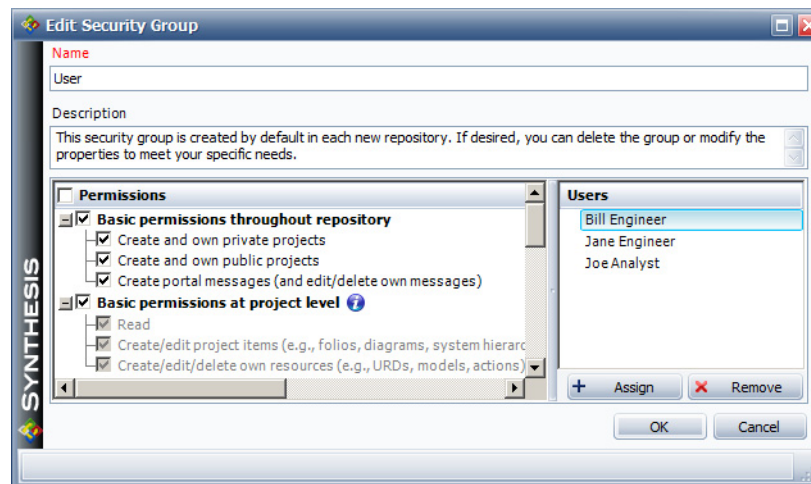
Creating, Editing or Deleting Security Groups

If you have the “Manage users and logins” permission in the database, you can manage the security groups by choosing **File > Manage Repository > Authorized Users**.



In the Manage Repository Security window, click the **Security** tab to display a table of all the security groups that have been created in the database. Use the **Add**, **Edit** or **Delete** buttons below the table to manage the groups.

When you edit a security group, the left side of the Security Group window allows you to choose the permissions, while the right side shows all the users currently assigned to the group, as shown in the following example. Use the **Assign** or **Remove** buttons to modify the list of users.



2.3.4.1 Synthesis Permissions

Here is a summary of all the permissions that can be granted to a particular security group.

Basic permissions throughout repository

These permissions apply throughout the database if they are in any of the security groups that the user belongs to. These permissions do not depend on the security settings for a particular project.

Create and own private projects	You can create and own <i>private</i> projects in the database that are accessible only to you and to users with the “Manage all projects” permission.
Create and own public projects	You can create and own <i>public</i> projects that other users can view and edit (depending on the project security settings).
Create portal messages	You can create and send messages to other users via the Messages page in My Portal.

Basic and advanced permissions at project level

A user can have these permissions in some projects but not others, depending on the project security settings (*see Section 2.3.2 on page 45*). Regardless of the project security settings, these permissions are always automatically granted to the current project owner and anyone with the “Manage all projects” permission.

Read	You can perform tasks that do not modify the data in the project (e.g., view the analysis, calculate metrics in a Quick Calculation Pad, export data, etc.).
Create/edit project items	You can create and edit items in a given project, such as folios in Weibull++/ALTA, diagrams in BlockSim, system hierarchy items in Xfmea/RCM++/RBI, and the like.
Create/edit/delete own resources	You can create Synthesis resources (e.g., URDs, models, etc.) and edit or delete any existing resources you have created.

Delete project items	You can delete any item in a given project (e.g., folios in Weibull++/ALTA, diagrams in BlockSim, system hierarchy items in Xfmea/RCM++/RBI, and the like). This permission cannot be assigned unless you also have the “Create/edit project items” permission.
Create/edit/delete all resources	You can create, edit and delete any local resources in the project (not just the ones that you created).
Set project security	You can control who can view and edit a given project. This permission allows you to configure both project security settings (<i>see Section 2.3.2 on page 45</i>) and item permissions (<i>see Section 2.3.5 on page 56</i>).
Edit project properties	You can use the Project Properties window to edit the name, description, category and other settings of a given project. <i>See Section 2.2.2 on page 36.</i>

Lock or check out project	You can: • Lock and unlock a given project. <i>See Section 2.2.5 on page 40.</i> • Check in and check out a given project. <i>See Section 2.2.6 on page 40.</i>
Create restore points	You can utilize restore points for a given project, which are exact replicas of the project at a particular point in time (i.e., backups). <i>See Section 2.5.1 on page 68.</i>
Delete project	You can delete a given project.
Manage change logs in Xfmea/RCM++	You can enable and manage change logs within a given project. Change logs can be created for FMEAs and DVP&R analyses in Xfmea, RCM++ and RBI. <i>See Chapter 17.</i>
Approve change logs in Xfmea/RCM++	You can implement electronic approval tracking for change logs within a given project. Change logs can be created for FMEAs and DVP&R analyses in Xfmea, RCM++ and RBI. <i>See Chapter 17.</i>

Administrative permissions throughout repository

These permissions apply throughout the database if they are in any of the security groups that the user belongs to. These permissions do not depend on the security settings for a particular project.

Manage all projects	You have all the basic and advanced project-level permissions for all projects in the database. This overrides any project security settings and item permissions. This permission also gives you the ability to change the project owner for any given project and the ability to use the Manage Projects window (<i>see Section 2.2.7 on page 42</i>).
Manage users and logins	You can: • Use the Manage Repository Security window to add user accounts to the database and define security groups. <i>See Section 2.3.3 on page 48.</i> • Use the Prior Logins window to view and export a history of database logins. <i>See Section 2.3.8 on page 59.</i> • Use the Reset “In Use” Flags window to clear the “in use” status for selected database users. <i>See Section 2.3.7 on page 59.</i>
Manage e-mail notifications	You can: • Use the E-mail Notifications window to enable e-mail notifications sent by the software and control when they are sent. <i>See Section 2.4.1 on page 60.</i> • Use the Notification Groups window to add and manage the distribution groups for the e-mail notifications. <i>See Section 2.4.1.1 on page 61.</i>

Manage profiles and templates in Xfmea/RCM++	This permission is available only in enterprise databases. You can: • Use the Profiles/Library Manager window in Xfmea/RCM++/RBI to configure the predefined settings stored in the active library of the enterprise database. <i>See page 184 in Chapter 6.</i> • Use the Templates Manager window in Xfmea/RCM++/RBI to configure report templates stored in the enterprise database. <i>See page 442 in Chapter 23.</i>
Manage other repository settings	You can: • Use the Manage Units window to define the time units available for use in any project within the database. <i>See Section 2.4.2 on page 62.</i> • Use the Manage Warranty Units window in Weibull++ to set equivalencies between the time units used throughout the database and the time units used in some warranty folios. • Use the Define Default Names window to specify how default names for resources and blocks are created. <i>See Section 2.4.3 on page 63.</i> • Use the Task Types window in RCM++ and RBI to map the task types used in RCM++/RBI to the task classes in the universal reliability definition (URD). <i>See page 305 in Chapter 13.</i> • Use the Global Identifiers window to define the default names for identifier fields that can be used to search for blocks or resources within a given project. <i>See Section 2.4.4 on page 64.</i> • Use the Project Categories window to define the categories that can be used for grouping and filtering the projects in the database. <i>See Section 2.4.5 on page 65.</i> • Use the Restore Points window to manage restore points, which are exact replicas of the project at a particular point in time (i.e., backups) that can be restored when and if needed. <i>See Section 2.5.1 on page 68.</i>
Approve actions	You can review and approve actions, which are Synthesis resources that allow you to track progress made in a project. <i>See page 101 in Chapter 3.</i>
Manage all portal messages	You can edit or delete all messages you sent and messages addressed to you via the Messages page in My Portal.
Create/edit/delete global resources	You can create, edit and delete any global resources in the project (not just the ones that you created). In addition, you can transfer data from XFRACAS to the RDW (<i>see Section 2.7.1 on page 86</i>).

Manage Lambda Predict repository settings	You can: • Use the Manage FIDES Settings window in Lambda Predict to configure the FIDES-related settings stored in the database. This applies to the FIDES prediction standard only. • Use the Manage Custom Derating Standards window in Lambda Predict to create, edit or delete user-defined derating standards stored in the database. • Use the MIL-217 Custom Connections window in Lambda Predict to define failure rates for user-defined connectors stored in the database. This applies to the MIL-217 prediction standard only.
Manage dashboard templates	You can create and save layouts for use in the Dashboard Viewer in Weibull++, BlockSim and RGA. <i>See Section 2.7.4 on page 90.</i>

2.3.5 Setting Item Permissions

In a secure database, all project items (e.g., folios, diagrams, system hierarchy items, etc.) are, by default, set to inherit their permissions from the project. This means that if a user has the “Create/edit items” permission for the project, he or she will be able to edit all of the items by default. If you want to prevent some or all of those users from editing a particular item (i.e., lock or limit access to the item), you can use the Item Permissions window.

To set item permissions, you must either a) be the project owner, b) have the “Set project security” permission and/or c) have the “Manage all projects” permission.

The window functions a little differently depending on whether you’re working with items in a project explorer (e.g., folios, diagrams, etc.) or items in a system hierarchy.

Project Explorer Items

In Weibull++, ALTA, BlockSim, RENO, DOE++, RGA or Lambda Predict, select the item in the current project explorer and choose **Project > Current Item > Item Permissions**.



In the Item Permissions window, select the **Restrict editing to selected project users** option and then select which specific users will be able to edit this particular item. All others can view, but not edit, the item. Only users with editing rights to the project will appear in the list.

To remove item permissions and change the security settings back to the defaults, select the **Inherit from project** option.

System Hierarchy Items

In Xfmea, RCM++ or RBI, select the item and choose **System Hierarchy > Security > Item Permissions**. In MPC, select an item and choose [**Systems/Structures/Zones**] > **Security > Item Permissions**.

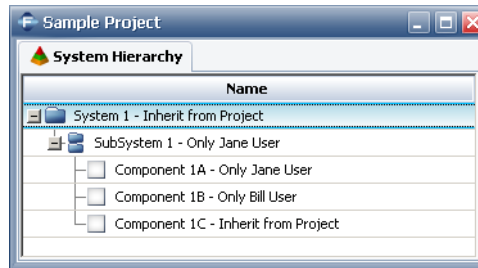


In the Item Permissions window, you can choose to:

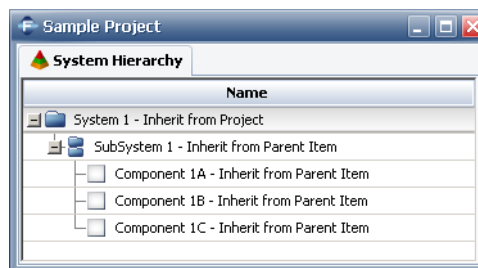
- Define the permissions for the item by selecting the **Restrict editing to selected project users** option and then selecting which specific users will be able to edit this particular item. All others can view, but not edit, the item. Only users with editing rights to the project will appear in the list.

- Set the item to inherit the same permissions as the next item above it in the system hierarchy by selecting the **Inherit from parent item** option.
- Remove item permissions and change the security settings back to the defaults by selecting the **Inherit from project** option.

If you select the **Apply to all dependents** check box, the software will automatically set the permissions for all next-level items in this branch of the hierarchy to match the item you are currently editing. For example, consider a case where each item in an Xfmea system hierarchy has different permissions, as shown next.



For a quick way to reset all of the item permissions to the defaults, you can open the Item Permissions window for SubSystem 1, set to **Inherit from parent item** and select the **Apply to all dependents** check box. The resulting system hierarchy is shown next.

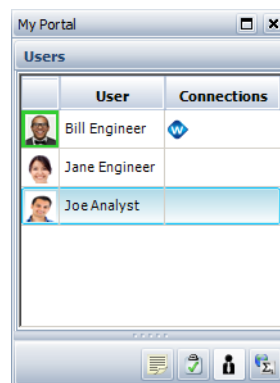


2.3.6 Status Indicators

Synthesis applications include status indicators that tell you which user accounts are currently logged in to the database and which project items (e.g., folios, diagrams, system hierarchy items, etc.) are in use or restricted.

Database Users

The names of all users who have accounts in the database are displayed on the Users page of the My Portal panel (**View > My Portal > Show My Portal**). A green status light around the user's profile image indicates that the user is currently connected to the database, as shown in the following example. The Connections column shows which Synthesis application(s) are currently connected.



You can refresh the list of users by choosing **View > Refresh > Refresh**.

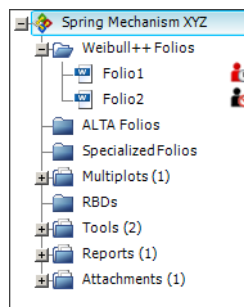


Project Items In Use or Restricted

When you encounter an item that is read-only (e.g., OK button is disabled in the window or you are unable to type in the cells of a worksheet or table), you can check the status of the item to see if it is currently **in use**  (i.e., you can't edit the item until the user closes the folio/diagram or selects a different item in the hierarchy) or **restricted**  (i.e., you don't have permissions to edit the item). If the item is in use, move the pointer over the icon to identify the user.

The location of these status icons will vary depending on which Synthesis application you are using:

- In projects that use a current project explorer to manage analysis data, the status icons are displayed next to the item's name in the current project explorer, as in the example shown next.



- In projects that use hierarchical trees to manage analysis data (as seen in the Xfmea, RCM++, RBI and MPC applications), the status icons are displayed in the User Access column of the system hierarchy. (To hide or display columns, right-click the column headers, then click **Customize Columns** to select which columns you want to display.)

Name				
Turbofan RS 007				
FIRE PROTECTION				
Detection				
Engine Fire Detection				
Zone 1 Sensor.				
Zone 2 Sensor.				
Extinguishing				
Engine Fire Extinguishing				
Fire Extinguisher bottle assembly.				

Tip: The application interface refreshes automatically whenever you make a change (e.g., close a project, create a resource, select a different item, etc.). If your computer will not let you edit an item that is in fact not currently being edited by another user, it could be because your computer has not been recently refreshed with the latest changes made by other database users. You can initiate the refresh manually by choosing **View > Refresh**.

In addition, the software employs "in use" flags within the database to record when an analysis is currently being edited by a particular user. If the refresh still does not show that the item has been released, then something might have occurred to prevent the flags from being reset correctly (e.g., a network interruption or if the software closes unexpectedly). Refer to Section 2.3.7 on page 59 for instructions on how to reset the flags throughout the database if this problem occurs.

2.3.7 Reset “In Use” Flags

Because Synthesis repositories allow simultaneous access by multiple users, it is necessary to store “in use” flags within the database to indicate when a particular portion of the analysis is currently being edited by a particular user. There are some circumstances when these flags might not be reset correctly when a user stops editing an analysis (e.g., if there is a network interruption or if the software closes unexpectedly). If that occurs, then the analysis will be locked for editing because the software receives an erroneous indication that it is still in use by another user.

To correct the problem, it is necessary to reset some or all of the “in use” flags within the database. To do this, you will need to have the “Manage users and logins” permission.

To reset the flags, choose **File > Manage Repository > Reset ‘In Use’ Flags**.



This opens the Reset 'In Use' Flags window, which shows all users who have an account in the database. (If you are working in a non-secure database, any user who has ever opened the database will have an account created automatically and will be shown in this list.) A status light is displayed for each user; if it is “lit up” (i.e., green), the user is currently logged in to the database. In addition, the Connections column shows the Synthesis application(s) that the user currently has connected to the database. You can select the check box for each user for whom you want to reset “in use” flags, then click **OK** to reset the flags.

IMPORTANT: It is important to make sure that no selected user is currently logged in to the database when you use this command. Users currently logged into the database can be viewed on the Users page of My Portal. *See Section 2.3.6 on page 57.*

2.3.8 Prior Logins

The Repository Logins window displays a record of the date and time the users in the database logged in. You will need to have the “Manage users and logins” permission to access the record.

To open the Repository Logins window, choose **File > Manage Repository > Prior Logins**.



The following options are available:

- Use the **Most Recent** filter to display in the table the last 10; 100; 10,00 or 10,000 users who logged in to the database.
- Use the **User** filter to specify whether the table will display the logs for all users or display only the logs for a selected database user.
- Click the **Send to Excel** button to export the data currently displayed in the table to an Excel spreadsheet.
- Click the **Clear Logins** button to clear the entire history of users who logged in to the database. Since this action cannot be undone, you will be prompted to confirm that you want to proceed before the records are erased.

Users currently logged into the database can be viewed on the Users page of My Portal. *See Section 2.3.6 on page 57.*

2.4 Repository Settings

Synthesis applications include a variety of tools to help authorized users manage settings that are shared by all users and all analysis projects in the same database. The following topics describe some of these features that are applicable for all (or most) Synthesis applications. This includes:

- **Notifications**
 - E-mail notifications and notification groups keep users up to date on the progress made in completing assigned actions - Section 2.4.1 (p. 60).
- **Time Units**
 - The Manage Units window allows you to define the “repository time units” that will be available for use in any project within the database - Section 2.4.2 (p. 62).
- **Names, Identifiers and Categories**
 - The Define Default Name Formats window allows you to specify the format for the default names of newly created resources and other items - Section 2.4.3 (p. 63).
 - The Global Identifiers window allows you to define identifiers (e.g., part number, version, supplier, etc.) that can be used to search for resources - Section 2.4.4 (p. 64).
 - Project Categories can be used to filter the projects displayed in the Project Manager - Section 2.4.5 (p. 65).
- **Integration with XFRACAS**
 - Setting up an XFRACAS Connection allows you to access XFRACAS data from a standard database. (For an enterprise database, the Synthesis and XFRACAS data will be stored in the same repository.) - Section 2.4.6 (p. 66)

For information about other repository settings that are available only in specific Synthesis applications, please consult the documentation for the application(s) where those features are used.

2.4.1 E-mail Settings

E-mail notifications can be an effective tool to facilitate communication between database users and to track the status of assigned tasks.

The E-mail Settings window allows authorized users to enable e-mail notifications within the current database for:

- Actions created in an FMEA, DFR plan or My Portal. These notifications can be sent manually. They can also be sent automatically based on the settings established in this window.
- Messages created in My Portal. These notifications can be sent manually.
- Change logs in Xfmea/RCM++/RBI that are assigned to be approved. These notifications will be sent automatically, if applicable.

To access the window, choose **File > Manage Repository > E-mail Settings**.

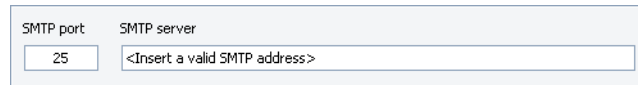


(If you do not have the “Manage e-mail notifications” permission, this command will not be visible in the Backstage view.)

Enabling E-mail Notifications

To configure the database to enable e-mail notifications, do the following:

1. Select the **Enable Notification E-mails** check box.
2. Specify a valid **SMTP port** and **SMTP server**. (You may need to consult with the IT professionals who have configured the e-mail server used within your organization.)



SMTP port	SMTP server
25	<Insert a valid SMTP address>

3. Enter your e-mail address in the **Recipient address for test e-mail** field and then click **Send Test E-mail**. If the test e-mail cannot be sent, an error message will be displayed.



Recipient address for test e-mail	Send Test E-mail
YourEmail@Company.com	

4. Once you have confirmed that the e-mail settings are valid, specify which automated notifications, if any, will be sent for action records:
 - **Upon creation:** Sends an e-mail to the Person Responsible and/or Approver when the action is first created.
 - **Upon modification:** Sends an e-mail to the Person Responsible and/or Approver each time an existing action is modified via the Action Properties window. Note that modifications applied via the Worksheet View in Xfmea/RCM++/RBI will not trigger an automated notification.
 - **Upon completion:** Sends an e-mail to the Approver when the completion date has been entered and the action is ready to be reviewed/approved.

For all of these automated notifications, you can also include the user who created the action as a primary recipient by selecting the **Action creators receive notifications** check box in the E-mail Settings window. Additionally, if other users and/or notification groups have been defined in the Action Notifications window for a particular action, they will also receive courtesy copies (CCs). Note that courtesy copies will not be sent if there is not at least one primary recipient (Person Responsible, Approver and/or Creator) for the e-mail.

5. Use the **Introduction to each action notification e-mail** field to specify the default text (up to 1,000 characters) that will be used at the beginning of each action notification e-mail. The rest of the e-mail will include all of the details that have been defined for the particular action record.
6. Click **OK** to save these settings for the current database.

Saving Settings for Future Standard Databases

If you want to use the same e-mail settings for each new standard database that you create from the current computer/username, click **Set As Default**. This button is not available if you are working with an enterprise database.

2.4.1.1 Notification Groups

The Define Notifications Groups window allows authorized users to manage the notification groups that are available within the current database.

If a notification group has been assigned to a specific action or message, all of the users assigned to that group will:

- Be able to see the record in My Portal.
- Receive courtesy copies of automated action notification e-mails, if any.

To access the window, choose **File > Manage Repository > Notification Groups**.



(If you do not have the “Manage e-mail notifications” permission, this command will not be visible in the Backstage view.)

Adding or Editing a Group

The table displays a list of the notification groups that have already been defined in the current database.

- To add a new group, click **Add**.
- To view or edit an existing group, double-click the row or select the row and click **Edit**.

In the Notification Group window, a unique **Name** is required and a short **Description** of the intended purpose for the group is optional.

The **Available Users** list shows all of the user accounts in the current database that are not yet assigned to the group. At least one user account must be moved into the **Selected Users** list.

There are a variety of ways to move records between the lists:

- To move one record, double-click the name, or select the name and click > or <.
- To move multiple records at the same time, press the **CTRL** key and click each name, then click > or <.
- To move all records at the same time, click >> or <<.

Deleting a Group

To delete an existing group, select a row and click **Delete** or press the **DELETE** key.

If the notification group has been assigned to any existing actions and/or messages, it will be removed automatically. *There is no undo for delete.*

2.4.2 Manage Units

Users with the “Manage other repository settings” permission can define the time units that will be available for use in any project within the database. This allows users to work with time-based inputs and results in the units that are appropriate for the situation. For example, you might have a data set in Weibull++ where times to failure were recorded in hours, but you want to obtain results from the QCP in terms of years. Similarly, you could accommodate a situation in RCM++, RBI or BlockSim where you need to define the duration of a maintenance task in terms of hours and to specify the total operating time of the system in terms of months. In MPC, using the predefined time units to set task intervals helps to ensure consistency and makes it possible to transfer data to Xfmea/RCM++/RBI if desired.

IMPORTANT: It is important to realize that making changes to the existing units can have implications for existing analyses throughout the database. Therefore, it is recommended to set up units once, upon creation of the database, if possible.

To define time units, choose **File > Manage Repository > Manage Units** to open the Define Units window.



The units are defined in relation to a common, or “base,” unit so that the software can convert data from one unit to another. For example, the units defined by default assign a conversion factor of 1 to the Hour unit, which indicates that an hour is equal to 1 System Base Unit (SBU); the Year unit has a conversion factor of 8760, which indicates that a year is equal to 8,760 SBUs (i.e., 8,760 hours). Note, however, that the SBU does not have to be hours. You could consider days to be your base unit and define all other units in relation to a day (e.g., an hour would be 1/24th of a base unit, with a conversion factor of 0.04167).

Each unit must have a name, an abbreviation of up to three characters and a conversion factor. In addition, each unit must be assigned to any one of the two available categories: Time or Usage.

Note: If you will be using the usage format of the Weibull++ warranty folio, note that only the units assigned to the Usage category will be available for those analyses; units assigned in the Time category are not available in the warranty usage format.

You can set any unit as the default by selecting it in the Default column; the default unit will be used automatically each time the software requires a unit.

- To edit an existing unit, click inside the cell and edit the text.
- To add a new unit to the bottom of the list, click inside the last row and type the text.
- To delete a unit, select the row and click the **Delete** icon. *There is no undo for delete.*



- To insert a new unit above an existing one, select the existing unit and click **Insert**.



- To move an existing unit up or down in the list, select the row and click the **Move Up** or **Move Down** icon.



2.4.3 Default Name Formats

When you add a resource to a project, it is given a default name unless you specify a different name. In all Synthesis applications other than MPC, users with the “Manage other repository settings” permission can specify how these default names are created in the current database via the Define Default Name Formats window, which is accessed by choosing **File > Manage Repository > Define Default Names**.



The Define Default Name Formats window consists of four tabs. The settings in the last three tabs will be used only for diagrams in BlockSim but they're visible when you open this window from any of the Synthesis applications.

- The **Resources** tab allows you to specify the default name formats for resources.
- The **RBD** tab allows you to specify the default name format for each type of block that you can add to a reliability block diagram in BlockSim. Note that this feature is not applicable for the blocks you create in a Weibull++ or ALTA diagram because those blocks are always named based on the calculated standard folio data sheet that they represent.
- The **Fault Tree** tab allows you to specify the default name format for each type of block (i.e., each type of gate or event) that you can add to a fault tree in BlockSim.
- The **Phase** tab allows you to specify the default name format for each type of block that you can add to a phase diagram in BlockSim.

All tabs work in the same way. Each row of the tab's table represents a type of resource or type of block. For each row:

- The **Resource Type** column displays the type of resource or block. This column cannot be edited.

- The **Resource Name** column displays the default name used for that type of resource or block (e.g., “Model” or “Block”). This will be the name represented by the \N code in the Name Format column described below. For example, if the Name Format for a model is set to \N \S (which is the default), then the default name for the first new model you create in the database will be “Model 1.” If you change the Name Format to \T \N \D, then default name for a model that you create in BlockSim at a particular time will be “BKS Model 9/15/2011 2:29:23 PM.” Click in the cell to edit the name; click outside the cell to accept your changes.
- The **Name Format** column allows you to specify the total default name format used for that type of resource or block, using the following elements:
 - \N returns the default name for the resource or block type, as specified in the Resource Name column.
 - \U returns the name of the user who created the resource or block.
 - \D returns the date when the resource or block was last modified.
 - \S adds a sequential number, or increment. For example, if the last URD created was URD 1, the next URD created will use 2 as the sequential number (i.e., URD 2).
 - \T returns the software tool used to create the resource or block.
 - \F returns the contents of each of the five identifier fields for the record (i.e., all global identifiers except the comments field). *See Section 2.4.4 on page 64.*
 - \G returns a summary of the properties of the resource or block.
 - \I inherits the name of the selected block when a resource is created from the Block Properties window. The default name for the resource type (i.e., \N) is also included. For example, if you create a new URD for Block 1 using the Block Properties window, the URD's name will be “Block 1 URD.” When a resource is not created from the Block Properties window, \I returns the same format as \N (e.g., “URD,” “URD_2,” etc.).

2.4.4 Global Identifiers

In all Synthesis applications other than MPC, identifiers are user-defined fields that can be used to search for certain types of records within the current project. The names of the identifiers are defined at the database level; these identifiers will be used in all projects throughout the database unless different settings are specified at the project level. *See Section 1 on page 67.*

The Global Identifiers window, accessed by choosing **File > Manage Repository > Global Identifiers**, is used to define the identifiers at the database level.



For each type of record, six identifiers are available: five “user-defined fields” (UDFs) and one comments field. Outside of this window (e.g., in properties windows, the Resource Manager, filters, etc.), these fields are known by the display names defined within this window. By default, the fields have the following display names:

- UDF 1: Name
- UDF 2: Number
- UDF 3: Version
- UDF 4: Applies To
- UDF 5: Keywords
- Comments: Comments

Not all of the identifier sets are applicable for all Synthesis applications. For example, tasks are used only in BlockSim, RCM++ and RBI. The affected applications are listed in parentheses for each identifier set.

To change the display name for a field, click the relevant cell in the Property Display Name column. When you are finished making changes to the cell, click outside the cell to accept the changes. Display names can be up to 60 characters long. The identifier fields themselves can contain up to 1,000 characters.

The changes that you make here will apply to all new projects added to the database. If the database already contains projects, your changes will not affect the existing projects unless you select the **Apply to existing projects** option at the bottom of the window.

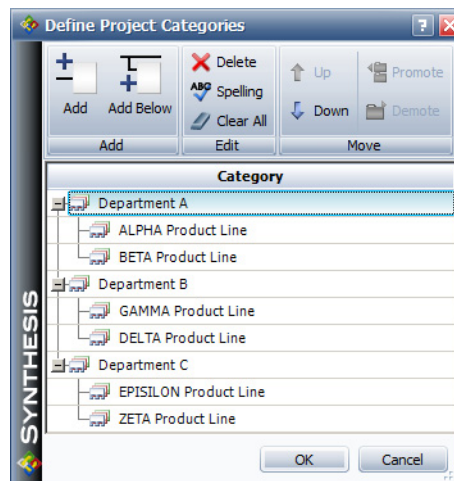
Tip: You can change identifiers at the project level on the Global Identifiers tab of the Project Properties window, which is accessed by choosing **Project > Management > Edit Project Properties**.

Selecting **Set as default for new databases** at the bottom of the window will save the settings that are currently displayed in the window as the default for all new standard databases that you create on your computer. If this check box is not selected, the default names given above (Name, Number, Version, etc.) will be used for new databases. This option is not applicable if you are working with an enterprise database.

2.4.5 Project Categories

Each Synthesis repository can contain a large number of analysis projects that may be accessed simultaneously by many different users. The flexible Project Categories feature allows you to group and manage the projects in a way that fits the specific needs of the users and the organization.

Just to give one simple example, the following picture shows a database that uses two category levels, where the projects are grouped first by department and then by product line. Of course, many other groupings could be defined depending on your particular objectives. You can add as many levels of indenture as needed.



This section describes how an authorized user can configure the categories for a particular database. These categories can then be applied to any project in the database (via the Project Properties window). They can also be used to filter any project in the list (via the Filter Properties window). For additional information, see http://Synthesis.Reliasoft.com/tips/project_categories.htm.

Defining Project Categories

Users with the “Manage other repository settings” permission can access the Define Project Categories window by choosing **File > Manage Repository > Project Categories**.



This window displays a list of the project categories that have been defined for the current database, shown in the order in which they will appear throughout the application. If you rename or delete a category, any projects that are already assigned will be updated automatically (the next time the interface is refreshed).

- To edit an existing category, double-click inside the cell and edit the text.
- To add a new category in the same level as the one that is currently selected, click **Add**.



- To add a new category in the level below the one that is currently selected, click **Add Below**.



- To move a selected category up or down within the same level, select the row and click **Up** or **Down**.



- To move a selected category to a different level, click **Promote** or **Demote**.



- To delete a category, select the row and press the **Delete** key or click the icon. To delete all categories at the same time, click **Clear All**. *There is no undo for delete.*



2.4.6 XFRACAS Connection

ReliaSoft's XFRACAS is a web-based, closed-loop, incident (failure) reporting, analysis and corrective action system designed for the acquisition, management and analysis of product quality and reliability data from multiple sources.

With the release of the Synthesis version, information in XFRACAS can be accessed via other Synthesis applications, allowing you to perform a variety of additional analyses on your XFRACAS data.

XFRACAS data is stored in a set of tables within a Synthesis enterprise repository. This means that when you are working with an enterprise database within other Synthesis applications, the XFRACAS data stored within the database is available. When you are working with a standard database, you can still work with XFRACAS data in any Synthesis application other than MPC. To do this, you simply specify where the XFRACAS tables of interest are located by choosing **File > Manage Repository > XFRACAS Connection**.



In the XFRACAS Connection Settings Window, you can specify that there are no associated XFRACAS tables for the current repository, or you can specify the connection settings for the enterprise repository that contains the XFRACAS tables of interest. Specifically:

- Choose the database type and version (i.e., Microsoft SQL Server 2005 or 2008, or Oracle 10 or 11).

- For SQL Server databases, enter the server name and database name. Select the **Use impersonation** check box if you want the connection settings to impersonate a Windows user account with a SQL Server login that can be shared by multiple users. This connection file can then be distributed to any user who does not have his/her own individual SQL Server login and is not part of an Active Directory group that has a login. *See Section 2.1.2.3 on page 30.*
- For Oracle databases, enter the port, host and service identifiers and the database schema. Your Windows login credentials are used for access to the database; enter your Windows password.

2.5 Backups and Database Maintenance: Protecting Your Data

Since each database may contain a large amount of valuable information that would be difficult to re-create, it is essential to make sure that you are diligent about storing adequate backups and performing the necessary maintenance activities to keep the database operating smoothly. The necessary procedures vary depending on the type of database.

Enterprise Database Maintenance

When you choose to store analysis information in an enterprise database, a database administrator must perform backups and database maintenance activities using the data management tools that are packaged with and/or designed for the database platform (e.g., SQL Server Enterprise Manager for SQL Server). Each individual organization typically establishes its own procedures for protecting the data stored in the Oracle or SQL Server databases. As a convenience for users who wish to explore the possibilities of an enterprise database implementation without making a large investment of time and resources, instructions on how to perform ReliaSoft's minimum database maintenance recommendations are posted on the ReliaSoft website:

See http://Synthesis.Reliasoft.com/sql_server.htm for SQL Server.

See <http://Synthesis.Reliasoft.com/oracle.htm> for Oracle.

Standard Database Maintenance

When you choose to store analysis information in a standard database, it will be subject to the same limitations and vulnerabilities as any other file that uses the Microsoft Access database file format. For example, the maximum file size is ~2GB, the maximum number of users is 255, etc. In addition, some specific database vulnerabilities are discussed in another Microsoft publication at <http://support.microsoft.com/kb/283849/EN-US/>. As this publication states:

“Microsoft Jet, the database engine that is used in Microsoft Access, is a file sharing database system. When Microsoft Jet is used in a multi-user environment, multiple client processes are using file read, write, and locking operations on a shared database. Because multiple client processes are reading and writing to the same database and because Jet does not use a transaction log (as do the more advanced database systems, such as SQL Server), **it is not possible to reliably prevent any and all database corruption.**” [emphasis added]

Although ReliaSoft's developers have made every effort to reduce or eliminate the possibility that the software will induce a database error, there is no way to absolutely prevent corruption that might be caused by other factors, such as faulty network hardware, an unexpected “crash” on your PC or a network interruption. Therefore, this section provides some recommendations for standard precautions that all users can take to protect the data in their standard databases from this type of corruption and reduce the impact of the data loss if corruption is unavoidable.

1. **Create backups regularly.** As with any resource that contains a large amount of valuable information that would be difficult to re-create, it is essential to make sure that you are diligent about creating and storing backup files. There are a number of ways this can be accomplished:
 - If you select **Automatically back up database upon closing** from the Synthesis Setup, any Synthesis application that you use to open the database will back up the database every time you close the file.

- If you have a database open and choose **File > Save As**, the application will create a copy of the database to a pathname/filename of your choosing.
 - If you browse to the database file (*.rsr9) in one of the Windows file management tools (such as My Computer or Windows Explorer), you can copy and paste the database file as needed.
2. **Compact and repair regularly.** Using the “Compact and Repair” feature will help to reduce the size of the database file and help to protect against problems with the operation of the database. If you have the database open and it is not currently in use by another user, you can initiate the process at any time by choosing **File > Manage Repository > Compact and Repair**.



3. Do not store the database in a shared network location if you suspect that your network connection and/or hardware may be unreliable. According to Microsoft, faulty network hardware is one of the main reasons why a file that uses the Microsoft Access database file format may become corrupted. As the Microsoft publication at <http://support.microsoft.com/kb/283849/EN-US/> states:

“The cause can be one or more links in the hardware chain between the computer that the database resides on and the computer that has the database open. This list includes, but is not limited to, network interface cards, network cabling, routers, and hubs.

Hardware-based corruption is typically indicated by .mdb files that cannot be restored through the use of compacting, repairing, or Jetcomp. **Hardware corruption will typically recur until the responsible hardware is repaired or replaced.**” [emphasis added]

If you have experienced this type of corruption for a standard database file, it is recommended that you take steps to correct the network problem or refrain from accessing database files over the network. In such cases, you may choose to use an enterprise database instead (i.e., Oracle or SQL Server), which would be less vulnerable to network interruptions. Alternatively, you could keep multiple analysis projects together in a single shared standard database file but ask users to export the analysis to a separate “working” database on their own computers when there is a need to make substantial modifications. Users could then import the data back into the shared database after the modifications have been completed.

4. **Do not allow the file size of the database to grow too large.** Performance will be affected by the size of the database and the number of simultaneous users. Therefore, it is important for users to monitor the sizes of their database files and take steps to export the data into several smaller and more manageable files if they become too large. Please be aware of the following factors, which can lead to very large database files:
- Failure to compact and repair the database on a regular basis.
 - Using a very large number of attached documents. In some cases, using a link instead of an attachment may provide equivalent functionality with a much smaller impact on the size of the database file.

If you try to open a standard database via the software and receive a message that says “Unable to open the database,” this is an indication that the database file may have become corrupted. Please contact ReliaSoft's Technical Support via phone, fax or e-mail and provide as much information as possible about exactly what you were doing when the corruption occurred. Whenever possible, please provide a copy of the corrupted file. In some cases, ReliaSoft may be able to provide assistance with salvaging some or all of the affected data. However, in many cases, the best recourse may be to restore the latest backup from before the corruption occurred.

2.5.1 Restore Points

One of the many data management capabilities offered by Synthesis is the option to create and manage restore points for any analysis project. Within the context of Synthesis, the phrase “restore point” refers to an exact replica of the project at a particular point in time (i.e., a backup) that can be restored when and if it is needed. A restore point will include all the data that the project contained at the time the restore point was created, including information about the project properties, security settings and project owner.

There are a variety of ways that this functionality could be used, depending on your particular analysis process and data management requirements. For example, if you are about to begin a major revision to an existing project, you could choose to archive the original version as a restore point and then proceed with updating the project. This would ensure that the active projects in the database contain only the most recent information but also provide easy access to a fully editable copy of the previous version of the analysis if it is ever needed.

The following sections describe how you can manage restore points.

What's Changed? In previous versions of the software, restore points were known as Project Baselines.

Create a Restore Point

If you are currently working in a project and you have any of the following permissions in the database:

- Project owner
- “Create restore points” permission
- “Manage other repository settings” permission

then you can create a restore point for the project at any time by choosing **Project > Management > Restore Point > Create Restore Point** or by right-clicking the name of the project in the project list and choosing the command on the shortcut menu.



IMPORTANT: When you create a restore point, any global resources used in the project are converted to local resources and stored with the backup. This ensures that you will have access to these resources upon restoration, regardless of what may have happened to the global resources in the interim.

Restore a Project

To restore all data from an existing restore point, use the **Restore Project** command. This opens the Restore Project window, which displays a list of all existing restore points for the project, if any. You have two options:

- **Overwrite existing project** allows you to roll back the current project to an earlier state. The restore process will complete as long as the project is not currently in use by another user. *There is no undo for project overwrites.* Therefore, it would be prudent to create a new restore point for the project before you overwrite it with one of the older restore points.
- **Create new project** allows you to use the restore point to create a new project. You may enter a unique name for the new project. When the restore process completes, the new project will be accessible from the project list.

Manage all Restore Points that Exist for the Database

If you have the “Manage other repository settings” permission, you can manage all the restore points that have been created in the database by choosing **File > Manage Repository > Restore Points**.



This opens the Restore Points window, which displays the details for each of the restore points. This includes the date when the restore point was created, the name of the restore point creator, the project name and any additional notes that the restore point creator may have added to help identify the purpose or context of the restore point. In Xfmea/RCM++/RBI, the project profile that was used to set the configurable project settings is also displayed.

- To create a new restore point, click the **Create** button. The Create Restore Point window will appear, which displays a list of all projects in the current database. Choose a project from the list, enter any notes that are appropriate to describe the purpose or the circumstances of the restore point and click **OK**.
- To delete an existing restore point, select the row and click the **Delete** button or press **DELETE**. *There is no undo for delete.*
- To create a new project that restores all of the data from an existing restore point, select the row and click the **Restore Project** button. You will be prompted to specify a unique name for the new project. When the process completes, you can close the Restore Points window and see that the new project is now accessible from the project list.

2.6 Import, Export and Data Conversion

Synthesis applications provide a variety of different tools for import, export and data conversion from external files and between Synthesis databases. The options will vary depending on which application you are currently using.

In all applications, you can:

- Import data from an existing database when you are creating a new one - Section 2.6.1 (p. 70)
- Convert and import data from prior version files - Section 2.6.2 (p. 71)
- Import/export selected projects - Section 2.6.3 (p. 80)

When applicable, you can also:

- Import/export selected project items or Synthesis resources - Section 2.6.4 (p. 80)
- Import from an Excel spreadsheet or delimited text file into a data folio - Section 2.6.5 (p. 82)
- Use XML files to import/export system configuration information in BlockSim or Lambda Predict - Section 2.6.6 (p. 85)

These features can be accessed either from the Import/Export Wizard (**Project > Management > Import/Export**) or from the Backstage View. *See page 130 in Chapter 4.*

In addition to the common functionality described in this chapter, some Synthesis applications provide other data transfer and import/export utilities that fit specific needs (e.g., the Import Bill of Materials feature in Lambda Predict, the Excel templates in Xfmea/RCM++/RBI, the ability to share analysis details between specific Synthesis applications.). For more information about these specialized tools, please consult the documentation for the particular application(s) involved.

2.6.1 Importing from an Existing Repository

When you are creating a new Synthesis repository, you have the option to import repository settings (e.g., user accounts, security groups, project categories, etc.) and/or entire analysis projects from another database.

If the **Import from existing repository** check box is selected when you start to create a new standard database or enterprise database, the Import Data from Existing Repository window will be displayed.

First, use the drop-down list or browse button (...) to select the database that you want to import from. This can be a standard database (*.rsr9) or an enterprise database connection file (*.rserp).

Then, use the check boxes to select the settings and/or projects you wish to import.

Finally, click **OK** to create the new database with the selected data imported.

Note: If you are creating a new enterprise database on SQL Server, the Create SQL Server login check box will be displayed at the bottom of the window. See Section 2.1.2.3 on page 30.

2.6.2 Importing from Prior Version Files

There are two ways to convert and import data from project files and standard database files that were created in previous versions of the software.

- Importing to a new standard database (**File > Open Repository**)
- Importing to an existing database and project (**Import > Other file**)

The options depend on which Synthesis application you're currently using:

- For Weibull++, ALTA, DOE++, RGA and BlockSim/RENO, you can use either method.
- For Lambda Predict, Xfmea/RCM++ and MPC, you must use the File > Open Repository method to import the data into a new project in a new standard database.

Finally, for an enterprise database created in Xfmea/RCM++ 5, there is a dedicated utility that you can access from the Backstage View. See Section 2.6.2.4 on page 75.

2.6.2.1 Importing to a New Standard Database (File > Open Repository)

For all Synthesis desktop applications, you can use the File > Open Repository method to import data from a project file or standard database that was created in a previous version of the software. This imports the data to a new project in a new standard database.

Do the following:

1. Choose **File > Open Repository**.
2. Browse for the file and click **Open**.
3. The conversion process will begin immediately for most applications. In BlockSim and MPC only, you will be prompted to specify some preferences and then click **OK** to proceed.
 - To convert from BlockSim 6 or 7 files, see Section 2.6.2.3 on page 72.
 - To convert from MPC 3 Databases, see Section 2.6.2.5 on page 77.

Note that although the conversion of Xfmea/RCM++ 5 databases does not require any user input, the process does apply some assumptions to address changes in the functionality and data structure between versions. For details, see Section 2.6.2.4 on page 75.

When the process completes, the original file will remain unchanged and the new standard database will be created in the same folder.

Tip: Once the new database has been created, you can use the Import/Export Projects feature to copy the data into an existing database, if desired. See Section 2.6.3 on page 80.

2.6.2.2 Importing to an Existing Database and Project (Import > Other file)

For the applications and file types shown in the following table, you can use the Import > Other file method to import data from a project file that was created in a previous version of the software. This imports the data to a selected project in an existing standard database or enterprise database.

Weibull++/ALTA	DOE++	RGA	BlockSim/RENO
ReliaSoft Office 7 projects (*.rso7)	ReliaSoft Office 7 projects (*.rso7)	RGA 7 projects (*.rga7)	BlockSim 7 projects (*.rbp)
Weibull++ 7 projects (*.rwp)	DOE++ 1 projects (*.rdoe)	RGA 6 projects (*.rga)	BlockSim 6 projects (*.rb6)
ALTA 7 projects (*.ralp)			RENO 1 projects (*.rnp)
Weibull++ 6 projects (*.rw6)			
ALTA 6 projects (*.ra6)			

Do the following:

1. Create a new project or open an existing project that you want to import the data into.
2. Choose **Project > Management > Import/Export > Import**.



3. In the Import wizard, choose **Other file** and click **OK**.
4. The conversion process will begin immediately for most applications. In BlockSim only, you will be prompted to specify some preferences and then click **OK** to proceed. *See Section 2.6.2.3 on page 72.*

Note that although the conversion of Xfmea/RCM++ 5 databases does not require any user input, the process does apply some assumptions to address changes in the functionality and data structure between versions. For details, see Section 2.6.2.4 on page 75.

When the process completes, the original file will remain unchanged and the converted data will be copied into the selected project.

2.6.2.3 Converting from BlockSim 6 or 7 Files

When you import from a BlockSim 6 (*.rb6) or BlockSim 7 (*.rbp) file, the Conversion Settings window allows you to specify:

- Whether you want the diagrams to be converted to analytical diagrams, simulation diagrams, or both.
- Whether the application will attempt to merge identical records when certain block properties are converted to Synthesis resources. For example, if the old diagram has two blocks with the same failure distribution, this can be imported as two separate but identical failure models, or as a single failure model that's linked from both blocks.

Tip: The default preferences for merging identical resources upon conversion are set on the Conversion page of BlockSim's Application Setup (**File > Application Setup**). Note that any changes you make in the Conversion Settings window will update your preferences in the Application Setup. In other words, the same options will be selected by the default the next time you attempt to convert a BlockSim 6 or 7 file on this computer.

Conversion Constraints and Differences

Numerous improvements have been made to the modeling capabilities and underlying analysis and simulation algorithms used in the Synthesis version of BlockSim. As a result, analysis or simulation of diagrams imported from previous versions of BlockSim may yield results that differ from the results originally obtained. In particular, results may differ in the following cases and/or for the following reasons:

- **Simulation diagrams:**

- When multiple blocks are used in conjunction with subdiagrams, the underlying order of block expansion differs between versions, so results may differ.
- In the Synthesis version, containers are treated as subdiagrams. The underlying order of block expansion differs between versions, so results may differ. However, some special cases will produce identical results. These include cases where:
 - The container is the only block in the diagram.
 - The container is at the end of the list in the original diagram (i.e., it was created last and has the highest block ID, which is automatically assigned by the software upon block creation).
- The load on contained load sharing blocks is calculated differently. Version 7 required a life-stress relationship for such configurations and based the re-calculation of load after block failure on that relationship; the Synthesis version calculates load using the weight proportionality factor as a multiplier.
- Normal/lognormal distributions have increased precision in the Synthesis version.
- Maintenance tasks that are performed at specified intervals (based on item age or calendar time) for multiple blocks are performed in a different order, producing results that are not identical, although the difference will not be statistically significant.
- Indirect cost is calculated differently. In version 7, the following was calculated at the end of the simulation:

$$\text{Indirect cost} = \text{Average stock level} * \text{Holding cost per item} * \text{Simulation end time}$$

In the Synthesis version, the indirect cost is calculated for each simulation and then averaged at the end to yield the indirect cost that is shown. This is because holding cost per item may be a distribution in the Synthesis version.

- The order in which random numbers are assigned in general is by block ID. This means that if diagrams have the same blocks with the same IDs in both the previous version and the current version, the results will be identical. Standby containers represent an exception to this. In version 7, the order of blocks is overwritten by the standby priority. Therefore, results may not be identical with standby containers if the block IDs do not match the block standby priorities. The difference should not be statistically significant.
- For mirrored blocks, in version 7, the block that fails is the source and all the other mirrors are assigned these failures. In the Synthesis version, the failures are assigned to the mirrored block with the lowest block ID. If the failure source is not the block with the lowest ID, then the results will be different between versions.
- Mirrored blocks inside subdiagrams are handled differently. In version 7, they were treated as different groups of mirrors; the Synthesis version treats them as the same group. This may produce results that are statistically different.
- Throughput is not available in fault trees in the Synthesis version.
- The throughput property **Send units to failed blocks** works differently for subdiagrams in the Synthesis version, in that it applies to the whole diagram. That is, if the current block is set to not send units to failed blocks and the next block is a subdiagram that is not operating, then the throughput will be re-routed if possible or the current block will accumulate backlog.

- Phases have different rules on how interrupted events are handled and may give different results when re-simulating.
- In the Synthesis version, containers do not exist in maintenance phases. Thus, the availability results for containers in phase simulation may be different than in previous versions.
- **Analytical diagrams:**
 - The load on contained load sharing blocks is calculated differently. Version 7 required a life-stress relationship for such configurations and based the re-calculation of load after block failure on that relationship; the Synthesis version calculates load using the weight proportionality factor as a multiplier.
 - Mirrored blocks inside subdiagrams are handled differently. In version 7, they were treated as different groups of mirrors; the Synthesis version treats them as the same group. This may produce results that are statistically different.
- **Other issues of interest when opening BlockSim 7 files:**
 - Nodes do not have failure/maintenance properties in the Synthesis version. Therefore, if a node has failure properties in BlockSim 7, it will be imported in the current version as two blocks: a node with the k-out-of-n and the throughput properties (if applicable) and a block with the failure properties positioned immediately after the node. If the node does not have failure properties, a second block will not be imported.
 - The load on contained load sharing blocks is calculated differently. Version 7 required a life-stress relationship for such configurations and based the re-calculation of load after block failure on that relationship; the Synthesis version calculates load using the weight proportionality factor as a multiplier. Because of this, if you convert a diagram that uses load sharing containers, you will need to manually configure the contained load sharing blocks after conversion.
 - Simulation FRED reports will be imported, but cannot be restarted or have levels appended/removed until the diagram is resimulated.

In addition, certain rules apply when importing maintenance properties from BlockSim 7:

- Preventive maintenance:
 - For each preventive maintenance setting, a new task will be created. For example, if the preventive maintenance policy is set to be performed upon system down and upon system age, two tasks will be created.
 - For each task created, the duration, crews, restoration factor, etc. will be identical.
- Inspections:
 - For each inspection setting, a new task will be created. For example, if the inspection policy is set to be performed upon system down and upon system age, two tasks will be created.
 - For each task created, the duration, crews, restoration factor, etc. will be identical. Note that inspections do not use pools.
 - If a detection threshold is defined in version 7, an on condition task will be created instead of an inspection task in the Synthesis version. A threshold is defined in version 7 if a Failure Detection Threshold greater than 0 and less than 1 is specified or if a P-F Interval greater than 0 is specified.
 - The inspection properties from version 7 will be transferred to the inspection properties of the on condition task in the Synthesis version.
 - The threshold (i.e., detection) information from version 7 will be transferred to the failure detection properties of the on condition task in the Synthesis version.
 - The preventive maintenance properties from version 7 will be transferred to the on condition task (upon detection) properties of the on condition task in the Synthesis version.
 - If a detection threshold is defined in version 7 but no preventive maintenance properties are defined, then only an inspection task will be created (i.e., the threshold is ignored).

- PM/Inspection based on group:
 - A task will be added and assigned to the maintenance group that the block belongs to. For example, if Block 1 belongs to Item Group 1 and has an inspection policy based on group maintenance in version 7, then in the Synthesis version an inspection task will be created and will be set to be performed upon group maintenance. Maintenance Group 1 will be checked in the list of groups that will trigger a maintenance, and Block 1 will be assigned to Maintenance Group 1.
 - If the block does not belong to a group, a task will not be added.
- The corrective maintenance properties will be imported as corrective tasks.
- A preventive maintenance action or an inspection based on maintenance phase and associated with a block in a standard phase will not be imported.

2.6.2.4 Converting Xfmea/RCM++ 5 Databases

You can convert/import data from an Xfmea/RCM++ 5 database into a Synthesis repository. This section describes:

- How to convert an Xfmea/RCM++ 5 standard database (*.rx5).
- How to import selected data from an Xfmea/RCM++ 5 enterprise database.
- Some conversion assumptions and tips that you should be aware of.

For information about converting and importing data from an Xfmea/RCM++ 5 library, please consult the “Configurable Settings” chapter in the Xfmea/RCM++/RBI documentation.

Standard Databases (*.rx5)

For Xfmea/RCM++ 5 standard databases, you must convert the entire *.rx5 file to a new Synthesis standard repository. (Later, you can use the Import/Export Projects feature to copy specific projects into an existing database, if desired.)

Do the following:

1. In the Synthesis version of Xfmea, RCM++ or RBI, choose **File > Open Repository**.
2. Select **RCM++ 5/Xfmea 5 (*.rx5)** from the **Files of type** drop-down list.
3. Select the file you wish to convert and click **Open**.

The application will create a new standard database file in the same directory with the extension *.rsr9; the existing *.rx5 file will remain unchanged.

Enterprise Databases

For Xfmea/RCM++ 5 enterprise databases, you can select which analysis projects and settings you wish to import into a Synthesis enterprise repository that has already been created.

Do the following:

1. Connect with the enterprise database you want to import into.
2. Choose **File > Manage Repository > Enterprise > Import from Prior Version**. (Note that this command is visible only if your user account has Admin permissions in the database.)

3. In the area at the top of the Import from Version 5 Enterprise Database window, enter the connection information for the Version 5 enterprise database and click **Connect**.
4. The table shows all of the data and settings in the original database. Use the check boxes to select which data you wish to import and then click **OK** to start the transfer.

Note: If you are importing into a SQL Server database, the **Create SQL Server login** check box will be displayed at the bottom of the window. This is applicable only if you are importing user accounts. See *Section 2.1.2.3 on page 30*.

Conversion Assumptions and Tips

When you convert data from an Xfmea/RCM++ 5 database, please consider the following assumptions and tips:

- **Conversion to Synthesis Resources**

Certain types of information in the Version 5 projects will be converted to *resources* in the Synthesis version. This includes reliability information (which will be converted to models), controls and actions. In these cases, records that have identical properties will be merged into a single resource. For example, if there were two identical actions in the original project, a single action would be created as a resource in the Synthesis project and used in both locations.

- **Conversion to Security Groups**

If you are working with secure databases, the access levels and access groups in Version 5 will be converted to security groups in Synthesis. Specifically:

- Repository-level security: User permissions assigned by access level in Version 5 will be assigned by the corresponding security group in the Synthesis version. For example, if a user had the Admin access level in the original database, then that user will be assigned to the Admin security group in the Synthesis version. If there is no corresponding security group in the Synthesis version, the user will be imported with no security groups assigned, and a user with “Admin” access level permissions will have to manually assign security groups to the imported user.
- Project-level security: For each access group in the Version 5 database, a security group will be created in the Synthesis repository. Because the Version 5 access groups could have different access levels for different users in the same group, it is not possible to automatically determine which permissions should be assigned for the new security group in the Synthesis version. Therefore, these groups will initially be assigned the default permissions; you can edit the permissions via the Security Groups tab of the Manage Repository Security window. Projects that had access limited by access group in Version 5 will continue to have their security set by the appropriate security group(s) at the project level in the Synthesis version.

- **Configurable Settings for Converted Projects**

When you convert an existing project from Version 5, the application will add new configurable settings for new features that were added in the Synthesis version. For example, the configurable PFD Worksheet settings will be added to the interface style, the quantitative values will be added to the occurrence rating scale, etc.

It is important to note that these default settings may need to be modified after the conversion. For details, please consult the “Configurable Settings” section in the Xfmea/RCM++/RBI User’s Guide.

2.6.2.5 Converting MPC 3 Databases

If you have an existing systems and powerplant analysis that was created in MPC 3, it is easy to convert the *.rsm file into a new Synthesis repository.

Choose **File > Open Repository**, select MPC 3 (*.rsm) from the **Files of type** drop-down list, and then browse for the desired file.

When prompted to enter a username and password, enter the administrative login from the old *.rsm file.

Note: By default, a converted Version 3 database is a secure database that transfers any user accounts that were defined in the old database. After the new database has been created, the administrator should review the automatically created user accounts and update as appropriate. See *Section 2.3 on page 44 for more information about database-level security.*

The final step is to use the Tasks Conversion window to review the task records that will be imported and make any updates that may be needed (see details below). Once you have completed the review, click **OK** to start the import.

When the process completes, there will be a new standard database file in the same folder and with the same name as the original *.rsm file. The new file will have the extension *.rsr9 and the original *.rsm file will remain unchanged.

Tasks Conversion Window

The Tasks Conversion window displays a list of all of the tasks defined in the original database and allows you to review how the records will be converted upon import. For any properties that are displayed with blue text, you have the option to change the task record data before it is imported.

Some task properties are handled a bit differently in Version 9 than they were in Version 3. Specifically:

- Some of the **Task Types** that were combined in Version 3 are now categorized separately in Version 9 (e.g., Operational Check (OPC) and Visual Check (VCK) are now separate task types).
- In Version 3, the task **Interval** was always stored as a text field. In Version 9, you can choose whether each task's interval will be stored as a text field or if it will instead be recorded as a number with an associated time unit (e.g., 2000 flight hours can now be stored as value=2000 and time unit = FHR). Numbers may be easier to sort and will also make it possible to perform simulation-based reliability calculations if you choose to import the analysis project to RCM++ or RBI.
- The **Zonal** field from Version 3 is called **Zonal Candidate** in Version 9. This is now a yes/no field that can be set to **Yes** only if the failure effect categorization (FEC) is set to 5 or 8 (i.e., a safety issue) and the task type is "General Visual Inspection (GVI)." Also in Version 9, the **Zone** field will be enabled only if Zonal Candidate is set to **Yes**.

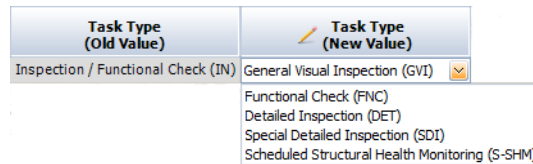
The following subsections describe the default conversion logic for Task Type, Interval and Zone.

Task Type

For the **Discard** and **Restoration** task types, there is no difference between Versions 3 and 9. The text in the Task Type (New Value) column will be displayed in italics to indicate that this property cannot be changed via the Tasks Conversion window.

Task Type (Old Value)	Task Type (New Value)
Discard (DS)	<i>Discard (DIS)</i>
Restoration (RS)	<i>Restoration (RST)</i>

For the remaining task types, the software will use the logic specified below to suggest a task type, but the property will be displayed in blue text to indicate that it can be edited. If you disagree with the default selection, you can choose one of the other eligible task types from the drop-down list, as shown in the following example.



- When the task type was set to **Inspection/Functional Check (IN)** in Version 3, the following logic will be applied in the specified order. For example, if the task description contains both the word “Visual” and the word “Function,” the General Visual Inspection task type will be applied by default because the word “Visual” will be matched first.

If the task description contains:	The default option is to import the task as:
Visual	General Visual Inspection
Special Detail	Special Detail Inspection
Health Monitor	Scheduled Structural Health Monitoring
Function	Functional Check
none of the words/phrases listed above	Detailed Inspection (DET)

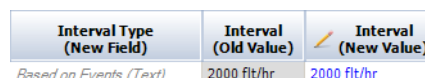
- When the task type was set to **Lubrication/Servicing (LU)** in Version 3, the default option is to import the task as Servicing (SVC) if the task description contains “Servic” and as Lubrication (LUB) if it does not.
- When the task type was set to Operational/Visual Check (OP) in Version 3, the default option is to import the task as Visual Check (VCK) if the description contains “Visual” and as Operational Check (OPC) if it does not.

Tip: The task types in MPC 9 are determined by the requirements of the MSG-3 guidelines and cannot be changed. However, the abbreviations can be configured to fit your particular preferences. If you want to change the default task type abbreviations (e.g., if you don't want to use DIS for Discard, RST for Restoration, etc.), click the **Task Type Abbreviations** button. The changes that you make in the Define Task Type Abbreviations window will automatically apply to all analyses in the current database. This window is also accessible from **File > Manage Repository > Task Types**.

Interval Type and Interval

Two options are displayed at the top of the Tasks Conversion window to determine how the task intervals will be imported:

- If you choose **Transfer all intervals as text**, the interval type for all imported task records will be set to **Based on Events (Text)** and the interval will be stored as a text field (just like in MPC 3). The Interval (New Value) column will be displayed in blue text to indicate that you can change the text if desired before the import.



- If you choose **Transfer intervals as numeric if possible**, the application will check to see if the original task interval begins with a number and is followed by a space and at least one text character. If it does (e.g., “2000 ft/hr”), the default option is to import it as a number with an associated time unit. If not (e.g., “Per Mfg Life Limit”),

the default is to import as text. Either way, you have the option to change both the interval type and new value before the import. For example:

Interval Type (New Field)	Interval (Old Value)	Interval (New Value)
Fixed (Numeric)	8000 flt/hr	8000 Fligh...

Interval Type (New Field)	Interval (Old Value)	Interval (New Value)
Fixed (Numeric)	8000 flt/hr	8000 (Fhr)
Fixed (Numeric)		
Based on Events (Text)		

Tip: If you want to change the time units displayed in the drop-down list, click the **Time Units** button. The changes that you make in the Manage Units window will apply immediately to the tasks that you are currently importing, and also to all other analyses you may later add to this database. This window is also accessible from **File > Manage Repository > Manage Units**.

The Tasks Conversion window uses a variety of techniques to try to match the text field from Version 3 with one of the specified time units in Version 9. There will be a match if the name or abbreviation of a Version 9 time unit either starts with or contains the text in the Version 3 field. For some predefined time units, the software also recognizes other commonly used abbreviations for the time unit (e.g., the software will recognize any of the following abbreviations as flight hours: Flt/Hr, Flight H, Flt H or Flt/H).

If your data set contains a task interval that is not recognized, you can do any of the following:

- Edit the text in the **Interval (New Value)** column so it will match either the name or the abbreviation of a predefined time unit. For example, if the Version 3 task record contains a misspelling for “2000 flight hours,” you can click inside the cell and remove the extra i.
- Click the **Time Units** button and define a new time unit for the database with a name or abbreviation that matches the data you want to import. For example, if the Version 3 task record has an interval of “5 Weeks,” you can open the Manage Units window and create a new time unit with the name “Weeks.”
- Click **Cancel** to close the Tasks Conversion window then edit the original tasks in MPC 3 before starting the import again.

Zonal Candidate and Zone

If all of the following conditions are met, the **Zonal Candidate (New Value)** column will be set to **Yes** by default and any information from the **Zone** field will be transferred during the import:

- The failure effect categorization (FEC) is set to 5 or 8 (i.e., it is a safety issue).
- The Task Type is set to General Visual Inspection (GVI).
- The Zonal property in the original MPC 3 analysis contains the word “Transfer.”

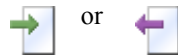
If you don't want the task to be considered for zonal analysis even though it meets the requirements, you can click inside the Zonal Candidate (New Value) column and choose No from the drop-down list. If this column displays No in italics, this indicates that at least one of these conditions is not met and the property cannot be changed.

Zonal (Old Value)	Zonal Candidate (New Value)	Zone (Old Value)	Zone (New Value)
Transfer	Yes	400	400
-	<i>No</i>	400	
Transfer	Yes	400	400
	No		
	Yes		

2.6.3 Importing/Exporting Projects

All Synthesis desktop applications make it easy to import or export selected projects from one database to another.

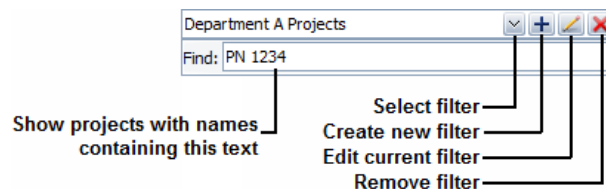
First, choose **Project > Management > Import/Export**.



In MPC, the import/export window opens directly. In all other applications, a wizard displays the options that are relevant for the current application. Select **Projects** and click **OK**.

Once the Import Projects or Export Projects window is open, do the following:

- Use the drop-down list or browse button (...) to select the database that you want to import from or export to.
 - This can be any existing standard database (*.rsr9) or enterprise database connection file (*.rserp).
 - If you are exporting, you can also use the add button (+) to create a new standard database to export into.
- The tree displays the projects that are available to be imported or exported. If desired, you can use the **Filter** and **Find** tools to limit the list of projects displayed. *For details, see page 95 in Chapter 3.*



- Use the check boxes to select which project(s) you want to import/export then click OK to copy the data.

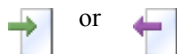
Tip: Project names must be unique within each database. If you attempt to import/export a project with a name that already exists in the destination database, the application will automatically increment the name. For example, if "Project1" already exists, the new project might be renamed to "Project1_1," "Project1_2," etc.

2.6.4 Importing/Exporting Project Items or Resources

When applicable, Synthesis applications make it easy to import/export selected project items (e.g., folios, diagrams, plot sheets, workbooks, etc.) or Synthesis resources (e.g., models, maintenance tasks, etc.) between existing projects. The projects can be in the same database or in different databases.

- The **Items** option is available for all desktop applications except Xfmea/RCM++/RBI and MPC.
- The **Resources** option is available for all desktop applications except MPC.

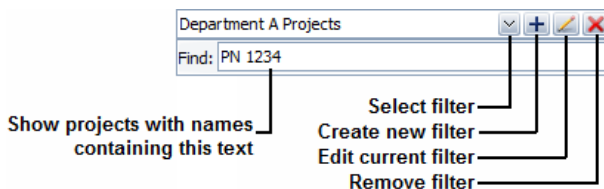
First, open the project that you want to import to or export from and choose **Project > Management > Import/Export**.



In the wizard, choose **Items** or **Resources** and click **OK**.

Once the Import Window or Export Window is open, do the following:

1. Use the drop-down list or browse button (...) to select the database that you want to import from or export to.
 - This can be the current database, or you can choose another existing standard database (*.rsr9) or enterprise database connection file (*.rserp).
 - If you are exporting, you can also use the add button (+) to create a new standard database and project to export into.
2. Use the tree in the **Source Project** or **Destination Project** area to select the project that you want to import from or export to. If desired, you can use the **Filter** and **Find** tools to limit the list of projects displayed. *For details, see page 95 in Chapter 3.*



3. Use the check boxes in the **Select Items** area to select which project items or resources you want to import/export.
 - For project items, this area will display the same folders that appear in the current project explorer. A +/- icon next to the folder indicates that it contains at least one project item that can be imported or exported.
 - For resources, this area will display a folder for each type of Synthesis resource that exists in the selected project.
4. Click **OK** to copy the data.

Tip: The names of project items and resources must be unique within each Synthesis project. If you attempt to import/export something with a name that already exists in the destination project, the application will automatically increment the name. For example, if "Folio1" already exists, the new folio might be renamed to "Folio1_1," "Folio1_2," etc.

Keeping Associated Items/Resources Together

It is important to note that some project items and resources link to other items or resources in the same project. For example, an overlay plot usually links to at least one analyzed folio or diagram. Likewise, a URD (universal reliability definition) resource usually links to a variety of different models, maintenance tasks, crews, etc.

In the case of project items, the application will automatically import/export the associated analyses, even if you did not specifically select to import/export them. For example, if you select to import an overlay plot, the folio(s) or diagrams(s) that were used to generate the plot will be automatically imported along with the plot.

In the case of Synthesis resources, the application will automatically copy any linked resources. For example, if you select to import a URD, all associated models, maintenance tasks, crews, etc. will be imported regardless of whether you selected each individual check box.

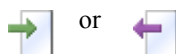
2.6.5 Importing from Excel or Delimited Text Files

In Weibull++/ALTA, RGA and DOE++, it is easy to import data from any of the following file types into a folio.

- Excel files (*.xls, *.xlsx)
- Tab, comma, space and semicolon delimited files (*.txt, *.csv, *.prn, *.smc)

Tip: Other Synthesis applications use different tools for importing/exporting via Excel (i.e., for importing Bill of Materials data in Lambda Predict and failure mode data in Xfmea/RCM++/RBI and MPC). For more information about those features, please consult the documentation for each particular application.

First, open the project that you want to import into and choose **Project > Management > Import/Export**.



In the wizard, choose **Other file** and click **OK**.

Browse for the file you wish to import from and click **Open**. Note that:

- In DOE++, the data will be copied into a new free form folio, where you can then designate columns for factors and responses and analyze the data. If you are importing from an Excel file that has multiple worksheets, the sheet that was active the last time the file was opened will be used.
- In Weibull++/ALTA and RGA, you will need to specify which data will be imported and how it will be mapped to the columns in the particular type of data folio. The following sections describe how to map the data for import into a Weibull++, ALTA or RGA data folio. This includes:
 - Selecting which data sheets will be imported
 - Using the control panel to map the columns that will be imported
 - Setting the import template directory
 - Creating a new import template
 - Applying a saved import template
 - Importing the data

2.6.5.1 Selecting Which Data Sheets Will Be Imported

The left side of the utility displays the data from the Excel or delimited text file that is currently selected. If you wish to open a different source file, click **Open**.



If you are importing from an Excel file that has multiple worksheets, use the tabs at the bottom of the window to view and set the import preferences for each sheet.

Use the options at the top of the control panel for each sheet to specify whether the data will be imported.

- **Do not import sheet:** The control panel will not contain any other options and the data will not be imported.
- **Import sheet:** The control panel displays the options you need to either manually map the columns or use a template to automatically apply the same mapping that was used for another file.

2.6.5.2 Using the Control Panel to Map the Columns That Will Be Imported

If you are not using a template, or if you need to modify the settings after an import template has been applied, do the following:

1. Use the **Data Type** drop-down list to specify which type of folio to import into.
 - This can be different for each sheet, and it determines which options will be available in the rest of the control panel.
2. Click inside each column that you wish to import and then click the corresponding button in the control panel to map it to a column in the data folio. This updates the column header and maps the data to a column in the data folio.
 - If the header displays a letter, the data in that column will not be imported.
 - If the header displays a name, the data will be imported to the column associated with that name.
 - To remove the column mapping, click inside the column and click the corresponding button again.

As an example, the following picture shows data that will be imported into a Weibull++ standard folio. Column A will not be imported. The rest of the data has been assigned to columns that are used in the standard folios.

	A	Number in State	Last Inspected	State F or S	Time	Subset ID
1	Row #	Qty	Last Inspected	F/S	End Time	Failure Mode
2	1	5	0	F	6.12	Mode 5
3	2	16	6.12	F	19.92	Mode 3
4	3	12	19.92	F	29.64	Mode 6
5	4	18	29.64	F	35.4	Mode 6
6	5	18	35.4	F	39.72	Mode 1
7	6	2	39.72	F	45.24	Mode 2
8	7	6	45.24	F	52.32	Mode 4
9	8	17	52.32	F	63.48	Mode 5
10	9	73	63.48	S	63.48	End of Test

3. If you are importing to an ALTA standard folio, use the **Number of Stresses** field to specify how many stress columns will be created in the new folio (maximum = 8). Note that:
 - If you enter a value that is less than the number of columns that were mapped with the **Stress** button, the “extra” stress column data will not be imported.
 - If the number is greater, the additional stress columns will be created in the new folio and you can enter the data later.
4. If the source file contains column headings or other introductory material that should not be imported, use the **Start from Row** field to specify where the actual data begins. For example, in the picture above, the first row contains heading labels so the data import should begin from Row 2.

2.6.5.3 Setting the Import Template Directory

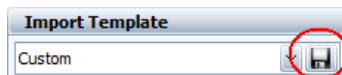
If you will be importing data from multiple files that have the same structure, you can use saved template files (*.waim in Weibull++/ALTA or *.rgaim in RGA) to automatically map the columns for all other similar files that you need to import from.

By default, template files will be stored at C:\Users\<username>\AppData\Roaming\ReliaSoft\<application>\Import Templates. This directory determines which templates will be displayed in the **Import Template** drop-down list in the control panel. It also sets the default path for saving any new templates you create.

If you want to access templates from a different location, click the **Import Template Directory** button at the top of the window and select a different folder.

2.6.5.4 Creating a New Import Template

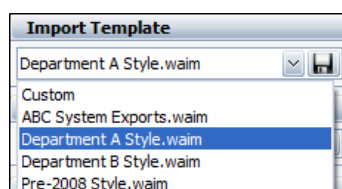
1. Open a data file and use the control panel buttons to map the columns.
2. Click the **Save** icon in the Import Template area on the control panel.



3. Specify a name and click **Save**.

2.6.5.5 Applying a Saved Import Template

1. Open the data file and select **Import sheet** to display the rest of the control panel options.
2. Make sure the **Import Template Directory** is set to the folder that contains the applicable template file(s).
3. Use the drop-down list in the **Import Template** area to select the template you want to apply.



The utility will automatically assign the column mappings defined in the template. If desired, you can use the control panel to make further adjustments before import.

4. When you are satisfied with the mapping, click **Import** to create the new folio.



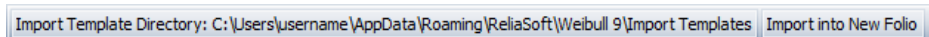
Tip: If you make adjustments after applying the template, you have the option to click **Save** in the **Import Template** area to either replace the existing template, or create a new template with a different name.

2.6.5.6 Importing the Data

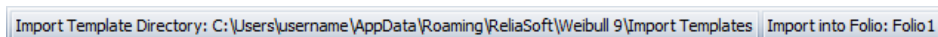
When you are ready to import the data, click the **Import** button.



By default, the application will import the data into a new standard folio. The status bar will display “Import into New Folio,” as shown in the following example.



If you prefer to import into an existing folio instead, click the **Import to Existing Folio** button and choose one of the available folios. When you return to the import window, the status bar will now display the name of the selected folio, as shown in the next example.



2.6.6 Using XML in BlockSim and Lambda Predict

In BlockSim and Lambda Predict, you have the option to use XML (extensible markup language) files to import or export system configuration data and item properties.

Both applications utilize open schemas published by ReliaSoft. You can use these files to transfer data to/from other applications or database systems.

In BlockSim, the XML files include the block properties and information about how the blocks are connected in a reliability block diagram or fault tree diagram. They do not include visual aspects such as diagram style settings, block style settings, etc. BlockSim supports both import and export via XML.

In Lambda Predict, the XML files include the structure of the system hierarchy in a prediction folio and some of the item properties. Lambda Predict supports export to XML.

Exporting to XML

To create an XML file, first open the project and then choose **Project > Management > Import/Export > Export**.



In the wizard, choose **Other file** and click **OK**.

Specify the desired pathname/filename and click **Save**. This will export the relevant information for all of the diagrams or prediction folios in the current project. Other project items (such as RENO flowcharts, plots, attachments, etc.) are not included.

Importing from XML

There are two ways to import from an XML file.

If you want to import to a new project in a new standard database:

1. Choose **File > Open Repository**.
2. Browse for the file and click **Open**.

If you want to import to a selected project in an existing standard database or enterprise database:

1. Create a new project or open an existing project that you want to import into.
2. Choose **Project > Management > Import/Export > Import**.



In the wizard, choose **Other file** and click **OK**.

3. Browse for the file and click **Open**.

2.7 Importing XFRACAS Data to Weibull++ or RGA

Starting with Version 9, you can access XFRACAS data from within Weibull++ or RGA for life data analysis or reliability growth analysis. This functionality is available when you are working with an enterprise database that has XFRACAS data in it, or when you are working with a standard database that has a connection to external XFRACAS tables defined (*see Section 2.4.6 on page 66*).

Accessing XFRACAS data is a two-part process.

- First, you specify the components of interest and pull the data from XFRACAS into the Reliability Data Warehouse (RDW) - Section 2.7.1 (p. 86)
- Once the data set is in the RDW, you can:
 - View the data in a variety of graphical presentations via the Dashboard Viewer. This tool is also available for viewing BlockSim simulation results - Section 2.7.4 (p. 90)
 - Choose the incidents to include in the Weibull++ or RGA data set and extract the data to a standard folio - Section 2.7.2 (p. 87)

2.7.1 Transferring Data from XFRACAS to the Reliability Data Warehouse (RDW)

In Weibull++ and RGA, the Reliability Data Warehouse (RDW) allows you to view data from XFRACAS. Data in the RDW can be extracted to standard folios for data analysis. To bring data into the RDW, choose **Project > Synthesis > XFRACAS to RDW**.



Note: This command is available only in Weibull++ or RGA, and only when you are working with an enterprise database that has XFRACAS data in it, or when you are working with a standard database that has a connection to external XFRACAS tables defined (*see Section 2.4.6 on page 66*). It is available to users with the “Create/edit/define global resources” permission in Synthesis and the “Synthesis - Read Data” permissions for the associated XFRACAS tables.

If no XFRACAS entity has previously been selected for the current database, then you will be asked to select an entity to import from. Otherwise, the last selected entity will be used. Once an entity has been selected, the XFRACAS to RDW interface will open. You can select a different entity at any time by clicking the **Change Entity** icon on the control panel.



The **Select Parts** area displays all available parts in the XFRACAS entity, organized by system hierarchy. In this area, select the check box for each part that you want to pull incident (i.e., failure) data for.

Tip: You can configure the appearance of the window and filter the data in the table, as explained in Section 2.7.3 on page 89.

In Weibull++, the application will pull all incident data for the selected parts into the RDW data set. In RGA, you can use the **Additional Settings** area of the control panel to filter the data that you want to pull. You can decide:

- Whether to include only system down events, or all types of events.
- Whether to include only data for systems commissioned between specified dates, or data for all systems.

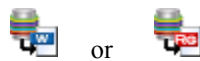
When you have selected all of the parts of interest and specified any relevant settings, click the **Send to RDW** icon on the control panel.



You will be prompted to name the data set. It is important to remember that each data set you create is a static record of the XFRACAS data at that point in time (i.e., the data set will never be updated). For this reason, you may want to name your data sets in a way that clearly indicates when they were created. When you click **OK**, the extraction process will begin. Depending on the amount of data that you are extracting, this may take some time.

2.7.2 Transferring Data from the Reliability Data Warehouse (RDW) to a Standard Folio

Once XFRACAS data has been pulled into the RDW, you can extract it to a Weibull++ or RGA standard folio at any time. To do this, choose **Project > Synthesis > RDW to Folio**.



The RDW to Folio window will appear, with the most recent data set displayed.

In this window, you will specify which data you want to extract and how the values in the data should be entered in the resulting standard folio.

Selecting the Data to Extract

You can work with one or more data sets at a time. Working with multiple data sets may be useful in certain circumstances. For example, if you have extracted an individual data set for each version of a part, you can select all of those data sets in order to analyze all versions together. To change the data set(s) that you are working with, choose **Data Set > Select Analytical Data Set**.



Choose the desired data set(s) in the Select Analytical Data Set window, then click **OK** to display the data set(s) in the RDW to Folio window.

Note: You can use the Auto Filter row, which appears immediately below the column headers, to help you find data sets of interest.

Additionally, you can double-click a data set name to rename it, and click the **Delete** icon to delete the selected data set(s). Each data set is a static record of the XFRACAS data at the moment of data set creation (i.e., the data set will never be updated). Therefore, you may want to ensure that data set names clearly indicate when they were created, and delete old data sets when they are no longer applicable.

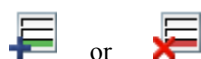
Each row in the table represents an incident from XFRACAS and can be extracted as a data point in the resulting data set.

- In Weibull++, incidents are considered failures if the Incident Category in XFRACAS is Chargeable and the replaced part has a failure type of “failure.” All other incidents are considered suspensions.
- In RGA, the Top Level Serial Number column is used to determine the System ID for each system. The earliest data point for each system will be considered the start time and the latest data point will be considered the end time.

The Export Status column shows whether each row will be included in the extraction.

- **Included:** Incidents that will be included in the Dashboard chart and/or exported to the standard folio are shown in green.
- **Invalid:** Incidents with a State Time of less than 0 are shown in red.
- **Ignored:** Incidents with a State Time of 0 and marked as suspensions in the State FS column are shown in gray. This applies only in Weibull++.
- **Excluded:** Incidents that have been manually excluded are shown in blue.

By default, incidents that are marked as Invalid or Ignored will be excluded from the extraction. You can manually include such incidents, or manually exclude incidents that were marked as Included by default, by selecting the row(s) and choosing **Current Row > Include** or **Current Row > Exclude** (to select multiple rows, hold down the **CTRL** key while clicking the rows).



If you are uncertain about whether you want to include a particular row in the extraction, you can select the row and choose **Current Row > View XFRACAS Incident** to open the incident in your web browser. This command is available only if you have permission to view incidents in the current XFRACAS entity.



You may also find it useful in this process to view a graphical presentation of the current data set(s). To open the Dashboard Viewer for this purpose, choose **Dashboard > Dashboard Viewer**.

To view only those rows that are included, choose **View > Show Only Selected**. You can choose this command again to show all records.



Tip: You can configure the appearance of the window and filter the data in the table, as explained in Section 2.7.3 on page 89.

Specifying the Extraction Settings

You can specify which columns in the data set will be used to populate the Time and Subset ID or Comments columns in the standard folio using the **Data Set > Set Time Column**, **Data Set > Set Subset ID Column 1** and **Data Set > Set Subset ID Column 2** commands.



For the Time column, you will choose a single column in the data set. For instance, choosing the State Time column will enter the values from that column in the Time to F or S column in the resulting Weibull++ standard folio or in the Time to Event column in the resulting RGA standard folio.

For each Subset ID column (in Weibull++) or Comments column (in RGA), you can choose one or more columns in the data set to include in the column. If you include information from multiple data set columns in a Subset ID or Comments column, the information will be separated with a dash. For example, choosing the Set Subset ID Column 1 command and choosing the Report Type and Category columns will result in values in the form “Report Type -

Category” (e.g., “Field Issue - Component Failure” or “In-House Testing - Installation Issue”) in the Subset ID 1 column in the resulting Weibull++ standard folio or in the first Comments column in the resulting RGA standard folio.

Note: All columns will be available for selection, regardless of whether they currently appear in the data table. You can add columns to the data table via the Column Chooser. See Section 2.7.3 on page 89 for more information.

Once you have specified the extraction settings, click **Extract Selected** to extract the “included” incidents from the RDW and create the standard folio.



2.7.3 RDW Interfaces: Configuration and Data Filtering Tools

In both the XFRACAS to RDW interface and the RDW to Folio window, you can configure the interface appearance and filter the data sets in numerous ways. Many of these tools are shared between the two interfaces.

To configure the appearance of the interface:

- To change the order of the columns, click a column name and drag the column to the desired location.
- To resize columns, you can:
 - Drag the edge of a column header to the desired position.
 - To automatically resize a column to fit the data, double-click the edge of the column header or right-click the column header and choose **Best Fit** on the shortcut menu.
 - To resize all columns in the table to fit the data that they contain, right click a column header and choose **Best Fit (all columns)**.
- To hide or show columns, right-click any column header and choose **Column Chooser** on the shortcut menu. You can then click the header of any column and drag it into the Column Chooser to hide it from the data set. To show additional columns, drag them from the Column Chooser to the desired location.
- To sort the data set by a column, click the column name. The sort direction is indicated by an arrow beside the column name; click again to reverse the direction of the sort. Note that in the XFRACAS to RDW interface, the data will be sorted by the specified field at each level of the hierarchy.
- In the RDW to Folio window, you can group the data set by one or more columns.
 - To quickly group the data set by one column, right-click the column header and choose **Group By This Column**.
 - To perform more advanced grouping, choose **Additional Options > Show Group By Box**. The Group By box will be displayed above the table. To group by a column, click the column name and drag it into the Group By box. You can drag multiple columns into the Group By box; the order in which they appear determines the way the records are sorted, and you can drag them within the Group By box to reorder them. Note that each column name in the Group By box has an arrow indicating the direction of the sort; you can click the column name to reverse the direction.

To filter the data set:

- The Auto Filter row appears by default immediately below the column headers. Enter text in any cell in this row to display only those rows that contain matching text in that field. You can hide or show the Auto Filter row by right-clicking any column header and choosing **Hide Auto Filter Row** or **Show Auto Filter Row**.
- In the XFRACAS to RDW interface, click the **Search** icon on the control panel to open the Search window.



On the Find tab of the Search window, you can specify text to search for, which column to search for the text in and whether the text should be located only at the start of the field or anywhere within the field. The Query tab allows you to search for multiple text strings in a given column by entering each text string and then adding it to the **Criteria** list.

- In the RDW to Folio window, the Find panel allows you to search for text within the data currently displayed in the table. Choose **Additional Options > Show Find Panel** or right-click any column header and choose the command to display the panel. Enter text in the field and click **Find** to filter the data displayed in the table. You can click **Clear** to remove the filter. To close the panel, click the **X** or clear the command.
- You can also use the Advanced Filters functionality, which is always enabled for these interfaces. *See page 172 in Chapter 5.*

2.7.4 Dashboard Viewer

The Dashboard Viewer allows you to view Synthesis data in a variety of graphical presentations. You can use it to create plots and charts based on:

- Data imported into the Reliability Data Warehouse (RDW)
- BlockSim simulation results

In Weibull++ and RGA, it is accessed by choosing **Dashboard > Dashboard Viewer** in the RDW to Folio window. In BlockSim, it is accessed by choosing **Simulation > Dashboard > Dashboard Viewer**.



The contents of the Dashboard Viewer will vary depending on the templates that have been created for your application. To choose a template, select it from the drop-down list at the top of the window.

Note: Dashboard templates are created via the Dashboard Designer and managed via the Dashboard Manager, both of which are available only to users with the “Create dashboard templates” permission.

Interface

3

Most Synthesis applications have their own Multiple Document Interfaces (MDIs) that provide full-featured support for the relevant analysis methods. (The exceptions are Weibull++/ALTA and BlockSim/RENO, which can display both applications in a shared MDI.)

When you are using multiple Synthesis applications simultaneously, different applications will open in separate MDIs but they can all connect to the same repository, and even to the same analysis project.

All Synthesis MDIs share a common structure, which includes the following elements.

Ribbon and Backstage View

The Ribbon at the top of the MDI replaces the toolbars and menus of previous versions of the software. The Ribbon is divided into tabs that organize commands into logical groups. Some tabs will always be available (such as File, Home, etc.) while others are *contextual* and will appear only when you are working on a particular task.

The first tab in the Ribbon, the File tab, provides access to a special type of interface called the Backstage view. This is where you will create and open databases, manage settings that apply to the entire database, access the Help Center, etc. For more information about the Ribbon, Backstage View and Help Center, see the “Ribbon” chapter.

Project Manager and My Portal

The **Project Manager** allows you to manage the projects within the current database and, for many Synthesis applications, it also allows you to manage all of the folios, diagrams, reports, attachments, etc. in the current project. This panel is docked on the left side of the MDI and pinned by default. (“Pinned” means that the entire panel is always visible unless you decide to hide or “unpin” it.) *See Section 3.2 on page 95.*

My Portal provides access to messages between users, actions that need to be performed, a list of users who are currently logged in to the same database and context-sensitive notes about the feature you are currently using. This panel is docked on the right side of the MDI and unpinned by default. (“Unpinned” means that only a small tab will be visible in the interface unless you move the pointer over the tab to make the entire panel visible.) *See Section 3.3 on page 98.*

For both of these MDI features, you can decide whether the panel will be visible and how it will be positioned in the interface. *See Section 3.1 on page 92.*

Tip: If desired, you can change the overall color scheme used in the MDIs for all Synthesis applications on your computer. Choose **File > Synthesis Setup** to open the Synthesis Setup window and then use the **Skins** drop-down list to select the style you prefer.

Status Bar

The status bar at the bottom of the MDI displays the following:

- The software name and version.
- The path and filename (if applicable) of the database that you are currently using.
- The currently active project.
- If you are connected to an enterprise database, a connection speed indicator, as follows:
 - < 30 ms: Good (acceptable performance)
 - 30 - 70 ms: OK (may exhibit some delays in operations, opening/closing windows, etc.)
 - 70 - 110 ms: Slow (will exhibit some delays in operations, opening/closing windows, etc.)
 - 110 - 150 ms: Very slow (will exhibit significant delays in operations, opening/closing windows, etc.)
 - > 150 ms: Extremely slow (will result in unacceptable performance and usability)
- Your login information. Double-clicking this section of the status bar provides quick access to the User Login and Contact Information window, where you can view/modify your display name and other contact details.

3.1 Show, Tile, Dock and Pin Panels

In all Synthesis applications, the MDI includes a Project Manager panel and a My Portal panel. You can decide whether each panel will be displayed and how it will be positioned in the interface at any given time.

Show or Hide

To show or hide the Project Manager panel, choose **View > Project Manager** and toggle the **Show Project Manager** command on or off.

For My Portal, toggle the **View > My Portal > Show My Portal** command.

You can also hide either panel by clicking the X at the top of the window.

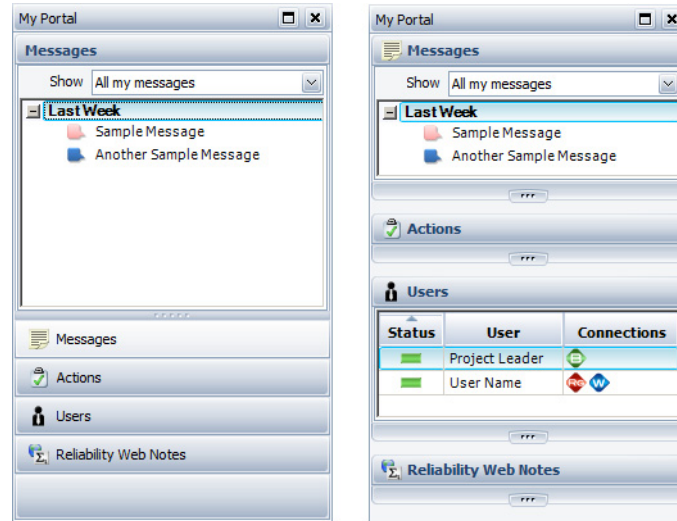


Tile or View One Page at a Time

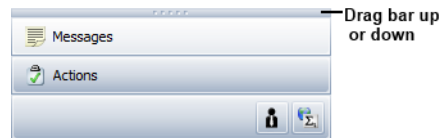
In all Synthesis applications, My Portal consists of four pages. You have the option to view one page at a time (and use large buttons or small icons at the bottom of the panel to switch between pages) or tile the pages so that more than one page can be visible at the same time. To specify your preference, choose **View > My Portal** and toggle the **Tile My Portal** command on or off.

When applicable, these same options are available for the Project Manager panel. Choose **View > Project Manager** and toggle the **Tile Project Manager** command on or off. (This command is not available in applications such as Xfmea, RCM++, RBI and MPC, which have only a single page in the Project Manager.)

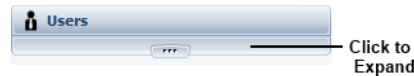
As an example, the first picture shows the My Portal panel when it is not tiled. The second picture shows the tiled panel, with two of the four pages expanded to be visible at the same time.



When the panel is not tiled, you can drag the horizontal splitter bar up to display large buttons or down to display small icons.



When the panel is tiled, you can use the handle buttons to expand or collapse each page.



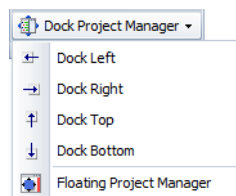
Dock or Float

For both panels, you have the option to dock the panel on the left, right, top or bottom side of the MDI. When the panel is docked, it cannot be moved but you can change the width (if docked left or right) or height (if docked top or bottom) by dragging the edge to the desired position.

Alternatively, you can choose to float the panel as a window that can be resized and dragged to any location on the desktop.

There are several ways to set the docking position:

- Choose **View > Project Manager > Dock Project Manager** and then choose the desired option.



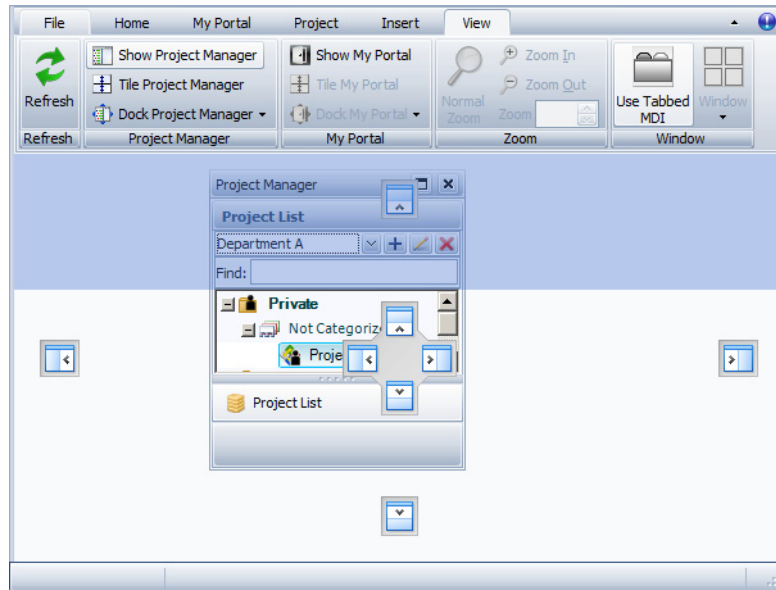
The same options are available when you choose **View > My Portal > Dock My Portal**.

- If the panel is currently floating:

- Double-click the window's title bar to return it to the most recent docked position.

OR

- Click the window's title bar and drag it onto one of the location icons that become visible while you are moving the window. When the window is correctly positioned, blue shading will show where the window will be docked when you release the mouse button. (Note that the window's title bar must be exactly positioned above one of these location icons before the blue shading appears. If you don't see blue shading, the panel will not be docked when you release the mouse button.)



If you prefer to float the window, you can:

- Choose either:
 - **View > Project Manager > Dock Project Manager > Floating Project Manager**

OR

- **View > My Portal > Dock My Portal > Floating My Portal**
- Double-click the title bar of the docked panel.

Pinned or Unpinned

When docked, both panels can also be toggled between pinned and unpinned states by clicking the pushpin icon in the panel's title bar. When the pushpin in the icon is vertical , the panel is pinned and will be displayed at all times.

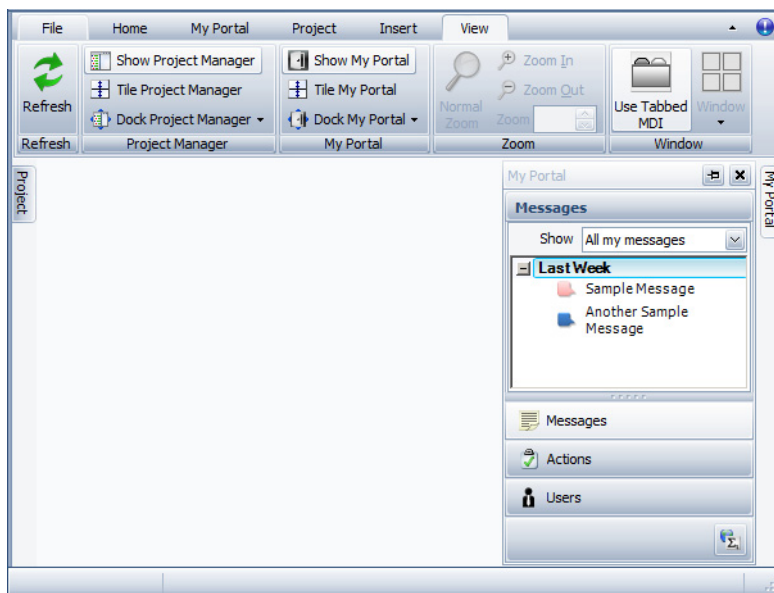
When the pushpin is horizontal , the panel is unpinned. A tab will be displayed at the docking location for each unpinned panel.

The behavior for unpinned panels is as follows:

- If you point to the tab, the panel displays only until you point to something else.
- If you click the tab, the panel stays displayed until you click something else.

- When a panel is unpinned, it cannot be undocked or moved.

As an example, the following picture shows the Project Manager panel docked on the left side of the MDI, unpinned and hidden, while the My Portal panel is docked on the right side of the MDI, unpinned and visible (either because the user moved the pointer over or clicked the tab).



3.2 Project Manager

The Project Manager provides the tools you need to browse or search for a particular project or analysis folio in a Synthesis repository. Depending on the application, the Project Manager consists of either one or two pages:

- In all Synthesis applications, the project list displays all the projects in the current database. (For Xfmea, RCM++, RBI and MPC, this is the only page available in the Project Manager).
- In Weibull++, ALTA, BlockSim, RENO, RGA, Lambda Predict and DOE++, the Current Project page of the Project Manager displays all the analysis folios, reports and other items in the current project that apply to the software you are using. *See Section 3.2.2 on page 97.*

There may be up to four nodes in the project list, indicating the sharing status of the projects: Private and Public projects, Locked projects and Checked Out projects.

Each node may be further broken down by project category and/or by project owner. This ensures that projects will be organized in a logical, manageable way within the project list.

Opening a Project

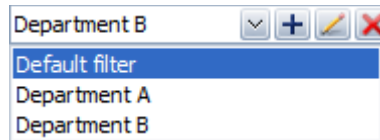
To open an existing project, double-click the project name or select the project and choose **Project > Management > Open Project**.



Note: Remember that each project may contain items from any Synthesis application but you will only see the items that are relevant for the application you are currently working with (e.g., Weibull++ analysis folios are visible only when the project is opened in Weibull++). Common items, such as project attachments, are visible from all applications.

Filtering the List of Projects

The **Filter** area at the top of the project list allows you to refine which projects are displayed in the list. This feature might be particularly useful for an enterprise database that may be used to store analysis projects for the entire organization in a single centralized location. In such cases, the number of projects displayed in the project list could become overwhelming and these filters provide the ability to display only those projects that are of interest to you at any given time.



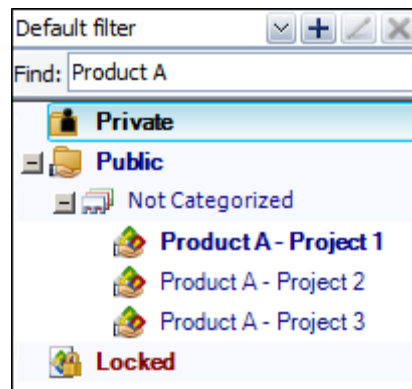
Use the drop-down list to select which filter will be applied. The **Default filter** option always shows all projects in the database. Other filters can be created and managed by each individual user. In other words, the filters that you have defined will be saved in the database and associated with your user account. When you use this account to log into the database from any computer, your filters will be available to you. However, they will not be visible to other users.

Click the **Create new filter** icon **+** to create a new filter or click the **Edit current filter** icon  to edit the filter that is currently selected. Both commands open the Filter Properties window so you can view or modify the filter criteria.

To delete a filter, select it from the list and then click the **Delete current filter** . Remember that this will completely remove the filter from the database and this cannot be undone. If you want to keep the filter for future use and simply stop using it right now, choose a different filter from the drop-down list.

Searching for a Particular Project

You can also search for projects by entering text in the **Find** field. The project list updates dynamically to show only the projects with names that contain the text that you have entered. As an example, the following picture shows a quick way to find all of the projects for a particular product line by using the project names instead of predefined categories or other filter criteria.



3.2.1 Filter Properties Window

The Filter Properties window is used to create new filters or edit existing filters. These filters can be used to limit the projects displayed in the project list, in the Manage Projects window or when importing/exporting entire projects or items/resources.

The custom filters that you create will be saved in the database and associated with your user account. When you use this account to log into the database from any computer, your filters will be available to you. However, they will not be visible to other users.

Specify a unique name for your filter and then use the following properties to define how the filter will limit the projects shown in the list:

- **Filtering Options**

- **Filter by owner** filters by the name of the project owner. The available names are based on the user accounts defined in the current database.
- **Filter by category** filters by the selected project category. The available categories are based on the project categories that have been defined in the current database.
- **Filter by analysis** filters by the types of analyses contained in the project.
- **Filter by 'last update' user** filters by the name of the person who last modified the project.
- **Filter by 'last update' date** filters by the date when the project was last modified.

- **Other Options**

- If **Show locked projects** is selected, the Locked node will be displayed in the project list and any locked projects will be displayed under it. If this check box is cleared, the Locked node and all locked projects will be hidden.
- If **Group by category** is selected, the Public, Private and (if **Show locked projects** is selected) Locked nodes will each be subdivided into nodes for each project category. Only those categories that are currently in use by at least one project will be shown. If this check box is cleared, projects will not be divided by category.
- If **Group by owner** is selected, the projects will be grouped according to project owner. If the **Group by category** check box is also selected, each project category will be grouped by category and then by owner.

3.2.2 Current Project Explorer

In all Synthesis desktop applications except Xfmea, RCM++, RBI and MPC (which use the system hierarchy to manage all of the different analyses in a given project), the Current Project page of the Project Manager allows you to manage all of the relevant *project items* (e.g., folios, diagrams, etc.) in the project that is currently open. Starting in version 9.0.9, this page is identified in the Project Manager by the project name.

Note: Remember that each project may contain items from any Synthesis application but you will only see the items that are relevant for the application you are currently working with (e.g., Weibull++ analysis folios are visible only when the project is opened in Weibull++). Common items, such as project attachments, are visible from all applications.

The current project explorer presents all of the project items in a hierarchical tree structure. The project name is displayed at the top of the tree. The folders that contain the analysis and reporting components of the current project, as well as project-level attachments, are displayed in nodes below the project name.

Click the plus (+) button to open a folder and display the items within that folder. Click the minus (-) button to close a folder.

The **Filter based on creator** drop-down list allows you to show only the items that were created by a particular user, if desired.

Opening Items

Double-click an item to open that item in the MDI or to bring that item to the front of the MDI if it is already open. (Note that if you double-click an attachment that appears in the current project explorer, it will open in its corresponding application, as long as that application is installed on your computer.)

Tip: In all Synthesis applications, projects can be shared by multiple users and the current project explorer may display an “in-use” icon to indicate the status of an item that can't be edited because it is currently locked or being edited by another user.

Adding Items

You can add items to the project by choosing the relevant command on the Insert tab of the Ribbon. You can also right-click the relevant folder and choose an appropriate command from the shortcut menu that appears.

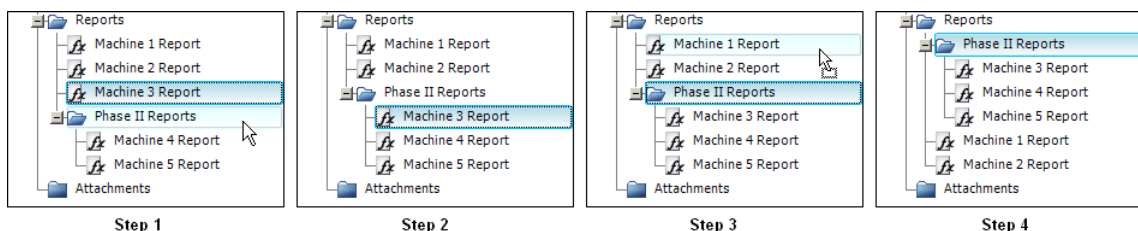
Editing, Renaming, Duplicating or Deleting Items

To manage existing items within the project (i.e., **Edit Item**, **Rename Item**, **Duplicate Item** and **Delete Item**), right-click the item and choose a command from the shortcut menu or select the item and use the commands in the Current Item group on the Project tab of the Ribbon.

Organizing Items

In addition to the top-level folders that are fixed for each application you also have the ability to create your own custom sub-folders to organize project items (the exception being the Attachments folder, which you cannot add sub-folders to). To add a custom sub-folder, right click any existing folder and choose **Add Folder** from the shortcut menu.

You can also arrange custom sub-folders and project items by dragging them to the desired location. Dragging a folder or project item onto a folder will place it into the bottom of that folder. Dragging a folder or project item onto a project item will place it in the same level above that item. Using Weibull++ reports as an example, consider the following steps:



In Step 1, Machine 3 Report is being dragged onto the Phase II Reports folder. Step 2 shows that Machine 3 Report is then located at the top of the list within the Phase II Reports folder. In Step 3, the Phase II Reports folder is being dragged onto Machine 1 Report. Step 4 shows that the Phase II Reports folder is then positioned above Machine 1 Report.

3.3 My Portal

My Portal provides additional information relevant to your work within the database. Four pages are available within My Portal:

- The Messages page
- The Actions page
- The Users page
- The Reliability Web Notes page

When you first activate the software, My Portal will be “docked” as a panel on the right side of the MDI and will be in an unpinned state. My Portal can be manipulated in a way similar to the Project Manager. *See Section 3.1 on page 92.*

Messages

The **Messages** page allows you to communicate with other users who have access to the database. Note that all users have the ability to manage the messages sent to their user accounts, but the ability to create messages is based on the permissions assigned to the user accounts.

The messages displayed on this page depend on your selection in the **Show** field at the top. If you select **All my messages**, you will see all messages that you created and all messages that are directed to you, either individually or as part of the All Users group. You can also choose to view only messages that you created or only messages directed to you individually.

The messages will appear in the order in which they were created, and an icon will appear next to each message to indicate its specific priority level (blue = Low, pink = Medium and red = High).

- To create a message, choose **My Portal > Messages > Create Message**. The Message window will appear. *See Section 3.3.1.*
- To edit a message, double-click the message or select the message and choose **My Portal > Messages > Edit Message**.
- To delete a message, select the message and choose **My Portal > Messages > Delete Message**.
- To refresh the list of messages, choose **View > Refresh > Refresh**.

Actions

The **Actions** page allows you to view the actions that you are involved with. Actions are resources that allow you to ensure that appropriate progress is being made. (Refer to the “Actions” section in the “Resources” chapter for more information.) The actions displayed on this page depend on your selections in the filter options fields, which are accessible by opening the drop-down list at the top of the page. The following filters are available:

- The **Project** field allows you to specify the project for which you want to view actions. Select **All Projects** to view actions for all projects in the database.
- The **Show** field allows you to specify which actions are displayed based on your type of involvement with the actions. You can choose to view only the actions that you are assigned to review, only the actions that you created, only the actions that you are monitoring via notifications or only the actions that are approved by you.
- The **Status** field allows you to specify which actions are displayed based on the action status. You can choose to view only actions that are reviewed and approved, complete, overdue or due. To view all actions regardless of their status, select **All Statuses**.
- The **Priority** field allows you to specify which actions are displayed based on the action priority. To view all actions regardless of priority, select **All**.

The displayed actions will be categorized according to their status (i.e., Overdue, Not Started, In Progress, Completed and Approved). Within each category, they will be arranged in the order in which they were created. A due date will appear next to each action.

You can create, edit and delete actions in the same basic way that you work with messages, using the commands in the Actions group of the My Portal Ribbon tab. Note that you must have a project selected in the **Project** filter field in order to create an action.

If Microsoft Outlook is installed on your computer, you can choose **My Portal > Actions > Add Action to Outlook** to create a calendar event based on the action on your own Outlook calendar. By default, the event will be scheduled for the action's due date, but you can make modifications to the event in the properties window that appears.

Users

The **Users** page displays a list of all users who have an account in the database. (If you are working in a standard database without login security, any user who has ever opened the database will have an account created automatically and will be shown in this list.) A status light is displayed for each user; if it is “lit up” (i.e., green), the user is currently logged in to the database. In addition, the Connections column shows the Synthesis application(s) that the user currently has connected to the database. Clicking a column header in the list of users sorts the list by that column; click again to reverse the direction of the sort.

- Choose **My Portal > Users > My Profile** to open the User Login and Contact Information window, which allows you to edit the contact information associated with your user account.
- To refresh the list of users, choose **View > Refresh > Refresh**.

Reliability Web Notes

The **Reliability Web Notes** page provides access to further information on the interface that you are currently working with. Choose **My Portal > Reliability Web Notes > Get Notes for Active Item** or click the button at the bottom of the page to see basic theoretical information that may be of use in your current task, as well as links to further information and examples.



You can also select the **Automatically retrieve notes** check box to have the software automatically update the displayed notes depending on what item is currently active.

3.3.1 Message Window

The Message window allows you to add or edit messages that are displayed on the Messages page of My Portal. This window is accessed by clicking **Create Message** or **Edit Message** on the My Portal tab of the Ribbon, or by double-clicking a message.

To specify the user(s) who will see the message, click the arrow in the **Address To** field.

- Select **All Users** to address the message to all users associated with the project.
- To address specific members or notification groups:
 - Select the **Selected Groups/Users** option to enable the remaining address options.
 - Then select the check box for each desired notification group and/or individual user. (Note that you can click the + beside each notification group to view the members of the group.)
 - When you are done specifying who will see the message, click inside the **Address To field** again.

Enter a subject and the message details, then specify the priority level of the message. Messages marked as low priority will be displayed in My Portal with a blue indicator, medium priority messages with a pink indicator and high priority messages with a red indicator.

Finally, specify the date range during which the message will be displayed. If e-mail notifications are enabled for the database, you can select the **Also send this via e-mail** option to send an e-mail copy of the message to the recipient(s).

3.3.2 Actions

Actions are resources that enable you to track the progress for assigned tasks. The same action record can be used multiple times in different locations, if appropriate. Actions can be created, displayed and/or managed: a) via My Portal in all Synthesis applications, b) via the Resource Manager in all Synthesis applications except MPC and c) in FMEAs and DFR plans in Xfmea/RCM++/RBI.

This section focuses on general considerations that will be applicable regardless of which application you are using and where the action is being used. For specific instructions regarding how to create or edit an action in each location, please consult the documentation for that particular feature. The following topics are discussed here:

- Actions as resources - Section 3.3.2.1 (p. 101)
- Action statuses - Section 3.3.2.2 (p. 101)
- Action properties - Section 3.3.2.3 (p. 102)
- Using the Approve, E-mail and Outlook commands - Section 3.3.2.4 (p. 103)

3.3.2.1 Actions as Resources

As with any other Synthesis resource:

- Any changes to the action properties will be reflected in all locations where the resource is used.
- If you remove an action from an FMEA or DFR plan, it will remain in the project unless/until an authorized user deletes it from the database.
- If an action resource is not currently used in an FMEA or DFR plan, an authorized user (i.e., the project owner, the action creator or any user with the “Create/edit/delete all resources” permission) can delete it via My Portal or the Resource Manager.

In addition, the **Trace Usage** icon at the bottom of the window opens the Dependency Viewer, which allows you to see where the resource is used and what other resources are associated with it.



3.3.2.2 Action Statuses

The action status is determined automatically based on the dates defined for the action:



An action is **Overdue** if its due date is prior to today's date.



An action is **Not Started** if its start date is later than today's date.



An action is **In Progress** if its start date is today's date or earlier and its due date is today's date or later.



An action is **Completed** if a completion date has been entered and no approver has been assigned.



An action is **Pending Approval** if a completion date has been entered and an approver has been assigned.



An action is **Approved** if an approval date has been entered.

3.3.2.3 Action Properties

The properties enabled in the Action window (and their display names) will depend on the interface style settings that have been defined for the current project in Xfmea/RCM++/RBI. If you have one of those applications installed and have permission to edit the project properties, you can choose **Project > Management > Configurable Settings > Interface Style** to view or change the settings for the current project.

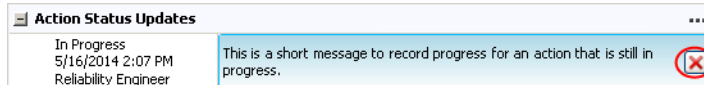


- In the **Action** area, note the following:
 - The **Action Description** is required.
 - The **Short Description** is a shortened version of the record description that will be used in locations where the full description would be too long to display (e.g., diagrams). If the field is blank when you save the record, the software automatically populates it based on the first 50 characters of the record description. This will not be automatically updated if you later change the full description.
 - For the **Person Responsible**, you can type a description (up to 150 characters) or select a specific database user from the drop-down list. If you select a database user, the action will be displayed in that user's My Portal and he/she can also receive automated e-mail notifications, if applicable.
- In the **Timeline** area, note the following:
 - The **Planned Start Date** and **Planned Due Date** are for bookkeeping purposes only; they are not used in determining the action status.
 - The **Start Date**, **Duration** and **Due Date** fields are used to determine the action status. In addition, once you have entered the start date:
 - If you enter/change the due date, the duration will be updated automatically.
 - If you enter/change the duration, the due date will be updated automatically.
 - Entering a **Completion Date** will change the action's status from due/overdue to complete. It also triggers an automated e-mail notification if the database is configured to send e-mails "Upon completion."
- In the **Approval** area, note the following:
 - If you decide to assign an **Approver** to review and approve the action after it is completed, you must select a database user who has the "Approve actions" permission. The action will be displayed in that user's My Portal and he/she can also receive automated e-mail notifications, if applicable.
 - The **Approval Date** will be entered automatically when the assigned approver chooses the **Approve** command.
 - The **Approval Comments** field will not be available until the assigned approver has entered an approval date.
- The **Action Status Updates** area displays any notes that have been added to report progress toward the completion of the action.
 - To add a new note, click the heading and then click the **Add** icon that becomes visible.



Note that if an action has not yet been completed, you can choose any action status update type from the drop-down list in the Action Status Update window. Choosing **Not Started** or **In Progress** will not affect the action's status. Choosing **Completed** will enter a completion date for the action and will change the action's status to complete. If an action has already been completed, the only action status update type that will be available is **Completed**.

- To delete an existing note, click inside the field and then click the **Delete** icon that becomes visible. *There is no undo for delete.*



- The **E-mail Notifications** area allows you to access the Action Notifications window, which identifies the database users who can receive notifications regarding the current action. *See Section 3.3.3 on page 103.* These settings apply to automated e-mail notifications (if any) and the Actions page of the My Portal window.
- The **History** area provides information about the creation and last modification of the resource. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the resource.

3.3.2.4 Approve, E-mail and Outlook Commands

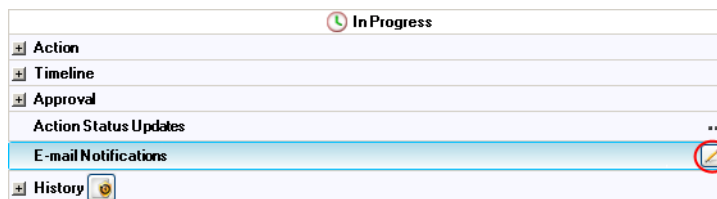
Three commands will be enabled only when applicable. For most applications, they will be available as buttons at the bottom of the window. If you are using Xfmea/RCM++/RBI and working with an action that's used in an FMEA or DFR plan, they will be available from the Ribbon at the top of the window.

- The **Approve** command will be enabled if you are assigned to review/approve the action and a completion date has been entered. When you choose the command, the software automatically enters the approval date, and the comments field becomes enabled so you can add any relevant notes.
- The **E-mail** command will be enabled if an authorized user has defined a valid SMTP server via the E-mail Settings window. This allows you to manually send an e-mail containing the current action details to any valid e-mail address.
- The **Outlook** command will be enabled if Microsoft Outlook is installed on your computer. This provides a quick way to add the task to your Outlook calendar. By default, the event will be scheduled for the action's due date, but you can make modifications before saving the new event to your calendar. Note that you may need to give focus to the Outlook application in order to see the window.

3.3.3 Action Notifications Window

The Action Notifications window allows you to specify individual users and/or groups of users who will be able to monitor the progress for the current action. These settings apply to automated e-mail notifications and the Actions page of My Portal.

To view or configure these settings, first open the Action window and click the E-mail Notifications heading. Then click the **View/Edit E-mail Notifications** icon that becomes visible.

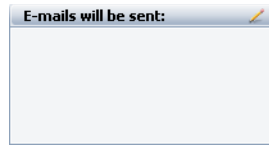


E-mails Will Be Sent

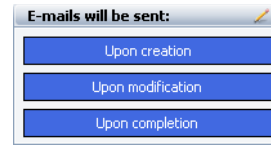
The **E-mails will be sent** area indicates which e-mail notifications, if any, have been enabled for all action records throughout the current database. (Notifications are enabled via the E-mail Settings window, which can be accessed by clicking the Edit icon in this area.) It may look like any of the following three pictures:



E-mail notifications are not enabled for this database



Automated e-mails are not enabled, but you can send e-mails manually



Some automated notifications are enabled; the specific buttons identify which ones

Users and Groups

The rest of the window identifies which users and/or groups are assigned to monitor the current action. These users receive automated e-mail notifications (if applicable) and will also be able to see the action displayed in the My Portal window.

Action Creator: If the **Action creators receive notification** check box is selected in the E-mail Settings window for the database, the user who created the action will receive a courtesy copy of all automated e-mail notifications.

Person Responsible: The user who is assigned to complete the action will receive any automated e-mail notifications that are sent "Upon creation" and/or "Upon modification."

Assigned Reviewer: The user who is assigned to review and approve a completed action (aka the "Approver") will receive any e-mail notifications that are sent "Upon creation," "Upon modification" and/or "Upon completion."

Notification Groups and Other Users: The selected notification groups and other individual users will receive courtesy copies (CCs) for all automated e-mail notifications related to this specific action, as long as there is at least one primary recipient (Person Responsible, Approver or Action Creator) for the e-mail.

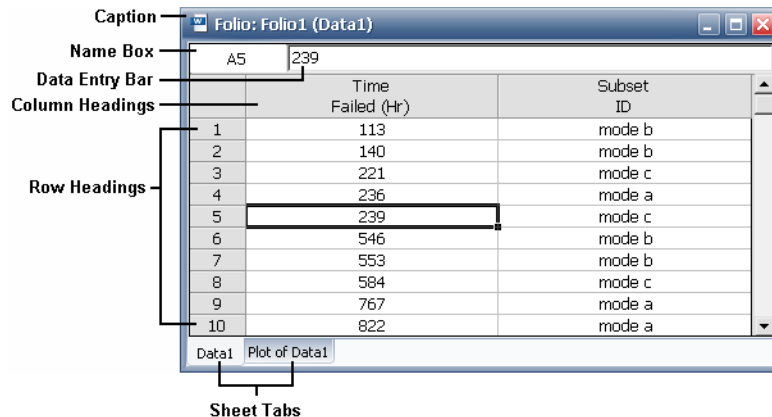
- The list of notification groups can be defined for the current database by user(s) with the "Manage e-mail notifications" permission.
- The list of other users contains all of the user accounts that are defined in the current database.

3.4 Data Sheets

Analysis folios in Weibull++, ALTA, RGA and DOE++ are made up of data sheets. This section describes the basic components of a data sheet and shows how you can resize the columns and rows, and enter formulas.

Components of a Data Sheet

Data sheets in most folio types share the same general components. The following picture shows the basic components of a data sheet using one particular format of the Weibull++ standard folio as an example.



- **Caption** displays the name of the folio and the name of the sheet that is currently displayed.
- **Name Box** displays the location of the currently selected cell by listing the column letter and row number that intersect at the cell's location. Note that the column letter represents the order of the column as it appears in the data sheet.
- **Data Entry Bar** displays the contents of the selected cell, which may be text, a numerical value or a formula. For text or numerical values, you can enter, or edit, the information directly inside the cell or inside the data entry bar. For a formula, you must use the data entry bar for editing; the cell will display only the calculated value.
- **Row Headings** identify the row numbers. You can change the name or number of a row by double-clicking its heading. The row will still retain its order number in the data sheet.
- **Column Headings** indicate the title for the entries in each column. These titles depend on the type of data you are entering. You can change the name of a column by double-clicking its heading.
- **Sheet Tabs** represent the different sheets within the folio. To switch between sheets, click the appropriate tab. You can change the name of a sheet by double-clicking its tab.

Each standard folio can contain up to 256 data sheets with up to 65,536 data rows per sheet. However, the application's speed of execution is inversely proportional to the number of data rows in the current data set. In addition, the number of folios that can be opened at once is dependent upon the amount of memory of your system.

Resizing Columns and Rows

To resize the columns for data sheets in folios in Weibull++, ALTA and RGA, there are two ways:

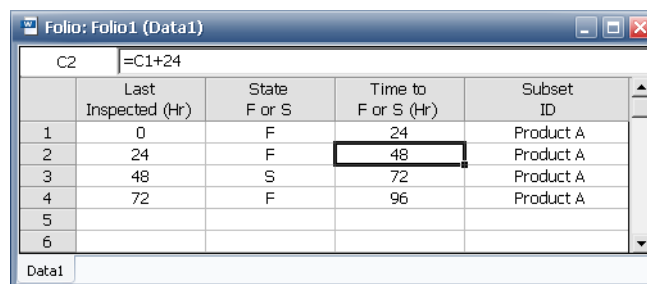
- To resize a single column, point the pointer on the line that borders the column in the column header. The pointer will change to a double-headed arrow. Click and then drag the double-headed arrow to the left or right to resize the column. To save the changes, choose **Home > Edit > Format Selection > Column Width Style > Keep as Set by User**.
- To span the columns across the spreadsheet with equal widths, choose **Home > Edit > Format Selection > Column Width Style > Span Evenly**. To keep the ratio of the column widths to span across the spreadsheet after they have been resized, choose **Span Proportionally**.

To resize the rows, there are two ways:

- To resize a single row, point the pointer on the line that borders the row in the row header. The pointer will change to a double-headed arrow. Click and then drag the double-headed arrow up or down to resize the row.
- To resize several rows all at once, select a cell in each of the rows to be resized and then choose **Home > Edit > Format Selection > Row Height**. This opens the Row Height window, which allows you to set the row height of the selected cells and specify a unit of measurement for the height.

Entering Formulas in the Data Sheet

Except for DOE++, data sheets in Weibull++, ALTA and RGA allow you to enter formulas in columns that do not require entries to be dates, times or text (e.g., you cannot use formulas in the State F or S column in a Weibull++ standard folio, or in the Classification column in an RGA standard folio). For example, in a Weibull++ standard folio, if you have a data set where the units were inspected every 24 hours, you can speed up data entry by creating a formula to add 24 hours to the previous inspection time, as shown next.



The screenshot shows a window titled 'Folio: Folio1 (Data1)'. Inside is a table with the following data:

	Last Inspected (Hr)	State F or S	Time to F or S (Hr)	Subset ID
1	0	F	24	Product A
2	24	F	48	Product A
3	48	S	72	Product A
4	72	F	96	Product A
5				
6				

At the top of the window, a formula bar shows 'C2' and the formula '=C1+24'. The 'Time to F or S (Hr)' column values are 24, 48, 72, and 96, which are the cumulative values from the 'Last Inspected (Hr)' column plus 24.

There are two types of cell references (locations) when inputting a formula: absolute and relative. By default, the cell reference is relative, meaning that as a formula is copied and pasted to other cells, the cell references in the formula will be adjusted to reflect the new relative location. In the previous figure, the formula in cell C2 is copied and pasted into cell C4. This changes the cell reference in the formula from “=C1+24” to “=C3+24”; therefore, the time value in C4 is 72+24 = 96.

In contrast, an absolute reference does not change when the formula is copied to other cells. Absolute references are designated by placing a dollar sign (\$) in front of the row and/or column to be made absolute. If the formula in the example were rewritten to “=C\$1+24”, then copying the formula to cell C4 would retain the cell reference to C1 and the time value in C4 would result to 24+24 = 48.

3.5 Change Units

In the current versions of Weibull++, ALTA and RGA, you have the ability to define the time units used for the data set and calculations. For example, if your data set contains failure times in hours, you now have the option to perform calculations using different time units such as years, months, days, etc. The software performs the unit conversion automatically. Authorized users can define the time units that will be available for use in any project within the database and set up the conversion factors. (Refer to the “Manage Units” section in the “Working in Synthesis” chapter for more information.)

The units are displayed in the header of the relevant column in the data sheet. If you wish to change the time units of an existing data sheet, click the **Change Units** icon on the Main page of the control panel.



In the Change Units window, the units that are currently being used in the data sheet will be displayed at the top of the window. In the **Change Units To** field, you can choose any other defined time unit to be used in the data sheet. In the **Conversion Options** area, specify what will happen when the units are changed:

- You can convert the existing data to the new units. For example, if you had a time of 10 in a data sheet that was using hours, that time would become 600 if you converted the data to minutes (10 hours x 60 minutes per hour = 600 minutes). For standard folios, when this option is selected, you can select whether you want to copy the data to a new sheet in the folio and then perform the conversion, leaving the original data sheet unchanged, or convert the data in the current sheet.
- You can leave the data unchanged and just apply the new units. This would be appropriate if, for example, you had entered all of your data and then realized that the data sheet was using different units from the original units in which the times were measured.

3.6 General Spreadsheets

General Spreadsheets can be inserted into any of the standard folios in Weibull++, ALTA and RGA. These provide the same spreadsheet capabilities that are available in the analysis workbook, but they are stored together with an analysis folio. You may prefer to use this reporting tool if you are performing custom calculations based on the data sheets in the same folio and you wish to keep the analyses together with their source data.

To add a general spreadsheet to a folio, right-click the data sheet tab area (the area at the bottom of the window that shows the name of the data sheets in the folio) and choose **Insert General Spreadsheet** on the shortcut menu. This command also appears in the Ribbon tab for the particular type of data folio. For example, to insert a general spreadsheet into a Weibull++ standard folio, you can choose **Life Data > Folio Sheets > Insert General Spreadsheet**.



Unless explicitly stated as being restricted to an analysis workbook, all components and tools that are available in an analysis workbook are also available in a general spreadsheet.

3.7 Control Panels

Many of the analysis folios, diagram sheets and other interfaces in Synthesis applications utilize a control panel that allows you to make required inputs, initiate the desired analysis or simulation and view/access applicable results. (Control panels are not used in Xfmea, RCM++, RBI, MPC and Lambda Predict, which use the Analysis Panel; see Section 3.9.) This section describes some features that are common to most control panels, including:

- Switching between pages in a control panel - Section 3.7.1 (p. 108)
- Hiding/displaying the entire panel - Section 3.7.2 (p. 108)
- Using the Identifiers page to record information about the particular analysis - Section 3.7.3 (p. 109)
- Using the Notifications page to view the calculation/simulation status for the current folio or diagram, and read any relevant warnings or notes (e.g., calculation errors) - Section 3.7.4 (p. 109)
- Using the Utilized Resources page (BlockSim only) to view a list of the Synthesis resources that are being directly used by the blocks in the current diagram - Section 3.7.6 (p. 110)

For information about using the Publishing page to publish or update a model based on the current analysis, please refer to the “Publishing Models” section in the “Resources” chapter.

For information about the control panel commands and options that are relevant for a specific type of folio or diagram sheet, please consult the section for that particular interface.

3.7.1 Switching Between Pages

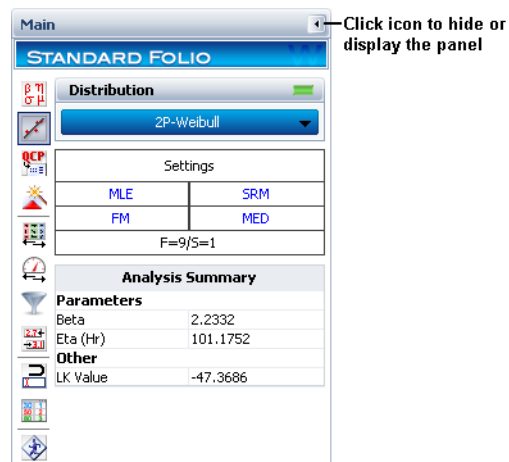
Many control panels and navigation panels (e.g., the navigation panel on the left side of the Resource Manager) contain multiple pages that vary depending on the type of analysis. You can switch between pages by clicking either the large buttons or small icons at the bottom of the control panel.

The large buttons are displayed in a vertical column; the small icons are displayed in a horizontal row. To change between the button types, point to the horizontal splitter bar above the buttons and drag it up or down. If you drag the horizontal splitter bar to the bottom of the control panel, all of the pages will be accessed by small icons. If you drag it as far up as it will go, all of the pages will be accessed by large buttons. Positions in between allow you to use some large buttons and some small icons.



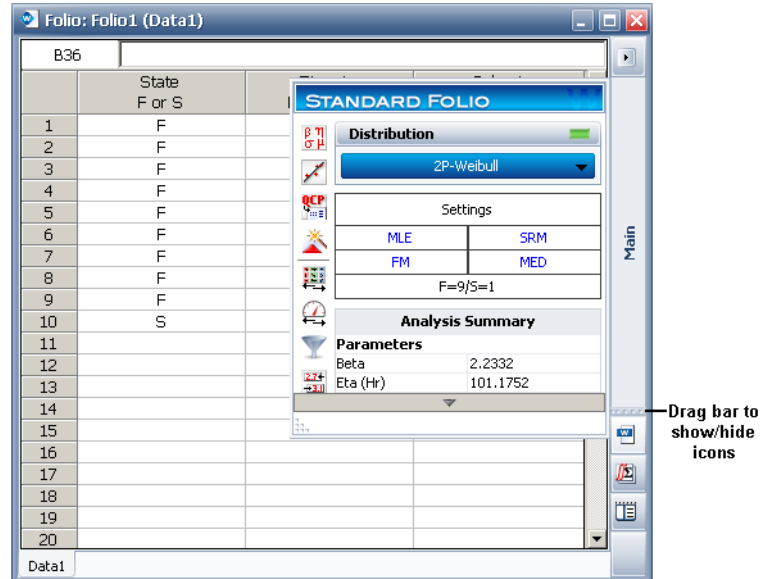
3.7.2 Hiding or Displaying a Control Panel

The control panel can be toggled between hidden and displayed states by clicking the **Hide** or **Show** icon in its title bar, as shown below using a Weibull++ standard folio as an example.



When the control panel is hidden, a bar representing the control panel will be displayed on the right side of the window, as shown next. The label in the vertical bar indicates which page of the control panel is currently active

(“Main” in this case). When you click the bar, the page will be displayed temporarily. When you click anywhere outside of the control panel page, it will be automatically hidden again.



3.7.3 Control Panel Identifiers Page

As described in the “Publishing Models” section of the “Resources” chapter, certain analyses can be published as models that become resources available for other analyses. For example, you could perform a life data analysis in Weibull++, publish the results as a model, and then use that model to describe the reliability of an item in RCM++.

The Identifiers page of the control panel allows you to enter specific information (e.g., name, part number, etc.) that will be associated with the model when it is published. This will help you to search for the model when you need to use it in another analysis.

To edit the labels for these user-defined identifier fields at the database level, choose **File > Manage Repository > Global Identifiers**.



To edit the labels at the project level, choose **Project > Management > Edit Project Properties** and go to the Global Identifiers tab.



You can enter up to 1,000 characters of text in these fields; if the text is too long to be displayed in the field, you can click the arrow at the bottom of the field to show the remaining text.

Note: If you are working in a secure database, the ability to edit the labels of the user-defined fields is typically restricted to users with the “Manage other repository settings” permission.

3.7.4 Control Panel Notifications Page

The Notifications page is available in the control panel for certain types of analyses. The **Current Status** field provides information on the analysis status of the folio. This information will match the color of the status icon used for the Notification page; a green light indicates that the folio has been analyzed, and a red light indicates that the folio has not been analyzed since changes were last made to it.

The **Latest Notifications** area of the page can display warnings and errors generated during analysis. To clear the display, click the **Clear** icon.



You can copy a warning to the Clipboard by clicking the warning and then clicking the **Copy** icon. The text will then be available to be pasted into other windows or other applications.



You can also export the contents of the **Latest Notifications** area to an Excel file by clicking the **Export to Excel** icon.



3.7.5 Control Panel Utilized Resources Page

In BlockSim only, the diagram control panel contains a Utilized Resources page. This page displays a grouped list of all of the resources that are used directly by blocks in the diagram (i.e., not applied via any other resource or tool). For example, a universal reliability definition (URD) that is assigned to a block will be displayed in this list, but the model assigned to the URD will not be shown, nor will any tasks assigned to the URD. Similarly, if a block belongs to a maintenance group, that maintenance group will be shown in the list. However, if a block has a state change trigger, the maintenance group(s) used for that trigger will not be shown in the list unless some block in the diagram belongs to them. Refer to the “Resources” chapter for more information.

This list is not updated automatically; if you have made changes to the diagram, you can click the **Refresh** icon to update the list.



You can double-click a resource in the list to open its properties window for viewing or editing. You can also click the **Resource Manager** icon to view/manage all of the resources available in the project.



3.7.6 Control Panel Utilized Resources Page

Each BlockSim diagram’s control panel contains a Utilized Resources page. This page displays a grouped list of all of the resources that are used directly by blocks in the diagram (i.e., not applied via any other resource or tool). For example, a universal reliability definition (URD) that is assigned to a block will be displayed in this list, but the model assigned to the URD will not be shown, nor will any tasks assigned to the URD. Similarly, if a block belongs to a maintenance group, that maintenance group will be shown in the list. However, if a block has a state change trigger, the maintenance group(s) used for that trigger will not be shown in the list unless some block in the diagram belongs to them. Refer to the “Resources” chapter for more information.

This list is not updated automatically; if you have made changes to the diagram, you can click the **Refresh** icon to update the list.



You can double-click a resource in the list to open its properties window for viewing or editing. You can also click the **Resource Manager** icon to view/manage all of the resources available in the project.



3.8 Results Window

The Results window is used in many Synthesis applications to show detailed calculation results. From this window, you can edit the results, copy the results to the Clipboard or print the results.

The toolbar contains the following tools:



Cut cuts the selected text to the Clipboard. Data stored in the Clipboard can be pasted into this and other applications.



Copy copies the selected text to the Clipboard. Data stored in the Clipboard can be pasted into this and other applications.



Paste pastes the contents of the Clipboard into the current control.



Page Setup allows you to specify printing options using the Page Setup window. *See page 497 in Chapter 29.*



Print Preview allows you to preview the current page before it is sent to the printer. *See page 502 in Chapter 29.*



Print sends the current document to the printer.



Send to Excel allows you to save the current selection as a Microsoft Excel (*.xls) file and then opens that file in Excel, if it is installed on your computer.

Note that the Results window may contain multiple sheets, accessible via the page index tabs at the bottom of the window.

3.9 System Panel and Analysis Panel

Some Synthesis applications use two convenient panels to manage all of the analysis information in a particular project (Xfmea, RCM++, RBI and MPC) or in a particular prediction folio within the project (Lambda Predict).

The first panel (called the *System panel* or the *System Hierarchy panel*) allows you to build simple or complex multi-level configurations that contain the items you plan to analyze. The second panel (called the *Analysis panel* or the *Properties panel*) contains all of the properties and analyses for the item that is currently selected.

This section discusses the ways in which you can configure the layout of these two panels to fit your particular workspace preferences.

Change Orientation

You can display the panels side-by-side or with one panel above the other.



To switch between layouts, choose **View > Workspace Layout > Change Orientation**.

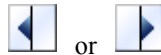


Resize a Panel

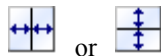
You can resize the panels by dragging and dropping the vertical (or horizontal) separator into the desired position.

Hide a Panel

You can also completely hide either panel so that the other can fill the available space. Choose **View > Workspace Layout > Hide [System Panel/System Hierarchy]** or **[Analysis Panel/Properties]**.



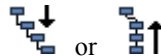
When you wish to return to the two-panel layout, choose the **Split Panels** command.



Expand or Collapse Nodes

When the panel presents data in a hierarchical tree configuration (e.g., the system hierarchy, FMEA hierarchy, etc.), the View tab provides several flexible options for expanding and collapsing the nodes (branches) that are currently displayed.

To expand or collapse all branches at the same time, choose **Expand Tree** or **Collapse Tree**.



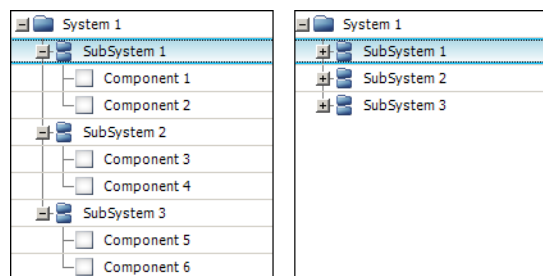
To expand or collapse a specific branch, you can click the + or - icons, or select the item and choose **Expand Node** or **Collapse Node**.



To collapse all branches in the tree to a specific level, select any item at the desired level and choose **Collapse to Level**.



As an example, the following pictures show how the hierarchy collapses to the second (subsystem) level.



Selecting Which Columns to Display

When applicable, you can hide, display or reorder the columns shown in a particular type of hierarchy by right-clicking any column header and choosing **Customize Columns**. These settings are stored per computer/username, and different users may have different display preferences without affecting the stored data. The same preferences can also be managed from the relevant page of the Application Setup.

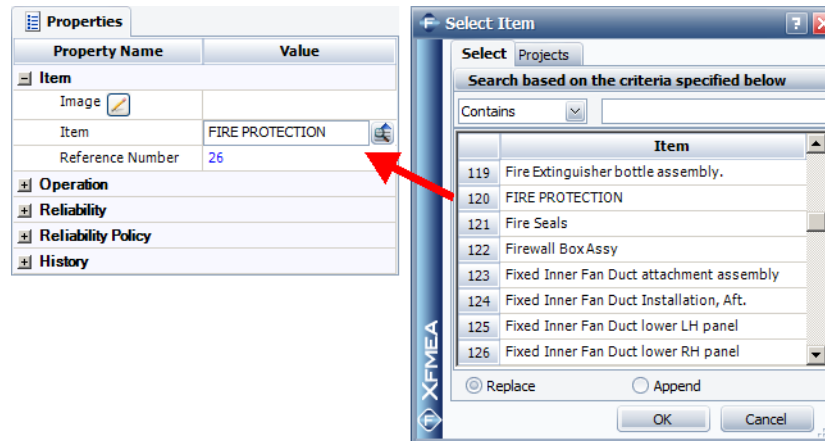
3.10 Select Existing Window

The Select Existing window provides a list of existing descriptions that might apply to the current text field. It is used extensively in applications such as Xfmea, RCM++, RBI and MPC, which facilitate data management and reporting for analyses that are based on lengthy text descriptions of intended functions, potential failure modes and recommended corrective actions. This feature is also available when applicable in other Synthesis applications.

Whenever the Select Existing window is available for a text field, the icon will be displayed.



The following picture shows an example of how a Select Existing window may be used in Xfmea to populate a text field. The list in the example is generated automatically from text that has been entered in the **Item** field for other projects within the database.



Depending on the type of text field, the Select Existing window may have two or three tabs. The **Select** tab displays a list of existing text descriptions for the selected text field. The **Project** tab and **Phrase Set** tab display a list of all the projects/phrase sets in the current database, allowing you to select the sources for the descriptions that will be displayed in the Select tab.

Filtering the Text Descriptions in the Select Tab

To insert one of the descriptions into the current field, double-click the row or select the row and click **OK**. If the **Replace** option is selected, the description will replace the current contents of the field. If the **Append** option is selected, the description will be added to the end of the current contents of the field.

The descriptions are sorted alphabetically. When the list (table) has focus, you can type a letter to move to the first description in the list that begins with the letter. You can also filter these descriptions by entering one or more keywords into the input box in the filtering area at the top of the window. You can specify how to match the specified keywords using the drop-down list.

- **Contains** returns descriptions that contain the exact string entered. For example, if you type “provides adequate structural” in the input box, then all instances that contain that phrase will be found. This includes descriptions such as “Provides adequate structural support,” but does not include descriptions such as “Provides structural reinforcement,” “Allows adequate air flow,” etc.
- **Contains Any** returns descriptions that contain any of the keywords entered. Keywords should be entered as a comma-delimited list. For example, if you type “provides, adequate, structural” in the input box, then all instances that contain any of those words anywhere within the field will be found. This includes descriptions such as “Provides structural reinforcement,” “Allows adequate air flow,” “Provides adequate structural support,” etc.

- **Contains All** returns descriptions that contain all of the keywords entered. Keywords should be entered as a comma-delimited list. For example, if you type “provides, adequate, structural” in the input box, then all instances that contain all of those words anywhere within the field will be found. This includes descriptions such as “Provides adequate structural support” and “Reinforces structural elements to provide adequate stability,” but does not include descriptions such as “Provides structural reinforcement,” “Allows adequate air flow,” etc.
- **Begins With** returns descriptions where the keyword(s) appear at the start of the field. For example, if you type “provides adequate” in the input box, then only the instances in which that phrase appears at the start of the field will be found. This includes descriptions such as “Provides adequate structural support,” but does not include descriptions such as “Provides support adequate for load of 500 kg,” “Fan provides adequate air flow,” etc.
- **is** returns descriptions that are identical to the exact string entered or matches the whole field. For example, if you type “provides adequate support” in the input box, then any description that contains that phrase, and only that phrase, will be found. The description “Provides adequate support” would be returned. Descriptions such as “Provides adequate structural support” and “Provides adequate support for load of 500 kg,” would not be included.

As you type in the **Find** field, the list is updated based on the filter criteria that you specified.

Selecting Data Sources in the Projects/Phrase Sets Tab

The Projects tab is available for nearly all types of items or records, while the Phrase Sets tab is available only for FMEA records (Xfmea, RCM++ and RBI). Each time you open a Select Existing window, it will use the same project sources/phrase sets that were selected the last time you used the utility.

In the Project tab, you can select the **Current** option to display the relevant descriptions from the current project only.

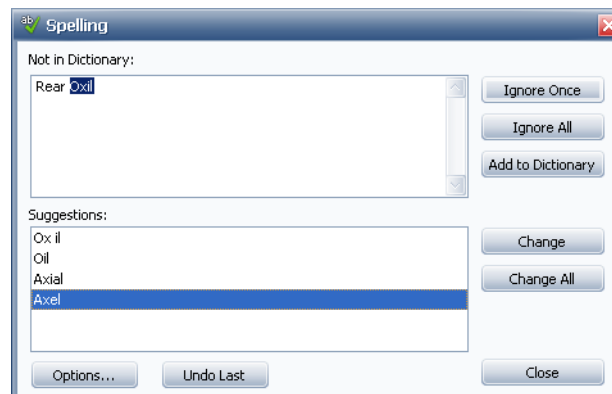
For both the Project and Phrase Set tabs, you can select either the **All** option, which displays the relevant descriptions from all projects/phrase sets in the current database, or the **Selected** option, which allows you to specify which projects/phrase sets to draw the descriptions from. When this option is selected, a list of the projects/phrase sets in the current database will become enabled. If the check box for a project/phrase set is selected, the relevant descriptions from that project will be displayed.

3.11 Check Spelling

Synthesis applications offer the ability to check the spelling of your text. This utility is available in different places within the software. For windows that offer the spell check functionality (e.g., Project Properties window, etc.), the Check Spelling icon  will be displayed within the window itself. For data sheets, spreadsheets and system hierarchies that offer the functionality, the Check Spelling icon will be available on the Ribbon and you can access it by choosing **Home > Edit > Spelling**.

Note: In system hierarchies (Xfmea, RCM++, RBI, MPC and Lambda Predict), the utility will check the property fields of the selected item only. This means that sub-items and text in analysis tabs, such as the FMEA tab in Xfmea, are not checked.

Whenever text that is not in the application's dictionary is found, the Check Spelling window displays the text in question and offers a list of suggestions to verify the error or confirm the correction, as shown in the following example.



- **Ignore Once** ignores the current instance of the highlighted word but continues to highlight it if the same word appears again.
- **Ignore All** ignores all instances of the word in the current form.
- **Add to Dictionary** adds the highlighted word to the dictionary on your computer so the spell checker will not treat it as a misspelling. The dictionary file is saved in the default Documents folder on your computer (e.g., My Documents\ReliaSoft\Dictionaries).
- **Change** replaces the current instance of the highlighted word with the word that is currently selected in the **Suggestions** area. If no word is selected, the first one will be used. Double-clicking a word in the **Suggestions** area is another way to change the highlighted text.
- **Change All** replaces all instances of the highlighted word with the word that is currently selected in the **Suggestions** area. If no word is selected, the first one will be used.
- **Options** opens the Spelling Options window, which provides additional settings to how the spell checker functions:
 - The **General options** area provides a list of the types of text that can be ignored by the spell checker (e.g., numbers, e-mail addresses, etc.). Select or clear each check box to specify how the spell checker will work on your computer.
 - In the **Edit custom dictionary** area, the **Edit** button opens a window that displays all of the words that you have added to the custom dictionary on your computer. You can edit the custom dictionary by adding or removing words in the list and then clicking **OK**.
 - **International dictionaries** allows you to choose the language of the dictionary that will be used on your computer.
- **Undo Last** reverses the last change that was made.

3.12 Find Tool

Most Synthesis applications offer the ability search for (and in some cases, replace) specific text or values in spreadsheets and in certain analysis folios. When applicable, the Find icon will be available on the Ribbon and you can access it by choosing **Home > Edit > Find** or **Find and Replace**.



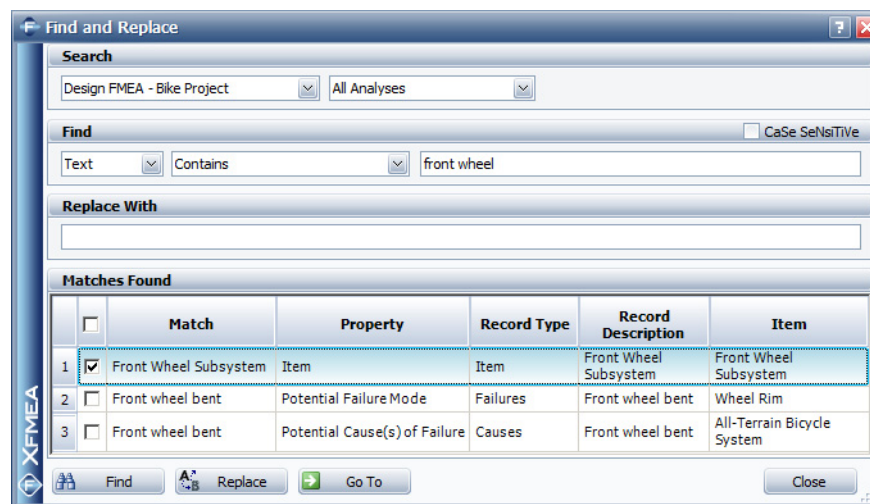
In the Find window, use the search bar to type the text or value you wish to locate. Optional settings that apply to the current sheet may also be displayed and can include any of the following:

- The **Match case** check box limits the search to text that have the same case. For example, the search term “teXt” will not find “Text” because the case does not match.
- The **Match whole field only** check box limits the search to text/numbers that are identical to the search term. For example, the search term “capacitor” will not find “filter capacitor” because the search term makes up only part of the field.
- The **Find entire cells only** check box is similar to the **Match whole fields only** check box, but applies to spreadsheets. In addition, spreadsheets provide the option to specify the order in which to search, either **By Rows** or **By Columns**; and the option to limit the search to within equations (**Formulas**) or within the results of an equation (**Values**).
- The **Replace** button extends the basic Find functionality by allowing you to replace the text or value that matches your search. When you click the button, the **Replace With** field will become visible so that you can type the text or values that will replace the found text/value.
 - To replace all instances without review, click **Replace All**.
 - To review the instances before replacing the material, click **Find Next** to locate the first place the material occurs, then either click **Find Next** to leave the current match as-is and find the next occurrence or click **Replace** to replace the current match and find the next occurrence.

Tip: To ensure that all instances of searched for text are replaced (including multiple instances within the same cell), you may need to click **Replace All** several times.

3.12.1 Searching FMEA Records in Xfmea, RCM++ and RBI

In Xfmea, RCM++ and RBI, the expanded Find utility gives you the flexibility to search for FMEA records within specified projects in the current database. The following picture shows an example of the utility in Xfmea.



The **Search** area contains drop-down lists that allows you to specify which project, analyses or record properties to search. If you want to search all data in the current project, accept the default **All Analyses** option. If you want to

search in a specific project and/or in a specific analysis or record property, choose different options from the drop-down lists.

Note: For options in drop-down lists (e.g., the Action Category list) or for options in rating scales (e.g., the Initial Severity for effects) you can search for and replace records in the current project only. For example, this capability might be used if you have created a process FMEA with data transferred from an existing design FMEA and you need to update all of the analysis data in the project to match the new settings. In this case, in the design FMEA's Action Category drop-down list, the actions that were assigned to the "Design" group will be handled in the process FMEA by the "Manufacturing" group. To do so, you can use the Find and Replace window to search for all records that have been assigned to the old category (e.g., "Design") and replace with the new category (e.g., "Manufacturing").

The **Find** area allows you to specify the text, date or number that you want to search for. The first drop-down list allows you to choose the type of data (i.e., text, date or number) and the second drop-down list displays the options that will determine a match. When you are searching for text, you can select or clear the **CaSe SeNsIiTive** check box to determine whether the search will consider the case. For example, if this option is selected, the search term "teXt" will not find "Text" because the case does not match.

Note: You can find fields that have no data in them by choosing **is empty** in the Find area.

The **Replace With** area allows you to specify the text, date or number that can be used to replace the existing data for any matches that you select.

After you have made your selections in the Search and Find areas, click the **Find** button. The **Matches Found** area will display a list of any records that match your search criteria.

If you want to go to a specific record, select the match and click the **Go To** button or double-click the match. The project will open with the matching record selected.

If you want to replace the text, date or number with the data that you have specified in the **Replace With** area, select the match(es) and click the **Replace** button. To select all matches for replacement, click the check box in the table header. To select individual matches, click the check box in each row.

3.13 Quick Parameter Estimator (QPE)

The Quick Parameter Estimator (QPE) allows you to estimate the parameters of a distribution based on information you have about the reliability of a product, the probability of an event occurring or the typical duration of a task. In all Synthesis applications, you can open the QPE from the Model window or Model Wizard by clicking the **QPE** icon.



In Weibull++/ALTA, it's also accessible from the Home tab of the Ribbon and several analysis interfaces (including the Weibull++ standard folio, the Weibull++ Monte Carlo and SimuMatic utilities, and the Expected Failure Times Plot).

The QPE includes a Wizard view and an Expert view, described below. You can toggle between the different views by clicking the **Use Expert** or **Use Wizard** button at the bottom-left corner of the window.

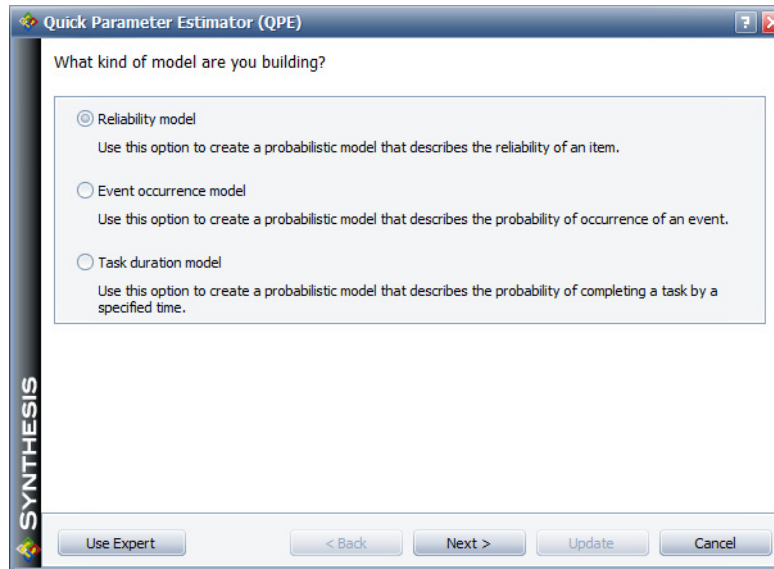
- The Wizard view automatically selects a distribution and estimates that distribution's parameters based on your responses to a series of questions. The first page of the Wizard view asks you to choose among three different types of models that you can build with the QPE. Subsequent pages will ask more specific questions related to your selected model.

- The Expert view allows you to estimate the parameters of a distribution using either two unreliability values at specified times or one unreliability value and the other parameter(s) of the distribution. Unlike the Wizard view, you must select a distribution to solve the parameter(s) for.

What's Changed? In previous versions of some ReliaSoft applications, the Expert view of the Quick Parameter Estimator was known as the Parameter Experimenter.

3.13.1 Wizard View

To use the Wizard view of the Quick Parameter Estimator (QPE), simply follow the prompts on each page. The first page will present and describe three different types of models that you can build with the QPE.



Below are the three models and the kind of information you'll need to provide in subsequent pages.

To build a **Reliability model** you need to provide information about:

- How age affects the product's reliability
- The product's intended design life and the estimated warranty time
- Best-case, worst-case and most likely unreliability estimates for the product at the end of the design life and warranty time

To build an **Event occurrence model** you need to provide information about:

- Whether age affects the probability of the event's occurrence
- Best-case, worst-case and most likely estimates for how often the event will occur

To build a **Task duration model** you need to provide information about:

- Best-case, worst-case and most likely estimates for how long it will take to complete the task

The last window will display the tool's selected distribution and the calculated parameters. It will also provide one of the two options described below.

- If you opened the QPE from an analysis folio or utility, the **Update** button will be available in case you wish to update that window using the selected distribution, calculated parameters and selected time units.

- In Weibull++/ALTA, if you opened the QPE from the Ribbon, the **Finish & Copy** button will be available in case you wish to copy the parameters results to the Windows clipboard.

3.13.2 Expert View

To use the Expert view of the Quick Parameter Estimator, click the **Use Expert** button at the bottom-left corner of the window. The window will appear as shown next.

Follow the steps below to use the Expert view:

- Choose a distribution from the **Distribution** drop-down list. This is the distribution that you will solve the parameter(s) for. Then choose the appropriate time units from the **Units** drop-down list.
 - If you are not sure which distribution to select, consider using the Wizard view of the QPE instead.
 - Your choice of time units applies to all time inputs and applicable parameters of the distribution (such as the eta parameter when the Weibull distribution is used).
- Select an appropriate option in the **Quantification Method** area. The following two methods are available:
 - The **Unreliability and a Parameter** method solves for one parameter of the distribution. It requires one unreliability point (i.e., an unreliability value at a specified time) and the values of all the parameters of the selected distribution except the parameter you will solve for.
 - If you select this method, you must then enter one unreliability point in the **Point #1** area. For example, if you believe that your product has an unreliability of 10% at 100 hours, then you would enter **100** in the **Time** field and **0.10** in the **Unreliability** field.
 - In the **Solve for Parameter** area, select the parameter that you wish to solve for. The remaining parameters in this area will have input fields enabled. Enter the known values of these parameters.
 - The **Two Unreliability Points** method solves for all the parameters of the distribution. It requires two unreliability points that you will provide in the **Point #1** and **Point #2** areas.

Tip: If you are building an event occurrence or task duration model, you can treat an “unreliability” point as the probability that an event will occur or that a task will be completed by a specified time. For example, if you are modeling the probability of an event’s occurrence and you believe that there is a probability of 30% that the event will occur before 150 hours, then you would enter **0.3** in the **Unreliability** field and **150** in the **Time** field.

- Click **Calculate** to solve for the unknown parameter(s).
 - If you opened the QPE from an analysis folio or utility, you may click the **Update** button if you wish to update that window using the selected distribution, calculated parameters and selected time units.
 - In Weibull++/ALTA, if you opened the QPE from the Ribbon, you may click the **Finish & Copy** button if you wish to copy the results to the Windows Clipboard.

3.13.3 ALTA Version of the QPE

In ALTA only, another version of the Quick Parameter Estimator (QPE) allows you to estimate the parameters of a model based on information you have about the reliability of a product at normal and accelerated stress levels. In ALTA, you can open the ALTA QPE from the Ribbon by choosing **Home > Tools > Quick Parameter Estimator (ALTA)**.



The window will appear as shown next.

You can also open the ALTA QPE from the ALTA standard folio (by leaving the folio's data sheet empty and clicking **Calculate**), as well as the ALTA Monte Carlo and SimuMatic utilities.

Follow the steps below to use the ALTA QPE:

- The first page of the window will be used to estimate the product's mean life under normal stress conditions.
 - Choose a model from the **Model** drop-down list. This is the model that you will solve the parameter(s) for. Then choose the appropriate time units from the **Units** drop-down list. Your choice of time units applies to all time inputs and applicable parameters of the model (such as the eta parameter when the Weibull distribution is used).
 - Select an appropriate option in the **Quantification Method** area. The following two methods are available:
 - The **Unreliability and a Parameter** method solves for one parameter of the model. It requires one unreliability point (i.e., an unreliability value at a specified time) and the values of all the parameters of the selected model except the parameter you will solve for.
 - If you select this method, you must then enter one unreliability point for normal use conditions in the **Point #1** area. For example, if you believe that your product has an unreliability of 10% at 100 hours

under normal use conditions, then you would enter **100** in the **Time** field and **0.10** in the **Unreliability** field.

- In the **Solve for Parameter** area, select the parameter that you wish to solve for. The remaining parameters in this area will have input fields enabled. Enter the known values of these parameters.
- The **Two Unreliability Points** method solves for all the parameters of the model. It requires two unreliability points under normal use conditions that you will provide in the **Point #1** and **Point #2** areas.
- In the **Use Stress Level** area, you must enter the stress level that the product will experience under normal conditions. In multi-stress situations, this stress level will be a combination of stress values for each stress type.
- If the **Number of Stresses** field is enabled, enter the number of stresses that will be used in your model. (Note that different models have different requirements for the number of stresses that can be used.)
- Click the arrow inside the **Use Stress Value(s)** field. In the table that appears, enter a stress value for each stress type. If there are multiple stress values, they will appear in the field separated by semicolons.

Stress	Value
Stress 1	328
Stress 2	2

- Click **Next >** to go to the Life at Each Stress Level page. The **Use Stress Level** area of the page will display the product's mean life at the specified use stress level based on your previous inputs. In the **Accelerated Level 1** area, you must enter the estimated mean life for the product at an accelerated stress level.
- To enter the accelerated stress level, double-click inside the **Stress Value(s)** field. In the table that appears, enter the stress value for each stress.

Stress	Value
Stress 1	348
Stress 2	2

- In the **Characteristic Life** field, enter the product's characteristic life at the associated accelerated stress level.
 - For the Weibull distribution, the characteristic life is equal to the value of the eta parameter (i.e., the time at which unreliability = 63.2%).
 - For the lognormal distribution, it is equal to Exp(Log-mean) (i.e., the time at which unreliability = 50%).

- For the exponential distribution, it is equal to the mean life.

Note: The number of accelerated stress levels you must provide life estimates for will equal the number of stresses that will be used in the selected model. For example, if the model uses two stress types, as shown above, then there will be an **Accelerated Life 2** area in which you must provide a characteristic life estimate for a second accelerated stress level.

- Click **Next** > again to see the calculated parameters.
 - If you opened the QPE from the Monte Carlo or SimuMatic utility, you may click the **Update** button if you wish to update that window using the selected model, calculated parameters and selected time units.
 - If you opened the QPE from the Ribbon, you may click the **Finish & Copy** button if you wish to copy the results to the Windows Clipboard.

3.14 History Logs

By default, all Synthesis applications will automatically store and display information about when particular portions of the analysis were created and last updated, and by whom. For example, you can view creation and modification information for system hierarchy items in Xfmea/RCM++/RBI on the Properties tab in the Analysis panel. You can access similar information about folios and diagrams in Weibull++, BlockSim and similar applications by selecting the project item in the current project explorer and choosing **Project > Current Item > View Item History**.



If desired, you also have the option to activate a full history log for any Synthesis project that stores a more detailed history of the specific changes. (In secure databases, you must be the project owner or have the “Manage all projects” permission to do this.) To activate this log for the current project, choose **Project > Management > History Log**.



For any other project, right-click the project in the project list and choose the command on the shortcut menu. In the Project History Log window that appears, click **Activate**.

Note: Keeping a full history log will increase the size of the database and will cause a slight degradation in performance.

Once this log has been activated, there are two interfaces that display information about the changes.

- The **Project History Log** displays changes that were performed throughout the entire project, with any of the Synthesis applications. *See Section 3.14.1 on page 123.*
- The **Record History Log** displays changes that were performed for a specific folio, system hierarchy item, FMEA record, resource, etc. *See Section 3.14.2 on page 123.*

It is also important to note that you have the option to create **Archives** for log entries that occurred before a specific point in time, as a way to make sure that the logs are more manageable to work with. The archived entries can still be viewed in the Project History Log if you specifically select to view them, but they will never be displayed in the Record History Log. *See Section 3.14.3 on page 123.*

You can deactivate the history log at any time from within the Project History Log. When you do this, the recorded data is retained unless you select to clear it in the confirmation message that appears.

3.14.1 Project History Log

To access the Project History Log, choose **Project > Management > History Log**. (In secure databases, you must be the project owner or have the “Manage all projects” permission to do this.)



In addition to allowing you to activate or deactivate the full history log for a particular project, this window also displays all of the changes that were performed throughout the entire project, with any of the Synthesis applications. Use the **Filter Based On** area on the right side of the window to determine which changes will be displayed at any given time. For example, you might choose to display a list of all changes that were made by Joe User in the last week, or a list of all changes that were made by any user in Weibull++ today, and so on.

If desired, you can click **Send to Excel** to export the data that is currently shown in the table to a new *.xlsx file.

3.14.2 Record History Log

Once a history log has been activated for the project, you can access the history log data for any item that is subsequently added or edited. This includes, but is not limited to, project items (e.g., folios, diagrams, MultiPlots, etc.); items shown in the system hierarchy in Xfmea/RCM++/RBI and Lambda Predict; analyses in Xfmea/RCM++/RBI; records for analyses such as FMEAs; and certain resources. Depending on the type of item you are working with, you may access the record history log in various ways.

- For items shown in the current project explorer, select the item and choose **Project > Current Item > View Item History** or right-click the item and choose the command on the shortcut menu. Note that if the history log has not been activated, this command will instead display a message that displays the date and time the item was created and the name of the creator, along with the date and time the item was last modified and the name of the user who made the modifications.



- For analyses in Xfmea/RCM++/RBI, choose the **History Log** command in the Tools group of the Ribbon tab relevant to the analysis or right-click the analysis tab in the Analysis panel and choose the command on the shortcut menu.



- For other records, such as items shown in the system hierarchy, resources, etc., click the **View Item History** icon in the item's properties.

The Record History Log provides information on changes made only to the selected item, and shows only those entries that have not yet been archived. If desired, you can click **Send to Excel** to export the data that is currently shown in the table to a new *.xlsx file.

3.14.3 Creating and Managing Archives

Within the context of the history log, an archive is a subset of the full project history log that contains older entries that are no longer actively of interest. For example, if you want to limit the amount of information that is visible in the log, you might choose to archive all entries that occurred more than one week ago. Entries that have been archived can still be viewed in the Project History Log if you specifically select to view them, but they will no longer be visible in the Record History Log windows.

To create a new archive, specify a time frame in the **Archive Current Entries Through** area and click the Archive button. For example, if you choose to archive entries through **One Week Ago**, all entries in the history log that are dated as of one week ago or earlier will be stored in an archive that is named according to the most recent date in the archive.

To view the entries that have been archived, select the archive of interest from the **Archives** drop-down list in the **Filter Based On** area.

Note: When a restore point is created for a project, all current entries in the history log are automatically archived. See page 68 in Chapter 2.

To delete an archive, select the archive from the **Archives** drop-down list in the **Filter Based On** area and click the **Delete** icon that appears in the field.

3.15 Attachments

All Synthesis applications allow you to attach URLs and/or files that were created in other applications. This helps you to keep supporting documentation all together in the same place with your analysis. The locations where you can attach files will vary depending on which Synthesis application you are using. All applications support attachments for the project and for most types of Synthesis resources. Some applications (such as Xfmea, RCM++, RBI, Lambda Predict and MPC) support attachments for individual records in a system hierarchy or analysis hierarchy. BlockSim and RENO support attachments for individual blocks in diagrams and flowcharts.

In all Synthesis applications, attachments can be either linked or embedded.

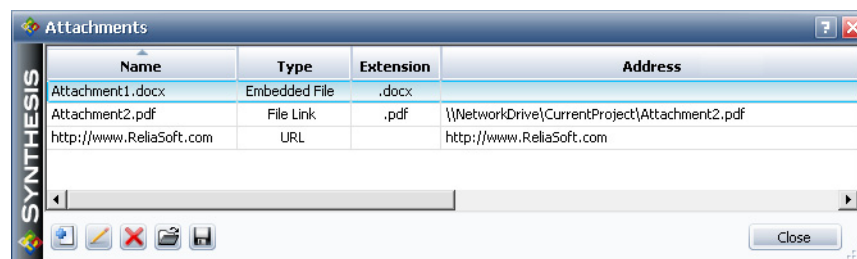
- **Linked** attachments may be URLs or files. For these attachments, the software stores the path to the URL or file. This allows you to open the resource in its original location (e.g., Internet, intranet or network directory), provided that the necessary software is installed on your computer and the link is valid. The files themselves are not stored inside the database.
- **Embedded** attachments are always files (i.e., you cannot embed a URL). For these attachments, the software stores a complete copy of the attached file inside the database. Please note that embedded attachments will increase the file size of the database.

Two windows are used to work with attachments. The Attachments window allows you to manage all of the URLs/files attached to a particular location (e.g., project, resource, hierarchy record or block).

The Add/Edit Attachment window is used to specify the details of an individual file or URL, and will be displayed whenever you choose to create or edit an attachment.

3.15.1 Attachments Window

The Attachments window displays a list of all the URLs/files that are attached to a particular location, as shown next.



Click a column header to sort the attachments by that column; click the column header again to reverse the direction of the sort.

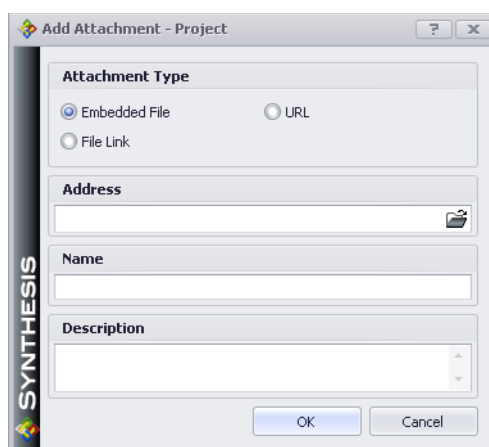
The icons at the bottom of the window allow you to **Add** a new attachment (📎), **Edit** the properties of the selected attachment (✏️), **Delete** the selected attachment (❌), **Open** the selected attachment (📁) or **Save** a copy of the selected attachment (💾).

You can also double-click a row to open the selected attachment, or press **DELETE** to remove it.

Note that when you delete an embedded file, the actual file is deleted from the database and this cannot be undone (unless you happen to have a saved backup (*see page 67 in Chapter 2*) or restore point (*see page 68 in Chapter 2*) that you could roll back to). When you delete a file link or URL, this simply removes the link, leaving the original file untouched.

3.15.2 Add/Edit Attachment Window

The Add/Edit Attachment window is displayed whenever you add or edit the properties of an attachment.



Three types of attachments are supported:

- With an **embedded file**, the file is stored directly in the database and it will be accessible to any user who has the required software installed.
- With a **file link**, only the pathname/filename is stored in the database so the file will only be accessible to users who have the required software installed and have access to the specified network folder.
- With a **URL**, you can specify any web-based resource on the Internet or a private intranet (e.g., a web-based document management system, FRACAS incident report, etc.). The application will attempt to open the link in the user's default web browser.

If you are attaching a file, the Address field will display a **Browse** icon (📁) so you can select the file to be attached.

If you are attaching a URL, the **Name** field will be populated automatically as you type the URL into the **Address** field. This is for your convenience only and you can specify a different name if desired.

3.15.3 Attachment Locations

As mentioned above, the locations where you can attach files will vary depending on which Synthesis application you are using.

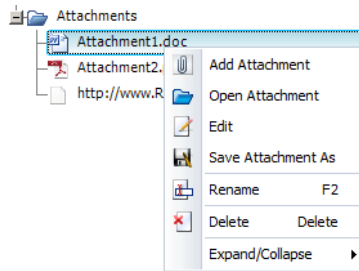
Tip: In most cases, the caption bar in the Attachments window will provide an indication of which type of attachment you are working with. For example, when you are working with project-level attachments, the caption bar will indicate "Project:" followed by the specific name of the project.

3.15.3.1 Project Attachments

All Synthesis applications support attachments at the project level. In all applications, project attachments can be displayed/managed from the **Attachments** icon in the Project Properties window.



For most applications, project attachments can also be displayed/managed from the Attachments folder in the current project explorer.



In Xfmea, RCM++, RBI and MPC (which do not have a current project explorer), you can also access the project attachments by selecting **Project > Synthesis > Attachments**.

3.15.3.2 Synthesis Resource Attachments

All of the applications that utilize Synthesis resources support attachments at the resource level. For example, you can attach a file to a URD, a model, etc.

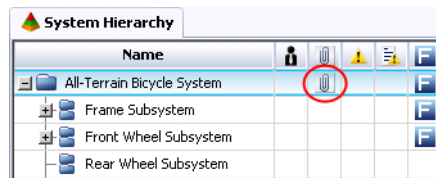
To access attachments for an existing resource, you can click the **Attachments** icon in the resource's properties window.



3.15.3.3 Hierarchy Attachments

Some applications, including Xfmea, RCM++, RBI, Lambda Predict and MPC, support attachments for individual items or records in a system hierarchy or analysis hierarchy. For example, in Xfmea, you can create attachments for a particular item, or for a particular record in the FMEA for that item.

To access attachments for items or records in a hierarchy, you can double-click inside the Attachments column. (If this column is not displayed on your computer, right-click inside the column headers and choose **Customize Columns**.) You can also choose **Tools > Attachments** on the Ribbon tab for the hierarchy that you are currently working with.



For records in an analysis hierarchy (such as FMEA or functional failure analysis), the attachment icon can also be accessed from within the record properties window.



3.15.3.4 Block Attachments

BlockSim supports attachments for individual blocks in a diagram. To access attachments for a block, you can click the **Attachments** icon in the Block Properties window.



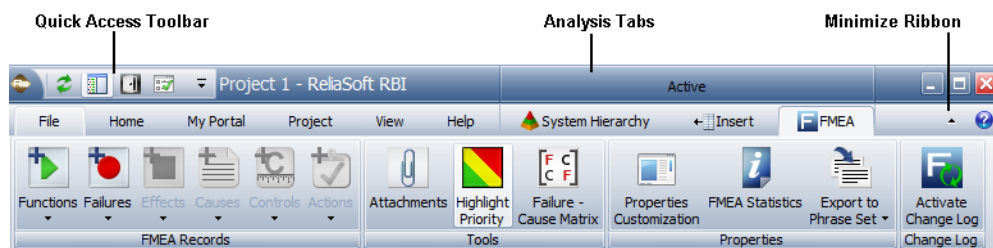
Ribbon

4

The application has a user-interface called the *Ribbon*. This interface is designed to improve efficiency by displaying only the commands you need to complete a specific task. The Ribbon is divided into tabs that relate to a task or activity, such as managing the items in the system hierarchy or performing a specific analysis. Each tab contains the related commands, which are intuitively organized into groups. Depending on the activity you are in, some commands may appear dimmed or will not appear at all.

This section is intended to serve as a comprehensive reference to the commands found on the Ribbon. Note that many features in the application also have a shortcut menu (accessed by right-clicking) that gives access to commands that are commonly used for that feature. All commands available in the shortcut menus are also available on the Ribbon. In addition, the Ribbon includes a customizable Quick Access Toolbar that allows you to display frequently used commands. *See Section 4.1 on page 129.*

Tip: To maximize your workspace, you can choose to automatically minimize the Ribbon and display only the tab names. To do this, click the arrow on the right-side of the Ribbon, (labeled “Minimize Ribbon” in the picture below). The Ribbon will be expanded when you click a tab and then minimized after you click a command.



4.1 Quick Access Toolbar

The Quick Access Toolbar is a customizable feature of the Ribbon that allows you to access frequently used commands without changing the tabs.

- To add your favorite commands to the Quick Access Toolbar, right-click the command on the Ribbon and select **Add to Quick Access Toolbar**.
- To remove a command from the toolbar, right-click the command on the Ribbon or on the Quick Access Toolbar and select **Remove from Quick Access Toolbar**.
- Right-clicking anywhere within the Quick Access Toolbar also gives you the following commands:
 - **Show Quick Access Toolbar Below the Ribbon** or **Show Quick Access Toolbar Above the Ribbon**. The command that appears depends on where the toolbar is currently displayed on the Ribbon.

- **Minimize the Ribbon** maximizes your workspace by allowing you to display only the tab names on the Ribbon. The Ribbon will be expanded when you click a tab and then minimized after you click a command. To keep the Ribbon always expanded, clear the check box.

4.2 Backstage View (File Tab)

The Backstage view (File tab) is the first view you will see when you start the application. It allows you to work with databases and application-level settings. In other words, the Backstage view allows you to do things *to* a database, while the commands on the other tabs of the Ribbon allow you to do things *within* the database.

To access the Backstage view from within the application, click the **File** tab on the Ribbon. You can click any Ribbon tab to exit the Backstage view and return to the MDI workspace.

The area on the left side of the Backstage view is called the *Tab Pane*. It contains commands for working with the database and access to the tabs of the Backstage view.

The following commands are available in the Tab Pane:



Save As saves a copy of the standard database to another pathname/filename and/or file type. You can save it as a new standard database (*.rsr9) or a compressed standard database (*.rsgz9).

Tip: Note that Synthesis applications do not provide a **Save** command because changes are saved automatically as you work in all database-driven Synthesis applications. If you used to rely on the ability to close a standalone file without saving recent changes, the **Restore Points** feature provides similar functionality within Synthesis. See page 68 in Chapter 2.



Pack and E-mail compresses a copy of the current standard database to a *.rsgz9 file and attaches it to a new e-mail message. If no e-mail program is installed or no default e-mail program is defined on the computer, a message notifying you of this will be shown. This command is not available if you are working with an enterprise database.

When you open the compressed file, a new database will be created from that file and saved in your local drive (C:\Documents and Settings\username\My Documents\ReliaSoft\Files). Any changes made to the new database will not affect the original copy.



Open Repository opens an existing standard database (*.rsr9) or enterprise database (*.rserp), or a compressed standard database (*.rsgz9). You also can select a database file in the Windows Explorer and double-click or drag it into the MDI to open it. If you want to convert a standard database that was created with Xfmea 5 or RCM++ 5, choose the appropriate option from the drop-down list in the Open Database window.



Close Repository closes the database. You also can close the database by opening another database or by exiting the application.

- **Recent** shows a list of recently opened database files (*.rsr9 and *.rserp) and a list of recently accessed locations. Clicking a database will open it, and clicking a location will allow you to browse for databases in that location. The number of items in these lists is set in the **Recent Repository List** area of the Synthesis Setup (see page 503 in Chapter 30). You can pin items to a list by clicking the pushpin icon associated with the item; when the pin is vertical, the item will not roll off the list.
- **New** allows you to create a new standard database (see page 26 in Chapter 2) or a new connection file for access to an enterprise database (see page 28 in Chapter 2).
- **Launch Application** provides quick launch icons for other Synthesis applications that are installed on your computer. If you are currently connected to a database when you click one of these icons, the same database will automatically be opened in the new application.

- **Manage Repository** contains tools that control various repository-level settings. These include:

Note: Most of these tools are available only when a repository is currently open. If you are working in a secure database, some tools may not appear at all. Your access to these tools is based on the permissions assigned to your user account.

- **Security**



Authorized Users controls the users who can access a secure database. *See page 48 in Chapter 2.*



Prior Logins displays a list of prior logins to the current database and allows you to export this information to Excel. *See page 59 in Chapter 2.*



Reset “In Use” Flags allows you to reset the flags that indicate the “in use” status of projects or items within a project. *See page 59 in Chapter 2.*

- **Notifications**



E-mail Settings controls whether e-mail notifications are enabled and when they are sent. *See page 60 in Chapter 2.*



Notification Groups allows you to define distribution groups to receive e-mail notifications. *See page 61 in Chapter 2.*

- **Profiles and Templates**



Profiles/Library Manager allows you to configure the predefined settings of the profiles stored in the software library. Profiles allow you to customize the look, drop-down lists, rating scales and other settings of a particular project in order to fit the needs of the analysis. *See page 184 in Chapter 6.*



Templates Manager allows you to manage the configurable templates that can be used for customized reports, saved queries or importing/exporting data via Excel. *See page 442 in Chapter 23.*

- **Repository Settings**



Manage Units allows you to define the time units available for use in any project within the database. *See page 62 in Chapter 2.*



Define Default Names allows you to specify how default names for resources and blocks are created. *See page 63 in Chapter 2.*



Task Types maps the task types that are used in only in RCM++ or RBI to the corresponding task classes in the universal reliability definition (URD) so that simulation and cost calculation results in are accurate. *See page 305 in Chapter 13.*



Global Identifiers allows you to define the names of the identifiers, which are fields that can be used to search for blocks or resources within the current project. *See page 64 in Chapter 2.*



Project Categories allows you to define the categories that can be used to filter the projects displayed in the project list. *See page 65 in Chapter 2.*



Restore Points allows you to manage restore points, which are exact replicas of the project at a particular point in time (i.e., backups) that can be restored when and if needed. *See page 68 in Chapter 2.*



Compact and Repair helps to reduce the size of the current database to protect against data loss or file corruption. *For details on protecting your data, see page 67 in Chapter 2.*



XFRACAS Connection allows you to specify the location of and the connection settings for the XFRACAS tables associated with the current standard database. For enterprise databases, the XFRACAS data stored within the database is accessible automatically. *See page 66 in Chapter 2.*



Dashboard Manager is available only when working with simulation diagrams, and only if you have permission to manage dashboard templates. It opens the Dashboard Manager window, which allows you to see all of the templates that have been defined for use in the Dashboard Viewer in Weibull++, BlockSim and RGA, and to import, rename and/or delete templates.

○ Enterprise



Repository Creation opens a wizard that leads you through the steps to create a new enterprise repository (SQL Server or Oracle database). To use this option, you must have access to a server with a supported version of SQL Server or Oracle and you must have the appropriate permissions to create a new database on the server.

Note that if no database is currently open, the Repository Creation wizard and the Upgrade Repository wizard are the only options available.



Import from Prior Version opens a window that allows you to import from an enterprise database created in version 5. This icon is available only when you are connected to an enterprise database and have “Manage all projects” and “Manage users and logins” permissions. *See page 75 in Chapter 2.*



Upgrade Repository allows you transfer all of the existing data from a Version 8 enterprise database to a Version 9 enterprise database. *See page 33 in Chapter 2.*

- The **Help Center** provides a variety of resources to help you use the application more effectively. In addition, the Help Center displays information about the application, including the Compile Release Version (CRV) and License information. *See Section 4.2.1 on page 133.*



Application Setup opens the Application Setup, which allows you to set your preferences for working with analyses, such as the math precision, default plot settings and the like. The settings apply only to the current computer/username, and they do not affect the results of the analyses. *See page 505 in Chapter 30.*



Synthesis Setup opens the Synthesis Setup, which allows you to set your preferences for the entire Synthesis repository, such as when to backup the database, the color-scheme of the interface and the like. The settings apply only to the current computer/username, and they do not affect the results of the analyses. *See page 503 in Chapter 30.*

ReliaSoft Online Pane

The area on the right side of the Backstage view is called the *ReliaSoft Online Pane*. There are three pages available in this pane, accessed by the icons at the top of the pane:



The **ReliaSoft Online Home** page displays software tips, announcements and upcoming training seminars for this application.



The **Latest News** page displays recent announcements about ReliaSoft's reliability software and services.



The **Synthesis Portal** page displays tips and announcements related to the entire Synthesis Platform.

Note that an active Internet connection is required to see this information.

4.2.1 Help Center (File > Help)

The Help Center, which is part of the Backstage view, is intended to help you use the application more effectively by providing quick access to a variety of support tools. To access the Help Center, choose **File > Help**. For your convenience, the same commands are also available in the Ribbon's Help tab. *See Section 4.7 on page 143.*

Using This Application



Online Help File opens the application's help file. If you have an active Internet connection, the help topics that you see will always be the most up-to-date versions available. If you do not have an active Internet connection, the help topics that you see will be the local copy that was installed on your machine.



User Guide opens the application's *User's Guide* (in PDF format) if you have an active Internet connection.

Online Resources



ReliaSoft.com opens the main page of the ReliaSoft.com website (<http://www.Reliasoft.com>).



Weibull.com opens the Weibull.com website, which is devoted entirely to the topic of reliability engineering, reliability theory and reliability data analysis and modeling. (<http://www.Weibull.com>)



ReliaWiki.org opens the ReliaWiki website, which is both a resource portal and a wiki for professionals in reliability engineering and related fields. (<http://www.ReliaWiki.org>)



Reliability Discussion Forum opens the Reliability Discussion Forum website, which is designed to facilitate communication within the reliability engineering field. These forums are open to everyone and no password is required. ReliaSoft personnel monitor and participate in the discussions. (<http://www.ReliasoftForums.com>)

Examples



Open Examples Folder provides access to a set of example projects that are designed to help you explore various software features.



Quick Start Guide opens the application's Quick Start Guide (in PDF format) if you have an active Internet connection. This guide contains step-by-step examples designed to assist you in learning to use the application software.

Technical Support



E-mail Support generates an e-mail to request technical support. The e-mail is pre-populated with information about your license and operating system, which the technical support representative will need for troubleshooting the issue.



Contact ReliaSoft USA provides the contact information you will need to obtain technical support. *See page 2 in Chapter 1.*



Contact Global Support Center helps you find your localized ReliaSoft support center.



Check for Update allows you to download the latest free service release for the software.

- **Licensing** displays your license and registration details. To view or edit additional information, click **License Manager**. The License Manager displays additional information about which products you have currently registered and your contact information on file with ReliaSoft. *See Section 4.2.2 on page 134.*
- **About** displays the application's Compile Release Version (CRV) (sometimes called a “build number”), which allows you to determine whether you have the latest version of the software.

4.2.2 License Manager

The License Manager allows you to view and manage license-related details for the Synthesis applications that are currently activated on your computer. You can use this interface to:

- View and edit the contact information that is on file with ReliaSoft or change the password associated with your ReliaSoft ID.
- Deactivate the current application (if you don't plan to continue to use it on this computer or for this user).
- Check out or check in a CAL (which is applicable only for concurrent network licenses and serves to “reserve a seat” on the license that you share with other users).

To open the License Manager, click the **License Manager** link in the Help Center or choose **Help > Updates & Licensing > License Manager**.



You will be prompted to enter the password that was sent via e-mail when you first registered your ReliaSoft ID. This password is required if you want to modify your contact information. For everything else, you can click **Cancel** to proceed without it. (If you forgot your password, you can request to have the information sent to the e-mail address on file for your registration by clicking **E-mail my password to me.**)

View and Edit Contact Information and Password

The **Contact Information** page displays the name, phone number and other details that are on file with ReliaSoft.

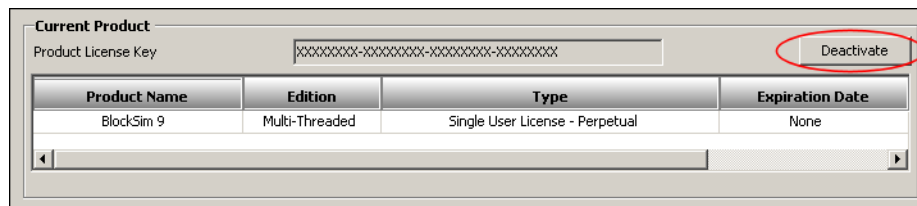
- If you need to download the latest information from the license server, click **Synchronize**.
- If you want to change your password or any of the current contact information, type the new information into the fields on this page and then click **Update Information on Server**.

Both actions require authentication. If you have not already entered the current password that's associated with your ReliaSoft ID, you will be prompted again to enter it.

Deactivate the Current Application

If you don't plan to continue to use the current Synthesis application on a particular computer (or for a particular user), you can use the License Manager to deactivate it. This does not require authentication; you can proceed with the deactivation even if you have not entered your password.

Click the **Deactivate** button in the current product area on the **Products** page.

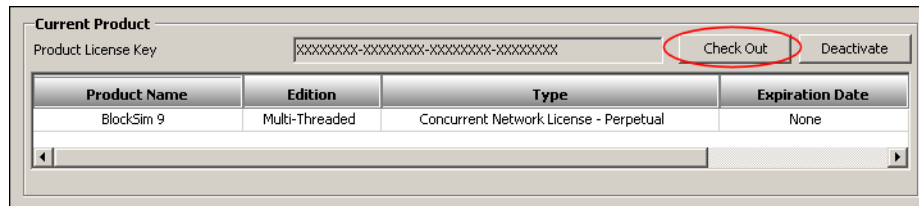


The application will shut down immediately after you deactivate, so you will be prompted to confirm that you're ready to continue. If you later try to access this application again for this computer/user, you will be prompted to repeat the activation process.

Check Out or Check In a CAL (for Concurrent Network Licenses)

If you have a concurrent network license¹, a specified number of *Concurrent Access Licenses* (CALs) are shared by the pool of *Named User Activations*. For example, there could be 30 named users but the application can be active on only 10 computers at the same time.

If you need to be sure that the application is available when you need it, you may have the option to check out (i.e., reserve) a CAL for a specified period of time. For example, you might wish to use this feature if you plan to be working without the Internet access required to obtain a CAL from the license server, or if you need to make sure that all of the CALs will not be taken by other users when you really need to access the software. However, it is important to remember that this reduces the number of CALs available for the rest of the pool of named users until the CAL is checked back in or otherwise released. If your license permits you to check out a CAL, the necessary buttons will be visible in the current product area on the **Products** page.



- If you don't currently have a CAL checked out, the **Check Out** button will be displayed. Click the button to reserve a CAL.
- If you currently have a CAL checked out, the **Check In** button will be displayed instead. Click the button when you're ready to make the CAL available again to the rest of the named user pool.

4.3 Home Tab

The Home tab contains commands related to using the Clipboard and importing records.

Clipboard



Paste

- **Paste** pastes the contents of the Clipboard into the current diagram or sheet.

For items in the System panel, the pasted item(s) will be placed into the level below the currently selected item and will include any lower level items and associated analyses. If you want to paste the items to the same level or system level — or if you want to paste the item without associated information — use the **Paste Special** command.

For records in the FMEA hierarchy view in the Analysis panel, the pasted data will include any dependent records (e.g., if you copied a cause that has associated actions or controls, the actions and controls will be pasted also). If you want to paste the record only, use the **Paste Without Dependents** command.

- **Paste As Top Level** pastes the cut/copied record(s) from the System hierarchy as a system.
- **Paste Special** opens the Paste Special window. (Note that this command is available only when working in the System panel.) See Section 4.9.1 on page 147.

¹. For more information on license types, please visit <http://www.ReliaSoft.com/license.htm>.

- **Paste Without Dependents** pastes the selected records in the Analysis panel without any dependent records. (Note that this command is available only when working in the Analysis panel.)
- **Paste as Unique** pastes the selected control or action as a new resource that is not associated with (linked to) the original. The description of the new record will be incremented automatically so it remains unique. For example, if the original description is “Do this and that,” then the description of the new record might be “Do this and that_1.” This command is available only when working with controls or actions in an FMEA. After you break the association, changes that are made to one resource will not be applied automatically to the other.



Cut cuts the selected text or graphic to the Clipboard. Data stored on the Clipboard can be pasted into this and other applications.



Copy copies the selected text or graphic to the Clipboard. Data stored on the Clipboard can be pasted into this and other applications.



Copy Active View copies the currently visible contents of the System panel or Analysis panel to the Clipboard as a graphic that can be pasted into other applications. The entire visible area within the active panel/tab will be copied but any information that is not currently visible will be excluded.



Copy Current Analysis makes a copy of the analysis tab that currently has focus in the Analysis panel.



Paste Analysis pastes the copied analysis to the currently selected item. Note that you will only be able to copy/paste analyses between projects that have the same FMEA structure. *For more information about FMEA structures, see page 342 in Chapter 14.*



Delete Current Analysis deletes the analysis tab that currently has focus in the Analysis panel.

Edit



Delete deletes the selected project, item or record and all associated data. For secure databases, the ability to delete a project is restricted to users with the “Delete project” or “Manage all projects” permissions.



Spelling allows you to automatically spell check the entire analysis displayed in the table or worksheet that is currently displayed (e.g., FMEA worksheet, DRBFM worksheet, DVP&R worksheet or control plan worksheet). If you want to use spell check for the records in the FMEA hierarchy, use the command that appears in each separate record properties window. *For complete information on the spell check feature, see page 114 in Chapter 3.*



Find and Replace allows you to find or replace specified text, dates, numbers or drop-down list options within the current project. *See page 115 in Chapter 3.*



Undo Last Delete cancels the last delete action you performed within the project.

Move Record



Promote promotes the selected item to the next higher level in the system hierarchy. When an item is promoted, all associated next level items and analyses also will be moved



Demote demotes the selected item to the next lower level in the system hierarchy. When an item is demoted, all associated next level items and analyses also will be moved. An item can be demoted only if there is another item on the same level and above the selected item that it can be demoted under.



Up moves the selected record up in a branch of the system hierarchy or FMEA hierarchy view.



Down moves the selected record down in a branch of the system hierarchy or FMEA hierarchy view.

Reporting



Reports allows you to generate predefined reports in Microsoft Word or Excel. *See Chapter 23.*



Queries allows you to search the project or database for the records that meet your specific query criteria. The results can be exported to Excel and you also have the option to save and re-use queries. *See Chapter 24.*



Plots allows you to create graphical charts based on analysis data. First, you will be prompted to select the item(s) from the current project that will be the source of the data. Then you can choose the chart type and make any other required inputs. *See Chapter 25.*



DLA opens a window that displays information about effects that have been defined for each FMEA in the analysis. This command is available starting in version 9.0.2. *See page 367 in Chapter 14.*



MIL-1629A Criticality will be visible only if you have selected the option on the Settings page of the Application Setup window. (*See page 507 in Chapter 30.*) If there is at least one criticality analysis field enabled in the project, this command opens the MIL-1629A Criticality Analysis window, which provides an alternative to the standard criticality analysis performed directly in the FMRA. *See page 379 in Chapter 16.*

Excel



Excel

- **Send Current View to Excel** allows you to send the contents of the System panel or the tab in the Analysis panel that currently has focus to an Excel spreadsheet.
- **Import from Excel** allows you to import data from an Excel spreadsheet. You can choose an existing template or create a new template that determines how the data will be “mapped” from the Excel file to the data fields supported by RBI. *See page 427 in Chapter 22.*
- **Export to Excel** allows you to export data to an Excel spreadsheet. You can choose an existing template or create a new template that determines how the data will be “mapped” from RBI to the Excel file. *See page 429 in Chapter 22.*

Launch



Another Synthesis Application provides a drop-down list of the other Synthesis applications that are installed on your computer. When you click an icon, the same database will automatically be opened in the new application.

4.4 My Portal Tab

The My Portal tab contains commands related to using the My Portal feature. *See page 98 in Chapter 3.*

Messages



Create Message opens the Message window, which allows you to compose and send messages within the database. *See page 100 in Chapter 3.*



Edit Message opens the Message window, which allows you to view and edit all of the properties of the message.



Delete Message deletes the current message.

Actions



Create Action opens the Action window and adds an action to the project. *See page 101 in Chapter 3.*



Edit Action opens the Action window, which allows you to view and edit all of the properties of the action record.



Delete Action deletes the current action record.



Add Action to Outlook adds an event, on the Action's due date, to your Outlook calendar.

Users



My Profile opens the User Login and Contact Information window where you change your contact details for your user account in the current database. *See page 51 in Chapter 2.*

Reliability Web Notes



Get Notes for Active Item allows you update the Reliability Web Notes page of the My Portal window with information related to the item that you currently have open. The information includes a brief description of the item, as well as links to examples and theory articles. *See page 98 in Chapter 3.*

4.5 Project Tab

The Project tab contains commands related to creating projects and working with the project properties. Unless otherwise indicated, these commands apply to the project that is currently selected in the project list. *See page 95 in Chapter 3.* There are three ways to select a project and apply a command:

- By right-clicking the project in the project list and choosing the command from the shortcut menu.
- By selecting the project in the project list and then clicking the command on the Ribbon.
- By clicking anywhere inside the project that is currently open/visible and then clicking the command on the Ribbon.

Management



Create Project adds a new project to the current database. At a minimum, you must specify the project name.



Open Project opens the selected project.



Close Project closes the project that is currently open/visible and all of the analyses it contains.



Duplicate Project creates a copy of the selected project. The new project will have the same name as the original with an increment number added to the end (e.g., Project_1, Project_2, etc.).



Delete Project moves the selected project to the recycle bin. *See page 43 in Chapter 2.*



Transfer Project allows you to create a new project with data transferred from the project that is selected in the project list. This might be used, for example, to create a new process FMEA with data transferred from an existing design FMEA. *See page 368 in Chapter 14.*



Edit Project Properties allows you to view and edit the properties of the selected project. *See page 67 in Chapter 2.*



Manage Projects opens the Manage Projects window, which allows you to edit the security settings and properties of all projects in the database in one location. *See page 95 in Chapter 3.*



Import/Export gives you the option to open either the Import or Export wizard. The Import wizard allows you to import projects, resources or items from an existing database into the current database, while the Export wizard allows you to export to a new or existing database. *See page 70 in Chapter 2.*



Configurable Settings

- **Interface Style** opens the Project Interface Style window. *See page 187 in Chapter 6.*
- **RD Questions** opens the Risk Discovery Questions window where you can change the Risk Discovery questions used in this project. *See page 197 in Chapter 6.*
- **RD Ratings** opens the Risk Discovery Ratings window where you can change the Risk Discovery ratings used in this project. *See page 198 in Chapter 6.*
- **Severity** opens the Ratings Scales window where you can change the severity ratings used in this project. *See page 196 in Chapter 6.*
- **Occurrence** opens the Ratings Scales window where you can change the occurrence ratings used in this project. *See page 196 in Chapter 6.*
- **Detection** opens the Ratings Scales window where you can change the detection ratings used in this project. *See page 196 in Chapter 6.*
- **Severity Class** opens the Ratings Scales window where you can change the severity class ratings used in this project. *See page 196 in Chapter 6.*
- **Failure Probability** opens the Ratings Scales window where you can change the failure probability ratings used in this project. *See page 196 in Chapter 6.*
- **FEC Logic** opens the FEC Logic window where you can change the failure effect categorization (FEC) logic values used in this project. *See page 200 in Chapter 6.*
- **Tasks Logic** opens the Task Logic window where you can change the task selection questions used in this project. *See page 202 in Chapter 6.*



Restore Points gives you the option to utilize restore points, which are exact replicas of the project at a particular point in time (i.e., backups). To create a restore point for the selected project, use the **Create Restore Point** command. To restore all data from an existing restore point, use the **Restore Project** command. *See page 68 in Chapter 2.*



Check In/Out allows you to check out the selected project and make it available for editing only to you, while all other users in the database have read-only access to the project. No other user can edit the project unless you check in the project or undo the check out. *See page 40 in Chapter 2.*



Recycle Bin

- **Empty Recycle Bin** permanently deletes all projects under the Recycle Bin heading in the project list. *There is no undo for emptying the recycle bin.*
- **Restore Project** is available only when you have selected a project under the Recycle Bin heading. The selected project will be recovered from the recycle bin and restored to its original location in the project list.
- **Delete Project** permanently deletes the selected project. *There is no undo for delete* unless you have a stored backup (*see Section 2.5 on page 67*) or restore point (*see Section 2.5.1 on page 68*).



History Log is available only if you are the project owner or have the “Manage all projects” permission. It opens the Project History Log window, which allows you to activate and deactivate the history log for the project and, if the history log is currently activated, to view changes that have been performed throughout the entire project, with any Synthesis application. *See page 122 in Chapter 3.*

E-mail Project



Pack and E-mail compresses a copy of the selected project to a *.rsgz9 file and attaches it to a new e-mail message. If no e-mail program is installed or no default e-mail program is defined on the computer, a message notifying you of this will be shown.

Security



Lock Project moves the project into the Locked heading of the project list. When a project is locked, all database users (including the user who locked the project) will have read-only access to the project. In addition, a locked project cannot be deleted or have its properties and public/private status edited. To unlock a project, choose **Unlock Project**. *See page 40 in Chapter 2.*



Make Private moves the selected project into the Private heading of the project list. To move a private project to the Public heading, choose **Make Public**. *See page 39 in Chapter 2.*



Change Owner allows you to assign a different database user to be the owner for the selected project. *See page 38 in Chapter 2.*



Project Security is available only for public projects in secure databases. It opens the Project Properties window with the Security tab active, where you can specify the user accounts that can view/modify the selected project. *See page 67 in Chapter 2.*

Synthesis



Attachments adds linked or attached files to the selected project. *See page 124 in Chapter 3.*



Resource Manager opens the Resource Manager window, which allows you to view and edit all of the resources (URDs, models, tasks, etc.) available to the selected project. *See page 169 in Chapter 5.*



Task Packaging opens the Scheduled Task Packaging window, which allows you to group tasks into task packages for the most efficient allocation of resources and downtime management. *See page 326 in Chapter 13.*

4.6 View Tab

The View tab contains commands related to configuring the layout of the application's interface.

Refresh



Refresh refreshes the display in the Project window. If multiple users are accessing the same project simultaneously, this command will refresh your screen with any changes made by other users. When you make a change to the project, your window will be refreshed automatically.

Project Manager



Show Project Manager brings the Project Manager into focus. If the Project Manager is unpinned and hidden, choosing this command will display it. *See page 95 in Chapter 3.*



Dock Project Manager opens a submenu that allows you to choose the desired position for the Project Manager: Dock Left, Dock Right, Dock Top, Dock Bottom or Floating.

My Portal



Show My Portal opens the My Portal window, which provides information relevant to your work within the database, such as messages from other users, recommended actions for a particular project item, status of other users logged in to the database and other information. *See page 98 in Chapter 3.*



Tile My Portal tiles the Messages, Actions, Users, and Reliability Web Notes pages so they are all displayed simultaneously within the My Portal panel.



Dock My Portal opens a submenu that allows you to choose the desired position for the Portal: Dock Left, Dock Right, Dock Top, Dock Bottom or Floating.

Workspace Layout



Change Orientation toggles between the two possible orientations for the System panel and the Analysis panel. These panels can be side-by-side or one on top of the other.



Hide System Hierarchy hides the System panel in the Project window. When you want to show the panel again, choose **View > Workspace Layout > Split Panels**.



Hide Properties hides the Analysis panel in the Project window. When you want to show the panel again, choose **View > Workspace Layout > Split Panels**.



Split Panels splits the Project window into two equal panels, with 50% of the available space used for the System panel and 50% of the available space used for the Analysis panel.

Expand/Collapse



Expand Tree expands the hierarchy to show all items/records. This command is available when the System panel or when the FMEA hierarchy view or DFR Planner view in the Analysis panel has focus.



Collapse Tree collapses the hierarchy to hide all items/records except the top level. This command is available when the System panel or when the FMEA hierarchy view or DFR Planner view in the Analysis panel has focus.



Expand Node expands the hierarchy to show all items/records in the existing branch. This command is available when the System panel or the FMEA hierarchy view in the Analysis panel has focus.



Collapse Node collapses the hierarchy to hide all items/records except the top level item/record in the branch. This command is available when the System panel or when the FMEA hierarchy view or DFR Planner view in the Analysis panel has focus.



Collapse to Level collapses the hierarchy to the level of the record that is currently selected. This command is available when the System panel or when the FMEA hierarchy view or DFR Planner view in the Analysis panel has focus. For example, if you have selected a cause in the FMEA hierarchy view and choose this command, all branches in the FMEA hierarchy view will be collapsed to the cause level and the nodes for controls and actions will be hidden.

Zoom



Normal Zoom sets the degree of magnification to 100%.



Zoom In increases the degree of magnification.



Zoom Out decreases the degree of magnification.



Custom Zoom allows you to specify the degree of magnification.

Window



Use Tabbed MDI maximizes the windows to fill the full space available in the MDI and shows a tab for each open window. If you clear this command, the open windows will be displayed as separate windows that can be resized and moved around within the MDI.



Window

- **Cascade** cascades all open project windows inside the MDI. This command is available only when you are not using a tabbed MDI view.
- **Tile Horizontally** horizontally tiles all open project windows inside the MDI. This command is available only when you are not using a tabbed MDI view.
- **Tile Vertically** vertically tiles all open project windows inside the MDI. This command is available only when you are not using a tabbed MDI view.
- **Arrange Icons** bottom aligns all icons of the minimized windows inside the MDI. This command is available only when you are not using a tabbed MDI view.
- The **Windows** list displays a list of all project windows currently open inside the MDI. You can make any of the open project windows active by clicking its name in this list.
- **Close All Windows** closes all open project windows inside the MDI, leaving only the Project Manager and My Portal panels open (if they were selected to be shown).

FMRA



Show FMRA enables/disables the FMRA tab in the system panel. *See Chapter 8.*

4.7 Help Tab

The Help tab provides easy access to the same help resources that are available from the Help Center in the Backstage View.

Using This Application



Online Help File opens the application's help file. If you have an active Internet connection, the help topics that you see will always be the most up-to-date versions available. If you do not have an active Internet connection, the help topics that you see will be the local copy that was installed on your machine.



User Guide opens the application's *User's Guide* (in PDF format) if you have an active Internet connection.



Quick Start Guide opens the application's *Quick Start Guide* (in PDF format) if you have an active Internet connection. This guide contains step-by-step examples designed to assist you in learning to use the application software.



Open Examples Folder provides access to a set of example projects that are designed to help you explore various software features.



ReliaSoft.tv opens the ReliaSoft TV website (<http://www.Reliasoft.tv>).

Online Resources



ReliaSoft.com opens the main page of the ReliaSoft.com website (<http://www.Reliasoft.com>).



Weibull.com opens the Weibull.com website (<http://www.Weibull.com>).



ReliaWiki.org opens the ReliaWiki website (<http://www.Reliasoft.org>).



Reliability Discussion Forum opens the Reliability Discussion Forum website (<http://www.ReliasoftForums.com>).

Technical Support



E-mail Support generates an e-mail to request technical support. *See page 2 in Chapter 1.*



Contact ReliaSoft USA provides the contact information you will need to obtain technical support.



Contact Global Support Center helps you find your localized ReliaSoft support center.

Updates & Licensing



Check for Update allows you to download the latest free service release for the software.



License Manager displays your license and registration details. *See Section 4.2.2 on page 134.*

4.8 System Hierarchy Tab

The System Hierarchy tab contains commands related to using the System panel. *See Chapter 7.*

Add



Add System adds a new top level (system) item to the System panel. The new item will be added to the bottom of the list.



Add Next Level Item adds a new item to the next level below the item that is currently selected in the System panel. The new item will be added to the bottom of the list for that level.



Add Same Level Item adds a new item to the same level as the item that is currently selected in the System panel. The new item will be added to the bottom of the list for that level.



Insert Same Level Item adds a new item to the same level as the item that is currently selected in the System panel. The new item will be inserted above the selected item.

Risk Based Inspection



Add RBI Equipment allows you to select one of the equipment types that are eligible for RBI analysis and add the item to the system hierarchy.



Add Component allows you to select one of the component types that are eligible for RBI analysis and add the item to the system hierarchy. *See page 273 in Chapter 12.*



Convert to Equipment allows you convert an item in the system hierarchy to an RBI equipment item. *See page 274 in Chapter 12.* This command is available starting in version 9.0.3.



PRD Components are available when working with a pressure relief device.

- **Assign Components** opens a window where you can select which existing components to the pressure relief device.
- **Go to Component** displays the properties of the selected component.
- **Remove Component** removes the component from the pressure relief device.



Calculate Risk calculates the results of the RBI analysis. *See page 281 in Chapter 12.*



Risk Categories opens a window where you can view or modify the Risk Priority rating scales that will be used for all RBI analyses in the current database. *See page 270 in Chapter 12.*



Management Score opens a window where you can set the Management Systems Evaluation score for all RBI analyses in the current project. *See page 271 in Chapter 12.*

Security



Item Permissions is available only for secure databases. It opens the Item Permissions window, which allows you to specify the user accounts that can view or modify the item. *See page 67 in Chapter 2.*

Diagrams



Process Flow Diagram opens the process flow diagram associated with the selected item. If you have not yet created a diagram for the item, you will be prompted to choose whether to create a blank diagram or create blocks automatically based on the item's FMEA or control plan. *See page 485 in Chapter 28.*



FMEA Block Diagram opens the FMEA Block diagram (also called a "Boundary Diagram") associated with the selected item. If you have not yet created a diagram for the item, you will be prompted to choose whether to create a blank diagram or create blocks automatically based on the selected portion of the system hierarchy. *See page 483 in Chapter 28.*



Cause and Effect Diagram opens the existing cause and effect diagram (also called a "fishbone diagram") associated with the selected item. If you have not yet created a diagram for the item, it will be created automatically. *See page 486 in Chapter 28.*

Tools



Properties Customization opens the Properties window where you can change the properties that are available for the items in this project. *See page 188 in Chapter 6.*



Attachments allows you to manage the linked or attached files for the selected item. *See page 124 in Chapter 3.*



Renumber All Items rennumbers all items based on their position in the system hierarchy and resets all of the automatically generated system numbers. ***This cannot be undone.*** In the window that displays, click the **Apply to reference number** field check box to have RBI generate an item number that is stored in each item's Reference Number field. You may want to do if the numbers fall out of sequence.



Update Short Descriptions updates the text in every Short Description field to be the same as the Full Description field values for all applicable records in this project. These changes are not recorded or displayed in any change log.

Lambda Predict



Import Prediction Items allows you import systems from a Lambda Predict analysis in to the current project. This command is available starting in version 9.0.2. *See page 221 in Chapter 7.*

MPC



Import MPC Systems allows you import systems from an MPC analysis in to the current project. *See page 220 in Chapter 7.*

XFRACAS



Import Hierarchy Items allows you to import XFRACAS systems into the System panel. *See page 222 in Chapter 7.*



Associate Item associates the currently selected item with the XFRACAS hierarchy. To remove the association, choose **Remove Association**.



Synchronize Item synchronize the item properties for the currently selected item and its associated items in the XFRACAS hierarchy.



Import Failures synchronizes the failures and cause in the FMEA with their associated records in XFRACAS.

4.9 Insert Tab

The Insert tab contains commands for adding analyzes to items in the System panel.

Planning



Add DFR Planner adds a tab in the Analysis panel for the Design for Reliability (DFR) Planner associated with the selected item. *See Chapter 9.*



Add Analysis Plan opens the Analysis Plan window and adds a tab in the Analysis panel for the analysis plan associated with the selected item. *See Chapter 11.*



Add Risk Discovery adds a tab in the Analysis panel for the risk discovery analysis associated with the selected item. *See Chapter 10.*

FMEA



Add FMEA adds a tab in the Analysis panel for the failure modes and effects analysis (FMEA) associated with the selected item. *See Chapter 14.*



Add DRBFM adds a tab in the Analysis panel for the design review based on failure modes (DRBFM) analysis associated with the selected item. *See Chapter 21.*

Other



Add DVP&R adds a tab in the Analysis panel for the design verification plan (DVP&R) analysis associated with the selected item. *See Chapter 18.*



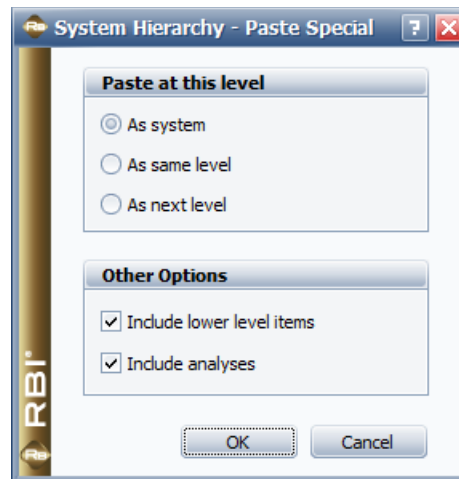
Add PFD Worksheet adds a tab in the Analysis panel for the PFD Worksheet associated with the selected item. *See Chapter 19.*



Add Control Plan adds a tab in the Analysis panel for the control plan associated with the selected item. *See Chapter 20.*

4.9.1 Paste Special Window

The Paste Special window allows you to specify how the item(s) that were cut or copied in the System panel will be pasted:



The options in the Paste at this level section allow you to specify the level in the system hierarchy to which the item(s) will be pasted:

- **As system** pastes to the top (system) level.
- **As same level** pastes to the same level as the item that is currently selected. (This position also might be referred to as a “sibling.”)
- **As next level** pastes to the level below the item that is currently selected. (This position also might be referred to as a “child.”)

The options in the Other Options section allow you to specify which associated data, if any, will be pasted along with the item(s).

- **Include lower level items** pastes any lower level items (sub-items).
- **Include analyses** pastes any associated analyses (i.e., DFR Planner, PFD worksheet, risk discovery, analysis plan, FMEA, DRBFM, DVP&R or, control plan). If this check box is not selected, only the item properties and attachments (i.e., links/attachments, process flow diagram, FMEA Block diagram, cause and effect diagram) will be pasted.

4.10 Active Tabs (Alphabetical)

Active tabs contain commands related to a type of analysis. These tabs are displayed only when the related analysis is active. For example, the FMEA tab contains commands related to working on an FMEA, while the Control Plan tab contains commands related to working on a control plan.

4.10.1 Control Plan Tab

This Ribbon is available only when working with a control plan analysis. *See Chapter 20.*

Part/Process



Add Part/Process adds cells to the control plan worksheet for describing the part/process that is being analyzed. The new cells will be added below the part/process records that have been defined already.



Insert Part/Process adds cells to the control plan worksheet for describing the part/process that is being analyzed. The new cells will be inserted above the part/process record that is currently selected.

Characteristic



Add Characteristic adds cells to the control plan worksheet for describing the characteristics that must be kept under control. The new cells will be added below the characteristics that have been defined already for the current part/process.



Insert Characteristic adds cells to the control plan worksheet for describing the characteristics that must be kept under control. The new cells will be inserted above the characteristic that is currently selected.

Method



Add Method adds cells to the control plan worksheet for describing the control methods that have been defined. The new cells will be added below the methods that have been defined already for the current characteristic.



Insert Method adds cells to the control plan worksheet for describing the control methods that have been defined. The new cells will be inserted above the method that is currently selected.

Sync



Sync with PFD Worksheet allows you to transfer data from the PFD worksheet to the control plan based on the criteria that you specify. *See page 415 in Chapter 20.*



Sync with FMEA allows you to transfer data from the FMEA to the control plan based on the criteria that you specify. *See page 415 in Chapter 20.*

Tools



History Log opens the Record History Log window for the current analysis. This window displays changes that have been performed for the analysis. This command is available only if the history log has been activated at the project level. *See page 122 in Chapter 3.*



Properties Customization opens the Properties window where you can change the properties that are available for the control plan records in this project. *See page 188 in Chapter 6.*

4.10.2 DFR Tab

This Ribbon is available only when working with a DFR Planner. *See Chapter 9.*

Gate



Add Gate adds a top-level to the analysis.



Add Next Level Gate adds a new gate to the next level below the gate that is currently selected in the Analysis panel. The new gate will be added to the bottom of the list for that level.



Add Same Level Gate adds a new gate to the same level as the item that is currently selected in the Analysis panel. The new gate will be added to the bottom of the list for that level.



Insert Gate adds a new gate to the same level as the item that is currently selected in the Analysis panel. The new gate will be inserted above the gate that is currently selected.



Edit Gate opens the DFR Gate Properties window, which allows you to view and edit all of the properties of the gate record. *See page 252 in Chapter 9.*

Action



Add Action adds an action to the gate.



Add Existing Action opens the Select Resource window where you can select an existing action to add to the DFR plan. *See page 101 in Chapter 3.*



Edit Action opens the Action window, which allows you to view and edit all of the properties of the action record. *See page 101 in Chapter 3.*



Make Action Unique creates a new record that is not associated with (linked to) the existing Synthesis resource. The information in the Description column for the new record will be incremented automatically so it remains unique. For example, if the original description is “Do this and that,” then the description of the new record might be “Do this and that_1.” After you break the association, changes that are made to one resource will not be applied automatically to the other.



Synchronize Action opens the Synchronize Action to DFR Timeline window, which allows you to automatically change the date of an action to match that of the gate it was added to (or vice versa). *See page 254 in Chapter 9.*

Tools



Attachments adds linked or attached files to the selected record. *See page 124 in Chapter 3.*



Send to Library sends the current DFR plan to the Profiles/Library Manager where it can be used in other DFR plans. *See page 184 in Chapter 6.*



History Log opens the Record History Log window for the current analysis. This window displays changes that have been performed for the analysis. This command is available only if the history log has been activated at the project level. *See page 122 in Chapter 3.*



Shift Dates opens the Shift Dates window where you can shift the start and/or due dates of a selected gate and all its lower-level gates/actions in the DFR Planner by a specified duration of days or months. *See page 254 in Chapter 9.*



Remove Gaps in Dates automatically removes gaps between the start and end dates in the DFR plan. This command also automatically updates the precedent gates to reflect the order of gates in the hierarchy (i.e., if gate A is immediately above gate B and on the same level, gate A will become gate B's precedent).



Set Planned Dates allows you to either (a) clear all the gates' planned start and end dates or (b) set all the planned dates to match the actual start/end dates.

4.10.3 DRBFM Tab

This Ribbon is available only when working with a Design Review Based on Failure Mode (DRBFM) analysis. *See Chapter 21.*

Records



Parts/Functions adds cells to the DRBFM worksheet for describing the change and the parts/functions that might be affected by the change.

- If you choose **Add Part/Function**, the new cells will be added below the parts/functions that have been defined already.
- If you choose **Insert Part/Function**, the new cells will be inserted above the part/function that is currently selected.



Concerns adds cells to the DRBFM worksheet for describing concerns related to the change. The concerns in a DRBFM are similar to the failure modes in an FMEA. The DRBFM worksheet provides two columns for concerns. The Design Engineer view displays only the first column and the Review Team view displays both columns. For a given row of the worksheet, you can type in only one column or the other.

- If you choose **Add Concern**, the new cells will be added below the concerns that have been defined already for the current part/function.
- If you choose **Insert Concern**, the new cells will be inserted above the concern that is currently selected.



Effects adds cells to the DRBFM worksheet for describing the effects that may result if the concern (failure mode) occurs.

- If you choose **Add Effect**, the new cells will be added below the effects that have been defined already for the current concern.
- If you choose **Insert Effect**, the new cells will be inserted above the effect that is currently selected.



Causes adds cells to the DRBFM worksheet for describing the possible causes of the concern. The DRBFM worksheet provides two columns for causes. The Design Engineer view displays only the first column and the Review Team view displays both columns. For a given row of the worksheet, you can type in only one column or the other.

- If you choose **Add Cause**, the new cells will be added below the causes that have been defined already for the current effect.
- If you choose **Insert Cause**, the new cells will be inserted above the cause that is currently selected.



Controls adds cells to the DRBFM worksheet for describing the controls that are in place to reduce the likelihood that the cause will occur (Prevention Controls) or increase the likelihood that the cause will be detected before it reaches the end user (Detection Controls).

- If you choose **Add Control**, the new cells will be added below the controls that have been defined already for the current cause.
- If you choose **Insert Control**, the new cells will be inserted above the control that is currently selected.



Actions adds cells to the DRBFM worksheet for describing the actions that will be assigned to address the concern. The DRBFM worksheet provides separate columns for three types of actions: design-related actions, testing-related actions and manufacturing-related actions. For a given row of the worksheet, you can define any or all of the three types of action.

- If you choose **Add Action**, the new cells will be added below the actions that have been defined already for the current control.
- If you choose **Insert Action**, the new cells will be inserted above the action that is currently selected.

Sync



Get Functions from FMEA displays a list of all functions defined in the FMEA. You can choose to import any of these functions to the DRBFM. *See Chapter 21.*



Send Functions to FMEA displays a list of all functions defined in the DRBFM. You can choose to export any of these functions (along with all related concerns, effects, causes, controls and actions) to the end of the FMEA. *See Chapter 21.*



Get Header from FMEA imports the data from the FMEA header to the DRBFM header. This will replace any header information that has been defined already for the DRBFM.



Send Header to FMEA exports the data from the DRBFM header to the FMEA header. This will replace any header information that has been defined already for the FMEA.

Tools



History Log opens the Record History Log window for the current analysis. This window displays changes that have been performed for the analysis. This command is available only if the history log has been activated at the project level. *See page 122 in Chapter 3.*



Properties Customization opens the Properties window where you can change the properties that are available for the DRBFM records in this project. *See page 188 in Chapter 6.*

4.10.4 DVP&R Tab

This Ribbon is available only when working with a Design Verification Plans (DVP&Rs) analysis. *See Chapter 18.*

Plan



Add Plan adds cells to the DVP&R worksheet for describing a test plan. The new cells will be added below the test plans that have been defined already.



Insert Plan adds cells to the DVP&R worksheet for describing a test plan. The new cells will be inserted above the test plan that is currently selected.

Report



Add Report adds cells to the DVP&R worksheet for describing the results of a test. The new cells will be added below the test reports that have been defined already for the current test plan.



Insert Report adds cells to the DVP&R worksheet for describing the results of a test. The new cells will be inserted above the test report that is currently selected.

Sync



Sync with FMEA allows you to transfer data from the FMEA to the DVP&R based on the criteria that you specify. *See Section 18.4.2 on page 401.*

Tools



History Log opens the Record History Log window for the current analysis. This window displays changes that have been performed for the analysis. This command is available only if the history log has been activated at the project level. *See page 122 in Chapter 3.*



Properties Customization opens the Properties window where you can change the properties that are available for the DVP&R records in this project. *See page 188 in Chapter 6.*



Attachments adds linked or attached files to the selected plan or report. *See page 124 in Chapter 3.*

Change Log



Activate Change Log/View Change Log allows you to view or manage a change log for the DVP&R. A change log records a history of the specific changes that were made in each tracked revision to the analysis since the log was activated. *See Chapter 17.*

4.10.5 FMEA Tab

This Ribbon is available only when you are working in the FMEA tab in the Analysis panel. This tab can be used to perform a Failure Modes and Effects Analysis (*see Chapter 14*) or to record the Functional Failure Analysis for RCM (*see Chapter 13*).

FMEA Records



Functions

- **Add Function** adds a function to the FMEA. If you are working in the hierarchy view, the Function Properties window will open. *See page 354 in Chapter 14.* If you are working in the worksheet view, a new cell will be added in the Function column.
- **Insert Function** inserts a function above the function that is currently selected in the FMEA. If you are working in the hierarchy view, the Function Properties window will open. If you are working in the worksheet view, a new cell will be inserted in the Function column.
- **Import Functions** allows you to query an existing data source and then select existing record(s) to import into the FMEA. *See page 217 in Chapter 7.*
- **Edit Function** opens the Function Properties window, which allows you to view and edit all of the properties of the function record.



Failures

- **Add Failure** adds a failure mode to the FMEA. If you are working in the hierarchy view, the Failure Properties window will open. *See page 356 in Chapter 14.* If you are working in the worksheet view, a new cell will be added in the Failure column.
- **Insert Failure** inserts a failure mode above the failure mode that is currently selected in the FMEA. If you are working in the hierarchy view, the Failure Properties window will open. If you are working in the worksheet view, a new cell will be inserted in the Failure column.
- **Import Failures** allows you to query an existing data source and then select existing record(s) to import into the FMEA. *See page 217 in Chapter 7.*
- **Edit Failure** opens the Failure Properties window, which allows you to view and edit all of the properties of the failure mode record.
- **Relationship Diagram** opens the relationship diagram for the selected failure mode. If you have not yet created a diagram, it will be created automatically. *See page 488 in Chapter 28.*



Effects

- **Add Effect** adds an effect to the FMEA. If you are working in the hierarchy view, the Effect Properties window will open. *See page 358 in Chapter 14.* If you are working in the worksheet view, a new cell will be added in the Effect column.
- **Insert Effect** inserts an effect above the effect that is currently selected in the FMEA. If you are working in the hierarchy view, the Effect Properties window will open. If you are working in the worksheet view, a new cell will be inserted in the Effect column.
- **Import Effects** allows you to query an existing data source and then select existing record(s) to import into the FMEA. *See page 217 in Chapter 7.*
- **Edit Effect** opens the Effect Properties window, which allows you to view and edit all of the properties of the effect record.
- **Effect Categorization** opens the Failure Effect Categorization window, which allows you to identify and evaluate the effects of the functional failure. *See page 298 in Chapter 13.*
- **Cause and Effect Diagram** opens the cause and effect diagram (also called a “fishbone diagram”) for the selected effect. If you have not yet created a diagram, it will be created automatically. *See page 486 in Chapter 28.*



Causes

- **Add Cause** adds a cause to the FMEA. If you are working in the hierarchy view, the Cause Properties window will open. *See page 360 in Chapter 14.* If you are working in the worksheet view, a new cell will be added in the Cause column.
- **Insert Cause** inserts a cause above the cause that is currently selected in the FMEA. If you are working in the hierarchy view, the Cause Properties window will open. If you are working in the worksheet view, a new cell will be inserted in the Cause column.
- **Import Causes** allows you to query an existing data source and then select existing record(s) to import into the FMEA. *See page 217 in Chapter 7.*

- **Edit Cause** opens the Cause Properties window, which allows you to view and edit all of the properties of the cause record.
- **Reliability Policy**
 - **Create New URD** opens the Universal Reliability Definition window where you can set the cause's failure rate behavior. *See page 164 in Chapter 5.*
 - **View URD** opens the Universal Reliability Definition window.
 - **Apply Existing URD** opens the Select Resource Window where you can pick an existing URD to apply to the cause. *See page 175 in Chapter 5.*
 - **Remove URD** removes the URD from the cause.
- **Task Manager** opens the Task Manager window, which allows you to work with tasks assigned to causes within the FMEA and to choose an appropriate maintenance strategy by using one or both of the available task selection methods. *See page 300 in Chapter 13.*



Controls

- **Add Control** adds a control to the FMEA. If you are working in the hierarchy view, the Control Properties window will open. *See page 362 in Chapter 14.* If you are working in the worksheet view, a new cell will be added in the Control column.
- **Insert Control** inserts a control above the control that is currently selected in the FMEA. If you are working in the hierarchy view, the Control Properties window will open. If you are working in the worksheet view, a new cell will be inserted in the Control column.
- **Add Existing Controls** allows you to query an existing data source and then select existing record(s) to import into the FMEA. *See page 217 in Chapter 7.*
- **Make Control Unique** creates a new record that is not associated with (linked to) the existing Synthesis resource. The description of the new record will be incremented automatically so it remains unique. For example, if the original description is “Do this and that,” then the description of the new record might be “Do this and that_1.” After you break the association, changes that are made to one resource will not be applied automatically to the other.
- **Replace with Existing** opens the Select Resource window so that you can replace the selected record with a Synthesis resource that already exists in the project. After you create this association, changes that are made to one instance of the resource will be applied automatically to all other instances. *See page 175 in Chapter 5.*
- **Edit Control** opens the Control Properties window, which allows you to view and edit all of the properties of the control record.



Actions

- **Add Action** adds an action to the FMEA. If you are working in the hierarchy view, the Action window will open. *See page 101 in Chapter 3.* If you are working in the worksheet view, a new cell will be added in the Action column.
- **Insert Action** inserts an action above the action that is currently selected in the FMEA. If you are working in the hierarchy view, the Action window will open. If you are working in the worksheet view, a new cell will be inserted in the Action column.
- **Add Existing Action** allows you to query an existing data source and then select existing record(s) to import into the FMEA. *See page 217 in Chapter 7.*

- **Make Action Unique** creates a new record that is not associated with (linked to) the existing Synthesis resource. The description of the new record will be incremented automatically so it remains unique. For example, if the original description is “Do this and that,” then the description of the new record might be “Do this and that_1.” After you break the association, changes that are made to one resource will not be applied automatically to the other.
- **Replace with Existing** opens the Select Resource window so that you can replace the selected record with a Synthesis resource that already exists in the project. After you create this association, changes that are made to one instance of the resource will be applied automatically to all other instances. *See page 175 in Chapter 5.*
- **Edit Action** opens the Action window, which allows you to view and edit all of the properties of the action record.

Tools



Attachments adds linked or attached files to the selected record. *See page 124 in Chapter 3.*



Highlight Priority if selected, uses color to highlight the FMEA records based on logic that has been defined for the project. By default, the software will categorize issues as high (red), medium (yellow) or low (green) priority based on specified RPN thresholds. A user with the “Edit project properties or “Manage all projects” permission can customize this logic from the FMEA > RPNs page in the interface style. *See page 190 in Chapter 6.*



Failure - Cause Matrix opens a window that displays the unique failure modes and causes that have been defined in the FMEA. This matrix helps to see when the same cause has been identified for more than one failure mode. *See page 365 in Chapter 14.*



History Log opens the Record History Log window for the current analysis. This window displays changes that have been performed for the analysis. This command is available only if the history log has been activated at the project level. *See page 122 in Chapter 3.*



Properties Customization opens the Properties window where you can change the properties that are available for the FMEA records in this project. *See page 188 in Chapter 6.*



FMEA Statistics opens a window that displays some overall statistics for the FMEA. This includes details such as the total number of causes defined in the analysis, the percentage of causes that have the RPN ratings defined, the total number of actions defined in the analysis, the percentage of actions that are complete, etc. *See page 366 in Chapter 14.*



Export to Phrase Set

- **Export to a New FMEA Phrase Set** allows you to export the descriptions from the current FMEA to a new phrase set in the active library. When prompted, type a name (required) and description (optional) for the new phrase set and click **OK**. *See page 200 in Chapter 6.*
- **Export to an Existing FMEA Phrase Set** allows you to export the descriptions from the current FMEA to an existing phrase set. When prompted, select a row in the list of phrase sets that exist in the active project and click **OK**.

Change Log



Activate Change Log/View Change Log allows you to view or manage a change log for the FMEA. A change log records a history of the specific changes that were made in each tracked revision to the analysis since the log was activated. *See Chapter 17.*

4.10.6 FMRA Tab

This Ribbon is available only when you are working in the FMRA tab in the System panel with a Failure Modes and Reliability Analysis (FMRA). *See Chapter 8.*

Add System Items



Add System adds a new top level (system) item to the System panel. The new item will be added to the bottom of the list.



Add Next Level Item adds a new item to the next level below the item that is currently selected in the System panel. The new item will be added to the bottom of the list for that level.



Add Same Level Item adds a new item to the same level as the item that is currently selected in the System panel. The new item will be added to the bottom of the list for that level.

Add FMEA Items



Add Function adds a function to the FMRA. The new function will be added to the bottom of the list.



Add Failure adds a failure mode to the FMRA. The new failure will be added to the bottom of the list for that level.



Add Cause adds a cause to the FMRA. The new cause will be added to the bottom of the list for that level.

RAM Analysis



Calculate (Reliability) calculates and displays the reliability and criticality values for each record in the FMRA hierarchy.



Simulate (Availability) displays the reliability, availability and cost calculations (obtained via simulation) for each record at the end time specified in the simulation settings.



Highlight applies a color-coding gradient to the results shown in each column, from green (least “desirable” result) to red (most “desirable” result). This command toggles highlighting on and off.



Policy Update opens the Reliability Policy Update window, where you can change the policy type for all applicable records in the FMRA hierarchy. *See page 233 in Chapter 8.*



Mirrors

- **Add Cause to Mirror Group** opens the Add to Mirror Group window where you can add a cause to an existing mirror group or create a new mirror group that the cause will be added to. *See page 234 in Chapter 8.*
- **Remove Cause from Mirror Group** removes the cause from the mirror group that it belongs to.
- **Clear All Mirror Groups** removes all causes from all mirror groups.



Optimum Replacement opens the Optimum Replacement window, which allows you to define the cost of planned and unplanned replacement tasks and calculate the optimum replacement time, as well as the cost per unit time at that replacement time. *See page 324 in Chapter 13.*

4.10.7 PFD Worksheet Tab

This Ribbon is available only when working with a PFD Worksheet. *See Chapter 19.*

Operation



Add Operation adds cells to the PFD worksheet for describing the operation that is being analyzed. The new cells will be added below the operation records that have been defined already.



Insert Operation adds cells to the PFD worksheet for describing the operation that is being analyzed. The new cells will be inserted above the operation record that is currently selected.

Product Characteristic



Add Product Characteristic adds cells to the PFD worksheet for describing the product characteristics that have been defined. The new cells will be added below the product characteristic records that have been defined already for the operation.



Insert Product Characteristic adds cells to the PFD worksheet for describing the product characteristics that have been defined. The new cells will be inserted above the product characteristic that is currently selected.

Process Characteristic



Add Process Characteristic adds cells to the PFD worksheet for describing the process characteristics. The new cells will be added below the process characteristic records that have been defined already for the current product characteristic.



Insert Process Characteristic adds cells to the PFD worksheet for describing the process characteristics that have been defined. The new cells will be inserted above the process characteristic that is currently selected.

Sync



Sync with System Hierarchy allows you to transfer data from the PFD worksheet to the system hierarchy. *See page 407 in Chapter 19.*

Tools



History Log opens the Record History Log window for the current analysis. This window displays changes that have been performed for the analysis. This command is available only if the history log has been activated at the project level. *See page 122 in Chapter 3.*



Properties Customization opens the Properties window where you can change the properties that are available for the PFD worksheet records in this project. *See page 188 in Chapter 6.*

Synthesis Resources

5

In Synthesis applications, *resources* contain various types of information that can be shared between analyses. Resources may be created in one application and then shared with other Synthesis applications where they may be relevant. When the resource is updated with new information, the change is reflected in all analyses that rely upon it.

An example of a Synthesis resource is a model that represents a product's probability of operating successfully over time. The model may be defined manually or published from an application such as Weibull++/ALTA, RGA or Lambda Predict. Then it can be used in applications such as BlockSim, Xfmea, RCM++ or RBI as part of the universal reliability definition (URD) of a particular component/assembly.

The following sections discuss:

- A summary of all Synthesis resource types - Section 5.1 (p. 159)
- Local vs. global resources - Section 5.1.1 (p. 161)
- How to use wizards to create, select or edit resources - Section 5.2 (p. 162)
- The two most fundamental resource types:
 - Universal Reliability Definitions (URDs) - Section 5.3 (p. 164)
 - Models - Section 5.4 (p. 166)
- How to use the Resource Manager - Section 5.5 (p. 169)
- How to use the Dependency Viewer - Section 5.6 (p. 176)

5.1 Types of Resources

This table describes the types of resources that you can use in different Synthesis applications. These resources can be created while you're performing an analysis and also from the Resource Manager.

Note: The Resource Manager in each Synthesis application displays only the resources that may be relevant for that application. For a summary of which applications can create and/or use different types of resources, see: <http://www.ReliaSoft.com/synthesis/integration.htm>.

Resource	Used In
Universal reliability definitions (URDs) describe a set of reliability and maintenance characteristics for a particular component/assembly. <i>See Section 5.3 on page 164.</i>	BlockSim, RCM++, Xfmea, RBI
Models can represent probabilities, durations or costs, either fixed or time-dependent. They are used by other resources to represent the reliability of a component, the duration of a task, the expected cost of a repair, etc. <i>See Section 5.4 on page 166.</i>	Can be published from analyses in Weibull++, ALTA, BlockSim, DOE++, RGA and Lambda Predict, or created manually. Used in BlockSim, RENO, RCM++, RBI and Xfmea. <i>(For details on how to publish models, see Section 5.4.1 on page 168.)</i>
Tasks represent maintenance activities: - Corrective tasks are unplanned maintenance performed when a failure occurs. - Scheduled tasks can include preventive maintenance, inspections and on condition maintenance. <i>For more information on tasks, see page 306 in Chapter 13.</i>	BlockSim, RCM++, RBI
Task packages represent groups of tasks that are performed together at scheduled intervals. <i>See page 329 in Chapter 13.</i>	BlockSim, RCM++, RBI
Crews represent the personnel who will perform a maintenance task. <i>See page 318 in Chapter 13.</i>	BlockSim, RCM++, RBI
Spare part pools determine whether a spare part will be available, how long it will take to obtain and how much it will cost. <i>See page 320 in Chapter 13.</i>	BlockSim, RCM++, RBI
Maintenance groups are used to model situations in which some event within the group can trigger maintenance or state changes for other components/assemblies. <i>See page 323 in Chapter 13.</i>	BlockSim, RCM++, RBI
Switches describe how the activity transfers between active and standby blocks in BlockSim's standby containers/gates.	BlockSim
Mirror groups are used to represent the exact same component/event in more than one location within your analysis. <i>See page 234 in Chapter 8.</i>	BlockSim, RCM++, Xfmea, RBI
Maintenance templates define the activities that will be performed during a maintenance phase in a phase diagram.	BlockSim
Actions describe specific assignments that need to be performed. <i>See page 101 in Chapter 3.</i>	All applications via My Portal; RCM++, RBI and Xfmea for analyses
Controls may be used in FMEAs and/or control plans to represent methods to reduce or eliminate the risk associated with potential failures. <i>See page 362 in Chapter 14.</i>	RCM++, Xfmea, RBI

Resource	Used In
Variables store numerical values that can be programmatically varied during simulation.	BlockSim, RENO, DOE++
RENO functions store equations that are evaluated based on input values passed to the function during simulation.	RENO
RENO static functions store equations that are evaluated before simulation begins.	RENO
RENO simulation definitions are used to trigger simulation of a BlockSim diagram from within a RENO flowchart, allowing you to use one or more results from the simulation in the flowchart.	RENO
RENO tables store arrays of values in rows and columns.	RENO

5.1.1 Local and Global Resources

By default, resources are *local*, which means they can be used only within the project in which they were created. For certain types of resources, however, you can set them to be *global resources*, which are available for any project within the database. This can be done for resources of the following types:

- URDs
- Models
- Corrective tasks and scheduled tasks
- Task packages
- Crews
- Pools
- Maintenance groups
- Variables

If you make a resource global, any resources assigned to it will become global as well (e.g., if a URD has an assigned model, making that URD global will also make the model global). Similarly, you cannot assign a local resource to a global one.

To make a resource global, select it in the Resource Manager and choose **Home > Actions > Make Global**.



Icons are used in the Resource Manager and in resource wizards to indicate which resources are local and which are global.



Local Resource Global Resource

Note: When you create a restore point, any global resources used in the project are converted to local resources and stored with the backup.

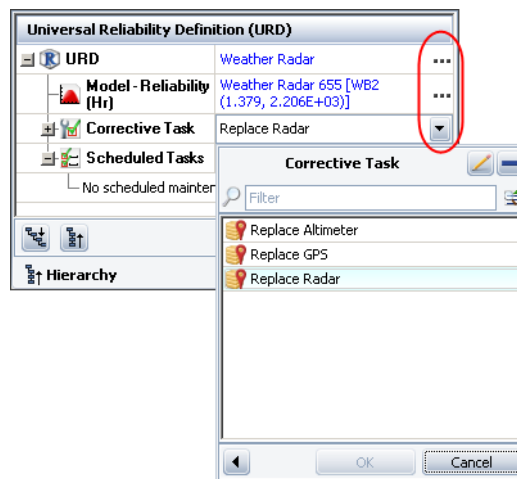
5.2 Creating and Selecting Resources

This topic describes how to use resource wizards to create and edit Synthesis resources while you're performing an analysis or creating a URD. In addition, you may also need to:

- Use the Resource Manager (*Section 5.5 on page 169*) to see all of the resources that are available to use in the current project. In addition to creating and editing resources, the manager also allows you to:
 - Delete resources that are no longer needed.
 - Create global resources that are available to all projects in the database.
- Publish a model that is linked to an existing analysis. *See Section 5.4.1 on page 168.*

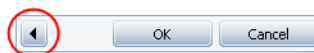
Opening a Resource Wizard

Throughout all Synthesis applications, the availability of a resource wizard is usually indicated by an ellipsis (...) or an arrow in the resource field. Simply click twice in the field to open the wizard.



Back Arrow and Main Page

Each wizard contains multiple pages with different options on each page. If the option you need is not immediately visible, you can click the **Back** arrow to see the Main page, which shows all the options that are applicable for the current situation.

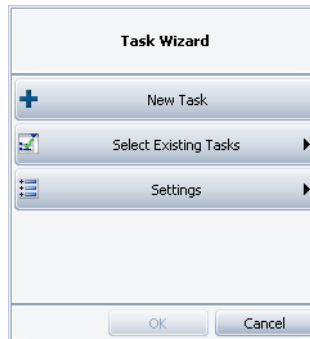


As an example, the following pictures show some of the different options that will be available on the Main page for specific situations and resource types.

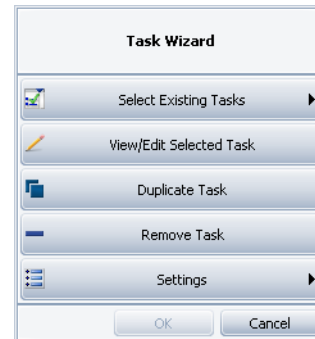
If a model hasn't been defined...



If a task hasn't been defined...



If a task has already been defined...

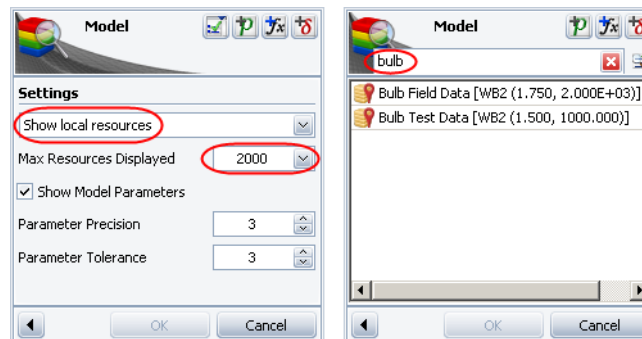


Selecting an Existing Resource

The Select page of the wizard displays a list of existing resources that meet the criteria specified on the Settings page. You can then further limit the list by typing inside the text box.

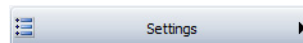


As an example, the following pictures show a situation in which the settings are configured to display up to 2,000 models (more resources take longer to load) from the current project only (called local resources), and the user has selected to see only the ones in which the name includes "bulb."



In addition, for model resources only, you must specify whether you want to display the model parameters in the list (which also takes longer to load); and if so, the number of decimal places (called *Parameter Precision*) and the point at which the software will switch to scientific notation (called *Parameter Tolerance*).

To change the initial criteria for the list, click the **Back** arrow and then click the **Settings** button on the main page.



Alternatively, if you need more information about the available resources and/or a wider range of filtering tools, you can click the icon to open the Select Resource window.



Creating a Resource

In most wizards, you can click the **Create New** button or icon to create a new resource.



In the model wizard, click the button or icon for the type of model you want to create:



New Constant



New Distribution



New Dynamic

Editing a Resource

If a resource has already been assigned, you can view and/or edit its properties by clicking the **View/Edit** button or icon.



If you have the permissions needed to edit the resource, any changes you make will apply everywhere that the resource is used. This includes analyses in other Synthesis applications.

Removing a Resource

If a resource has already been assigned, you can remove it from this location by clicking the **Remove** button or icon.



The resource will remain in the database for use in other locations. If you want to completely remove a resource from the database, you'll need to use the Resource Manager or Select Resource window.

5.3 Universal Reliability Definitions (URDs)

A universal reliability definition (URD) describes a set of reliability and maintenance characteristics for a particular component/assembly. Like any other Synthesis resource, you can create or edit URDs while you're performing a relevant analysis, and from the Resource Manager.

Note: Depending on where you are using a URD, only those properties that are relevant are applied. For example, if you apply a URD to a block in an analytical diagram in BlockSim, only the failure model associated with the URD will be applied to the block.

Naming the Resource

For a new resource, a name will be proposed automatically based on the default naming criteria established for the current database in the Define Default Name Formats window. You can replace this with your own name of up to 150 characters, if desired. Remember that the name and identifiers are the primary way in which your team will be able to find the Synthesis resources you need for your analyses.

Hierarchy Tab

Use the Hierarchy tab to view and/or edit the URD's properties. You can choose or create:

- A **model** to describe the behavior associated with the URD. This can be a reliability model, a probability of failure model or an event occurrence model.
- A **corrective task** that describes the maintenance action taken to restore a failed component to operational status.
- Zero, one or many **scheduled tasks** that describe the preventive maintenance, inspections and/or on condition maintenance tasks. The tasks are displayed in the order in which they will be performed; you can use the up and down arrows in the cells in this column to move the task up and down the priority list.

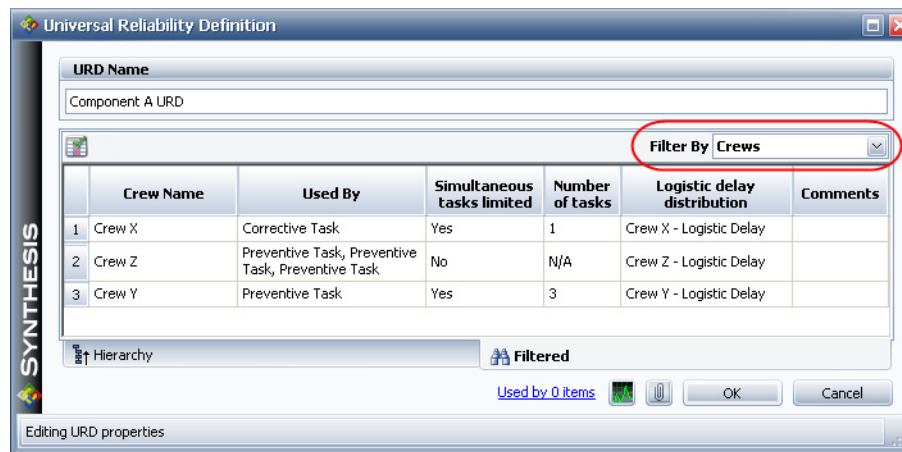
Additionally, the following are shown:

- **Identifiers** allows you to enter additional identifying information that can be used to search for this resource.
- **History** provides information about the creation and last modification of the resource. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the resource. *For more information, refer to the “History Logs” section in the “Working in Synthesis” chapter.*



Filtered Tab

Use the Filtered tab to see the resources that are shown in the Hierarchy tab, filtered by resource type. For example, the following picture shows the crews used in this URD.



Double-click any row to view or edit the properties of the resource.

You can change the columns shown in this view by clicking the **Column Chooser** icon.



Trace Usage

For an existing resource, a link at the bottom of the properties window indicates how many times it is currently being used. If you need more information, click the link or the **Trace Usage** icon.

[Used by 1 item](#)

This opens the Dependency Viewer, which allows you to explore both where the resource is being used and what other resources are associated with it. *See Section 5.6 on page 176.*

5.4 Models

In Synthesis applications, *models* can represent probabilities, durations or costs, either fixed or time-dependent. They are used by other resources to represent the reliability of a component, the duration of a task, the expected cost of a repair and many other characteristics.

Like any other Synthesis resource, you can create or edit models while you're performing a relevant analysis, and from the Resource Manager (*Section 5.5 on page 169*). In addition, you can publish models that are based on an existing analysis (e.g., a life data analysis in Weibull++, a diagram in BlockSim, etc.). *For more information on publishing models, see Section 5.4.1 on page 168.*

This topic describes the properties for both types of models. The interface will vary based on the particular situation.

Naming the Resource

For a new resource, a name will be proposed automatically based on the default naming criteria established for the current database in the Define Default Name Formats window. You can replace this with your own name of up to 150 characters, if desired. Remember that the name and identifiers are the primary way in which your team will be able to find the Synthesis resources you need for your analyses.

Model Basis and Status

In published models only, the **Model Basis and Status** area identifies the analysis that the model is based on. If the published model reflects the latest analysis results, the status is "Synchronized." If the analysis has been modified since the model was last published, the status is "Out of Sync."

Tip: If you have the ability to open the original analysis (i.e., if the required Synthesis application is activated on your computer and your user account has permissions to access the analysis), the **Source** will be configured as a link and there will also be a **Data Source** button at the bottom of the window.

Model Category

The category determines where and how a model can be used. If you are using a resource wizard to create a new model, it will be assigned automatically based on what's relevant for the current field. If you are publishing a model or creating it from the Resource Manager, you must select the appropriate option. Once a model has been created, you cannot change its category.

- **Reliability, Probability of Failure and Event Occurrence** models represent a likelihood of occurrence.
- **Duration** models represent a length of time.
- **Cost per Unit Time** models are used for costs that accrue over time (e.g., the crew charges \$50 per hour).
- **Cost** models are used for costs that don't depend on time (e.g., the part costs \$100 or the crew charges \$50 per service call in addition to their hourly rate).

Model Type

- A **distribution** model represents behavior that varies based on factors such as time and/or applied stress. For a published model, the inputs and parameters will be specified automatically based on the associated analysis. For manually created models, you can:
 - Select a distribution from the drop-down list and then enter the required parameter(s).
 - Use the Quick Parameter Estimator (QPE) to estimate the parameters of a distribution based on what you know about the behavior.

Tip: If you have the ability to open the original analysis (i.e., if the required Synthesis application is activated on your computer and your user account has permissions to access the analysis), the **Source** will be configured as a link and there will also be a **Data Source** button at the bottom of the window.

- A **constant** model represents a fixed probability (e.g., 0.9), duration (e.g., 2 hours) or cost (e.g., \$10 or \$10 per hour).
- A **dynamic** model represents a fixed probability, duration or cost, based on a specified variable. The variable can then be programmatically varied during simulation in one of two ways, thereby changing the value of the model for successive simulation runs.
 - For RENO flowcharts, the variable can be varied using RENO's sensitivity analysis/multiple analyses features.
 - When simulating a simulation worksheet, the values used by the variable will be specified in the worksheet.

When dynamic models are used outside of these circumstances, they are treated as constant models using the defined initial value of the variable.

Identifiers and History

For manually created models, the Identifiers tab of the properties window shows the following:

- **Identifiers** allows you to enter additional identifying information that can be used to search for this resource.
- **History** provides information about the creation and last modification of the resource. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the resource. *For more information, refer to the “History Logs” section in the “Working in Synthesis” chapter.*



For published models, identifiers are shown on the Identifiers tab of the control panel for the associated analysis.

Trace Usage

For an existing resource, a link at the bottom of the properties window indicates how many times it is currently being used. If you need more information, click the link or the **Trace Usage** icon.

[Used by 1 item](#) 

This opens the Dependency Viewer, which allows you to explore both where the resource is being used and what other resources are associated with it. *See Section 5.6 on page 176.*

5.4.1 Publishing Models

This section provides general information about how to create and work with *published models*, which are model resources that have been published from and continue to be associated with an existing analysis. For information about additional options and requirements in specific applications, see:

- “Publishing Fitted and Analytical Models” in the BlockSim documentation.
- “Publishing Models from R-DOE Results” in the DOE++ documentation.
- “Publishing from Failure Rate Predictions” in the Lambda Predict documentation.
- “Publishing Models from Analysis Results” in the RGA documentation.

The Synthesis Platform does not automatically update the published model when something changes in the original analysis, but users have the option to republish the model at any time. For any other analysis that uses the model, the change will be reflected the next time that other analysis is recalculated/resimulated.

Publishing Tools

For most Synthesis applications, the following model publishing tools are found on the Publishing page of the control panel. In Lambda Predict, they are located on the Model tab of the Properties panel.



Publish Model publishes the analysis to a model, making it accessible to all Synthesis applications.

- If the analysis has never been published, this will create a new model and you will be prompted to specify the name and category.
- If the analysis has already been published, this will update the existing model and change the model's status from “Out of Sync” to “Synchronized.”



Publish to Existing Model allows you to select an existing model (using the Select Resource window) and replace it with an association to the current analysis.



Trace Usage opens the Dependency Viewer (*Section 5.6 on page 176*), which allows you to see where the model is used.



View Model displays the properties for the published model. This information will be available to any Synthesis user who is considering whether to use the model in a particular analysis.



Remove Association removes the link between the current analysis and the published model. The model will continue to be a resource in the database but it can no longer be synchronized with the analysis.

Published Model Summary

After the model has been published, the summary table in the control panel (or Model tab in Lambda Predict) will display the model's name, along with the following details:

- When the **Status** changes from “Unpublished” to “Published,” the label becomes a link that opens the model's properties window.
- **Linked?** indicates whether the published model has been used. If the model is in use, you can click the link in this field to open the Dependency Viewer.
- **Synchronized?** displays “Synchronized” if the published model reflects the latest results from the associated analysis. If that analysis has been modified since the model was last published (e.g., if more data has been added, an analysis setting has changed, etc.), the status will display as “Out of Sync.”
- The **Created By** and **Modified By** fields display the names of the users who created and last updated the model. Click either of the links to see the dates and times.

Model Basis and Status

When a model has been published from an existing analysis, its properties window will include the following additional information:

Model Basis & Status	
Source	Folio1/Data1
Application	Weibull++
Type	Standard Folio
Status	Synchronized

- **Source** is the Synthesis analysis that the model was published from.
- **Application** is the Synthesis application that is required to view/edit the original analysis.
- **Type** is the kind of folio or diagram that the model is based on. For example, this might be a standard folio in Weibull++, an analytical diagram in BlockSim, a failure rate prediction in Lambda Predict, etc.
- **Status** displays “Synchronized” if the published model reflects the latest results from the associated analysis. If that analysis has been modified since the model was last published (e.g., if more data has been added, an analysis setting has changed, etc.), the status will display as “Out of Sync.”

Tip: If you have the ability to open the original analysis (i.e., if the required Synthesis application is activated on your computer and your user account has permissions to access the analysis), the **Source** will be configured as a link and there will also be a **Data Source** button at the bottom of the window.

5.5 Resource Manager

The Resource Manager allows you to create, view, edit and delete Synthesis resources. It also helps you to trace where each resource is used, and to create global resources (*Section 5.1.1 on page 161*) that are available to all projects in the database.

To open the Resource Manager, choose **Project > Synthesis > Resource Manager**.

To use the utility, choose the type of resource that you want to work with in the navigation panel on the left side of the window. A table that displays the resources of the selected type will be shown on the right side of the window. For information on configuring the table and limiting the resources shown, refer to *Choosing and Configuring Columns (Section 5.5.1 on page 171)* and *Finding and Filtering Records (Section 5.5.2 on page 172)*.

Note: The Resource Manager in each Synthesis application displays only the resources that may be relevant for that application. For a summary of which applications can create and/or use different types of resources, see: <http://www.ReliaSoft.com/synthesis/integration.htm>.

Creating, Viewing, Editing and Deleting Resources

You can:

- Create a new resource of the selected type by choosing **Home > Edit > New**.



To add multiple resources at the same time, specify the quantity in the **Home > Batch Add > Number to Add** field and then choose **Home > Batch Add > Add Items**. You will specify the properties for one of the new resources, and the additional resources will be duplicates of that. You can then edit each resource individually, or in BlockSim you can go to the Item Properties Table to edit them in a spreadsheet format.

- Duplicate an existing resource by selecting the row in the table and choosing **Home > Edit > Duplicate**.



- View or edit an existing resource by double-clicking the row in the table or by selecting the row and choosing **Home > Edit > View**.



- Delete an existing resource by selecting the row in the table and choosing **Home > Edit > Delete**.



You cannot delete a resource that is currently being used in any other resource or analysis.

Note: A published model cannot be edited or deleted from the Resource Manager. If changes are needed, you must update the original analysis and then republish the model. If you wish to delete the model, you must first remove the association with the original analysis and also make sure the model is not being used. *See Section 5.4.1 on page 168.*

Tracing Where Resources Are Used

With a single resource selected, you can choose **Home > Actions > Trace Usage** to open the Dependency Viewer, which provides information on where the resource is used and any additional resources that the currently selected resource itself uses. *See Section 5.6 on page 176.*



If you need to know which resources are not currently being used (e.g., because you want to delete obsolete records), choose **Administration > Selection > Show Only Unused**.

Local and Global Resources

As explained in Section 5.1.1 on page 161, local resources are available only in the current project, while global resources are available for use in any project in the database. To make a local resource global, select the row in the table and choose **Home > Actions > Make Global**.



Any associated resources will also be made global. For example, if you make a URD global, any associated models and tasks will also be made global. Similarly, you cannot assign a local resource to a global one.

The far left column in the Resource Manager displays an icon that indicates whether each resource is local or global.



Local Resource



Global Resource

You can use the **Home > Filter > [Show Local Resources/Show Global Resources/Show All Resources]** command to show only local resources, only global resources or all resources.

Exporting Information from the Resource Manager

To print the current view of the Resource Manager, choose **Home > Edit > Print**.



To send the contents of the Resource Manager to Excel, or to a built-in analysis workbook or spreadsheet if that's available in the current application, choose **Administration > Actions > Transfer Report**.



In the Transfer Report window that appears, you can select to export either the current item (i.e., the table for the currently displayed page) or the full report (i.e., the tables for all pages in the Resource Manager).

5.5.1 Choosing and Configuring Columns

In the Resource Manager and in BlockSim's Item Properties Table, you can configure the columns to suit your needs. These settings are stored per computer/username for each application, and different users may have different display preferences without affecting the stored data.

- To rearrange the columns, select a column header and drag it to the place in the grid where you want the column to appear. The column positions that you specify will be “remembered” and used each time you use the application.
- To resize the columns, you can do any of the following:
 - Drag the edge of the column header to the desired position.
 - To automatically resize one column to fit the data, double-click the edge of the column header or right-click the column header and choose **Best Fit** on the shortcut menu.
 - To resize all columns to fit the data, choose **Best Fit (all columns)** on the shortcut menu.
- To sort the table by a given column, click the column header. You can reverse the direction of the sort by clicking the column header again. You can also right-click the column header and choose **Sort Ascending** or **Sort Descending** on the shortcut menu, or choose **Clear Sorting** to stop sorting by the selected column.

You can specify which columns will appear in the table in two ways:

- Click the **Columns** icon at the bottom of the navigation panel to display a list of available columns in the navigation panel.



- Choose **Home > Columns > Column Chooser** or right-click any column header and choose **Column Chooser** to open the Select Columns window, which offers a sortable list of the available columns for the current type of item. The order that you sort by in this window does not affect the column positions in the Resource Manager or Item Properties Table.

5.5.2 Finding and Filtering Records

In table-based interfaces such as the Resource Manager, BlockSim's Item Properties Table and the Reliability Data Warehouse interfaces, there are several ways to find and filter data. Each of these tools can be used separately, or in conjunction with the others.

5.5.2.1 Auto Filter Row

The Auto Filter row appears by default immediately below the column headers. Enter text in any cell in this row to display only those items that start with matching text in that field.

	Model Name	Distribution	Model Category
	Component A		
	Component A - Reliability	Lognormal	Reliability
	Component A - Repair Duration	2P-Weibull	Duration
	Component A - Spare Delay	2P-Weibull	Duration

You can hide or show the Auto Filter row by choosing **Home > Filter > Display Auto Filter Row** or by right-clicking any column header and choosing **[Hide/Show] Auto Filter Row**.



5.5.2.2 Find Panel

The Find panel, which is hidden by default, allows you to search for specific text in any record property. Right-click any column header and choose **Show Find Panel** to display the panel above the column headers.

Enter text in the field and click **Find** to filter the items displayed in the table and highlight the matching text. You can click **Clear** to remove the filter. To close the panel, click the **X** or right-click any column header and choose **Hide Find Panel**.

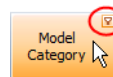
✕ duration Find Clear			
	Model Name	Distribution	Model Category
			
	Component A - Repair Duration	2P-Weibull	Duration
	Component A - Spare Delay	2P-Weibull	Duration

5.5.2.3 Advanced Filters

The Advanced Filters functionality is always enabled in the XFRACAS to RDW interface and in the RDW to Folio window. In the Resource Manager and the Item Properties Table, you can enable it by choosing **Home > Filter > Enable Advanced Filters**.

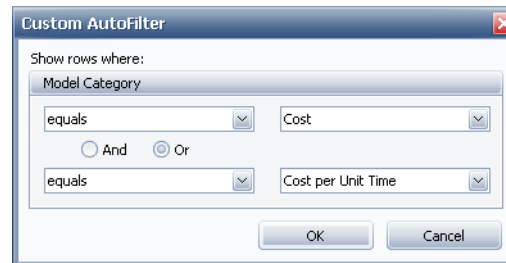


When advanced filters are enabled, a **Filter** icon will appear when you point to any column header in the table.

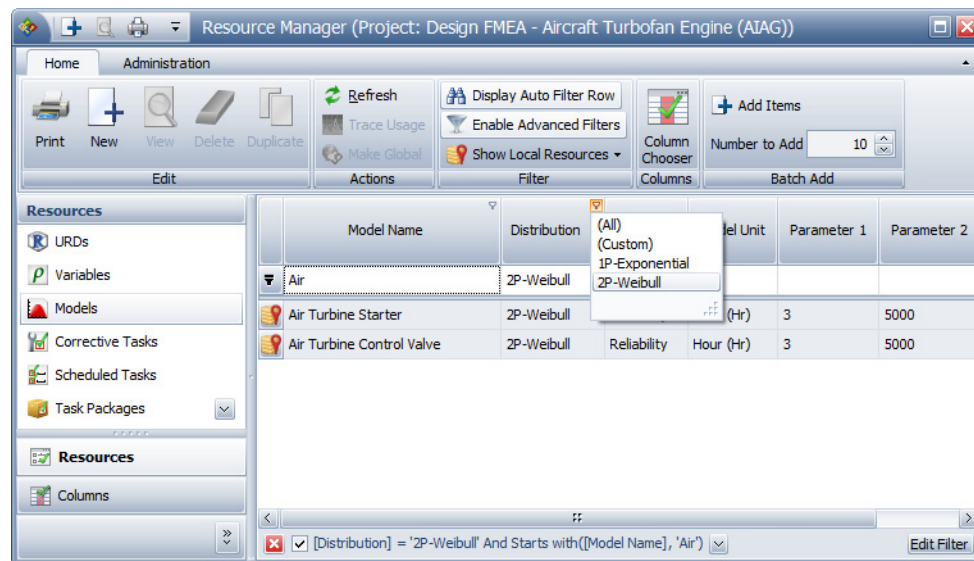


Click this icon to see a drop-down list of filters that you can apply for the currently selected column. These filters are automatically generated based on the values that currently exist in the column. For example, if you have reliability, duration and cost models in the project, those categories will automatically be available from the Model Category drop-down list.

If no automatically generated filters are available or if you want to specify more than one possible value, you can choose **(Custom)** to open the Custom AutoFilter window, which allows you to specify two filter criteria for the property, in either an “and” or an “or” relationship. For instance, the window shown next will filter the available models to show only the cost and cost per unit time models.



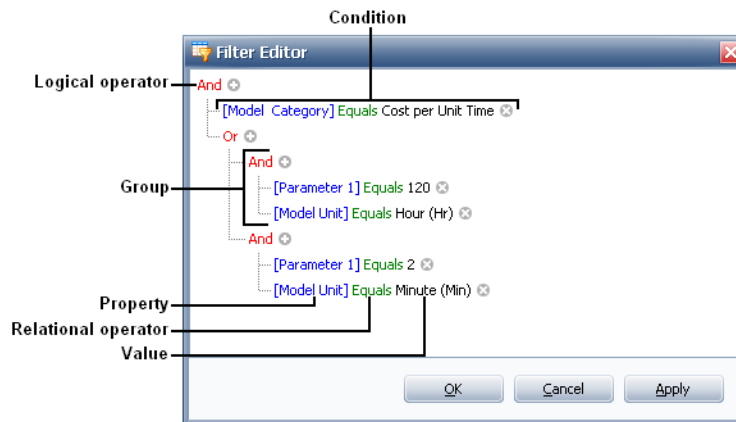
You can apply multiple filters in these ways to narrow the resources in the table as needed. Each column that has a filter applied will continue to display the Filter icon in the column header. The filters that you apply will appear at the bottom of the table, as shown next.



Click the check box to apply or remove the set of filters. Click the **X** to delete the set of filters entirely. To delete a single filter from the set, right-click the relevant column header and choose *Clear Filter*.

5.5.2.4 Filter Editor

When you have Advanced Filters enabled, you can edit the filters by clicking the **Edit Filter** button in the filter display or by right-clicking any column header and choosing **Filter Editor**. Note that this window also includes filters applied in the Auto Filter row.



Click any colored element in the window to view a drop-down list of available values.

- Click a red label if you want to:
 - change the logical operator (And, Or, Not And, Not Or)
 - remove the group
 - add a sub-group
 - clear the entire filter
- Use the + and x icons to add or remove conditions within an existing group.
- Click a blue label if you want to change the property (e.g., Model Name, Created By, etc.).
- Click a green label if you want to change the relational operator (e.g., Equals, Contains, Begins with, etc.).

For example, the filter shown above will display only cost per unit time models in which the rate equals either \$120 per hour or \$2 per minute.

5.5.3 Removing Unused and Duplicate Resources

The Resource Manager provides several tools to make it easy to delete unused resources and merge duplicate resources.

Finding and Removing Unused Resources

To find unused resources of the selected type, choose **Administration > Selection > Show Only Unused**.



Once you have found the unused resources, you can decide which ones to delete.

You can return to viewing all resources of the selected type by choosing the **Show All** command.



Finding Duplicate Resources

You may sometimes have duplicate resources within a project (i.e., several models that all represent the identical distribution, several tasks that are identical, etc.) within a project. For example, this might happen if you have imported diagrams that all reference the same model, but the imports happened at separate times and therefore the model had to be imported again each time.

To find duplicate resources, choose **Administration > Selection > Show Only Duplicates**.



In the window that appears, select the properties that must match in order for the resources to be considered duplicates. For example, if you are looking for duplicate URDs, you might select to compare the model, corrective task and scheduled tasks, but not the URD name. Once you have selected the columns to compare, click **OK** to show the duplicate resources.

You can merge multiple resources of the same type into one resource, either automatically or manually. Note that models must be of the same category in order to be merged, and you cannot merge published models.

IMPORTANT: Merging cannot be undone, and only the information from the “target” resource (i.e., the resource that you merge the others into) will be retained.

Automatically Merging Duplicates

To merge resources automatically, choose **Administration > Actions > Merge All Duplicates**.



This will find all sets of duplicates within the selected resource type (e.g., three identical Weibull models and 2 identical lognormal models); and for each set, it will merge the duplicates into the first instance found. After you confirm that this is what you want to do, you will be prompted to select the properties that must match in order for the resources to be considered duplicates. The process begins as soon as you select at least one column and click **OK**. It cannot be undone.

Selecting Resources to Merge

To merge resources manually, select the resources and choose **Administration > Actions > Merge & Delete**.



The window shows a list of the resources you selected to merge and allows you to choose which one will be retained (i.e., the one that the other selected resources will be merged into). After you click **OK**, this resource will be used in all places where the other selected resources were previously used.

5.5.4 Select Resource Window

The Select Resource window allows you to choose an existing resource to use at your current location. You can access it by clicking the **Select Existing** icon in any resource wizard.



The Select Resource window is similar to the Resource Manager, with the following differences:

- It shows only the resource type that you are currently working with.
- Each row in the table contains a radio button that allows you to select the resource for use.

- The window contains **OK** and **Cancel** buttons that allow you to apply the selected resource or close the window without applying a resource.

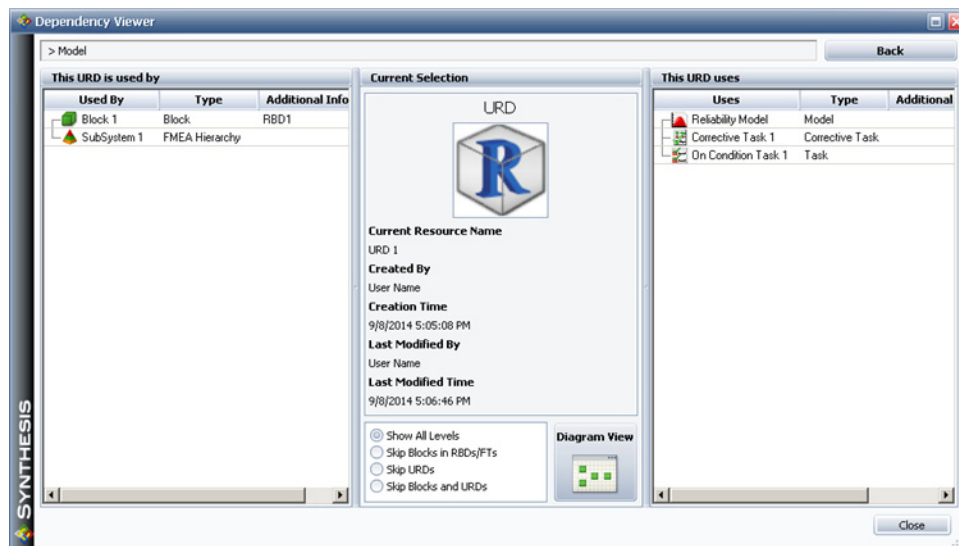
5.6 Trace Usage: Dependency Viewer

Because resources can be used multiple times, it is important to know where a given resource is used before making changes to it. The Dependency Viewer, which is accessed by clicking the **Trace Usage** icon in each resource properties window or in the Resource Manager, provides information on where the resource is used and what additional resources, if any, it uses.



The selected resource is shown in the **Current Selection** area in the middle of the Dependency Viewer.

The items that use the selected resource, if any, will be displayed in the **This [resource] is used by** area on the left. If it uses any resources, those resources will be displayed in the **This [resource] uses** area on the right. For example, in the picture shown next, the selected resource is a URD. It is used by Block 1 in a BlockSim diagram and by SubSystem 1 in an FMEA analysis. The URD uses an assigned model and two tasks.



You can edit any resource shown in the Dependency Viewer by right-clicking it and choosing **Edit Item** on the shortcut menu. The resource's properties window will open.

You can double-click an item in either area to make it the current selection in the window. For example, you could double-click a task used by the URD to see the model(s), crew(s) and/or spare part pool(s) that the task uses.

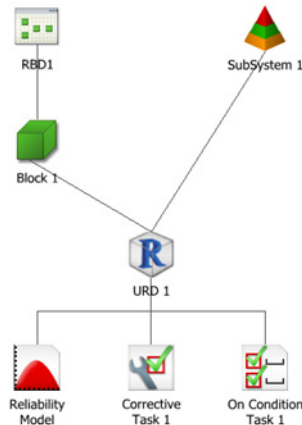
As you change selected items, each previous item that you selected will be added to the “path” of recent selections at the top of the window; click **Back** to go back through the path to the previously selected items. For example, the following picture shows a path in which the user started with the URD, then proceeded to its corrective maintenance task, the crew for that task and the logistic delay for that crew (not shown in the path because it is the current selection). The button now provides a quick way to go back through those same resources in reverse order if needed.



You can click the **Diagram View** button to open the diagram view of the Dependency Viewer (described in the next section). The currently selected item will be the main block in the diagram that is created.

Choosing What You See

In the **Current Selection** area, you can choose what is shown in the **This [resource] is used by** area. You have the option to skip the URD and/or the block that the resource is used by. For example, the image below shows the connections among analyses and resources that we have been discussing. If you have selected to show all levels, you can trace from Reliability Model to URD 1 to Block 1 to RBD 1. But if you have selected **Skip Blocks and RBDs**, it just shows that Reliability Model is used by RBD 1.

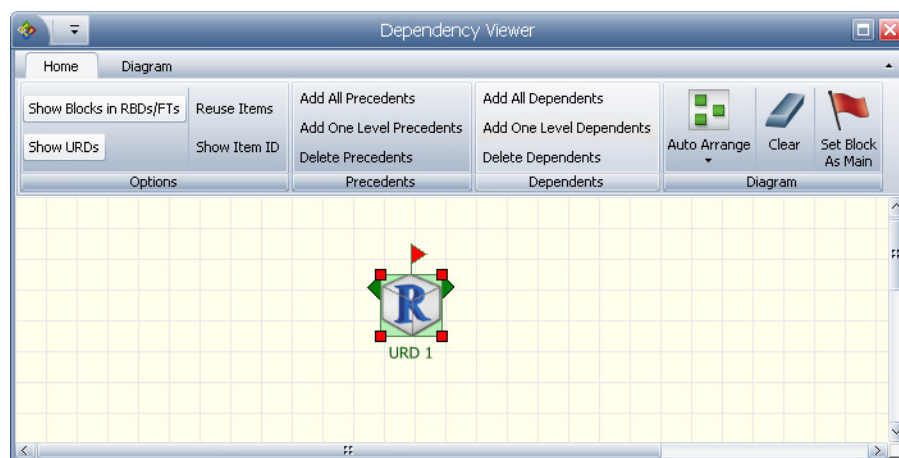


Note that blocks are always skipped in RENO flowcharts (i.e., only the flowchart will be shown as the precedent for a resource used by any block within the flowchart).

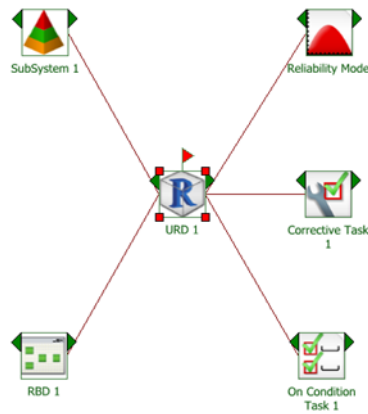
5.6.1 Dependency Viewer - Diagram View

The diagram view of the Dependency Viewer, which is accessed by clicking the **Diagram View** button, offers a diagram-based alternative to help you understand the connections among resources in your project.

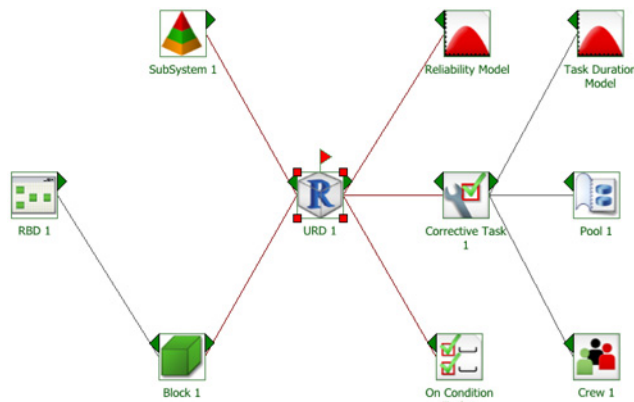
To understand how to use this view, consider the same example shown in the previous section. Clicking the **Diagram View** button for that example will yield a diagram view that shows only the main item (in this case, the URD), which is marked with a flag:



To view a graphical representation of the information that was shown in the Dependency Viewer, choose **Add One Level Precedents** and **Add One Level Dependents**. This will show the items that use the resource (i.e., its precedents), and the resources that it uses, if any (i.e., its dependents).



If you want to see all levels, choose **Add All Precedents** and **Add All Dependents**:

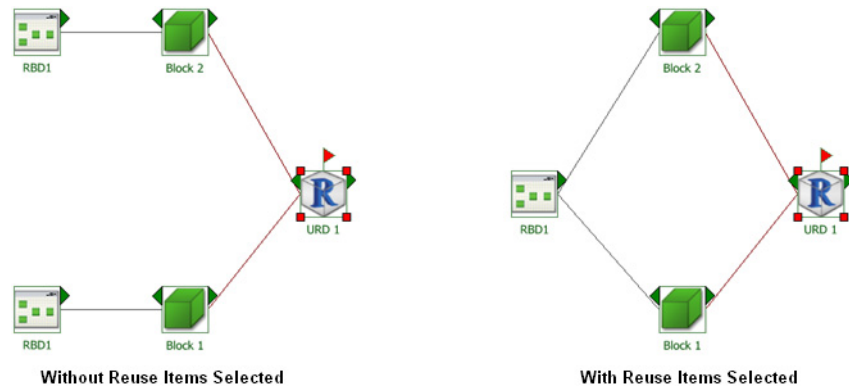


If you want to add or remove one branch at a time, click the green arrows on the sides of the blocks. Alternatively, if you want to remove one branch, select the block and choose **Delete Precedents** or **Delete Dependents**.

To set a different item as the main item in the diagram, select it and choose **Set Block as Main**. This serves the same purpose as changing the selected block in the Dependency Viewer.

Use the commands in the Options group of the Ribbon's Home tab to specify how the diagram will be constructed:

- Select **Reuse Items** to show each item only once in the diagram. For example, if you are viewing a URD that is used by two blocks in the same diagram and you choose **Add All Precedents**, the Reuse Items command will affect the display as shown next:



This command must be selected before the diagram is created, or you must clear the current diagram to apply it.

- Use the **Show Blocks in RBDs/FTs** and **Show URDs** commands to determine whether blocks and/or URDs are shown as intermediate steps between resources and the analyses in which they are used.
- Select **Show Item ID** to display the internal ID assigned to each resource, block and/or diagram. These IDs can be used to differentiate among items that share the same name.

The Diagram tab of the Ribbon offers zoom options and printing options, as well as the ability to copy the diagram or to export it as a graphics file.

Configurable Settings

6

All of the analysis settings that can be configured in Xfmea, RCM++ or RBI (including the data fields, the options in drop-down lists, the rating scales used for risk assessment and other analysis preferences) are stored together with the data for each project. This makes it possible to define different properties for different types of projects and, when multiple users cooperate on the analysis, it also ensures that all users see the same configurable settings for a particular project.

To save time and ensure consistency, authorized users can manage a library of predefined settings and profiles that can be copied into any particular analysis project. With an enterprise database, the library is stored directly in the database and can be accessed only by users with the “Manage profiles and templates in Xfmea/RCM++” permission. With standard databases, the library is a separate database (*.lb8) that can be stored on your computer or a shared network folder. Although you can maintain multiple library databases if desired, only one library can be active at any given time.

This chapter describes how to:

- Transfer settings between the library and projects - Section 6.1 (p. 182)
- Use the Profiles/Library Manager window to manage all of the predefined settings that are available to be assigned to any project - Section 6.2 (p. 184).
- Import settings from an existing library - Section 6.3 (p. 185)
- View or edit each type of configurable setting:
 - Profiles - Section 6.4 (p. 186)
 - Interface Styles - Section 6.5 (p. 187)
 - Rating Scales - Section 6.6 (p. 196)
 - Risk Discovery Questions - Section 6.7 (p. 197)
 - Risk Discovery Ratings - Section 6.8 (p. 198)
 - Phrase Sets - Section 6.9 (p. 199)
 - FEC Logic - Section 6.10 (p. 200)
 - Task Logic - Section 6.11 (p. 202)
 - Checklists - Section 6.12 (p. 203)
 - Assumptions - Section 6.13 (p. 203)
 - Surveys - Section 6.14 (p. 204)
 - DFR Planner Templates- Section 6.15 (p. 204)

- Convert libraries and profiles from Version 5 - Section 6.16 (p. 205)
- Convert configurable settings from Version 5 - Section 6.17 (p. 206)

6.1 Transferring Settings Between the Library and the Projects

As you begin working with the configurable settings in Xfmea, RCM++ or RBI, it may be helpful to keep a few basic principles in mind:

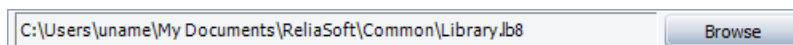
- A complete set of configurable settings are **stored with each project** in the database.
- The **library contains predefined settings** that can be copied into any given project at any time.
- Settings are **copied, not linked**.
 - Changing settings in the library does not automatically update any of the settings for existing projects. You will need to reapply the updated profile to each affected project.
 - Changing settings for a particular project does not automatically update the library that the settings were originally copied from. You will need to apply/transfer the same changes in the library, if appropriate.

For new users, we recommend the following basic workflow:

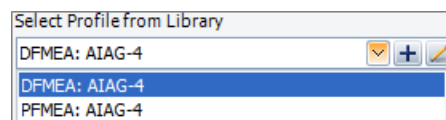
1. **Configure the library to contain the settings your organization will need.** Assign one user (or a small team of users) to use the Profiles/Libraries Manager to create a library that contains a predefined profile for each type of project your team may need to use. For example, your organization may need one profile for Design FMEAs and a second profile for Process FMEAs, then you may create a third profile for RCMs. Alternatively, you may need to create different profiles (e.g., with different rating scale criteria) for different product lines, etc.

Tip: If you start with the library that is installed with the software, it may help to avoid confusion if you delete any settings that are not relevant for your team. You can restore the original shipped library at any time if you need it.

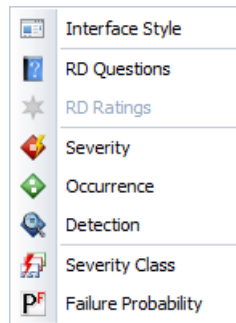
2. **Make sure that all users are sharing the same active library.** With an enterprise database, this is the only option. With standard databases, you can place the library database in a shared network location and then instruct all users to set this shared file as the *active* library on their computers. Alternatively, you can simply distribute a copy of the latest file to all users. When you're working with a standard repository, the active library can be set at the top of the Profiles/Libraries Manager window, as shown next.



3. **Establish the configurable settings for each project.** The simplest way to set the properties for a particular project is to choose a predefined profile from the drop-down list on the General tab of the Project Properties window. This will automatically copy all of the relevant settings from the library to the project.



4. **View/modify the settings for an individual project, if desired.** If you need to view or modify the settings for one particular project only, use the Configurable Settings tab of the Project Properties window or choose **Project > Management > Configurable Settings**.



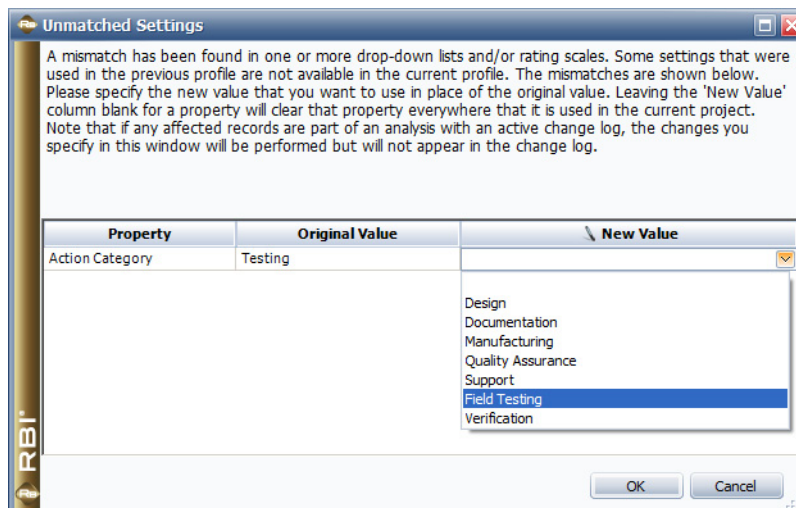
Remember that changing the settings in an individual project does not automatically update the library or any other projects.

- **If you want the changes to apply to all future projects**, it may be more efficient to update the active library and then reapply the profile to any existing projects that need to be updated.
- **If you want to change a particular project only**, edit the project settings directly via the Configurable Settings tab of the Project Properties window or by choosing the appropriate option from the Ribbon.

6.1.1 Unmatched Settings Window

If you change a drop-down list or rating scale in a project that already contains data, the Unmatched Settings window provides a quick and easy way to update existing records, if desired. This window will appear automatically when it is applicable.

For example, if you remove or rename one of the options in the **Action Category** drop-down list, and if the project contains any actions that have already been assigned to that option, you will be prompted to specify which category those actions should be reassigned to (if any). Simply select the appropriate option from the **New Value** drop-down list, as shown next.



6.2 Profiles/Library Manager

In RBI, a *profile* is a collection of predefined settings for a particular type of analysis. For example, your organization may need one profile for Design FMEAs and a second profile for Process FMEAs, then you may create a third profile for RCMs. A *library*, on the other hand, is a collection of profiles and other settings that can be applied to any project. The library file that is in effect at any given time on your computer is called the active library.

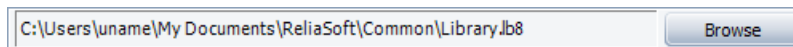
Note that:

- For standard databases (*.rsr9), library files have the extension *.lb8 and can be saved on your own computer or stored in a shared network location. The ability to modify the settings depends on whether the user has read/write access to the file.
- For enterprise databases (SQL Server or Oracle), the active library is stored within the enterprise database itself, and the ability to edit this library is restricted to authorized users only.

If you have the necessary permissions, you can view and edit all of the profiles in a library via the Profiles/Library Manager. To access this utility, first open a database, then choose **File > Manage Repository > Profiles and Templates > Profiles/Library Manager**.



If you are connected to a standard database, the address bar at the top of the Profiles/Library Manager window shows the location and name of the active library for your computer. You can click the **Browse** button to select a different library file to use.



6.2.1 Viewing or Editing Settings

The navigation panel on the left lists the different types of settings that can be predefined and stored in the library. The table on the right displays the predefined settings for the type that is currently selected. To view or edit the settings, simply double-click the row in the table or select the row and click **Add**, **Edit** or **Delete**.

- Profiles, which use the following settings - Section 6.4 (p. 186)
 - Interface Styles - Section 6.5 (p. 187)
 - Rating Scales (i.e., severity scale, occurrence scale and detection scale) - Section 6.6 (p. 196)
 - Risk Discovery Questions - Section 6.7 (p. 197)
 - Risk Discovery Ratings - Section 6.8 (p. 198)
 - FEC Logic - Section 6.10 (p. 200)
 - Task Logic - Section 6.11 (p. 202)
- Phrase Sets - Section 6.9 (p. 199)
- Checklists - Section 6.12 (p. 203)
- Assumptions - Section 6.13 (p. 203)
- Surveys - Section 6.14 (p. 204)
- DFR Planner - Section 6.15 (p. 204)

6.2.2 Importing Settings from Another Database

If you want to import settings from another database, first select the type of setting then click the **Import** button. If you import a profile, the application will also import copies of all related settings (i.e., the interface style, severity scale, etc.).

In addition, the **Copy Existing** button appears in many windows throughout the Profiles/Library Manager. This feature allows you to copy selected settings from another library to replace the ones in the current window. *For details, see Section 6.3.2 on page 186.*

6.2.3 Resetting a Standard Library

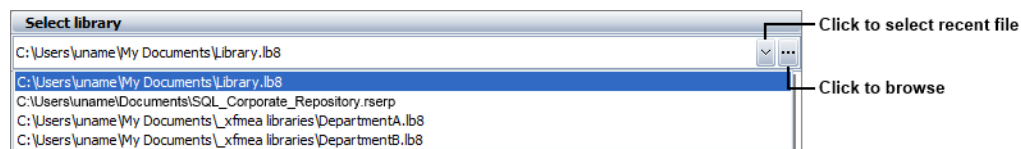
If you are working in a standard database (*.rsr9), the **Reset Library** button will be displayed at the bottom of the window. This button resets the active library to the default library that is shipped with the software (i.e., Library.lb8 for the English interface). This will not replace whatever library currently exists; rather, it will create a new standard library file in the C:\Documents and Settings\username\My Documents\ReliaSoft\Common folder. If a file with the name Library.lb8 already exists in this location, the new filename will have an increment at the end (e.g., Library_1.lb8).

6.3 Importing Settings to a Library

It is easy to import profiles and other settings (e.g., interface styles, rating scales, etc.) from another database. To do this, open the Profiles/Library Manager window, select the setting of interest from the navigation panel and then click the **Import** button.

In the Import to Library window, do the following:

1. Use the drop-down list or browse button (...) to select the library that you want to import from. This can be a standard library file (*.lb8) or an enterprise database connection file (*.rsrp).



2. The table shows all of the applicable settings in the library that is currently selected. Use the check boxes to select which settings you wish to import.
3. Click **OK** to copy the data into your active library.

6.3.1 Importing an Entire Profile

When you select to import a profile, the application will also import all related settings (e.g., the interface style, severity scale, etc.). If settings with the same name already exist in the destination library, the application will import them anyway and increment the name(s).

If you prefer for the imported profile to use any of the settings that were already present in the destination library, you can edit the profile to link to the existing settings and then delete the duplicate settings that were imported.

Tip: If you need to import multiple profiles that reference some of the same settings (e.g., if they all use the same rating scales or risk discovery questions), we recommend to import all of the profiles at the same time in order to limit the amount of work that will be required to manually adjust the profiles and delete extra settings.

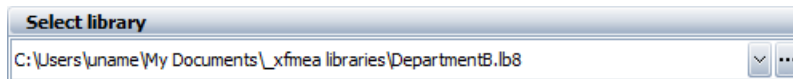
6.3.2 Copy Existing

The **Copy Existing** button appears in many windows throughout the Profiles/Library Manager. This feature allows you to select another library and copy selected settings to replace the ones in the current window. The following instructions explain how to copy an existing interface style. You can use a similar procedure for rating scales, risk discovery questions, etc.

1. Open an existing interface style and click the **Copy Existing** button at the bottom of the window.



2. In the Select window that appears, browse for the library file that contains the interface style you want to copy.



3. The table displays a list of the interface styles that have been predefined in the library that is currently selected. Double-click or select a row and click **OK**. This replaces all of the settings in the current interface style with the settings that were copied from the selected one.

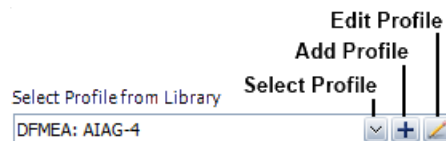
6.4 Profiles

A *profile* is a collection of predefined settings that can be used to update all of the configurable settings for any project at the same time.

The Profiles page in the Profiles/Library Manager shows all of the predefined profiles in the active library.

- To add a new profile, click **Add**.
- To edit an existing profile, select the row and click **Edit** or double-click the row.

You can also add or edit a profile from the General page of Project Properties window, as shown next.



6.4.1 Selecting the Default Profile

If you select the **Set this as the default** profile check box, the profile will be selected by default for each new project that you create when this library is active. Because only one profile can be the default at any given time, selecting this check box for one profile will have the effect of clearing it from the other profile that previously was the default.

6.4.2 Profile Settings

Each profile contains the following settings. For each type of setting, you can use the following menu to a) **Select** settings that have been predefined in the active library, b) **Add** new settings and/or c) **Edit** the predefined settings that are currently selected in the drop-down list.



- **General tab**
 - The **Interface Style** determines the data fields that will be enabled in the project, the options from configurable drop-down lists, the method of risk assessment, the order of the columns in analysis worksheets and other configurable preferences. *See Section 6.5 on page 187.*

- The **RPN Scales** will be used for any risk priority number (RPN) calculations in the project (*see Chapter 15*). For information about how to enable these rating scales for effect and cause records in the FMEA, see Section 6.5.5 on page 190. For information about how to create rating scales, see Section 6.6 on page 196.
 - The **Severity Scale** can be enabled for effect records in the FMEAs.
 - The **Occurrence Scale** and **Detection Scale** can be enabled for cause records in the FMEAs.
- The **Criticality Scales** will be used for any criticality analyses that you perform in the project (*see Chapter 16*). For information about how to enable these rating scales for failure records in the FMEAs, see Section 6.5.6 on page 193.
 - The **Severity Class** can use any of the predefined severity rating scales.
 - The **Failure Probability** can use any of the predefined occurrence rating scales.
- **Risk Discovery tab**

For risk discovery analysis (e.g., preliminary risk analysis, change point analysis, equipment selection, etc.), you can choose to use either questions or ratings.

 - The **Risk Discovery Questions** method uses a series of yes/no questions. *See Section 6.7 on page 197.*
 - The **Risk Discovery Ratings** method uses a set of factors and ratings that calculate a numerical value. *See Section 6.8 on page 198.*
- **Tasks tab**

In RCM++ or RBI only, the Tasks tab contains the settings for the logic diagrams used in traditional reliability centered maintenance (RCM) analysis.

 - The **FEC Logic** will be used in the Failure Effect Categorization window for effect records. *See Section 6.10 on page 200.*
 - The **Task Selection Logic** will be used in the Maintenance Task Manager window for cause records. *See Section 6.11 on page 202.*

Note: For any given profile, if you have chosen a task selection logic that presents different questions depending on the failure effect categorization then you must choose a failure effect categorization logic with the same number of categories. If the logics do not match, a message will be displayed when you attempt to save the profile.

6.5 Interface Styles

An *interface style* determines the data fields that will be enabled in the project, the options from configurable drop-down lists, the method of risk assessment, the order of the columns in analysis worksheets and other configurable preferences.

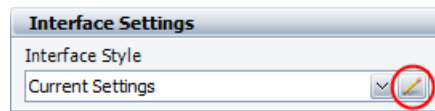
The Interface page in the Profiles/Library Manager shows all of the predefined interface styles in the active library.

- To add a new interface style, click **Add**.
- To edit an existing style, select the row and click **Edit** or double-click the row.

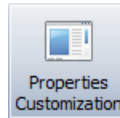
There are also several ways to edit the interface style for a particular project. Remember that changing the settings in an individual project does not automatically update the library or any other projects (*see Section 6.1 on page 182*).

- Choose **Project > Management > Configurable Settings > Interface Style**.

- Click the **Edit** icon on the Configurable Settings tab of the Project Properties window.



- Click any of the **Properties Optimization** icons that are available in FMEA record properties windows.



6.5.1 Viewing or Editing Settings

The navigation panel on the left lists the properties and other options that can be customized via the interface style. The table on the right allows you to view or edit the settings that are currently selected. The appearance of each page will differ depending on what can be customized. Each type of interface is discussed in the sections that follow.

- Customizing Record Properties - Section 6.5.2 (p. 188)
- Modifying Drop-Down Lists - Section 6.5.3 (p. 189)
- Reordering Worksheet Columns - Section 6.5.4 (p. 190)
- Configuring Risk Assessment Settings
 - FMEA > RPNs - Section 6.5.5 (p. 190)
 - FMEA > Criticality - Section 6.5.6 (p. 193)
- Configuring Synchronization Preferences
 - FMEA > Sync Options - Section 6.5.7 (p. 194)
 - Control Plan > Sync Options - Section 6.5.8 (p. 194)
 - DVP&R > Sync Options - Section 6.5.9 (p. 195)

6.5.2 Customizing Record Properties

For many types of records, you have the option to choose which properties will be enabled and what they will be called. All of the available properties will be displayed in a table like the one shown next:

Property	Type	\ Enabled	\ Display Name	\ Tooltip
CauseDescription	Text (2000)	* Yes	Cause	List the potential cause(s) for each failure. This should be the "actionable" level of the analysis, which is the level of causation at which corrective actions and/or controls could effectively be a...
Detection Method	Text (150)	No	Detection Method	Describe the mechanisms that are in place to detect the failure cause.
Compensating Provisions	Text (150)	No	Compensating Provisions	Describe the mechanisms that are in place to compensate if the failure cause occurs.
Classification	Drop-Down 	Yes	Classification	Use this column to identify and classify characteristics that require special manufacturing control, e.g. Critical, Significant, Key Leading, etc.

- **Property** is the basic name for the field. This cannot be changed.
- **Type** indicates whether the field contains text, a date, a number or a drop-down list.
 - If text, the number in parentheses indicates the maximum number of characters.
 - If a drop-down list (and if the property is enabled), you can click the **Edit** icon,  to view or edit the options that appear in the list.
- **Enabled** indicates whether the field will be enabled in the interface and report output. Click inside the cell to toggle between Yes and No. An asterisk (*) indicates that the field cannot be disabled.
- **Display Name** is the name that will appear in the interface and report output. This can be changed to whatever fits your needs.
- **Tooltip** is a short statement that will be displayed when a user holds the mouse over the field in a table or worksheet. This can be changed to whatever fits your needs.



Clear Tooltips deletes all of the tooltips from all of the properties in the current interface style.



Spelling checks the spelling of the text fields within the interface style.

Option to Disable Controls or Actions

On the FMEA > Controls page and the FMEA > Actions page, an additional option will be displayed above each properties table.

- If you clear the **Enable Controls for Causes** check box, all controls-related functionality will be disabled within the project. The properties table will be disabled because these settings are not applicable for this interface style.
- If you clear the **Enable Actions for Causes** check box, the actions-related functionality in FMEAs will be disabled within the project. However, the properties table will remain enabled because these settings will still be used for action records in the DFR Planner and the My Portal window.

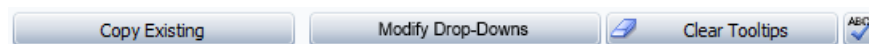
6.5.3 Modifying Drop-Down Lists

The Modify Drop-Downs window allows you to customize any of the drop-down lists that can be enabled via the interface style.

- If you want to edit one particular list, click the **Edit** icon in the **Type** column in the record properties table.

Action Category	Drop-Down 	Yes	Action Category	The category for the action (choose from menu).

- If you want to edit all of the drop-down lists that are currently enabled in the interface style, click the **Modify Drop-Downs** button at the bottom of the interface style window.

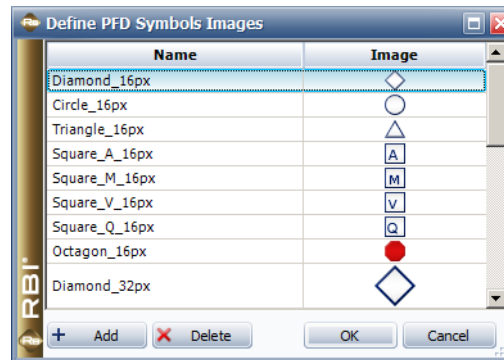


For most of the drop-down lists, you can simply type inside the table and use the buttons to **Delete Row**, **Insert Row** or **Move Up/Move Down**. For the certain fields that can be enabled for process flow diagram (PFD) worksheets, an additional step is required as described next.

6.5.3.1 Define PFD Symbols

For the **Operation Type** and **Operation Type Symbol** fields that can be enabled for PFD worksheets, you will need to select an image to represent each option type. *See Chapter 19.*

To customize the list of available images, click the **PFD Symbols** button at the bottom of the Modify Drop-Downs window. This opens the Define PFD Symbols Images window, as shown next.

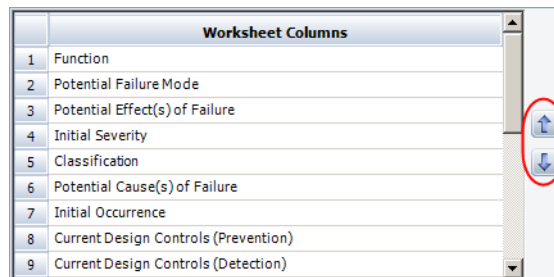


- To add an image, click the **Add** button and select a file. The available formats are *.png, *.bmp, *.dib, *.gif, *.jpg, *.wmf and *.emf. The file name and image appear in the window.
- To delete an image, click the image and then click **Delete**.

6.5.4 Worksheet Columns

For many of the analyses that use a worksheet (including FMEAs, PFD worksheets, DVP&Rs and DRBFMs), the **Worksheet Columns** page of the interface style allows you to specify the order in which the property columns will be displayed. These preferences will be saved with the project so the column order will be the same for all users who view the analysis.

The table shows all of the properties for that type of analysis that are currently enabled in the interface style (using the display name that has been specified in the record properties table(s)). You can use the arrows to move a selected property up or down in the list.



6.5.5 FMEA > RPNs

The FMEA > RPNs page of the interface style allows you to customize properties and functionality related to risk priority numbers (RPNs).

6.5.5.1 RPN Properties and Metrics

The table at the top of the page works like the other record properties tables (*see Section 6.5.2 on page 188*) except:

- An additional column, **Short Display Name**, specifies the abbreviation that will be used in some locations within the interface, plots and/or report output where the full display name will not fit.

- The metrics can be enabled only if the applicable rating scales are enabled. For example, since the Initial RPN metric is calculated based on the Initial Severity x Initial Occurrence x Initial Detection, if you disable the Initial Severity property, then Initial RPN will be disabled automatically. Likewise, if you enable the Initial RPN, then all of the ratings required to calculate that metric will be enabled also.
- The Initial Risk Ranking and Revised Risk Ranking properties can be enabled only if you have specified a risk ranking logic for the interface style as described below.

6.5.5.2 Highlight Priority

Two areas at the bottom of the page allow you to configure the logic that will be employed when a user turns on the Highlight Priority feature (**FMEA > Tools > Highlight Priority**) for FMEAs within the project.

- In the **Highlight Priority Based on** area, choose a rating or metric from the drop-down list and then specify the thresholds for high priority and low priority. (The options in the drop-down list will vary depending on which ratings and metrics have been enabled in the properties table. For example, if you have disabled the Initial RPN and Revised RPN properties, the RPN metric will not appear in the drop-down list for priority highlights.)
- In the **Select Highlight Colors** area, choose the colors that will be used to highlight the records in the FMEA that match the criteria for high, medium or low priority.

For example, consider the settings shown below:

When you are working with an FMEA in a project with these settings defined and choose **FMEA > Tools > Highlight Priority**:



- Causes with an RPN equal to or greater than 300 will be highlighted with a red background color.
- Causes with an RPN from 31 to 299 will be highlighted with a yellow background color.
- Causes with an RPN equal to or less than 30 will be highlighted with a green background color.
- Causes that do not have a calculated RPN will not be highlighted.

6.5.5.3 Risk Ranking Logic

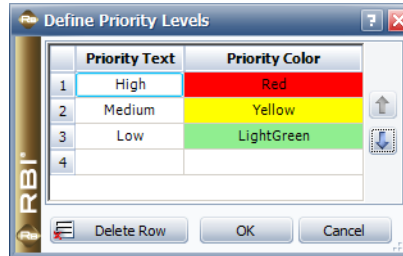
If you need to define a more complex logic for the priority highlights functionality, choose **Risk Ranking** from the drop-down list and then click the **Risk Ranking Logic** button.

To use this feature:

1. The first step is to define the priority levels that will be used for the configurable risk ranking logic. This can be the same three levels that are available for the basic priority highlights functionality (high, medium and low) or it can be configured to meet the specific categories used by your organization. For example, this could be two levels (such as Action Required and No Action Required) or four levels (such as Critical, High, Medium and Low), and so on.

To define the levels and the color associated with each level, scroll all the way to the right side of the Risk Ranking window and then click the **Edit** icon in the header of the Priority column.

This opens a window like the one shown next, where you can add, edit or delete levels, change the level order and select the desired priority color for each level.



- The next step is to determine where the highlight colors will be applied in the interface and reports. If you want to apply the highlight color to the RPN-related columns that already are displayed in the FMEA hierarchy view, worksheet and reports, choose the **Use RPN columns** option at the top of the window. If you want to add new columns to display the results of the more complex risk ranking logic, choose the **Use risk ranking columns** option.

Highlight Risk

☒ Use RPN columns
 ☐ Use risk ranking columns

Tip: When the **Use risk ranking columns** option is selected, the Initial Risk Ranking and Risk Ranking properties will become enabled in the table on the RPNs page of the Interface Style. When you close the Risk Ranking window and return to the RPNs page, you can customize these columns by editing the text in the Display Name, Short Display Name and Tooltips columns

- The last step is to define the logic that will be used to assign causes from the FMEA to the priority levels that you have defined. This can be based on any combination of the ratings and/or metrics that have been enabled in the interface style. You can create as many rows in the table as you need to define the prioritization logic used by your organization. Each row defines a logic statement based on up to three criteria. For each criterion, the first column specifies the rating or metric and the third column specifies a value. The second column specifies whether the rating or metric must be equal to (=), greater than (>), greater than or equal to (>=), less than (<) or less than or equal to (<=) the specified value.

For example, you might wish to configure the utility to categorize an issue as “High Priority” if the severity rating for the effect is greater than or equal to 8 and the RPN is greater than or equal to 200, as shown below.

Highlight Risk

☒ Use RPN columns
 ☐ Use risk ranking columns

	Criterion 1		AND	Criterion 2		AND	Criterion 3	Priority
1	Severity	>=	8	RPN	>=	200		High
2								

To do this, click inside the first column under Criterion 1 and choose **Severity** from the drop-down list, then click inside the second column and choose >=. Finally, type **8** in the third column. Then, click inside the first column under Criterion 2 and choose **RPN** from the drop-down list, click inside the second column and choose >= and type **200** in the third column. For this particular logic statement, a third criterion is not required so those columns are left blank.

6.5.6 FMEA > Criticality

The FMEA > Criticality page of the interface style allows you to customize properties and functionality related to quantitative or qualitative criticality analysis. *See Chapter 16.*

6.5.6.1 Criticality Properties

The table at the top of the page works like the other record properties tables (*see Section 6.5.2 on page 188*) except:

- An additional column, **Short Display Name**, specifies the abbreviation that will be used in some locations within the interface and/or report output where the full display name will not fit.
- At least one of these properties must be enabled if you want to perform Criticality Analysis.

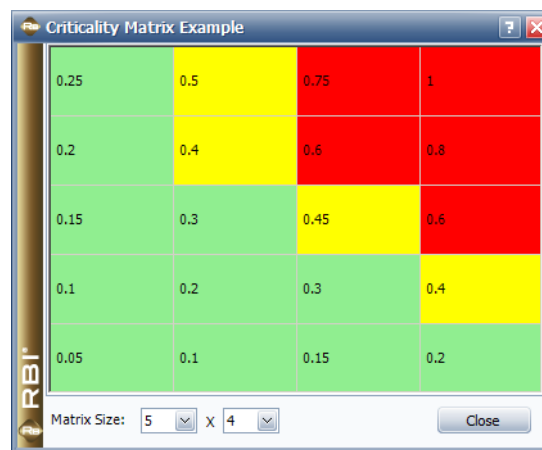
6.5.6.2 Criticality Matrix Priority Highlights

The settings at the bottom of the page allow you to customize the priority highlight colors that will be added to any quantitative or qualitative criticality matrix reports that you generate.

Do the following:

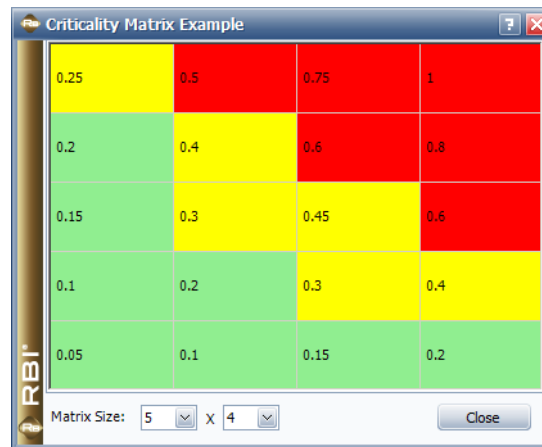
1. Click the **Preview** button to create a sample matrix, and then use the drop-down lists to specify the size of the matrix that you will be creating for criticality analyses in this project. For example, if you have configured the project to use the criticality rating scales from MIL-STD-1629A (a five-point scale for Failure Probability and a four-point scale for Severity Class):
 - The qualitative criticality matrix report will be 5 x 4 (i.e., Failure Probability on the vertical axis and Severity Class on the horizontal axis).
 - The quantitative criticality matrix will be 10 x 4 (i.e., calculated criticality on the vertical axis and Severity Class on the horizontal axis.)

The following picture shows a sample for the MIL-1629A qualitative matrix. Note that the software has assigned a value to each cell such that the smallest number appears in the bottom left corner and the largest number appears in the top right corner. It has also applied the highlight colors based on the thresholds that are currently specified (in this case, .6 for high priority and .4 for medium priority).



2. If you are not satisfied with the highlights that are shown in the sample, use the numbers in the cells to determine how the threshold values should be changed. For example, in the sample matrix shown above, if you wanted the top left corner of the matrix to be highlighted as medium instead of low priority, you would need to set the medium priority threshold to .25 instead of .4.

- Return to the FMEA > Criticality page and enter the new threshold values. Each number must be greater than zero and less than or equal to 1. In addition, the **High Priority Threshold** must be larger than the **Medium Priority Threshold**.
- Click the **Preview** button and set the matrix size again, then check to see if the new threshold values will result in the desired highlight pattern. For example, the following picture shows a new preview for a 5 x 4 matrix in which the high priority threshold has been changed to .5, and the medium priority threshold has been changed to .25.



- You can repeat this process as many times as needed until you're able to confirm that the specified threshold values will result in the highlight pattern you prefer for criticality matrix reports.

6.5.7 FMEA > Sync Options

The FMEA > Sync Options page of the interface style determines how FMEA functions will be created when a new FMEA is added to an analysis. Select one of the following options:

- Select **None** to not create any default functions.
- Select **Create functions from PFD worksheet operations** to use the operation descriptions in the PFD worksheet as functions in the FMEA.
- Select **Create functions from system hierarchy item** to use the name of the system hierarchy item as functions in the FMEA.
- Select **Create functions from system hierarchy item and dependents** to use the names of the system hierarchy and its dependents as functions in the FMEA.

6.5.8 Control Plan > Sync Options

The Control Plan > Sync Options page of the interface style determines how control plan data will be created when a new control plan is added to an analysis. *See Chapter 20.*

Select one of the following options:

- FMEA** allows you to create a new control plan based on an existing FMEA. The follow settings are available:
 - In the **Part/Process** list, select how you want the part/process records to be created from the FMEA:
 - If you stored descriptions of the process steps in the system hierarchy, then you would use the items as starting points for the Part/Process records in the control plan.
 - If you stored descriptions of the process steps as functions in the FMEA, then you would use the functions as starting points for the Part/Process records in the control plan.

- In the **Characteristic** list, select how you want to transfer the cause records from the FMEA:
 - If your cause records contain descriptions of the characteristics that need to be kept under control during the manufacturing process, then you could use them as starting points for the characteristic records in the control plan. If you do so, you can specify whether they are more likely to be product characteristics or process characteristics, which determines which column the data will be transferred to by default.
 - If your cause records do not have data that would be a good starting point for defining the characteristics in the control plan, then you could leave the characteristic records blank.
- Select the **All controls** option to transfer all the controls from the FMEA to the control plan. To transfer only the controls that meet the desired requirements, select the **Controls where type =** option and then select the required control type from the drop-down list.
- **PFD Worksheet** allows you to create a new control plan based on an existing PFD worksheet. *See Chapter 19.*

The following settings allow you to select how to transfer the characteristics and classifications that were defined in the PFD worksheet:

- Choose the **Transfer product and process characteristics to separate rows** option to transfer all the classifications that were defined in the PFD worksheet, as in the example shown next (where C1 is the classification of the product characteristic and C2 is the classification of the process characteristic):

Op. #	Process Name/Operation Description	Product Characteristic	Process Characteristic	Classification
1	Operation Description 1	Product Characteristic 1		C1
			Process Characteristic 1	C2
2	Operation Description 2	Product Characteristic 2		C1
			Process Characteristic 2	C2
3	Operation Description 3	Product Characteristic 3		C1
			Process Characteristic 3	C2

Example of product and process characteristics transferred to separate rows.

- Choose the **Transfer to same row and use the process characteristics classification** option to exclude the classification of the product characteristic from the sync process, as in the example shown next.

Op. #	Process Name/Operation Description	Product Characteristic	Process Characteristic	Classification
1	Operation Description 1	Product Characteristic 1	Process Characteristic 1	C2
2	Operation Description 2	Product Characteristic 2	Process Characteristic 2	C2
3	Operation Description 3	Product Characteristic 3	Process Characteristic 3	C2

Example of product and process characteristics transferred to the same row.

- Select **None** to create a blank control plan worksheet.

6.5.9 DVP&R > Sync Options

The DVP&R > Sync Options page of the interface style determines how FMEA data will be transferred to new DVP&Rs. *See Chapter 18.*

If the **Integrate New DVP&Rs with FMEA** check box is selected, data will be transferred automatically from the FMEA when you add a new DVP&R for an item that already has an FMEA. If the check box is not selected, data will not be transferred automatically and the new DVP&R worksheet will be blank.

As described in Chapter 18 on page 400, when you choose to transfer data automatically from the FMEA to the DVP&R, the software will create new Test Plan records in the DVP&R by transferring control descriptions from the FMEA. In addition, you have the option to:

- Create new Test Plan records in the DVP&R by transferring control and/or action descriptions from the FMEA.
 - If the Control Category property is enabled for the project (from the FMEA > Controls page of the interface style) or if the **Controls where type** = field is empty, then all controls descriptions will be transferred to the DVP&R. If the Control Category property is enabled, you can use the **Controls where type** = field to limit the transfer to only those controls descriptions with the specified categories. To define multiple control categories, use commas to separate the labels.
 - If the Action Category property is enabled for the project (from the FMEA > Actions page of the interface style) or if the **Actions where category** = field is empty, then all action descriptions will be transferred to the DVP&R. If the Action Category property is enabled, you can use the **Actions where category** = field to limit the transfer to only those action descriptions with the specified categories that you select. To define multiple action categories, select multiple items. Or you can select the **No actions** option to not transfer any actions.
- Transfer the cause description along with each control or action description. For example, if the **Incorporate cause description with controls and actions transferred to DVP&R** check box is selected and the cause description in the FMEA is “Failure cause” and the control description is “Design control” then the transferred test plan will be “Design control : Failure cause.”

6.6 Rating Scales

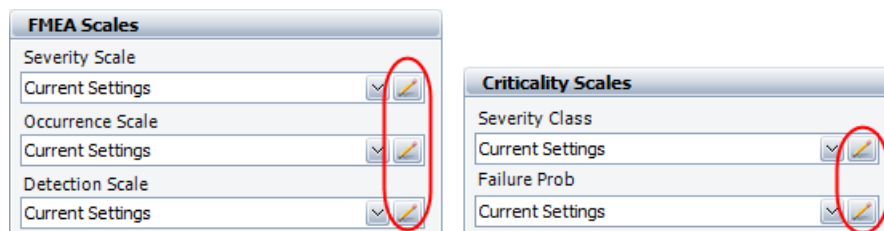
Severity, occurrence and/or detection rating scales can be used in either of the risk assessment methods: risk priority numbers or criticality analysis. These scales can contain any number of ratings (e.g., five-point scale, ten-point scale, etc.), and you can fully customize the values, descriptions and criteria.

The Severity, Occurrence and Detection pages in the Profiles/Library Manager show all of the predefined rating scales in the active library.

- To add a new rating scale, click **Add**.
- To edit an existing scale, select the row and click **Edit** or double-click the row.

There are also several ways to edit the rating scales for a particular project. Remember that changing the settings in an individual project does not automatically update the library or any other projects (*see Section 6.1 on page 182*).

- Choose **Project > Management > Configurable Settings > [Severity/Occurrence/Detection]**.
- Click one of the **Edit** icons on the Configurable Settings tab of the Project Properties window.



Editing a Scale

- Each **Value** must be unique within the scale and the values can be whole numbers or decimals. The software will order the numbers from smallest to greatest when you save the scale.
- **Description** specifies the short text description that will be associated with the numerical rating in the drop-down lists within the interface.

- **Criteria 1** and **Criteria 2** specify longer text descriptions of the criteria that can be used to determine whether the rating will be assigned to a particular issue. This information will be visible when the user clicks the **Select Existing** icon at the right side of the drop-down list for each rating scale in an FMEA.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling of the text fields within the window.

Quantitative Values

If you are working with an Occurrence or Failure Probability scale, this window will also display a **Quantitative Value** column and a **Treat Quantitative Values** area. These settings apply if you want to use the qualitative rating assigned to a record to set that record's quantitative probability of failure model. The model can then be used for reliability or criticality calculations in the FMRA. *See page 232 in Chapter 8.*

6.7 Risk Discovery Questions

For risk discovery analysis (e.g., preliminary risk analysis, change point analysis, equipment selection, etc.), you can choose to use either questions or ratings. *See Chapter 10.*

The risk discovery questions method uses a series of yes/no questions.

The RD Questions page in the Profiles/Library Manager shows all of the predefined sets of risk discovery questions in the active library.

- To add a new set of questions, click **Add**.
- To edit an existing set of questions, select the row and click **Edit** or double-click the row.

There are also several ways to edit the risk discovery questions for a particular project. Remember that changing the settings in an individual project does not automatically update the library or any other projects (*see Section 6.1 on page 182*). Also note that these options will be disabled if you have selected to use ratings rather than questions for the current project.

- Choose **Project > Management > Configurable Settings > RD Questions**.
- Click the **Edit** icon on the Configurable Settings tab of the Project Properties window.



Editing a Set of Risk Discovery Questions

- **Label** specifies a short text string (up to 50 characters) that summarizes the issue.
- **Question** specifies a longer text string (up to 255 characters) that contains a question that can be answered with Yes or No.

The questions will be displayed in the Risk Discovery analysis interface and reports in the order in which they appear in this table. To change the order of existing questions, use the **Move Up** or **Move Down** buttons. To insert a new

question above an existing question, select the existing question and click **Insert Row**. To delete a question, select the row and click **Delete Row**.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling of the text fields within the window.

6.8 Risk Discovery Ratings

For risk discovery analysis (e.g., preliminary risk analysis, change point analysis, equipment selection, etc.), you can choose to use either questions or ratings. *See Chapter 10.*

The risk discovery ratings method uses a set of factors and ratings that calculate a numerical value.

The RD Ratings page in the Profiles/Library Manager shows all of the predefined sets of risk discovery ratings in the active library.

- To add a new set of ratings, click **Add**.
- To edit an existing set of ratings, select the row and click **Edit** or double-click the row.

There are also several ways to edit the risk discovery ratings for a particular project. Remember that changing the settings in an individual project does not automatically update the library or any other projects (*see Section 6.1 on page 182*). Also note that these options will be disabled if you have selected to use questions rather than ratings for the current project.

- Choose **Project > Management > Configurable Settings > RD Ratings**.
- Click the **Edit** icon on the Configurable Settings tab of the Project Properties window.



Editing a Set of Risk Discovery Ratings

- **Category** specifies the type of issue that the rating addresses. This can be a text string up to 45 characters.
- **Factor** specifies a short text description of the particular issue being rated. This can be a text string up to 150 characters.
- **Option** specifies a short text description of the rating that can be applied for a particular issue (factor). This can be a text string up to 45 characters.
- **Rating** specifies the numerical value that will be applied to the record when the option is selected. This must be a number greater than zero. To provide maximum flexibility for defining the logic used to evaluate risk, the rating values are not required to be in any particular order and they are not required to be unique. In other words, the options do not have to be listed in ascending or descending order and there can be more than one option for the same factor that applies the same numerical value.

To edit any existing entry, simply type directly in the table cell. To add, insert or delete, click inside the appropriate column and then use the buttons under the table.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling of the text fields within the window.

6.9 Phrase Sets

A *phrase set* contains lists of predefined descriptions that can be used to define any of the text-based record properties in an FMEA. The descriptions in a phrase set are accessible via the Select Existing window when the phrase set has been selected to be “active” from the window’s Phrase Sets page. *See page 113 in Chapter 3.*

The Phrase Sets page in the Profiles/Library Manager shows all of the sets of predefined phrases in the active library.

- To add a new phrase set, click **Add**.
- To edit an existing phrase set, select the row and click **Edit** or double-click the row.

Note: Unlike many of the other settings stored in the active library and managed via the Profiles/Library Manager, the descriptions in a phrase set are not stored in the project properties for individual analysis projects. Rather, you can use any phrase set from the active library on your computer for any analysis project that you may be working on, and it is possible to use phrases from multiple different phrase sets in the same project.

You can use any or all of the following methods to create/update phrase sets.

- Type phrases into the tables
- Import phrases from Excel
- Export FMEA descriptions to phrase sets

6.9.1 Type Phrases Into the Tables

The navigation panel on the left side of the Edit Phrase Set window shows the types of records for which you can save phrases. The table on the right allows you to view/edit/add phrases for the record type that is currently selected.

Note that the columns show the basic names for all of the possible fields (i.e., the tables are not customized based on the display name and enabled/disabled preferences in a particular interface style). You can ignore any record types and/or record properties that you don’t want to save phrases for.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling of the text fields within the window.

6.9.2 Import Phrases from Excel

When you click the **Import from Excel** or **Export to Excel** buttons, the software will import or export the descriptions in the phrase set from/to the Excel file.

Note: When importing from an Excel file, this functionality adds unique descriptions only and appends them to the phrase set. For example, if the existing phrase set contains a failure cause called “Excessive condensation” and so does the Excel file that is being imported from, the phrase will not be duplicated.

6.9.3 Exporting FMEA Descriptions to Phrase Sets

You can export the descriptions from an existing FMEA to a new or existing phrase set in the active library. Do the following:

1. Open the FMEA.
2. Choose **FMEA > Tools > Export to Phrase Set > [Export to a New/Existing FMEA Phrase Set]**.
 - a. If you choose to export to a new phrase set, you will be prompted to enter the name (required) and description).
 - b. If you choose to export to an existing phrase set, you will be prompted to select one of the phrase sets from the active library.

Note: This functionality adds unique descriptions only. For example, if the existing phrase set contains a failure cause called "Excessive condensation" and so does the FMEA analysis that is being exported, the phrase will not be duplicated.

6.10 FEC Logic

The *FEC logic* determines the questions and categories that will be displayed in the Failure Effect Categorization window for effect records. *See page 298 in Chapter 13.* This is used for performing traditional reliability centered maintenance (RCM) analysis.

The FEC Logic page in the Profiles/Library Manager shows all of the predefined FEC logic diagrams in the active library.

- To add a new logic, click **Add**.
- To edit an existing logic, select the row and click **Edit** or double-click the row.

There are also several ways to edit the FEC logic for a particular project. Remember that changing the settings in an individual project does not automatically update the library or any other projects (*see Section 6.1 on page 182*).

- Choose **Project > Management > Configurable Settings > FEC Logic**.
- Click the **Edit** icon on the Configurable Settings tab of the Project Properties window.



Editing the FEC Logic

The first step is to choose the logic tree configuration from the drop-down list at the top of the window. Then you can type directly in the text boxes that are displayed. Each question can contain up to 255 characters and each category must have a label (up to 50 characters) and an abbreviation (up to 5 characters).



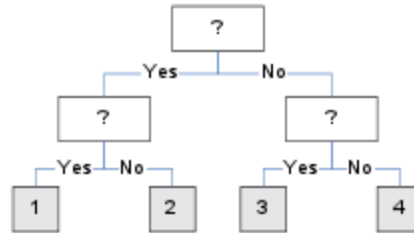
Clear All clears all entries and selections made in the window.



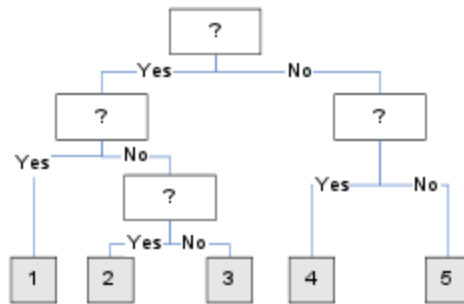
Spelling checks the spelling of the text fields within the window.

Available Tree Configurations

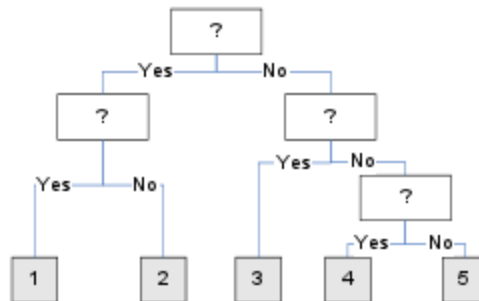
- **4 Categories** allows you to define three questions that lead to four FEC categories.



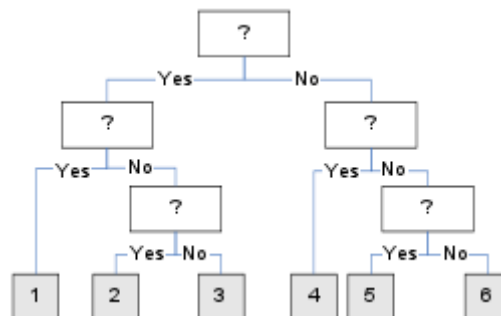
- **5 Categories (Split in Yes Branch)** allows you to define four questions that lead to five FEC categories. If the user answers “yes” to the first question and “no” to the second question, there will be a third question in that branch before the category is assigned.



- **5 Categories (Split in No Branch)** allows you to define four questions that lead to five FEC categories. If the user answers “no” to the first question and “no” to the second question, there will be a third question in that branch before the category is assigned.



- **6 Categories (Split in No Branch)** allows you to define five questions that lead to six FEC categories.



6.11 Task Logic

The task selection logic determines the questions that will be displayed in the Task Manager window for cause records. *See page 300 in Chapter 13.* This is used for traditional reliability centered maintenance (RCM) analysis.

The Task Logic page in the Profiles/Library Manager shows all of the predefined task selection logics in the active library.

- To add a new logic, click **Add**.
- To edit an existing logic, select the row and click **Edit** or double-click the row.

There are also several ways to edit the task selection logic for a particular project. Remember that changing the settings in an individual project does not automatically update the library or any other projects (*see Section 6.1 on page 182*).

- Choose **Project > Management > Configurable Settings > Tasks Logic**.
- Click the **Edit** icon on the Configurable Settings tab of the Project Properties window.



Editing the Task Logic

The first step is to specify whether the task selection questions will depend on the failure effect categorization (FEC) that has been assigned to the associated effect.

If you select **Same Questions for All FEC**, there will be a single table for defining the questions. The analysis will always consider the same types of maintenance tasks regardless of the consequences of failure.

If you select **Specific Questions for Each FEC in Selected Logic**, two additional drop-down lists will become enabled so you can define a separate set of questions for each effect categorization:

- Use the first drop-down list to specify the number of categories in the FEC logic that this task selection logic is planned to be used with (i.e., 4 categories, 5 categories or 6 categories).
- Use the second drop-down list (labeled FEC) to choose which set of questions will be currently displayed in the table.

Each table contains the following columns:

- **#:** Displays the numeric or alphanumeric label used to identify the question. This can contain up to 5 characters (e.g., 1, 2, 3, ... or 1A, 1B, 1C,... etc.).
- **Question:** Displays the question. This can be up to 255 characters.

The questions will be displayed in the Task Selection Question window in the order in which they appear in the table(s). To change the order of existing questions, use the **Move Up** or **Move Down** buttons. To insert a new question above an existing one, select the existing question and click **Insert Row**. To delete a question, select the row and click **Delete Row**.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling of the text fields within the window.

6.12 Checklists

A *checklist* contains a list of activities that need to be performed during an analysis project. You can copy a checklist from the active library to any analysis plan in an RBI project. *See Chapter 11.*

Note: Unlike many of the other settings stored in the active library and managed via the Profiles/Library Manager, the checklists are not stored in the project properties for individual analysis projects. Rather, you can use any checklist from the active library on your computer for any project that you may be working on, and it is possible to use different checklists for different analysis plans in the same project.

The Checklists page in the Profiles/Library Manager shows all of the sets of predefined checklists in the active library.

- To add a new checklist, click **Add**.
- To edit an existing checklist, select the row and click **Edit** or double-click the row.

Editing a Checklist

The descriptions will be displayed in the analysis plan interface and reports in the order in which they appear in this table. To change the order of existing descriptions, use the **Move Up** or **Move Down** buttons.

To insert a new description above an existing one, select the existing description and click **Insert Row**. To delete a description, select the row and click **Delete Row**.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling of the text fields within the window.

6.13 Assumptions

The *ground rules and assumptions* are a list of the information that all members of the analyses team will use to make judgments with in an analysis project. You can copy the assumptions from the active library to any analysis plan in an RBI project. *See Chapter 11.*

Note: Unlike many of the other settings stored in the active library and managed via the Profiles/Library Manager, the assumption lists are not stored in the project properties for individual analysis projects. Rather, you can use any assumption list from the active library on your computer for any project that you may be working on, and it is possible to use different assumption lists for different analysis plans in the same project.

The Assumptions page in the Profiles/Library Manager shows all of the sets of predefined assumption lists in the active library.

- To add a new assumption list, click **Add**.
- To edit an existing assumption list, select the row and click **Edit** or double-click the row.

Editing an Assumption List

The descriptions will be displayed in the analysis plan interface and reports in the order in which they appear in this table. To change the order of existing descriptions, use the **Move Up** or **Move Down** buttons.

To insert a new description above an existing one, select the existing description and click **Insert Row**. To delete a description, select the row and click **Delete Row**.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling of the text fields within the window.

6.14 Surveys

A *survey* contains a list of requirements that are believed to influence the success of an analysis project. You can copy a survey from the active library to any analysis plan in an RBI project. *See Chapter 11.*

Note: Unlike many of the other settings stored in the active library and managed via the Profiles/Library Manager, the surveys are not stored in the project properties for individual analysis projects. Rather, you can use any survey from the active library on your computer for any project that you may be working on, and it is possible to use different surveys for different analysis plans in the same project.

The Surveys page in the Profiles/Library Manager shows all of the sets of predefined surveys in the active library.

- To add a new survey, click **Add**.
- To edit an existing survey, select the row and click **Edit** or double-click the row.

Editing a Survey

The descriptions will be displayed in the analysis plan interface and reports in the order in which they appear in this table. To change the order of existing descriptions, use the **Move Up** or **Move Down** buttons.

To insert a new description above an existing one, select the existing description and click **Insert Row**. To delete a description, select the row and click **Delete Row**.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling of the text fields within the window.

6.15 DFR Planner

The DFR Planner page of the Profiles/Library Manager is used to delete DFR planner templates from the active library or import them from another library.

These templates allow you to reuse the phases from a design for reliability (DFR) process that was defined in a prior DFR planner. *See Chapter 9.* If you choose to create a new DFR planner on a computer with templates saved in the

active library, the Create DFR Planner window will appear and allow you to choose which template to base the new planner on. *See page 245 in Chapter 9.*

Note: Unlike many of the other settings stored in the active library and managed via the Profiles/Library Manager, DFR planner templates are not stored in the project properties for individual analysis projects. Rather, you can use any DFR planner from the active library on your computer for any project.

Each DFR planner is identified by a name (required) and short description (optional).

6.16 Converting Libraries and Profiles from Version 5

If you have customized the configurable settings in your Xfmea/RCM++ 5 library, you can automatically convert them for use in the new version. This section describes:

- How to import an entire library or selected profiles from a Version 5 standard library file (*.lb5).
- How to import library settings from a Version 5 Enterprise database.
- The new configurable settings that will be added to support new features that were added in the Synthesis Version. (You may need to modify the default options for these new settings after the profile(s) have been converted.)

6.16.1 Converting Standard Library Files (*.lb5)

If you have an existing Xfmea/RCM++ 5 standard library file (*.lb5), you can convert the entire library or just convert and import selected profiles.

To convert the entire library:

1. Open any standard database in the Synthesis version of Xfmea, RCM++ or RBI.
2. Choose **File > Manage Repository > Profiles/Library Manager**.
3. In the Profiles/Library Manager, click the **Browse** button in the top-right corner and choose **Xfmea 5/RCM++ 5 Library (*.lb5)** from the Files of type drop-down list, then select the file you want to convert.
4. Click **Open** and, when prompted, confirm that you want to proceed.

The application will create a new standard library file in the same directory with the extension *.lb8; the existing *.lb5 file will remain unchanged.

To convert and import only selected profile(s):

1. Open any standard database in the Synthesis version.
2. Choose **File > Manage Repository > Profiles/Library Manager**.
3. Select **Profiles** in the navigation panel and then click **Import**.
4. In the Import Profiles to Library window, use the drop-down list or browse button at the top of the window to select the file you want to import from.
5. The table shows the profiles that have been defined in the selected library. Select the profile you wish to import and click **OK**.

The application will import the profile and all of the associated settings (e.g., the interface style, severity scale, etc.). If settings with the same name already exist in the destination library, the application will import them anyway and increment the name(s). *For more information and tips, see Section 6.3 on page 185.*

6.16.2 Converting an Enterprise Database Library

To convert and import library settings from an Xfmea/RCM++ 5 enterprise database, you must have both of the following permissions:

- The “Admin” access level in the Version 5 database.
- The “Manage all projects” and “Manage users and logins” permissions in the Synthesis repository.

There are two ways to import the data. If you want to import the entire library, including settings that are not directly associated with a profile (e.g., phrase sets, checklists, DFR planner templates, etc.), you must use the Import from Prior version method described below. If you want to import selected profiles, you can use this method or the Import Profiles to Library method described above.

To use the Import from Prior Version method:

1. Connect with the enterprise database you want to import into.
2. Choose **File > Manage Repository > Enterprise > Import from Prior Version**.
3. In the area at the top of the Import from Version 5 Enterprise Database window, enter the connection information for the Version 5 enterprise database and click Connect.
4. The table shows all of the data and settings that are available to be imported. Find the **Profiles** heading.
 - If you select the **Profiles** check box, application will import the entire library, including settings that are not directly associated with a profile.
 - If you select individual profiles, the application will import only the selected profiles and the settings that are directly used by those profiles.
5. Click **OK** to copy the data.

6.17 Converting Configurable Settings from Version 5

When you convert an existing library profile from Xfmea/RCM++ 5, the application will add new configurable settings for new features that were added in the Synthesis version. Likewise, when you convert an existing project, its configurable settings will be updated in the same way.

Here is a summary of the settings that will be added, modified or changed:

Setting Type	Page	Comments
Interface	FMEA > Functions	New Op Seq Number field, which can be used to add a reference number to a function. In synchronized worksheets, the op seq number is also used to link a function to a particular item in the associated PDF worksheet or Control Plan worksheet.
	Tasks > Properties (RCM specific)	Many of the properties that were in the FMEA > Tasks page are now configured as part of the task resources (<i>see page 306 in Chapter 13 for details.</i>). The task properties that apply only in RCM++/RBI can be configured via the new Tasks > Properties (RCM specific) page.

Setting Type	Page	Comments
	FMEA > Sync Options	New options for creating FMEA functions from system hierarchy items or PFD worksheet operations. <i>See Chapter 19.</i>
	FMEA > Criticality	The Probability of Loss field was removed and is now generated from the FMRA. <i>See Chapter 8.</i>
	Control Plan > Sync Options	New options for synchronizing from the PFD Worksheet.
	DVP&R > Sync Options	New options for separately synchronizing controls and actions.
	PFD Worksheet	Added properties for the new PFD Worksheet functionality.
Occurrence Scale	Properties	New Quantitative Value column and options for automatically creating failure models based on the RPN occurrence ratings. <i>See page 232 in Chapter 8.</i>
Task Logic	Properties	Some of the task properties were removed because they are now part of the task resources.
DFR Planner Templates	Properties	Added templates for the new DFR Planner functionality. <i>See Chapter 9.</i>

Upon conversion, the application will apply default values for all of the new settings. It is important to note that these defaults may need to be modified after the conversion if you plan to use the Quantitative Value setting in the FMRA calculations for the converted project. *See page 237 in Chapter 8.* This is because the application is not able to interpret the numerical thresholds (if any) recorded in the Criteria descriptions, and therefore it must apply the same values for all converted rating scales.

For example, the following table shows part of the occurrence scale from the “DFMEA: AIAG-4” profile. As you can see, the default values that would be applied if you convert this rating scale from Version 5 would need to be changed to more appropriate values that match the thresholds specified in the text descriptions. For example, 1 in 1,000,000 vehicles is 0.000001, and so on.

Rating	Criteria	Quantitative Value	
		These are the values that will be applied to all scales by default upon conversion.	These are more appropriate values that match the criteria in this particular scale.
1 - Very Low	Failure is eliminated through preventive control.	0.000001	0.0000001
2 - Low	≤ 0.001 per thousand items/vehicles, 1 in 1,000,000	0.000010	0.000001
3 - Low	0.01 per thousand items/vehicles, 1 in 100,000	0.000100	0.000010
...			
10 - Very High	$\Rightarrow 100$ per thousand items/vehicles, $\Rightarrow 1$ in 10	0.900000	0.100000

When feasible, the most efficient and consistent way to apply these updates is to first obtain a fully updated profile in the Profiles/Library Manager and then use this profile to re-apply the settings for each converted project. Specifically, you will need to do the following:

1. Decide which library you will use and then confirm that the new settings are fully updated for all active profiles in the library:
 - If you had not customized any of the predefined profiles in the Version 5 library, we recommend using the new default library provided with the Synthesis version because it has appropriate values for the new settings (e.g., quantitative values that match any numerical criteria specified in the occurrence rating scales).
 - If you had created your own custom profiles in Version 5 or customized any of the predefined ones, we recommend converting the existing library and then reviewing/updating all of the new settings that were added during the conversion.
2. Convert one or more existing projects from Version 5.
3. For each converted project:
 - Choose **Project > Management > Edit Project Properties**.
 - On the General page of the Project Properties, choose the appropriate profile from the **Select Profiles from Library** drop-down list.
 - Click **OK** to reset all of the project's configurable settings based on the fully updated profile defined in the library.

Of course, you also have the option to review and manually update the configurable settings for any particular project, if desired. These are accessible from the Configurable Settings pages in the Project Profiles window, and also from **Project > Management > Configurable Settings**.



System Hierarchy

7

RBI's flexible system hierarchy interface allows you to manage large, multi-level system configurations with as many levels as you need and any number of items per level. You can fully define the properties for each item (e.g., supplier, part number, expected operating environment, etc.) and perform relevant analyses at any level within the system configuration.

To access the system configuration, click the System Hierarchy tab on the System panel. This panel can be displayed on the left side or the top side of the Project window; to change the location of the panel, choose **View > Workspace Layout > Change Screen Orientation**.



For RCM and FMEA analyses, the hierarchy will consist of systems, subsystems and components, as shown in the following simple example. You can perform a variety of different analyses at any level in the configuration, and the icons indicate which analyses will be available in the Analysis panel when the item is selected.

Name	ID				
System 1	1				
SubSystem 1	2				
SubSystem 2	3				
SubSubSystem 1	4				
SubSubSystem 2	5				

For RBI analyses, you have the option to define systems and subsystems, if desired. However, the risk based inspection analysis can be performed only for specialized items that represent specific equipment and component types that are addressed in the API RP 580/1 guidelines. (See page 273 in Chapter 12.) For example, in the hierarchy shown next, System 1 consists of two types of equipment: Heat Exchanger and Pipe. The RBI analysis can be performed for the two components: HEXTUBE and PIPE-1.

Name	Component Type	Area Risk (Plan Date)	Financial Risk (Plan Date)
System 1			
Heat Exchanger			
HEXTUBE	HEXTUBE		
Pipe			
PIPE-1	PIPE-1		

7.1 Available Columns

The columns in the system hierarchy can display different information about each item. To choose which columns will be displayed at any given time on your computer, right-click inside any of the column headers, then click **Customize Columns**. These settings are stored per computer/username on the System Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed. *See page 508 in Chapter 30.*

The following columns are available:

- **#** displays the record position number assigned by RBI based on the position of the item in the system hierarchy. For example, if you insert a new item above an existing item, then the new item will take the number of the existing item and all items below it will be renumbered. Likewise, if you delete an item, all items below it will be renumbered automatically.

Tip: If these numbers fall out of sequence, choose **System Hierarchy > Tools > Renumber All Items** to update them.

- **Name** displays the item name. This is a required field, and it is specified on the Properties tab of the Analysis panel.
- **Component Type** is relevant only for Component items in a risk based inspection analysis. It indicates the type of component (which determines the analysis method that will be used).
- **Area Risk (Plan Date)** and **Financial Risk (Plan Date)** are relevant only for Component items in a risk based inspection analysis. They indicate the risk priority that has been calculated from the RBI analysis. As discussed in more detail in Section 12.5.9 on page 281, the “Plan Date” is the next date when the component is scheduled to undergo major maintenance or replacement. The “Area Risk” represents the risk to the surrounding area assuming that you do not schedule any inspections prior to the plan date, while the “Financial Risk” represents the financial consequences.
- **Record ID** displays a unique identifier assigned by RBI. The record ID is unique among all system hierarchy items that are defined in the database. It can also be used in the Query Utility to help identify a specific item that may share the same name with another item.
- **User Access** displays an icon when the item is inaccessible. *See page 57 in Chapter 2.*
 -  **Restricted Access.** An item that is restricted to selected users and will not be available for editing until you are granted the appropriate item permissions. *See page 67 in Chapter 2.*
 -  **In-Use.** An item that is in-use will not be available for editing until the other user closes the item or selects a different item. You can display the username of the account that is editing the item by moving the pointer over the icon whenever you see it.
- **XFRACAS Associated Hierarchy Item** is available for Enterprise databases only. It indicates that the item is associated with an XFRACAS hierarchy item. If an association exists, future changes made to the item and/or its failures and causes in XFRACAS can be brought into RBI by synchronizing the data. *See Section 7.5.5 on page 222.*
- **Reference Number** displays the reference number associated with the item. To display this column in the current project, the field must be enabled on the Item > Properties page of the interface style. *See page 187 in Chapter 6.* The number is specified on the Properties tab of the Analysis panel.
 - If you wish to automatically generate reference numbers (e.g., 1.2.1) for all items based on their positions in the hierarchy, choose **System Hierarchy > Tools > Renumber All Items** and then select the **Apply to reference number field** check box. *This cannot be undone.*

- **Part Number** displays the part number associated with the item. To display this column in the current project, the field must be enabled on the Item > Properties page of the interface style. *See page 187 in Chapter 6.* The number is specified on the Properties tab of the Analysis panel.
- **FMEA Document Number** displays the document number for the FMEA associated with the item, if any. To display this column in the current project, the field must be enabled on the FMEA > Header page of the interface style. This number is specified on the Header tab of the FMEA, if there's an FMEA defined for the item.
- **Attachment** displays a paper clip icon  if one or more files have been attached to the corresponding item.
- **Flag** displays a flag for the item, if desired. The available flags are: Complete (indicated by a green flag), In Progress (indicated by a yellow flag) and Incomplete (indicated by a red flag). This flag is displayed in the interface only and does not affect reports.
- **DFR Planner** displays  if a DFR Planner has been created for the item. *See Chapter 9.*
- **Risk Discovery** displays an icon if a risk discovery analysis has been performed on the item. *See Chapter 10.* If the analysis indicates that the item requires more detailed investigation, the icon will be red ; otherwise, the icon will be green .
- **Risk Discovery Details** displays a number if a risk discovery analysis has been performed on the item.
 - If the analysis uses risk discovery questions, then this cell will display the number of questions with “Yes” answers. More “Yes” answers indicates greater risk. *See page 258 in Chapter 10.*
 - If the analysis uses risk discovery ratings, then this cell will display the sum of all the rating numbers selected in the analysis. Higher sums indicate greater risk. *See page 259 in Chapter 10.*
- **Process Flow Diagram Worksheet** displays  if a PFD worksheet has been created for the item. *See Chapter 19.*
- **FMEA** displays  if an FMEA has been created for the item. *See Chapter 14.*
 -  **Change Log Active.** This indicates that an FMEA change log is present and that a revision is in progress. *See Chapter 17.*
 -  **Locked FMEA.** This indicates that an FMEA change log is present and that no revision is active.
- **DRBFM** displays  if a design review based on failure mode (DRBFM) analysis has been created for the item. *See Chapter 21.*
- **DVP&R** displays  if a design verification plan and report (DVP&R) analysis has been created for the item. *See Chapter 18.*
 -  **Change Log Active.** This indicates that a DVP&R change log is present and that a revision is in progress.
 -  **Locked FMEA.** This indicates that a DVP&R change log is present and that no revision is active.
- **Control Plan** displays  if a control plan has been created for the item. *See Chapter 20.*
- **Process Flow Diagram** displays  if a graphical process flow diagram has been created for the item. *See page 485 in Chapter 28.*

- **FMEA Block Diagram** displays  if an FMEA Block diagram has been created for the item. *See page 483 in Chapter 28.*
- **Cause and Effect Diagram** displays  if a cause and effect diagram has been created for the item. *See page 486 in Chapter 28.*

7.2 Working with Items

This section describes some ways of manipulating items in the system hierarchy. For special considerations related to the Equipment and Component types that are used for risk based inspection analysis, see page 273 in Chapter 12.

7.2.1 Adding and Deleting Items

When you create a project, the first item is added automatically to the system hierarchy. To add more items, follow any of the instructions below. The new item will be added to the bottom of the list for the associated level.

- To add a new top-level (system) item, choose **System Hierarchy > Add > Add System**.



- To add a new item to the next level below a selected item, choose **System Hierarchy > Add > Add Next Level Item**.



- To add a new item to the same level as a selected item, choose **System Hierarchy > Add > Add Same Level Item**.

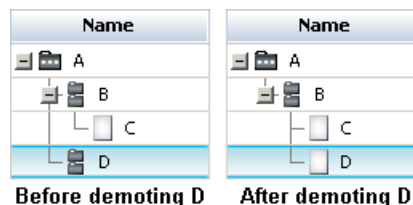


To delete an item from the system hierarchy, select the item and press **DELETE**. The item will be deleted, along with all sub-items and all associated analyses and attachments. *You can undo the last deletion only.*

7.2.2 Moving Items

You can move items within the system hierarchy by dragging them to the desired location. When an item is moved, all associated analyses and attachments will also be moved. You can also move the items in the system hierarchy using any of the following instructions.

- To move a selected item to the next higher or lower level, choose **Home > Move Record > Promote** or **Demote**. An item can be demoted only if there is another item on the same level and above the selected item that it can be demoted under.



- To move an item up or down within its current level, choose **Home > Move Record > Up or Down**.

7.2.3 Cutting/Copying and Pasting Items

You can cut or copy items in the system hierarchy and paste them to the same project or to another project within the same database. (Please note that if you want to share items between different databases, you must use the import/export functionality. *See page 70 in Chapter 2.*)

To cut/copy multiple items all at once, hold the **CTRL** key while clicking all the items you wish to select. To select multiple items that are adjacent, click the first item and then hold the **SHIFT** key while you click the last item. This will select all the items between the first and last.

You can then use the standard keyboard shortcuts for cut/copy (**CTRL+X** and **CTRL+C**) or you can choose **Home > Clipboard > Cut** or **Copy**. When an item is cut or copied, all next-level items also will be cut or copied, along with any analyses and attachments. You can then paste the item to the desired level in the system hierarchy.

- To paste the item as a dependent to the selected system, choose **Home > Clipboard > Paste** or press **CTRL+V**.
- To paste the item as a system, choose **Home > Clipboard > Paste > Paste as Top Level**.
- You also can choose **Home > Clipboard > Paste > Paste Special** to open the Paste Special window, which allows you to choose the level at which the cut or copied item will be pasted to the system hierarchy, and whether dependents and/or analyses will be pasted along with it. *See page 147 in Chapter 4.*

If an item is cut or copied and then deleted from the project, the copied data will also be deleted from the Clipboard. In addition, once an item has been cut or copied, any edits that are made to the original will also be applied to its copy in the Clipboard. Also note that you will not be able to cut or copy an item in a project that is locked by another user. *See page 57 in Chapter 2.*

Tip: You can also choose **Home > Clipboard > Copy Active View** to copy the currently visible contents of the System panel or Analysis panel to the Clipboard as a graphic that can be pasted into other applications. The entire visible area within the active panel will be copied but any information that is not currently visible will be excluded.

7.3 Item Properties

Each item in the system hierarchy can have basic identifying properties associated with it (such as name, description, part number, etc.). When an item is selected in the system hierarchy or the failure modes and reliability analysis (FMRA), as discussed in Chapter 8, you can view and edit this information on the Properties tab in the Analysis panel. For information about the additional properties that must be defined for components in a risk based inspection analysis, see page 274 in Chapter 12.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Item**
 - **Item Name:** This field is populated automatically by RBI based on the item's position within the system hierarchy, but it can be changed by the user. The field cannot be blank and cannot contain any of the following characters: \ / : " * ? < > |.
 - **Reference Number:** A reference number associated with the item.
 - **Version:** The version of the item that the associated analyses apply to.
 - **Part Number:** The part number of the item.
 - **Alternate Part Number:** An alternate part number for the item.

- **Item Description:** A description of the item.
- **Remarks:** Any additional information about the item.
- **Qty per System:** Quantity of identical sub-items in the system (e.g., 4 engines per airplane). This value will affect the calculations performed in the failure modes and reliability analysis (FMRA). *See Chapter 8.*
- **Qty per Assembly:** Quantity of the sub-item in the next higher level assembly (e.g., 2 engines per wing).
- **Supplier:** The manufacturer or distributor of the item.
- **Similar To:** Another item similar to this one.
- **Design Engineer:** The name of the design engineer for the item.
- **Drawing Number:** The number of the drawing associated with the item.
- **CAGE Code:** The Commercial and Government Entity (CAGE) code associated with the item.
- **LCN:** The logistic control number (LCN) associated with the item.
- **Reference Designator:** The reference designator for the item.
- **Environmental Conditions:** The environmental conditions that the item is expected to operate in.
- **MMEL:** The item's impact on the Minimum Master Equipment List (MMEL), as used in the aircraft industry.
- **User-Defined Fields:** Up to five text fields, two date fields, two number fields and two drop-down lists.
- The **Operation**, **Reliability/Availability** and **Reliability Policy** fields are relevant if you wish to perform a failure modes and reliability analysis (FMRA). An FMRA can be used to a) calculate criticality metrics, b) generate a baseline system reliability based on information in the FMEA, c) share system configuration and failure mode data between RBI to BlockSim or d) perform RCM calculations. *See Chapter 8.*
- The **History** fields display information about when the record was created and last modified. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the item. *See page 70 in Chapter 2.*

7.4 Associated Analyses and Diagrams

This section describes the RCM, FMEA and related analyses and diagrams that can be associated with any item in the system hierarchy. For information about the risk based inspection analysis properties and results, see page 274 in Chapter 12.

7.4.1 Available Analyses

The available analyses are summarized below. To add an analysis for an item, select the item and click the appropriate command on the Insert tab of the Ribbon. *See page 146 in Chapter 4.* You can also right-click the item name and choose an analysis from the **Analyses** submenu.



A **DFR Planner** helps you manage and track the progress of a Design for Reliability (DFR) process. *See Chapter 9.*



An **Analysis Plan** allows you to keep track of team members, ground rules and assumptions, estimated completion dates, scheduled work sessions and other details to help you plan and manage your analysis projects. *See Chapter 7.*



A **Risk Discovery Analysis** is a preliminary analysis that can involve answering questions and/or assigning ratings about possible risks. It can help you to choose which items should receive more detailed consideration via a failure mode and effects analysis (FMEA) or reliability centered maintenance (RCM) analysis. *See Chapter 10.*



A **Failure Modes and Effects Analysis (FMEA)** is a methodology designed to identify potential failure modes for a product or process, to assess the risk associated with those failure modes, to rank the issues in terms of importance and to identify and carry out corrective actions to address the most serious concerns. *See Chapter 14.*



Design Review Based on Failure Mode (DRBFM) is a methodology used to evaluate proposed changes to an existing design. It was developed by Tatsuhiko Yoshimura, working with Toyota Motor Corporation. DRBFM uses a worksheet similar to the FMEA worksheet, but it typically focuses on the failure modes that might be introduced by a specific change to a product or process. *See Chapter 21.*



A **Design Verification Plan and Report (DVP&R)** is a worksheet that is used to track the progress of design verification tests. *See Chapter 18.*



A **PFD Worksheet** captures details about what happens to the item in each step of its manufacturing or assembly process, and it records the product and process characteristics that are important to keep under control. The information from this worksheet can be used as an input to the process FMEA (PFMEA) and control plan for the item. *See Chapter 19.*



A **Control Plan** is used to keep track of characteristics that affect a product during the manufacturing process to ensure that the desired product specifications are met during the manufacturing process. It is often integrated with the PFD worksheet and/or process FMEA. *See Chapter 20.*

7.4.2 Available Diagrams

The available diagrams are summarized below. To create a diagram, choose **System Hierarchy > Diagrams > [Diagram Type]**.



A **Process Flow Diagram** is a high level chart that helps you visualize the steps that a product goes through in a manufacturing or assembly process. You can create a blank diagram or base one on the FMEA or control plan associated with the item. *See page 485 in Chapter 28.*

Tip: If you want to use a process flow diagram as a starting point for preparing process FMEAs (PFMEAs) or control plans, then the PFD worksheet may be a more appropriate tool. The PFD worksheet integrates the chart into a worksheet that records more detailed information about each step in the process and it allows you to synchronize the relevant information with the FMEA or control plan analysis. *See Chapter 19.*



An **FMEA Block Diagram (Boundary Diagram)** helps to define the scope of a particular analysis project and also may provide additional information that will be useful to the analysis team when they attempt to identify potential failure modes. You can create a blank diagram or base one on the system hierarchy. *See page 483 in Chapter 28.*



A **Cause and Effect Diagram** helps you visualize the relationships among the events described in your analysis. When you select an item and choose **System Hierarchy > Diagrams > Cause and Effect Diagram**, the diagram will be constructed based on the events described in the FMEA for that item. *See page 486 in Chapter 28.*

7.5 Importing Analysis Data

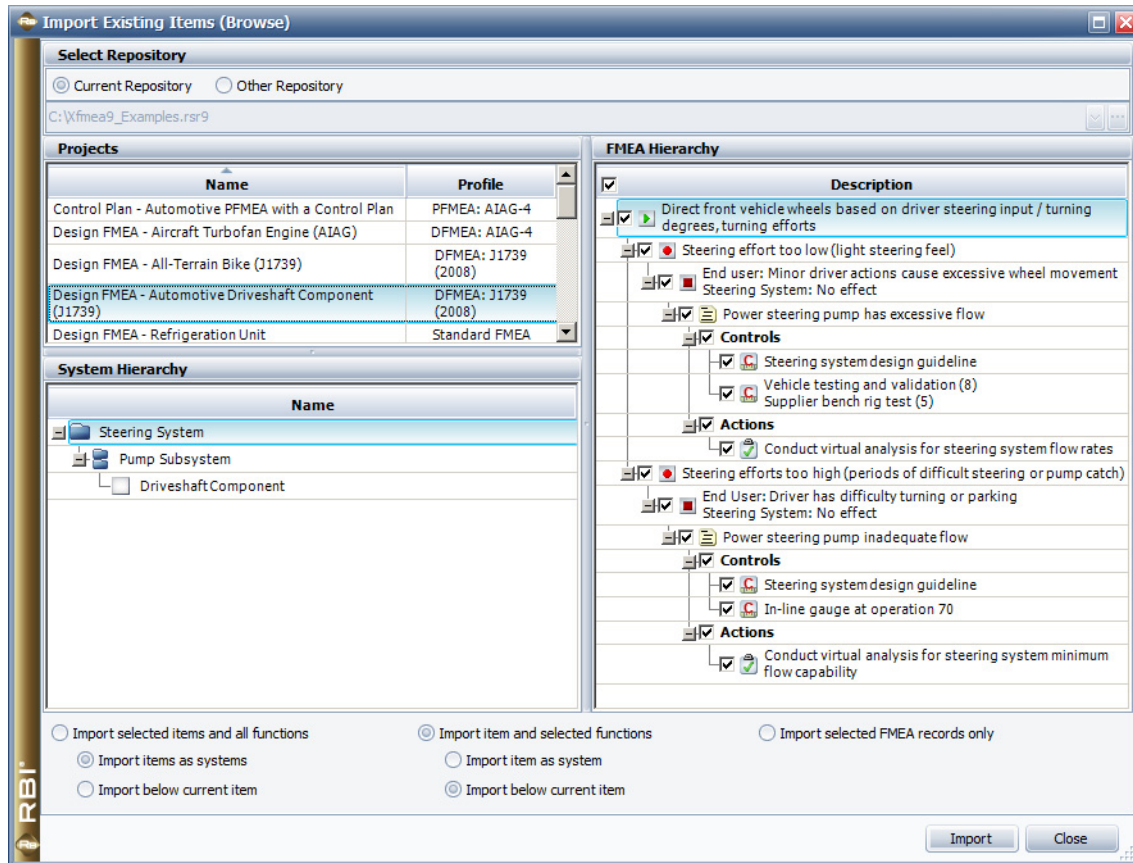
7.5.1 Importing Existing Items - Browse Method

You can use the Import Existing Items (Browse) window to import selected items from the system hierarchy and/or selected records from an existing FMEA.

First, open the project that you want to import from and choose **Project > Management > Import/Export > Import**.



In the wizard, choose **Items (Browse)** and click **OK**.



To use the Import Existing Items (Browse) window, do the following:

- Use the **Select Repository** area to select the database you wish to import from.
- Use the **Projects** area to select one of the projects in the database.

Note: This utility will display only projects that have the same FMEA structure as the project that is currently open. The FMEA structure determines how the effect and cause records will be displayed in the FMEA hierarchy, and it is set via the Project Properties window in Xfmea/RCM++/RBI. *For more information about FMEA structures, see page 342 in Chapter 14.*

- Use the options at the bottom of the window to select what will be imported, and then select the specific records you want to import:
 - **Import select items and all functions:** You can select one or more items from the System Hierarchy area. The selected items will be imported along with all of their associated FMEA data.
 - **Import item and selected functions:** You can select only one item from the System Hierarchy area and then use the FMEA Hierarchy area to select which of that item's FMEA records you wish to import. Both the item and the selected FMEA records will be imported.
 - **Import selected FMEA records only:** This is the same as the previous option except that the item will not be imported. Instead, the selected FMEA records will be imported to the item that is currently selected in the project.
- Click **Import** to copy the data.

7.5.2 Importing Existing Records - Query Method

Xfmea/RCM++/RBI makes it easy to search for existing analysis records based on up to three properties, and then import selected records into a specified location in the current project.

The name of this window, and the method of action, will vary depending on which type of record you want to find and import.

For system hierarchy items, use the **Import Items (Query)** option in the Import/Export Wizard or right-click the item and choose **Import/Export > Import Items (Query)**.



For functions, open an FMEA and choose **FMEA > Functions > Import Functions**.



There are similar commands for failures, effects and causes.

Note: This utility will display only projects that have the same FMEA structure as the project that is currently open. The FMEA structure determines how the effect and cause records will be displayed in the FMEA hierarchy, and it is set via the Project Properties window in Xfmea/RCM++/RBI. *For more information about FMEA structures, see page 342 in Chapter 14.*

7.5.2.1 Using the Utility

Regardless of the record type, all five of these utilities function in a similar manner.

	☐	Item	ID	Part Number	Alternate Part Number	Item Description	Remarks	Qty per System
1	☐	All-Terrain Bicycle System	1277					
2	☐	Brake Cable	1298					
3	☐	Brake Calliper	1300					
4	☐	Brake Lever	1297					
5	☐	Brake Pads	1299					
6	☐	Chain-Derailleur Subsystem	1282					
7	☐	Fork Tube	1291					
8	☐	Frame Subsystem	1278					

1. Use the **Database Location** area to choose where you wish to search. This can be:
 - Only the current project.
 - All projects in the current database.
 - All projects in another database.
2. Use the **Query Criteria** area to specify the keywords and/or phrases that you want to consider in the search. You can define up to three search terms, with the Boolean operators AND and OR. *Refer to Section 7.5.2.2 on page 219 for additional information.*
3. Click **Search** to display a list of records that meet your criteria.
4. Use the check boxes to choose which records you want to import.
5. Use the options at the bottom of the window to specify additional preferences. Specifically:
 - If you are importing items, specify which level in the system hierarchy the new items will be imported to:
 - **As system** pastes to the top (system) level.
 - **As same level** pastes to the same level as the item that is currently selected.
 - **As next level** pastes to the level below the item that is currently selected.
 - Also specify whether you want to import the sub-items and analysis data associated with the selected items:
 - **Include lower level items** imports any sub-items associated with the selected items.
 - **Include analyses** imports any associated FMEAs, control plans, etc. associated with the selected items. If this check box is not selected, only the item properties, attachments and diagrams will be imported.
 - If you are importing FMEA records, specify whether to include the dependent records. For example, if you are importing functions, you can import only the functions, or you can import the functions and their related failures, effects, causes, etc.
 - By default, dependent records will be imported. If you want to import only the individual records, select the **Import without dependents** check box.

6. Finally, click **OK** to copy the data.

7.5.2.2 Specifying Keywords and Phrases

When using the Import Existing Records - Query utility, you can limit the search by up to three keywords or phrases, using the three areas in the **Query Criteria** area, as shown next.

Note that the criteria drop-down lists use the property names (i.e., the names shipped with the application) and not the display names (i.e., the user-modified names).

Using the Boolean operators (AND, OR)

In the utility, the **AND** and **OR** Boolean operators do the following:

- **AND** searches for the items that match both the first and second keyword/phrase requirements. For example, if you select **Item Name** and enter “System A” in the first input box and then select **Part Number** and enter “12345” in the second input box, the utility will search only for the items with both “System A” anywhere within the Item Name field and “12345” anywhere within the Part Number field.
- **OR** searches for the items that match either the first or second keyword/phrase requirement. For example, if you select **Item Name** and enter “System A” in the first input box and then select **Part Number** and enter “12345” in the second input box, the utility will search only for the items with either “System A” anywhere in the Item Name field, “12345” anywhere in the Part Number field, or both.

Using All Three Keyword/Phrase Areas

If you use all three areas in the utility, RBI will always group the first two search terms when performing the query, and then perform the search with the AND operator taking precedence over the OR operator. The following examples illustrate this concept. In these examples, c1, c2 and c3 represent criterion 1, criterion 2 and criterion 3, respectively.

- Case 1: c1 **AND** c2 **OR** c3

To simplify, this phrase can be expressed using basic arithmetic operations as follows:

$$(c1 * c2) + c3$$

Therefore, the search will return results for items that satisfy both c1 and c2, as well as items that satisfy C3.

- Case 2: c1 **OR** c2 **AND** c3

This phrase can be expressed as:

$$(c1 + c2) * c3$$

or rewritten as:

$$(c1 * c3) + (c2 * c3)$$

Therefore, the search will return results for items that satisfy both c1 and c3, as well as items that satisfy both c2 and c3.

- Case 3: c1 **AND** c2 **AND** c3

In this case, software will search for items that satisfy all three criteria.

- Case 4: c1 **OR** c2 **OR** c3

In this case, the software will search for items that satisfy at least one of the three criteria.

7.5.3 Importing MPC Systems Into Xfmea, RCM++ or RBI

Although the system hierarchy and F-F-E-C that you create in MPC for an aircraft systems and powerplant analysis has many similarities with the FMEA and RCM analyses that you can perform in Xfmea, RCM++ or RBI, some key differences are that:

- The analysis in MPC is designed specifically for the needs of the aircraft industry and is subject to certain logic constraints and restrictions imposed by the MSG-3 guidelines.
- Xfmea/RCM++/RBI provide more flexibility and more options for data-driven system analyses (such as the ability to use failure mode and/or component data to estimate the reliability/availability for higher-level assemblies and systems).

Therefore, each application must store and manage the analysis data independently. In other words, if you are accessing the same project with both applications, the system hierarchy that you work with in MPC is independent from the system hierarchy that you work with in Xfmea/RCM++/RBI.

However, it is easy to copy any system from the MPC systems and powerplant analysis into the more flexible Xfmea/RCM++/RBI system hierarchy in the same project. The original system hierarchy in MPC will remain unchanged, and new (independent) records will be created in Xfmea/RCM++/RBI.

To use this feature, open the project in Xfmea, RCM++ or RBI and choose **System Hierarchy > MPC > Import MPC Systems**.

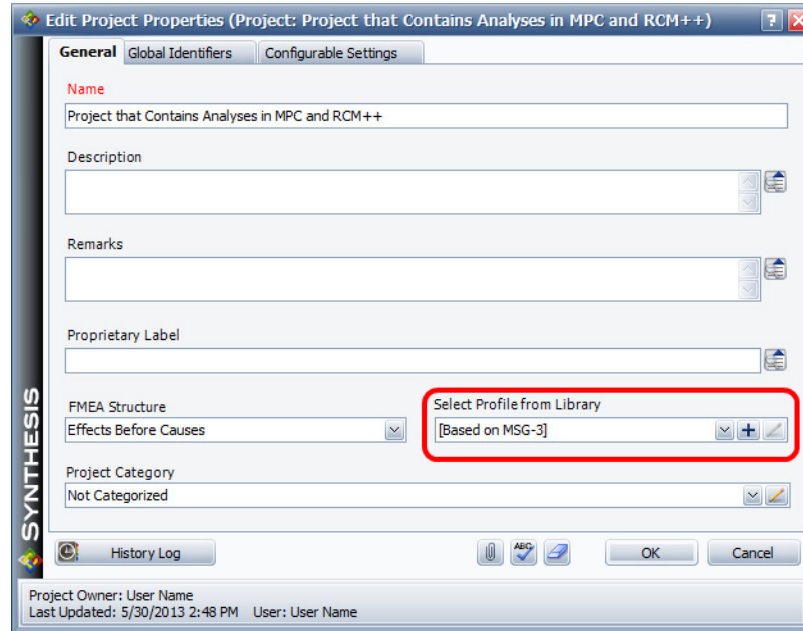


The window displays a list of the systems, if any, that have been defined in the MPC system hierarchy for the current project. Use the check boxes to select the MPC systems you wish to copy and click **OK**.

This process will automatically convert all of the relevant analysis information into the applicable feature(s) in Xfmea/RCM++/RBI.

If you are working with RCM++/RBI and you wish to see the MSI selection questions, failure effect categorization and task selection responses for the systems you import from MPC, make sure that the configurable project properties in RCM++/RBI are consistent with the MSG-3 guidelines. The easiest way to do this is to open the Project Properties

in RCM++/RBI (**Project > Management > Edit Project Properties**) and check to make sure that the configurable settings are based on the MSG-3 profile from the default library installed with Synthesis.



7.5.4 Importing from Lambda Predict to Xfmea/RCM++/RBI

Although the system hierarchy that you work with in Lambda Predict is independent from the system hierarchy that you work with in Xfmea/RCM++/RBI, the Synthesis Platform makes it easy to import items from a prediction folio into a hierarchy that will be used for FMEA, RCM or RBI analysis. The original system configuration in the prediction folio will remain unchanged, and new (independent) records will be created in Xfmea/RCM++/RBI.

To use this feature, open the project in Xfmea, RCM++ or RBI and choose **System Hierarchy > Lambda Predict > Import Prediction Items**.



The left side of the window displays all of the prediction folios that have been created in the current project using Lambda Predict. The right side of the window displays the system hierarchy from the prediction folio that is currently selected. Use the check boxes to select which items will be imported.

Any item properties in Lambda Predict that have an equivalent field in Xfmea/RCM++/RBI analyses (such as Part Number, Supplier, Item Description, etc.) will be imported.

There are two additional options:

Create URDs from published prediction models

The Synthesis Platform makes it possible to publish any failure rate calculated in a Lambda Predict prediction folio as a model resource that may be used in other Synthesis applications. [For details, see “Publishing a Synthesis Model” in the Lambda Predict help file.]

If you are importing prediction items that have been used to publish Synthesis models and you wish to use these published models to automatically define the reliability policies for the new items that will be created in Xfmea/RCM++/RBI, select the **Create URD from published prediction models** check box.

As an example, the following picture shows the reliability policy for an item imported from a MIL-217 prediction.

Reliability Policy	
Type	Define at this level
URD	System- MIL217
Model	LP_System: MIL217 [EX1 (1.757E-05)]

Create FMEA functions from the 'Function Description' field

If you are importing prediction items that have text in the “Function Description” field of the Lambda Predict item properties and you wish to use this text to automatically create the first FMEA functions for the new items that will be created in Xfmea/RCM++/RBI, select the **Create FMEA functions from 'Function Description' field** check box.

As an example, the following picture shows the function description for an item in Lambda Predict. This can be used to create the first function in the FMEA for the new item that is imported to the Xfmea/RCM++/RBI system hierarchy.

Properties	
Properties	Values
General	
Name	Capacitor
Part Number	PN9876
Supplier	ACME Supplies
Description	Description of the item.
Function Description	Description of the function(s) that the item is intended to perform.
Quantity	1
Analyst	Reliability Engineer
Approved By	Reliability Manager
Comments	Any comments related to the prediction analysis.

7.5.5 Import from XFRACAS

The Import Hierarchy Items from XFRACAS window allows you to import system hierarchy items from XFRACAS into the current project. This functionality is available only when you are working in a database that has associated XFRACAS tables. *See page 66 in Chapter 2 for additional information.*

To access the Import Hierarchy Items from XFRACAS window, choose **System Hierarchy > XFRACAS > Import Hierarchy Items**.



In the **Select Entity** area, specify the entity within the XFRACAS system that you want to import from. You can sort the list of entities by clicking the column header; click again to reverse the direction of the sort.

In the **Select Parts** area, select the check box for each system, subsystem and/or component that you want to include in the import. You can also select or clear the check box in the header to select or clear all of the check boxes in this area. If you want to import any failures and causes (called “failure modes” and “root causes” in XFRACAS) associated with the items, select the Import associated failures and causes check box at the bottom of the window.

Click **OK** to import the selected items.

Note: Each topmost item that you import will be added to the system hierarchy as a top level item, regardless of whether it was originally at the “system” level in XFRACAS.

If you are working in an enterprise database, the imported items maintain an association with the items within XFRACAS. This is indicated by the  icon in the XFRACAS Associated Hierarchy Item column in the System Hierarchy tab of the System panel (if that column has been selected for display on your computer). To hide or display columns, right-click the column headers in the System panel, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the System Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed. *See page 508 in Chapter 30.*

You can remove the association between the imported items and the XFRACAS hierarchy by selecting the top level imported item and choosing **System Hierarchy > XFRACAS > Remove Association**. You can also create an association between an item in the RBI system hierarchy and an item in XFRACAS, provided the item in RBI is not already associated with an XFRACAS item and is not a child of an item with an existing association. To do this, select the item in RBI and choose **System Hierarchy > XFRACAS > Associate Item**. The Associate Current Item with an XFRACAS Hierarchy Item window will appear.

- In the **Select Entity** area, specify the entity within the XFRACAS system that you want to create an association to. You can sort the list of entities by clicking the column header; click again to reverse the direction of the sort.
- In the **Select Parts** area, select the XFRACAS system, subsystem or component that you want to associate with the RBI item.

Future changes made to the associated items and/or their failures and causes in XFRACAS will not be reflected in RBI unless and until you manually sync the data.

- To sync item properties, select the item of interest in the system hierarchy and choose **System Hierarchy > XFRACAS > Synchronize Item**. This will synchronize the item properties for the selected item and its associated items (i.e., subsystems/components). If parts are found below the selected item in XFRACAS that do not exist in RBI, they will automatically be added to the system hierarchy in RBI. If parts are found below the selected item in RBI that do not exist in XFRACAS, no action will be taken.
- To sync failures and causes, select the item of interest in the system hierarchy and choose **System Hierarchy > XFRACAS > Import Failures**. In the Import Failure Modes from XFRACAS window that appears, the Existing area displays the selected item's failures and causes that have previously been imported from XFRACAS. The Import area displays all of the failures and causes that exist for the selected item in XFRACAS.
 - Records that have already been imported are shown with a green background; those that have not yet been imported are shown with a pink background. Records shown with a yellow background have been imported previously but have subsequently changed in XFRACAS.
 - The associated function for each failure in this area is displayed in the Associated Function column. The default function added for imported failures is "Item performs as intended." For records that have not previously been imported, you can change the function by clicking inside the cell and either entering a new function description or, if there are already functions associated with the system hierarchy item, selecting a function from the drop-down list.

Select the check box for each failure and/or cause that you want to import or re-import. If you select a cause, the associated failure will automatically be selected. You can also select or clear the check box in the header to select or clear all of the check boxes in this area. Click **OK** to import the new records. The default effect added for imported causes is "<Undefined>." You can edit these as needed after import.

Any functions or failures that exist in RBI and not in XFRACAS will be unaffected.

Syncing failures and causes applies only to the selected item, not to its associated items.

IMPORTANT: Associations between items in RBI and XFRACAS can be maintained only within enterprise databases, where the XFRACAS tables are located within the same repository as the RBI data. If you are working in a standard database and have set up a connection to XFRACAS tables via the XFRACAS Connection window, data that you import will no longer be associated with the XFRACAS data. You can, however, still use the Import Failures command to synch failures and causes, as this is performed via a text-based comparison.

For items that have an association with XFRACAS, the Observed Occurrences column in the FMEA hierarchy view (*see page 346 in Chapter 14*) displays the number of occurrences, as recorded in XFRACAS, of the failure mode/cause combination for the current system hierarchy item. To hide or display columns, right-click the column headers in the FMEA hierarchy view, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the FMEA Hierarchy page of the Application Setup (*see page 510 in Chapter 30*), so any project that you open on this computer will have the same columns displayed. The values in the Observed Occurrences column may be drawn from XFRACAS incidents, problems or failure analyses, depending on your selection on the FMEA Hierarchy page of the Application Setup.

- If you choose **Incidents**, the Observed Occurrences column in the FMEA hierarchy will display the number of incidents with each failure mode/cause combination.
- If you choose **Problems**, the column will display the number of problems with each failure mode/cause combination multiplied by the number of incidents associated with each problem.
- If you choose **Failure Analyses**, the column will display the number of failure analyses with each failure mode/cause combination.

Failure Modes and Reliability Analysis (FMRA)

8

The Xfmea/RCM++/RBI and BlockSim applications provide a failure modes and reliability analysis (FMRA) feature that is used to:

- Display, for the current project, the system hierarchy and Failure Modes and Effects Analysis (FMEA) records that could have an impact on system reliability/maintainability. This includes anything that could cause an item to fail to perform one of its intended functions or cause the failure of one of its sub-items. FMEAs can be created in Xfmea/RCM++/RBI.
- View and set the reliability/maintainability properties of these records.
- Perform different calculations based on these records, including:
 - Generating a preliminary baseline reliability estimate for the system based on occurrence ratings that have been assigned to the cause records.
 - Performing a quantitative criticality analysis to obtain a criticality number for each failure mode in the analysis.
 - Other reliability, availability and cost calculations. The specific functionality that is available will vary depending on the application(s) you have installed. For example, if you installed both Xfmea and BlockSim, you can synchronize the FMRA you built in Xfmea with diagrams in BlockSim to perform a more advanced analysis.

The following sections will discuss:

- Viewing the FMRA - Section 8.1 (p. 225).
- Working with records in the FMRA (e.g., adding/deleting records) - Section 8.2 (p. 227).
- Setting FMRA record properties (e.g., reliability policies) - Section 8.3 (p. 229).
- FMRA diagrams and the reliability-configuration of FMRA records - Section 8.4 (p. 235).
- Performing FMRA calculations - Section 8.5 (p. 237).

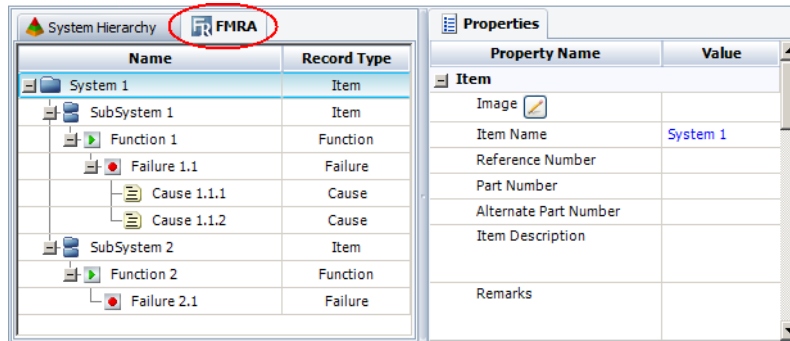
8.1 Viewing the FMRA

The FMRA can be enabled or disabled by choosing **View > FMRA > Show FMRA**. This command toggles the FMRA on and off.

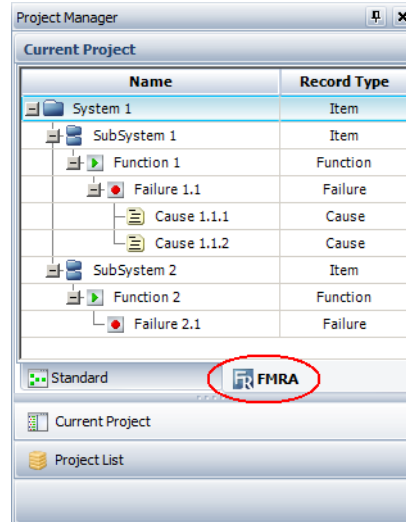


Once enabled, the way you access the FMRA depends on the application you are using.

- To access the FMRA in Xfmea/RCM++/RBI, go to the FMRA tab of the System panel, as shown next.



- To access it in BlockSim, go to the FMRA tab of the current project explorer, as shown next.



Interpreting the FMRA Hierarchy

The FMRA hierarchy displays all of the items in the system hierarchy, in addition to any functions, failures and causes that have been defined for those items. These are all the records that can impact the reliability/maintainability of the system. They are arranged in a tree-like configuration like the one shown above.

Each branch of the tree displays items and FMEA records down to the level at which the reliability is defined. In the example shown above, an FMEA has been created for SubSystem 1, and both cause records have URDs assigned to them, defining their probability of occurrence. SubSystem 2 also has an FMEA, but in that case the URD is assigned at the failure level. (Although cause records may be associated with that failure record, they are not shown because the reliability is calculated based on the URD assigned to the failure record.)

By default, the software assumes a reliability-wise series configuration of these records. Thus, System 1 fails if either of its two subsystems fails. SubSystem 1 fails if Cause 1.1.1 or Cause 1.1.2 occurs, and SubSystem 2 fails if Failure 2.1 occurs. If you do not want to assume a series configuration and you have BlockSim 9 installed on your computer, you can synchronize the hierarchy with RBDs, which allows you to arrange the records in a more complex configuration.

Available FMRA Columns

The FMRA hierarchy also contains columns that display calculation results and additional information about each record in the hierarchy. To hide or display columns, right-click the column headers, then click **Customize Columns** to select which columns you want to display. In Xfmea, RCM++ and RBI, these settings are stored per computer/username on the FMRA page of the Application Setup, so any project that you open on this computer will have the same columns displayed. *See page 509 in Chapter 30.*

The following columns can be displayed in any application that supports FMRA:

- **Name** displays the record description/name. This column cannot be hidden.
- **User Access** displays one of the following status indicators when the record is inaccessible.
 - If the record is being edited by another user, an in-use icon  will be displayed. Point to the in-use icon to display the name of the user who is accessing the item.
 - If you do not have the item permissions needed to edit the record, a restricted access icon  will be displayed.
 - If the record is locked by an FMEA change log, a locked FMEA icon  will be displayed. This means you will not be able to make any changes to the FMRA that would affect the locked FMEA (e.g., adding/removing records, changing the name of the locked record, etc.).
- **Record Type** displays whether the record is an item from the system hierarchy, or a function, failure or cause from an FMEA.
- **Synchronized with BlockSim** displays  if the record is being synchronized with an FMRA in BlockSim.
- **Reliability Policy** displays “Inherit” if the record's reliability will be determined by the reliability of its lower-level records. If a universal reliability definition (URD) is assigned directly to the record, this column will display the URD's name instead. If a record is set to “Define at this level” but has no assigned URD, then “Default (Not Set)” will be displayed and the software will assume that the reliability is 100% (e.g., for a cause record, the software would assume the cause never occurs). *See Section 8.3.1 on page 229.*
- **Mirror Group** displays the name of the mirror group that a cause belongs to, if any. All the causes in a mirror group are treated as one and the same event. *See Section 8.3.4 on page 234.*

The remaining columns pertain to different calculation results and are discussed in Section 8.5 on page 237.

8.2 Working with Records in the FMRA

A record will be automatically added to the FMRA hierarchy whenever you add an item to the system hierarchy or add a function, failure or cause to an FMEA. If you prefer, you can also add items, functions, failures and causes to your project (as well as delete them from the project) directly from the FMRA.

To move records within a project or across projects in the same database, you can cut/copy them and then paste them in the new location. (Please note that if you want to share records between different databases, you must use the import/export functionality.)

Note: If you set a record's reliability policy to “Define at this level,” you will not be able to add dependents to that record via the FMRA. For example, if an item's policy is set to “Define at this level,” then you will not be able to add any sub-items or FMEA records to that item. This is because once you define the reliability policy at a given level, any records at the lower level would be irrelevant to the software's calculations.

The following sections describe how to add, delete, cut, copy and paste records in the FMRA using the Xfmea/RCM++/RBI application. However, you can also perform these functions within BlockSim's FMRA using similar commands.

Adding and Deleting Records

Use any of the following commands to add an item to the FMRA. Any items you add will also appear in the system hierarchy.

- To add a new top-level (system) item, choose **FMRA > Add System Items > Add System**.



- To add a new item to the next level below a selected item, choose **FMRA > Add System Items > Add Next Level Item**.



- To add a new item to the same level as a selected item, choose **FMRA > Add System Items > Add Same Level Item**.



Use any of the following commands to add an FMEA record to an item. If you add a record to an item that does not already have an associated FMEA, the software will create a new FMEA for that item. (Note that you cannot add effects because they do not affect reliability or maintainability.) When applicable, the software will add an effect record to the FMEA as a placeholder.

- To add a function to a selected item, choose **FMRA > Add FMEA Items > Add Function**.



- To add a failure to a selected function, choose **FMRA > Add FMEA Items > Add Failure**.



- To add a cause to a selected failure, choose **FMRA > Add FMEA Items > Add Cause**.



To delete a record from the FMRA, select it and press **DELETE** (or choose **Home > Edit > Delete**). The record will be deleted, along with any dependents. *There is no undo for deleting a record.*

Cutting/Copying Records

First select the record(s), then use the standard keyboard shortcuts for cut/copy (**CTRL+X** and **CTRL+C**). You can also choose **Home > Clipboard > Cut** to cut them or **Home > Clipboard > Copy** to copy them. When a record is cut or copied, all dependents also will be cut or copied, along with any associated analyses and attachments.

Tip: In Xfmea/RCM++/RBI, you can also choose **Home > Clipboard > Copy Active View** to copy the currently visible contents of the System or Analysis panel to the Clipboard as a graphic that can be pasted into other applications. The entire visible area within the active panel will be copied, but any information that is not currently visible will be excluded.

Pasting Records

You can paste a record as a dependent to another record in the same project or to another project within the same database by pressing **CTRL+V** or choosing **Home > Clipboard > Paste**. The record will be pasted as a dependent to the selected record in the hierarchy.

In Xfmea/RCM++/RBI, you can paste an item as a top-level system by choosing **Home > Clipboard > Paste > Paste As Top Level**.

Once a record has been cut or copied, any edits that are made to the original will also be applied to its copy in the Clipboard. If a record is cut or copied and then deleted from the project, the copied data will also be deleted from the Clipboard. Also note that you will not be able to cut or copy a record in a project that is locked by another user.

8.3 Setting FMRA Record Properties

How you view and modify the properties of a selected record in the FMRA hierarchy will depend on the software you are using.

- In Xfmea/RCM++/RBI, a record's properties are accessed via the Analysis panel. (Note that the fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project.)
 - For all FMEA records and system items, the settings under the **Reliability Policy** heading on the Properties tab are used to set the reliability policy of that record.
 - All item properties can be edited via the Properties tab of either the FMRA or the system hierarchy.
 - For FMEA records that can be viewed in the FMRA (i.e., functions, failures and causes), the remaining properties are the same as those that can be edited from an FMEA, with the addition of the **Mode Ratio** and **Prob of Loss** fields for failure records that are used for quantitative criticality analysis (*see Section 8.5 on page 237*).
- BlockSim's abilities to view and modify a record's properties are limited. You can change the level at which the reliability is defined and edit the URDs that are used to define the reliability. You can also double-click a block in an FMRA diagram to modify the name of the corresponding record and other properties.

The following sub-sections discuss:

- Setting reliability policy types - Section 8.3.1 (p. 229).
- Using rating scales in the FMRA - Section 8.3.2 (p. 232).
- Using the Batch Update Reliability Policy window to simultaneously update multiple policies - Section 8.3.3 (p. 233).
- Using the Add to Mirror Group window to place the same cause in multiple locations - Section 8.3.4 (p. 234).

8.3.1 Setting Reliability Policy Types

Before you can perform any calculations with the FMRA, you must specify how the reliability/maintainability is calculated for each record in the hierarchy. An "Inherited" policy means the record's reliability/ maintainability is rolled up from its dependents. In all other cases, the calculated values depend on the URD that is assigned to the record. *See Section 8.5 on page 237.*

Note: The information in this section assumes that you understand how to configure URDs and use them to define reliability/maintainability characteristics within Synthesis applications.

Available Policy Types

The reliability policy type determines how a record's reliability/maintainability characteristics will be defined. The following policy types are available in any application that supports FMRA's:

- Define at this level:** This option is available for all records. When selected, you will be required to set the reliability/maintainability characteristics of the record by assigning a universal reliability definition (URD) to it. If the record does not yet have an assigned URD, "Default (Not Set)" will show in the Reliability Policy column of the FMRA. The software assumes that items with the default policy never fail (i.e., the reliability is always 100%) and failures with the default policy never occur (i.e., the probability of failure is always 0%).

Note: If you use this option with a record that has dependents, the software will hide those dependents in the FMRA. This is because they will be irrelevant to the FMRA's calculations.

- Inherit:** This option is available for all records except causes. When selected, the record will inherit its reliability characteristics from the URDs assigned to its dependents. For example, in the hierarchy shown below, System 1 inherits its reliability from its two components. SubSystem 1 inherits its reliability from its two cause records, and SubSystem 2 inherits its reliability from its failure record. Thus, the reliability of System 1 is determined by URD_1, URD_2 and URD_3.

Name	Reliability Policy
System 1	Inherit
SubSystem 1	Inherit
Function 1	Inherit
Failure 1.1	Inherit
Cause 1.1.1	URD_1
Cause 1.1.2	URD_2
SubSystem 2	Inherit
Function 2	Inherit
Failure 2.1	URD_3

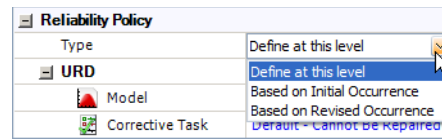
If you calculate the reliability characteristics using Xfmea/RCM++/RBI, the software will assume a reliability-wise series configuration (i.e., it will assume that the occurrence of any cause, or the failure of any sub-item, is sufficient for the entire system to fail). If you have BlockSim 9 installed on your computer, you can also synchronize the FMRA hierarchy with RBDs in BlockSim to arrange the records in a more complex reliability-wise configuration.

The policy types discussed next pertain to qualitative rating scales and can be selected only in Xfmea/RCM++/RBI. See Section 8.3.2 on page 232.

- Based on Failure Probability:** This option is only available for failure records, and only when the Failure Probability criticality analysis field is enabled for the project. When selected, a read-only probability of failure model (i.e., the probability that the failure mode will occur) will be automatically assigned to the record based on the rating selected in the Failure Probability drop-down list.
- Based on Initial/Revised Occurrence:** These options are only available for causes, and only when the Initial Occurrence and/or Revised Occurrence properties are enabled on the FMEA > RPNs page of the interface style. When selected, a read-only probability of failure model will be automatically assigned to the record based on the rating selected in the Initial/Revised Occurrence drop-down list.
- Based on RBI analysis:** This option is only available for RBI components, and only when the option to do so is selected when generating the RBI results. When selected, the model generated by the RBI analysis will be assigned to the component.

Selecting a Policy Type

In Xfmea/RCM++/RBI, you can change the reliability policy type of a selected record by choosing an option in the Type drop-down list on the Properties tab. The policies available for a cause record are shown next.



Tip: To change the policy types of multiple records at once in Xfmea/RCM++/RBI, open the Batch Update Reliability Policy window by choosing **FMRA > RAM Analysis > Policy Update**.

In BlockSim, you can change the policy type in the following ways:

- For any item or record that currently inherits its reliability information from a lower level item or record (i.e., any subdiagram block in a diagram), you can select it in the FMRA hierarchy or select the block in the diagram and choose **FMRA > Inheritance > Define at This Level**. The block in the diagram will change from a subdiagram block to a standard block; you can then open the Block Properties window and assign a URD to the block.
- For any item or record above the cause level that currently has reliability defined, you can select it in the FMRA hierarchy or diagram and choose **FMRA > Inheritance > Inherit**. You can then add the appropriate item(s) or record(s), either in the FMRA hierarchy or in the new subdiagram, and define their properties.

Assigning a Universal Reliability Definition

When **Define at this level** is selected as the policy type, you will have the option to assign a universal reliability definition (URD) to the selected record. The URD can include a probability model. RCM++/RBI and BlockSim can also include corrective and scheduled tasks.

When creating a new model for a record, please note the following:

- An item's model represents the item's reliability (i.e., the probability that the item will not fail).
- A function's model represents the probability that the item will fail to perform its intended function.
- A failure's model represents the probability that the failure will occur.
- A cause's model represents the probability that the cause will occur.

To edit a record's URD, select the record and then, on the Properties tab, double-click the URD, Model or Corrective Task field to open the associated resource wizard.

URD	URD1	...
Model	Model 1 [WB2 (1.500, 1000.000)]	▼
Corrective Task	Corrective Task Corrective Upon Failure	

Tip: If you want to add a scheduled task to the URD in RCM++/RBI, you can do so via the URD resource wizard. The task will then appear on the Properties tab.

To edit a record's URD in BlockSim, double-click the record in the FMRA hierarchy or double-click the block in the diagram. Then double-click the desired field in the **Universal Reliability Definition** area. Note that, to edit a record's URD in BlockSim, the FMRA must be synchronized with diagrams.

8.3.2 Using Xfmea/RCM++/RBI Rating Scales in the FMRA

Xfmea, RCM++ and RBI allow you to use qualitative ratings (e.g., “Level B - Reasonably Probable,” “Level E - Extremely Unlikely,” etc.) to rate causes and failure modes based on their relative probabilities of occurrence. In addition to being used in RPN calculations and qualitative criticality analysis, these ratings can also be used to assign quantitative models to cause and failure records in the FMRA (in the absence of more specific data).

By using rating scales to assign quantitative models to FMRA records, you can:

- Generate a preliminary baseline reliability estimate for a system based on probabilities of failure that are assigned via qualitative occurrence ratings.
- Perform a quantitative criticality analysis based on probabilities of failure that are assigned via qualitative failure probability ratings.

To use a rating scale in the FMRA, an authorized user must first configure the scale by associating a quantitative model (e.g., a constant failure probability of 5%) with each qualitative rating (e.g., “Level C - Occasional”). Then any user can choose to base an FMRA record's reliability policy on the record's assigned rating. The following sections explain how to edit the rating scales and how to base a policy on a rating scale.

Editing Rating Scales

Authorized users can edit the occurrence scale in the Rating Scale window for the current project or the library.

- To edit the scale for the project, choose **Project > Management > Configurable Settings > Occurrence**.
- To edit the scale for the library, open the Profiles/Library Manager and then click the **Edit** button on the Occurrence page. The window also will be displayed when you double-click one of the scales displayed on these pages.

The failure probability scale can only be edited for the current project. To do this, choose **Project > Management > Configurable Settings > Failure Probability**.

In the Rating Scale window (regardless of whether it is used to edit the occurrence scale or the failure probability scale), the **Quantitative Value** will be treated as either a fixed probability (that is the same for all times) or a probability at a specified time (assuming an exponential distribution). You select how the value is treated in the **Treat Quantitative Values As** area.

Note: When you convert an existing library or project from Version 5 of Xfmea/RCM++, the software will set the quantitative values of these scales to match those in the “RS DFR Focus” profile that ships with Version 9. Thus, after converting data, you may have to re-assign or manually adjust the associated profiles.

- To be able to assign fixed (i.e., time-independent) failure probabilities, select the **Fixed Probability (Q)** option.
For example, suppose you assigned a quantitative value of **0.01** to an occurrence rating of “7 - High.” In this case, if a cause is assigned an occurrence rating of “7 - High” and has a reliability policy based on the occurrence rating, then it will be automatically assigned a model that represents a fixed unreliability of 1%.
- To be able to assign time-dependent distributions with constant failure rates, select the **Exponential Distribution at $R(T) = 1 - Q$, and T is** option. The quantitative value will then be treated as an unreliability point at the time you specify in the **Time** field. This unreliability point will be used to solve for the exponential distribution's parameter.

For example, suppose you entered **1,000** for the time and **Hour** for the time units. Moreover, suppose you assigned a quantitative value of 0.01 to a rating of “Level C - Occasional.” In this case, if a failure has a rating of “Level C - Occasional” and a reliability policy based on the failure probability rating, then the software will solve for the exponential distribution's parameter given an unreliability of 1% at 1,000 hours.¹ A model using this distribution will then be automatically assigned to the failure.

Note: If you are using the Rating Scale window to edit the occurrence scale in an enterprise library, the time specified for this option will always be entered in base units. This is because the same standard library might be used by different databases.

Basing a Reliability Policy on a Rating Scale

When a user chooses to set the reliability policy of a failure or cause record based on a qualitative rating, the software will use the rating scales defined for the project to create a probability model for that record.

- To base a cause's reliability policy on an occurrence rating, first make sure that the Initial Occurrence and/or Revised Occurrence properties are enabled on the FMEA > RPNs page of the interface style and that the cause has an occurrence rating assigned. Then select **Based on Initial Occurrence** or **Based on Revised Occurrence** as the policy type.
- To base a failure's reliability policy on a failure probability rating, first make sure that the Failure Probability criticality analysis field is enabled for the project and that the failure has a failure probability rating assigned. Then select **Based on Failure Probability** as the policy type.

Tip: You can also view and select a rating scale by clicking the **Select Existing** icon that appears when you click inside the **Initial/Revised Occurrence** or **Failure Probability** field on the Properties tab for the selected failure/cause record.

If you later change the rating that the reliability policy is based on, or if you change the qualitative value associated with the rating in the rating scale, the software will automatically update the associated model.

8.3.3 Batch Update Reliability Policy Window

The Batch Update Reliability Policy window in Xfmea/RCM++/RBI is used to change the policy type for all the records in the FMRA of the selected types.

For example, if all of the system's causes have reliability policies that are currently based on their initial occurrence ratings, and you wish to update them based on their revised ratings instead, you could use this window to change all of their policies at once.

To open the window, choose **FMRA > RAM Analysis > Policy Update**.



The check boxes in the window determine which kinds of records will be updated, and the drop-down lists determine how the selected records will be updated (i.e., what policy type they will have). For example, to update all cause

¹. To solve for the parameter of the exponential distribution given the unreliability point, the software uses the same calculation method used in the Quick Parameter Estimator. For example, if the given unreliability point is 1% at 1,000 hours, then the model is an exponential distribution with $\lambda = 0.00001$. (You can choose to use mean time for exponential distributions on the Settings page of the Application Setup.)

records so their reliability is based on their initial occurrence ratings, you would select the **Cause** check box and then choose **Based on Initial Occurrence** from the drop-down list.

Select Records and Set Policy Types		
Item	Inherit	☐
Function	Inherit	☐
Failure	Inherit	☐
Cause	Based on Initial Occurrence	☒

Please note the following regarding the available policy types.

- If you select **Inherit**, all records of the specified type will have the “Inherit” policy. Note that all records with this policy are required to have dependents with assigned URDs.
- If you select **Define at this level**, then all records of the specified type will have the “Define at this level” policy. Records that previously had a different policy will have “Default (Not Set)” status, and the software will assume that their reliability is 100%.
- If you select **Based on Initial Occurrence**, you will only update causes that have an initial occurrence rating.
- If you select **Based on Revised Occurrence**, you will only update causes that have a revised occurrence rating.

8.3.4 Add to Mirror Group Window (FMRA)

By adding multiple cause records to a mirror group, you can place the same cause in more than one location in the FMRA hierarchy. This is useful when you need to consider common cause failures (i.e., single faults that result in the failure of multiple components) in your analysis. Typical examples of common cause failures include impact, vibration, temperature, contaminants, miscalibration, improper maintenance, and so forth.

Adding Causes to Mirror Groups

In the FMRA, mirroring is accomplished by adding causes to a mirror group via the Mirror Group window. To add a cause to a mirror group in Xfmea/RCM++/RBI, select it in the FMRA and choose **FMRA > RAM Analysis > Mirrors > Add Cause to Mirror Group**. For BlockSim, choose **FMRA > Mirror Groups > Mirrors > Add Cause to Mirror Group**.



- To create a new mirror group for the cause, select **Add to new** in the **Options** area and enter a name for the group.
- To add a cause to an existing group, select **Add to existing** in the **Options** area and then click the group in the **Select Mirror Group** area.

All cause records in a mirror group (i.e., “mirrored causes”) are treated as representing the very same cause. To accommodate this, the use of mirror groups will change the properties of cause records in the following ways. **Note that there is no undo for changed cause properties.**

- When a cause is added to a new mirror group or an existing empty group (i.e., one that includes no other causes), that cause’s properties will determine the group’s properties.
- When a cause is added to a mirror group that already includes other causes, that cause’s properties (e.g., the short description, reliability policy, etc.) will be changed to match the group’s properties.
- If you change the properties of a mirrored cause, that change will also be applied to all other causes in the same mirror group.

Removing Causes from Mirror Groups

To remove a cause from a mirror group in Xfmea/RCM++/RBI, select it and choose **FMRA > RAM Analysis > Mirrors > Remove Cause from Mirror Group**. For BlockSim, choose **FMRA > Mirror Groups > Mirrors > Remove Cause from Mirror Group**.



To remove all causes from all mirror groups, choose **FMRA > RAM Analysis > Mirrors > Clear All Mirror Groups**. For BlockSim, choose **FMRA > Mirror Groups > Mirrors > Clear All Mirror Groups**. (Note that this does not delete mirror groups; it only removes causes from them. To delete mirror groups, use the Resource Manager.)



8.4 FMRA Diagrams and Reliability-Wise Configurations

 **BLOCKSIM Only**

By default, the records in an FMRA are assumed to have a reliability-wise series configuration. In other words, if any failure mode occurs or any component fails, then the entire system fails. However, using BlockSim's FMRA diagrams, you can represent more complex configurations.

To do this, first make sure that the FMRA shown in BlockSim and the FMRA shown in Xfmea/RCM++/RBI are identical. In BlockSim, choose **FMRA > Refresh > Synchronize FMRA** to refresh the FMRA hierarchy and create the associated diagrams and blocks.



Note the following about FMRA synchronization:

- Changes that are made in BlockSim are synchronized and propagated to Xfmea/RCM++/RBI automatically, although you may need to refresh the view in Xfmea/RCM++/RBI to see them (**View > Refresh**).
- When items or records are added to the current FMRA in Xfmea/RCM++/RBI, they will not be displayed in BlockSim's FMRA hierarchy until you do one of two things:
 - Refresh the view (**View > Refresh**). When you do this, no associated diagrams or blocks will be created. You will not be able to open the new items/records as diagrams until you synchronize the FMRA.
 - Synchronize the FMRA (**FMRA > Refresh > Synchronize FMRA**). This will refresh the FMRA hierarchy and create the associated diagrams and blocks.
- If you no longer wish to synchronize the FMRA with BlockSim diagrams, you can choose **View > FMRA > Disassociate FMRA** to delete all of the diagrams and blocks associated with the current FMRA hierarchy and close the FMRA view. Once you have disassociated the FMRA, you can subsequently re-open the FMRA view, but none of the records will be synchronized with Xfmea/RCM++/RBI and there will not be any associated diagrams or blocks. You can resynchronize at any time.

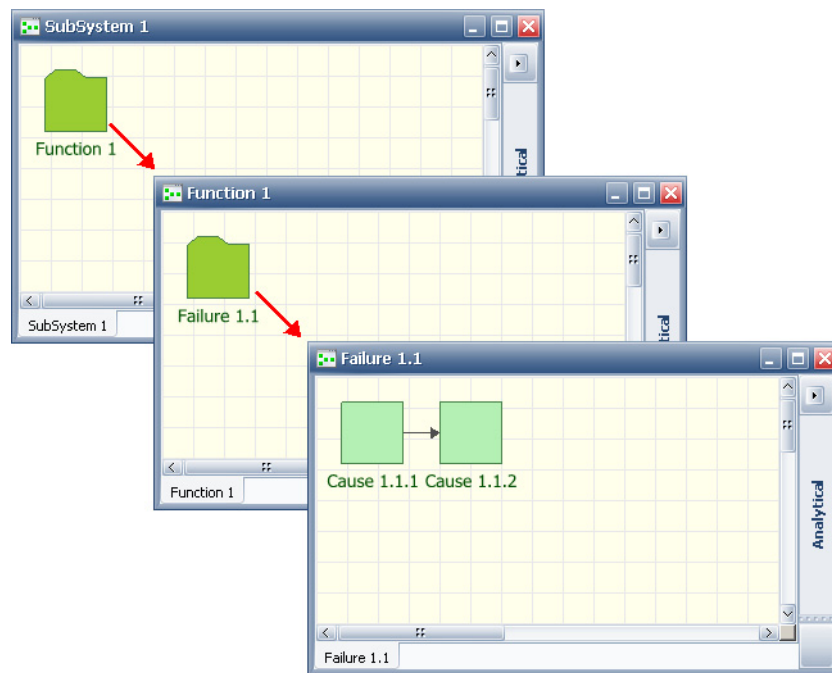
Working with FMRA Diagrams

IMPORTANT: The diagrams that you work with from within the FMRA view are distinct from the BlockSim diagrams in the project. FMRA diagrams relate to the analysis being performed in the project using Xfmea/RCM++/RBI. They are accessible only via the FMRA view, while all other diagrams are accessible only from the Standard tab of the current project explorer.

Each item and record in the FMRA hierarchy represents a reliability block diagram, with the exception of the lowest-level item in each branch, which represents a block in the parent diagram. The levels of the hierarchy are expressed using subdiagrams. For example, consider the FMRA hierarchy shown next.

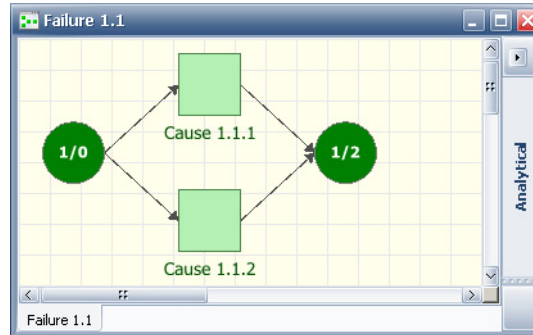
Name	Reliability Policy
System 1	Inherit
SubSystem 1	Inherit
Function 1	Inherit
Failure 1.1	Inherit
Cause 1.1.1	URD_1
Cause 1.1.2	URD_2
SubSystem 2	Inherit
Function 2	Inherit
Failure 2.1	URD_3

Now, let's look at the branch of the FMRA that begins with SubSystem 1. The associated FMRA diagrams are:



As you can see, the causes are assumed to be in a series configuration, as is the case with all reliability-wise configurations built in Xfmea/RCM++/RBI. Working with the FMRA in BlockSim allows you to change the reliability-wise configuration. For instance, let's imagine that the causes are actually in a parallel configuration—in

other words, the item will not fail if only Cause 1.1.1.1 happens OR only Cause 1.1.1.2 occurs, but the item will fail if both occur. To represent this, you would change the Failure 1.1 diagram as follows:



Note: In this example, the first node will function as a starter block because there are no paths leading into it.

By default, the FMRA diagrams are created as analytical diagrams. You can choose FMRA > Inheritance > Toggle Diagram Type to change them to simulation diagrams (or to change simulation diagrams to analytical diagrams). This command changes all of the FMRA diagrams in the project; you cannot have both analytical and simulation FMRA diagrams in the same project. You can analyze or simulate an FMRA diagram just as you would any other RBD, and can generate plots and QCP results for each diagram. You also can perform analytical calculations or simulation at the FMRA level.

8.5 Performing FMRA Calculations

The FMRA can perform a variety of analytical and simulation-based calculations. These calculations are based on the configuration of the FMRA hierarchy and the properties that you define for the records in the hierarchy. How you set up the FMRA and perform calculations will depend on which application you are using.

This section describes how to perform FMRA calculations, including:

- Setting up the FMRA
- Reliability calculations
- System availability and cost calculations
- Criticality calculations

Most of these calculations can also be performed within BlockSim, but it may be more convenient to perform most or all of these steps in Xfmea/RCM++/RBI unless you need to use BlockSim to customize the configuration of the FMRA records. This will minimize how often you have to switch back and forth between applications.

Setting up the FMRA

To perform any of the FMRA's calculations, you must first set up the FMRA hierarchy and define the relevant properties for each record. Typically, the initial setup is done in Xfmea/RCM++/RBI; it is possible, however, to perform basic functions in BlockSim.

- Add the system and all the records that could impact its reliability to the FMRA hierarchy. *See Section 8.2 on page 227.*

- In the FMRA, set the reliability policy for all records.
 - Items will typically inherit their reliability from their sub-items and cause records. Thus, URDs will typically be assigned at the item level and cause level. In some cases, you may have to assign URDs at the failure or function level. For example, you would assign a URD at the failure level for quantitative criticality analysis, or if you knew the probability of a particular failure mode occurring, but you didn't have that information for its causes.
- By default, when you select the “Inherit” policy, the software assumes a reliability-wise series configuration (i.e., the software assumes an item will fail if any of its sub-items fail or if any of its causes occur). To perform more complex calculations that do not assume a series configuration, you can use BlockSim’s FMRA diagrams to customize the configuration of the FMRA records.
- In Xfmea/RCM++/RBI, you can also select policies that assign models to records based on occurrence ratings or failure probability ratings. See Using Rating Scales in the FMRA.
 - In Xfmea/RCM++/RBI: On the Properties tab of the Analysis panel, define the following properties for each item.

Note: The fields that are enabled in the interface will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project.

- **Operating Time:** The amount of time for which the system is expected to operate. The reliability calculated for the system is the reliability at the specified operating time. This can be modified at the system level only. When you perform a simulation-based calculation, you can also edit this value in the simulation settings.
- **Current Age:** Defines the age of the item at the start of the analysis. It allows you to define items that have already accumulated age prior to the start of the current mission (i.e., used components).
- **Duty Cycle:** Allows you to model situations where the actual usage of an item during system operation is not identical to the usage for which you have data. This can include situations where the item:
 - Does not operate continuously (e.g., a DVD drive that was tested in continuous operation, but in actual use within a computer accumulates only 18 minutes of usage for every hour the computer operates).
 - Is subjected to loads that are greater than or less than the rated loads (e.g., a motor that is rated to operate at 1,000 rpm but is being used at 800 rpm).
 - Is affected by changes in environmental stress (e.g., a laptop computer that is typically used indoors at room temperature, but is being used outdoors in tropical conditions).

Continuous operation at the rated load is considered to be a duty cycle of 1. Any other level of usage is expressed as a percentage of the rated load value or operating time. For example, consider the DVD drive mentioned above; its duty cycle value would be 18 min / 60 min = 0.3. A duty cycle value higher than 1 indicates a load in excess of the rated value.
- **Maintenance Group:** This field is available only in RCM++/RBI, and it allows you to choose or create a maintenance group to assign to the item. A maintenance group is a set of items where some event within the group can trigger maintenance for one or more items, either within the group or outside of it. (This field is not applicable for reliability and criticality calculations.)
- **Target Reliability/Availability:** These optional fields are not required to perform calculations, but they allow you to record the reliability and, for RCM++/RBI, the availability that you hope to achieve and compare it to the calculated value.
- In BlockSim: Make any necessary changes to the diagrams to reflect the actual reliability-wise configuration. Additionally, if you have not already defined the operating time at which calculations will be performed in Xfmea/RCM++/RBI, you can do so in BlockSim by selecting the system in the FMRA hierarchy or opening the system diagram and choosing **FMRA > Inheritance > System Settings**. In the System Settings window, enter a value in the **Operating Time** field.

Reliability Calculations (Analytical)

After you set up the FMRA hierarchy, you can calculate the reliabilities of the records.

- In Xfmea/RCM++/RBI, these calculations are always available. Simply choose **FMRA > RAM Analysis > Calculate (Reliability)**. If there are multiple systems in the FMRA, or if the FMRA is synchronized with BlockSim, the Calculation Options window will appear so you can specify how the calculation will be performed.
- In BlockSim, these calculations are available when you are using analytical FMRA diagrams. To calculate results for the entire FMRA, choose **FMRA > Calculations > Calculate Tree**. You can also choose **FMRA > Calculations > Calculate Branch** to calculate results only for items within the selected system.

The following values are obtained from the calculation and may be shown in the FMRA. To change which results columns are visible, right-click the column headers of the FMRA, then click **Customize Columns**.

- **Analytical Results Status** displays a green indicator light if the analytic results are based on the current inputs. It displays a red light if they are not.
- **Reliability (Analytical)** displays the record's calculated reliability at the system's specified operating time. In Xfmea/RCM++/RBI, the reliability for each item will also be displayed in the **Current Reliability** field of the Properties tab when the item is selected. This value will be highlighted in red if it is below the specified target reliability.
- **Probability of Failure (Analytical)** displays the record's probability of failure at the system's specified operating time. This is the inverse of reliability (1-R).

Tip: If you are using the FMRA to estimate the system's baseline reliability, you may wish to thoroughly review and vet the first draft of the FMRA in order to improve the results. The ReliaWiki resource portal has more information on estimating reliability with the FMRA at: http://www.ReliaWiki.org/index.php/Using_FMRA_to_Estimate_Baseline_Reliability.

System Availability and Cost Calculations

Once it has been set up, the FMRA in RCM++/RBI and BlockSim can also be used to perform simulation-based calculations to predict the system's availability, the cost of operation and other values based on the reliability and the maintenance characteristics of the FMRA records. These calculations are not available in Xfmea.

IMPORTANT: When you perform simulation-based calculations in RCM++/RBI, the software always assumes a reliability-wise series configuration. If you modified the configuration using BlockSim, then you should also perform the simulation within BlockSim in order to take the new configuration into account.

- In simulation, random failure times are generated from each component's failure distribution. These failure times are then considered in accordance with the way the components are reliability-wise arranged within the system. The overall results are analyzed in order to determine the behavior of the entire system. Simulation can be used for complex scenarios involving a multitude of probabilistic events, such as corrective maintenance, preventive maintenance, inspections, imperfect repairs, crew response times, spare part availability, etc.
- In RCM++/RBI, simulation-based calculations are always available. Simply choose **FMRA > RAM Analysis > Simulate (Availability)**. A window will open where you can change the simulation settings. Click **OK** to perform the simulation.
- In BlockSim, simulation-based calculations are available when you are using simulation FMRA diagrams. Choose **FMRA > Calculations > Simulate Tree Elements** to open the Simulation Batch Mode window. You can select to include any or all of the systems in the FMRA in the simulation. Each diagram that is selected for simulation in batch mode must have its own simulation settings defined. Once you have specified all necessary settings, click **Run** to perform the simulation.

The following values are obtained from the simulation and may be shown in the FMRA. To change which results columns are visible, right-click the column headers of the FMRA, then click **Customize Columns**.

- **Simulation Results Status** displays a green indicator light if the simulation results are based on the current inputs. It displays a red light if they are not.
- **Operating Cost** displays the total costs that accrued during the simulation.
- **Cost per Operating Time** displays the operating cost divided by the total operating time.

Note: It is not possible to simulate failure times for components whose reliability is defined by a constant value. Failure times can be simulated only in contexts where reliability is time-dependent. Thus, the calculated operating costs for any component with a constant reliability will be zero. In these situations, it may be advisable to change the model from a constant value to a time-dependent distribution. See *Section 8.5.2 on page 241*.

- **Availability** displays the average availability (i.e., uptime divided by total operating time). This is a metric that reflects the probability that the item is operational (not failed or undergoing repair) when it is requested for use during the simulation.
- **RS FCI** shows the ReliaSoft Failure Criticality Index for each item. This is a relative index showing the percentage of times a failure of the component caused a system failure (i.e., the number of system failures caused by the component divided by the total number of system failures). Note that this relates only to failures; it does not include every event that could bring the system down (such as routine maintenance).
- **RS DECI** shows the ReliaSoft Downing Event Criticality Index for each item. This is a relative index showing the percentage of times that a downing event of the component caused the system to go down (i.e., the number of system downing events caused by the component divided by the total number of system downing events). Note that this only relates to downing events with a non-zero duration.
- **RS DTCTI** shows the ReliaSoft Downtime Criticality Index for each item. This is a relative index showing the contribution of each component's downtime to the system's downtime (i.e., the system downtime caused by the component divided by the total system downtime).

Criticality Calculations

In Xfmea/RCM++/RBI, if you wish to perform a quantitative criticality analysis, the software can calculate the probabilities of failure and use that information to calculate the criticality.

The following values are used only in criticality analysis and can be shown in the FMRA only if the applicable criticality analysis fields have been enabled for the project. (The Probability of Failure column, described in the Reliability Calculations section, is also relevant because it is used to solve for these values.) To change which results columns are visible, right-click the column headers of the FMRA, then click **Customize Columns**.

- **Mode Ratio** displays the probability that the item failure will be due to the failure mode under consideration. This value is used to perform criticality analysis.
- **Prob of Loss** displays a factor from 0 to 1 that describes the probability that this failure mode would result in a system failure. By default, this is set to 1 (Actual Loss).
- **Criticality** displays the calculated criticality value. This column must be displayed when the mode ratio or probability of loss is displayed.

8.5.1 Calculation Options Window (Xfmea/RCM++/RBI)

In Xfmea/RCM++/RBI, the Calculation Options window lets you choose which system(s) in the failure modes and reliability analysis (FMRA) will be calculated and which application will be used to perform the calculations. If the FMRA has multiple systems, or it has records synchronized with BlockSim, this window will appear when you choose **FMRA > RAM Analysis > Calculate (Reliability)**.



In the **What items do you want to calculate?** area, you can choose to perform calculations only for the system that is currently selected, or you can choose to calculate all the systems in the hierarchy.

In the **Calculate Method** area, two options will be available if there are records synchronized with BlockSim:

- The **Calculate using BlockSim** option is available only when there are records in the FMRA hierarchy that are currently synchronized with BlockSim. If you calculate using this option, the software synchronizes all records and then returns results based on BlockSim's representation of the FMRA, which uses synchronized RBDs.
- The **Calculate using current application** option will use the software you are currently using (i.e., Xfmea, RCM++ or RBI) to perform the calculations. This means that the software will assume a reliability-wise series configuration among all the records in the FMRA. For example, the software will assume that the occurrence of any one failure, or the failure of any one subsystem, is sufficient to make the entire system fail.

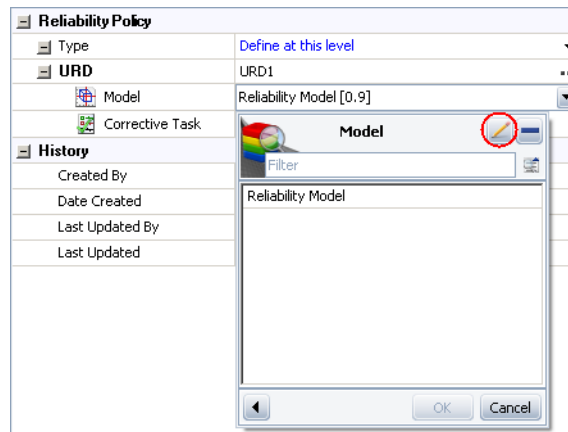
8.5.2 Changing Constant Probability Models to Distributions

At times you may need to change a constant probability model to a distribution. For example, to perform simulation-based cost calculations, the software must be able to simulate failure times for the product based on a time-dependent life distribution. Thus, if you try to perform cost calculations using constant (i.e., time-independent) reliability models, the results of the cost calculation will always be zero. To perform the calculations, you must change any constant model that is considered in the calculation to a time-dependent distribution, as described next.

This section explains how to change the constant probability model to a distribution in Xfmea/RCM++/RBI, but you can follow similar steps in BlockSim by opening the diagram for the record and editing its model in the Block Properties window.

- In the FMRA, select the record that has the model you wish to change. Then double-click the **Model** field under the **Reliability Policy** heading of the Properties tab.

- In the Model wizard that appears, click the **Remove** icon, as shown next.



Tip: As shown in the above example, you can tell whether a model is time-independent by looking at the text displayed in the **Model** field. If the name of the model is followed by a single decimal number in brackets (e.g., "[0.1]"), then the model is time-independent (in this case, the probability of failure is constant at 10%).

- After the model is removed, double-click inside the **Model** field again, then use the Model wizard to create a new distribution and link it to the record.
- After you save the new model, the text in the **Model** field of the Properties tab will indicate the new distribution and parameters. For example, if the model now uses a 2-parameter Weibull distribution (WB2), with beta = 1.5 and eta = 1,000, then the following text would be shown in the field.

URD	URD1	...
Model	Reliability Model [WB2 (1.500, 1000.000)]	▼
Corrective Task	Default - Cannot Be Repaired	

Design for Reliability (DFR) Planner

9

Design for Reliability (DFR) is a process in which a set of reliability engineering practices are utilized early in a product's design and integrated into the entire product development cycle. It is widely understood that the cost of addressing reliability issues increases significantly as a product progresses through the development cycle (e.g., it usually is much more expensive to provide support for an unreliable product than it is to improve a product's design). Thus, the effective use of DFR can minimize the costs and maximize the benefits of producing a reliable product.

For additional information on DFR, please read “Design for Reliability: Overview of the Process and Applicable Techniques” at: <http://www.ReliaSoft.com/newsletter/v8i2/reliability.htm>.¹

Because each stage of the DFR process may involve multiple activities (which themselves may involve multiple sub-activities), and because the full completion of one stage may be required before the team can move on to another stage, it is important to carefully manage each of the activities involved in the process. The DFR tab in the Analysis panel includes two different views for managing and tracking the progress of a DFR process:

- The Hierarchy view is used to manage the various properties of each stage, including its starting, ending and due dates. In this view, you can see all the activities of a DFR process arranged in a tree-based configuration. *See Section 9.1 on page 244.*
- The Plot view displays a timeline of the DFR process (or a specified part of the process) that you defined in the Hierarchy view. *See Section 9.10 on page 255.*

To add a DFR planner to a project, select an item in the system hierarchy and choose **Insert > Planning > Add DFR Planner**.



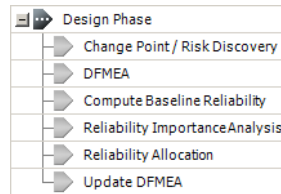
The Create DFR Planner window will appear and allow you to create a blank planner or select a template to base your new DFR planner on. *See Section 9.2 on page 245.* Using a template allows you to pre-populate the new plan with information about the typical Design for Reliability phases that are used by your organization. (If no templates exist in your active library, a blank planner will be created automatically.)

After the new planner is opened in the Analysis panel, the DFR planner icon will appear for the selected item in the system hierarchy (if you have selected to display the DFR column of the hierarchy). To hide or display columns in the system hierarchy, right-click the column headers, then click **Customize Columns** to open a window and select which columns you want to display. (You can also choose **File > Application Setup** then clear or select the relevant check boxes on the System Hierarchy page. *See page 511 in Chapter 30.*)

¹. To learn more about Design for Reliability, also consider attending ReliaSoft's D560 training seminar, “Design for Reliability (DFR) Program Planning and Implementation.” More information on this seminar is available at: <http://www.ReliaSoft.com/seminars/courses/d560.htm>.

9.1 DFR Planner Hierarchy View

The DFR planner's hierarchy view uses gates and actions arranged in a tree-based configuration to help you visualize the stages of a DFR process. For example, the configuration of the seven gates shown below represents the design stage of an item, which consists of six activities.



Certain properties (e.g., status and due dates) of higher-level gates are determined by the properties of their dependents. For example, if all six dependents in the above example were marked as complete, then the Design gate would automatically be marked as complete. In this way, the tool monitors how the progress of individual activities relates to the completion of the entire DFR process.

The DFR planner also allows you to link corrective actions to gates. Actions are used to track activities intended to help reduce the risk associated with potential failures. Certain properties of actions (e.g., due dates) will also determine the properties of their associated gates. (See Section 9.6 on page 251 for an explanation of the logic that determines how the properties of higher-level gates are determined.)

If you wish to only view the gates for the DFR process associated with the item selected in the system hierarchy, click **Selected item only** near the top of the DFR planner. Click **Selected item and dependents** if you wish to view the gates for all DFR processes associated with the selected item and all of its sub-items.

9.1.1 Available Columns

Certain properties for each gate/action are displayed in the planner's columns. To hide or display columns, right-click the column headers in the DFR planner, then click **Customize Columns** to open a window and select which columns you want to display. These settings are stored per computer/username on the DFR page of the Application Setup, so any project that you open on this computer will have the same columns displayed. *See page 511 in Chapter 30.*

Note: Unlike the analysis worksheets (e.g., the FMEA worksheet), the order of the columns in the DFR planner is specific to particular users on particular computers. To shift a column left or right, drag its column header to the desired location.

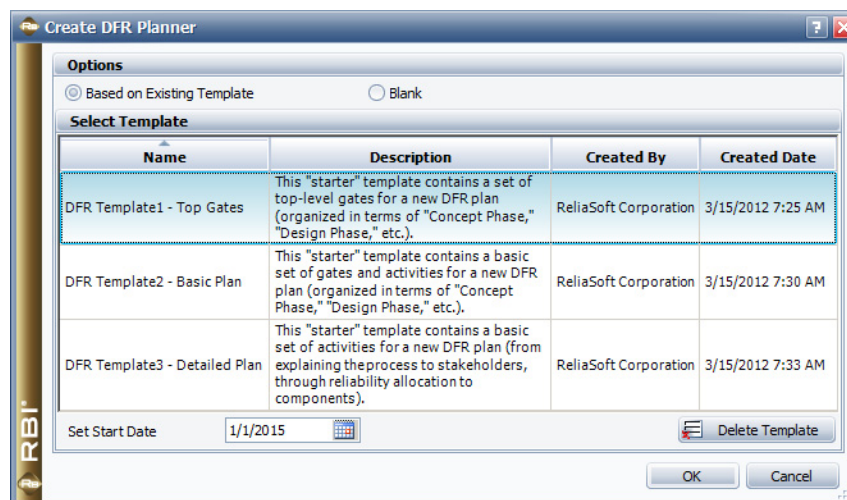
The following columns can be displayed:

- **Item** displays the item's name. This column is available only when the **Selected Item** and **Dependents** option is selected near the top of the DFR Planner tab.
- **Name** displays the name of the selected gate. This is a required input.
- **Attachment** displays a paper clip icon  if one or more files have been attached to the corresponding item. *See page 124 in Chapter 3.*
- **Description** displays a description of what is supposed to be accomplished by the end of this gate in the DFR process.
- **Deliverables** displays what will be completed by the end of the gate.

- **Status** displays the current gate status. The status is indicated by the following icons:
 -  = Not Started
 -  = In Progress
 -  = Complete
 -  = Overdue
- **Planned State/Due Date** displays the gate's planned start and due dates.
- **Start Date/Due Date** display the gate's actual start and due dates.
- **Duration** displays the number of days between the actual start and due dates.
- **Completion Date** displays when the gate was completed.
- **Priority** displays the gate's priority level (i.e., Low, Medium or High).
- **Completion Notes** displays notes about the gate's completion.
- **Other Notes** displays any additional notes regarding the gate.
- **Target Reliability** displays the reliability that is hoped to be achieved by completing the gate.
- **Achieved Reliability** displays the availability that is hoped to be achieved by completing the gate.
- **Target Availability** displays the reliability that was actually achieved by completing the gate.
- **Achieved Availability** displays the availability that was actually achieved by completing the gate.

9.2 Create DFR Planner Window

When you choose to create a new DFR planner on a computer with templates saved in the active library, the Create DFR Planner window will appear so you can choose a template to base the new plan on.



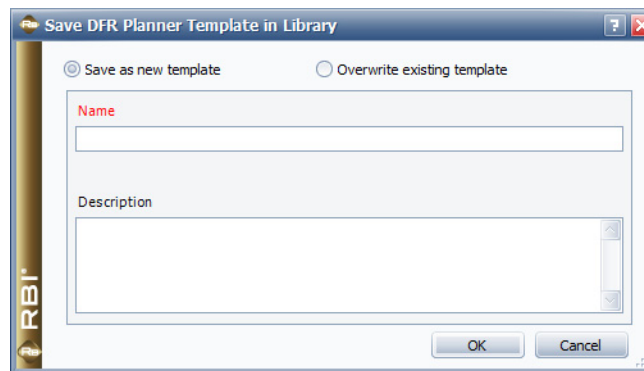
Templates allow you to pre-populate the new plan with information about the typical Design for Reliability phases that are used by your organization. You can then modify it to fit your specific situation and, if desired, save it as a new template for future use (see Section 9.3 on page 246).

- To base the new plan on a template, select **Based on Existing Template** in the **Options** area. All of the templates in the current database will be available in the Select Template area. After you select the template you wish to use, enter the starting date for the plan in the **Set Start Date** area and click **OK**.
- If you wish to create a blank DFR planner, select **Blank** in the **Options** area. The DFR Gate Properties window will appear so you can define the first gate in the new plan. See Section 9.7 on page 252.
- To delete a template from the active library, select it and click **Delete Template**.

If you wish to import a template from another library, use the DFR Planner page of the Profiles/Library Manager. See page 204 in Chapter 6.

9.3 Save DFR Template in Library

To save the current DFR plan as a reusable template that can serve as a starting point for future DFR plans, choose **DFR > Tools > Send to Library** to open the Save DFR Planner Template in Library window.



Once you save the template, it will be available to all projects in the current database, where you can access it via the Create DFR Planner window.

- Select the **Save as new template** option if you want to create a new template based on the current plan. Then enter a **Name** for the template and, if desired, a **Description**.
- Select the **Overwrite existing template** option if you want to replace a template in the library with one based on the current plan. The **Select template to overwrite** area will show all the templates in the library.

9.4 Working with Gates and Actions

The Hierarchy view of the DFR planner allows you to create and modify a tree-based configuration of gates and actions that represent a Design for Reliability process, as described below.

Note: To add or delete gates/actions, you must choose **Selected item only** at the top of the planner.

9.4.1 Adding, Editing, Deleting and Moving Gates

- To add a gate to the DFR planner, follow one of the instructions below. The DFR Gate Properties window will then open so you can define your new gate.

- To add a new top-level gate, choose **DFR > Gate > Add Gate**.



- To add a new gate to the next level below a selected gate, choose **DFR > Gate > Add Next Level Gate**.



- To add a new gate to the same level as a selected gate, choose **DFR > Gate > Add Same Level Gate**.



- To insert a gate at a specific location in the planner, right-click a gate and choose **Insert Gate** from the shortcut menu that appears. After you define the new gate, it will appear directly above the gate you selected.
- To edit a gate, double-click it in the DFR planner, which will open the DFR Gate Properties window. You can also choose **DFR > Gate > Edit Gate**.



- Note that some properties are automatically set by the software based on other properties, and thus cannot be changed manually.
 - If a top-level gate has no precedent, you can shift the start date and/or due date of the gate (and thus its dependents) by a specified number of days/months. Choose **DFR > Tools > Shift Dates** to open the Shift Dates window. *See Section 9.8 on page 254.*



- To delete a gate and all of its associated information (e.g., description, comments, start date, etc.), select it and then press **DELETE** (or choose **Home > Edit > Delete**). *You can undo the last deletion only.*
- You can move a gate to a higher or lower level in the hierarchy by right-clicking it and choosing **Promote** or **Demote** from the shortcut menu that appears.

9.4.2 Adding, Editing and Deleting Actions

- You can add a new action or an existing one to a gate in the DFR planner. *See page 101 in Chapter 3.* This will place the action on a lower level beneath the selected gate.

- To add a new action to a gate, select the gate and then open the Action window by choosing **DFR > Action > Add Action**.



- To add an existing action to a gate, select the gate and then open the Select Resource window by choosing **DFR > Action > Add Existing Action**.



- To edit an action in the DFR planner, select it and then open the Action window by choosing **DFR > Action > Edit Action**. Note that this action may be used elsewhere, and so editing it here may affect other analyses.



- If you have a single action used in multiple locations, but you want to change its properties in only one location in the DFR planner, select it and choose **DFR > Action > Make Action Unique**. This will replace the action in that location with a copy.



- To remove an action from the DFR planner, select it and press **DELETE** (or choose **Home > Edit > Delete**). Note that while the resource will no longer be used in this location, it will not be deleted from the project and will still be accessible via the Resource Manager and Select Resources windows.

9.4.3 Cutting/Copying Items

You can cut or copy gates in the DFR planner and paste them to the same project or to another project within the same database.

After you select the gate, you can use the standard keyboard shortcuts for cut/copy (**CTRL+X** and **CTRL+C**) or you can right-click the gate and choose **Cut** or **Copy** from the shortcut menu that appears. When a gate is cut or copied, all next-level gates also will be cut or copied.

9.4.4 Pasting Items

You can paste a gate as a dependent to another item in the same project or to another project within the same database by opening that project and pressing **CTRL+V** or right-clicking a gate and choosing **Paste** from the shortcut menu that appears. The item will be pasted as a dependent to the selected item in the hierarchy.

To paste the cut or copied item as a top-level gate, right-click the hierarchy and choose **Paste as Top Level** from the shortcut menu. The pasted gate will appear at the bottom of the DFR planner.

You also can choose **Paste Special** from the shortcut menu to open the Paste Special window, which allows you to choose the level at which the cut or copied item will be pasted to the hierarchy, and whether dependent gates and/or actions will be pasted along with it.

If a gate is cut or copied and then deleted from the project, the copied gate will also be deleted from the Clipboard. In addition, once a gate has been cut or copied, any edits that are made to the original will also be applied to its copy in the Clipboard. Also note that you will not be able to cut or copy a gate in a project that is locked by another user.

9.5 Working with Timelines

A gate's timeline consists of its start and due dates, as well as its duration and (if it has one) its specified *precedent* gate (i.e., the immediately prior gate on the same level). For gates that are first in their level (i.e., with no precedent gate), you can set the start date manually. For all gates you can set the end date and duration manually. All of these properties are defined in the DFR Gate Properties window. *See Section 9.7 on page 252.*

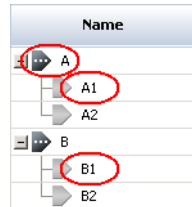
Whenever you change an end date, the software will adjust the duration of the gate automatically. Similarly, when you change the duration, the software will change the gate's end date automatically.

Below are instructions for common tasks that affect timelines.

IMPORTANT: Because making a change in one location of the hierarchy will often affect all gates below that location, you should review the affected dates in the plan after inserting, removing or moving gates, and after changing any start or due dates.

9.5.1 Editing Start Dates

You can directly edit the start date of any gate that is the first within its level, such as the gates highlighted in the hierarchy shown next.



However, for the remaining gates, the start date will be set automatically so it is identical to its precedent's due date. Thus, to change the start date of one of these later gates (A2 and B2 in the above example), you must change the due date or duration of the precedent gate (A1 or B1).

9.5.2 Entering Planned Dates

You can manually enter optional planned start/due dates for any gate. If you want to set the planned dates for all the gates simultaneously, choose **DFR > Tools > Set Planned Dates**. In the window that appears, you can choose to either:

- Clear all the planned dates in all the gates.
- or
- Set the planned start/due dates for all the gates so they are the same as the actual start/due dates.

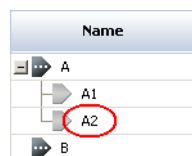
9.5.3 Removing Gaps Between Dates

If there are gaps between dates in your DFR plan (e.g., a top-level gate starts at 1/1/2015, but the first gate underneath it starts at 1/8/2015), you can modify the dates manually to remove the gaps, or you can automatically remove all the gaps by choosing **DFR > Tools > Remove Gaps in Dates**.

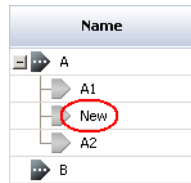
9.5.4 Inserting a New Gate at a Specific Location

To insert a new gate at a specific location, select a gate in the DFR plan and choose **DFR > Gate > Insert Gate**. The DFR Gate Properties window will appear so you can define the new gate, which will appear directly above the selected location and on the same level.

For example, if you select A2 in the hierarchy shown next and choose to insert a gate called “New”:



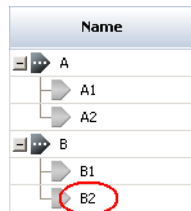
then the inserted gate will appear in the following location:



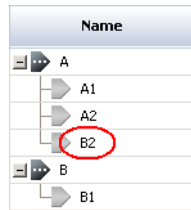
9.5.5 Moving a Gate to Another Level

To move a gate to a different location in the DFR plan (i.e., somewhere outside of the gate's current level), right-click the gate and choose **Cut** from the submenu that appears. Then right-click a different gate and choose **Paste**. The copied gate will be pasted into the next level of the selected gate, and it will appear as the last gate in that level.

For example, if you cut gate **B2** in the DFR plan shown next:



and paste it into gate A, then the DFR plan will appear as shown next:



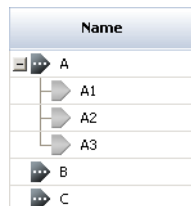
9.5.6 Moving a Gate Within the Same Level

To move a gate within the same level, you'll need to adjust the precedent gate for two of the gates in that level. A gate's precedent is immediately prior and on the same level. To change a precedent gate, use the drop-down list directly above the **Timeline** area in the DFR Gate Properties window.

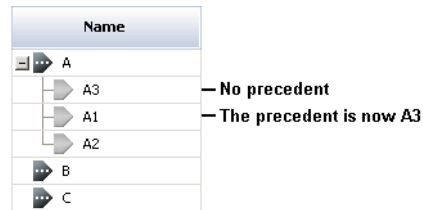
Precedent Gate	
A1	[v]

Timeline	
Planned Start Date	
Planned Due Date	
Start Date	1/8/2015
Duration (Days)	7
Due Date	1/15/2015

For example, if this is the current order of the gates:



and you want to change the order so A3 comes first and is then followed by A1 and A2, then you should change the precedent gate of A3 to “None” (since there will be no gate both prior to A3 and on the same level), and then change the precedent gate of A1 to “A3”.



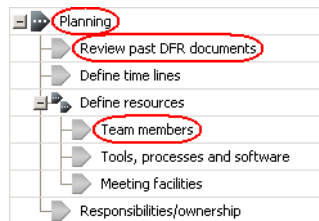
9.6 DFR Planner Logic

Certain properties of gates in the DFR planner can be directly edited, and the remaining properties are automatically determined from those. This section provides a brief overview of the logic that the software uses to determine a gate's properties.

9.6.1 How Dates are Determined

The DFR planner uses the following logic to determine the start, due and completion dates of higher-level gates based on their lower-level gates/actions.

- If a gate is without a precedent (i.e., without a prior gate on the same level), then its default start date can be changed directly. For example, in the image below, only the gates outlined in red can have their start dates changed directly.



- If a gate does have a precedent, its start date is equal to the precedent gate's due date.
- The due date and duration can be changed directly for any gate.
 - When you change the due date, the software will automatically change the duration by calculating the difference between the start date and the new due date.
 - When you change the duration, the software will automatically change the due date by adding the duration to the start date.
- If all of a gate's dependents have a completion date, then its completion date is equal to the latest completion date of those dependents. If any dependent is missing a completion date, then the higher-level gate has no completion date.

9.6.2 How Status is Determined

The software uses the following logic to determine the status of gates and actions based on their start dates, due dates and completion dates. The status is indicated by an icon in the Status column:  = Not Started,  = In Progress,  = Complete and  = Overdue.

- A gate/action is **Not Started** if its start date is later than today's date.

- It is **In Progress** if (a) its start date is today's date or earlier and (b) its due date is today's date or later.
- It is **Complete** if any completion date has been entered (even if the completion is later than today's date).
- It is **Overdue** if its due date is prior to today's date.

9.7 DFR Gate Properties Window

The DFR Gate Properties window displays the status of the selected gate at the top of the window (i.e., “Not Started,” “In Progress,” “Completed” or “Overdue”), and it allows you to view and edit the gate's other properties, described below. Note that when a higher-level gate's properties are determined by its lower-level gates/actions, the input fields for those properties will be disabled.

Gate	
Name	Gate 0
Description	Definition of Requirements
Deliverables	Target Reliability based on Field Data
Priority	High

Team Members	
...	

Precedent Gate	
None	

Timeline	
Planned Start Date	
Planned Due Date	
Start Date	12/1/2013
Duration (Days)	180
Due Date	5/30/2014

Completion	
Completion Date	
Completion Notes	
Other Notes	

Target Metrics	
Target Reliability	
Achieved Reliability	
Target Availability	
Achieved Availability	

History	
Created By	User Name
Date Created	11/4/2013 3:58 PM
Last Updated By	User Name
Last Updated	11/4/2013 3:59 PM

Gate

OK Cancel

Editing gate properties

- **Gate:** These fields provide details about the gate.
 - **Name:** The name of the gate. This is a required input.
 - **Description:** A description of what is supposed to be accomplished by the end of this gate in the DFR process.
 - **Deliverables:** What will be completed by the end of the gate.
 - **Priority:** The gate's priority level. You can choose Low, Medium or High from the drop-down list.

- **Team Members:** Displays all team members that are involved in completing this gate. Double-click the [...] icon to open the Select Users window. This window displays a list of users who have access to the database. (If you are working in a standard database without login security, any user who has ever opened the database will have an account created automatically and will be shown in this list.)
- **Precedent Gate:** Specifies the gate that is immediately prior to the selected one. For example, if the current order of gates A and B is A --> B and you wanted to change the order to B --> A, then you could set the precedent gate of B to “None” and then set the precedent gate of A to “B.”
- **Timeline**
 - **Planned Start / Due Date:** The gate's planned start and due dates. To clear/update the planned dates for all gates in the planner, choose **DFR > Tools > Set Planned Dates**.
 - **Start / Due Date:** The gate's actual start and due dates. You can enter the start date only for gates without precedents. You can enter the due date for any gate. See Section 9.6 on page 251 for information on how other dates are set automatically.
 - **Duration:** The amount of time between the actual start and due dates.
- **Completion**
 - **Completion Date:** The date the gate was completed.
 - **Completion Notes:** Notes about the gate's completion.
 - **Other Notes:** Any additional notes regarding the gate.
- **Target Metrics**
 - **Reliability/Availability:** The reliability or availability that you hope to achieve when the gate is completed (i.e., the target value) and that was actually achieved when it was completed (i.e., the achieved value). The achieved values may be obtained from the Current Reliability/Availability properties in the failure modes and reliability analysis (FMRA). *See Chapter 8.*
- The **History** fields display information about when the gate was created and last modified. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the item. *See page 70 in Chapter 2.*

For text fields, you can click the **Select Existing** icon inside the field. This will open a window that allows you to reuse text that has already been entered in this type of field. *See page 113 in Chapter 3.*

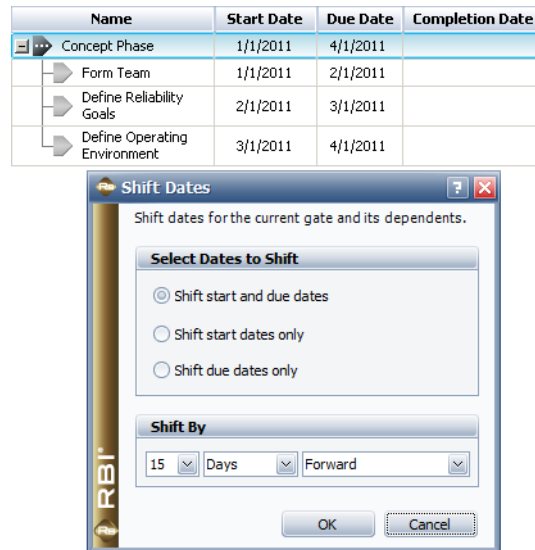


For date fields, you can click the field once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.

9.8 Shift Dates Window

The Shift Dates window is used to shift the start and/or due dates of a selected top-level gate and all its dependents by a specified duration of days or months. The dates can be shifted forwards (later) or backwards (earlier). This option is available only when a top-level gate with no precedent gate is selected. *For information about precedent gates, see Section 9.7 on page 252.*

For example, if you selected the “Concept Phase” gate highlighted below and made the selections shown, then the start and due dates of every gate shown would be shifted forward by 15 days (e.g., from 1/1/2011 to 1/16/2011).



9.9 Synchronizing Actions

When an action is first added to a gate, its start and due dates are equal to the gate. However, subsequent changes in the DFR planner can cause an action’s dates to fall out of sync.

When this happens, you can use the Synchronize Action to DFR Timeline window to automatically change the date of an action to match that of the gate it was added to (or vice versa). To open the window, select an action in the DFR planner and choose **DFR > Action > Synchronize Action**.

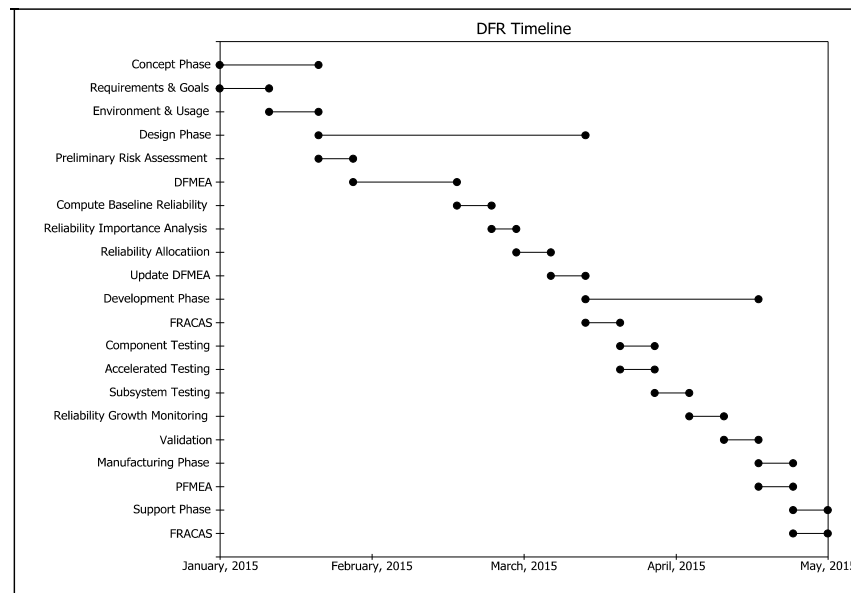


Depending on the properties of the selected action, the following options may be available:

- The **Change action start date to match gate** option shifts the start date of the action so that it matches the start date of the gate. The action’s duration will not change.
- The **Prolong gate to match action due date** option increases the gate’s duration so that the gate’s due date matches that of the action. The gate’s start date will not change. Note that changes in the gate’s due date may effect the dates of other gates. *See Section 9.6 on page 251.*

9.10 DFR Planner Plot View

The DFR planner's Plot view displays a timeline of the DFR process (or a specified part of the process) that you defined in the planner's Hierarchy view. An example timeline is shown next.



The generated timeline will represent the part of the DFR process that is specified in the **Filter Options** area. If you select **Gate**, the timeline will start and end with the top-level gates you select in the **Start Gate** and **End Gate** drop-down lists. If you select **Date**, the timeline will start and end at the dates you enter in the **Start Date** and **End Date** fields.

The **Display Options** area contains the following options:

- **Display Actions** shows both DFR gates and actions that are linked to those gates.
- **Auto Refresh** automatically refreshes the plot if any changes are made on the control panel.
- **Keep Aspect Ratio** keeps the proportion of horizontal size to vertical size constant when you resize the plot.
- **Show First Gate on Top** shows the first gate in the DFR process at the top of the plot; otherwise the first gate appears at the bottom of the plot.

The control panel of the Plot view also includes some of the options that are available on the Plot Viewer control panel. *See page 455 in Chapter 25.*

Risk Discovery (Equipment Selection) 10

The Risk Discovery tab in the Analysis panel allows you to perform a preliminary analysis that can help you select the equipment that will receive more detailed analysis.

- For RBI, this may be referred to as *Qualitative RBI*.
- For RCM, this may be referred to as the *Equipment Selection*.
- For FMEA, this may be referred to as a *Change Point Analysis* or *Preliminary Risk Assessment*.

There are two configurable methods available for performing this analysis; the one you use depends on your choice in the project properties. *See page 67 in Chapter 2.*

- Risk discovery questions allows you to answer a series of yes/no questions.
- Risk discovery ratings, allows you to assign ratings for a variety of different factors and then calculate an overall criticality value for each piece of equipment.

Whichever method is selected, the goal of this task is to provide a systematic approach to focus limited analysis resources where they will provide the maximum benefit and ensure the highest return on investment.

To add a Risk Discovery analysis, select an item in the System panel then choose **Insert > Planning > Add Risk Discovery**. The Risk Discovery tab will open in the Analysis panel.



In the System panel, the Risk Discovery column displays a green icon if a Risk Discovery analysis is associated with the item. Additionally, if the **Mark item for more detailed analysis** check box is selected at the bottom of the Risk Discovery analysis, then the Risk Discovery icon will display in red.

In the System panel, what the Risk Discovery Details column displays depends on the Risk Discovery type:

- If the project is using risk discovery questions, then this column will display the number of questions with “Yes” answers. More “Yes” answers indicates greater risk.
- If the project is using risk discovery ratings, then this column will display the sum of all the rating numbers selected in the analysis. Higher sums indicate greater risk.

To hide or display columns, right-click the column headers in the System panel, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the System Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed.

To generate a report of the Risk Discovery data, choose **Home > Reporting > Reports**. In the Reports window, the predefined reports are located in the Risk Discovery section of the Available Reports area.

10.1 Using Questions

If you have specified to use risk discovery questions for the project, the Risk Discovery analysis presents a series of yes/no questions that are configurable via the Project Properties window. *See page 67 in Chapter 2.* Each question has a label that is colored green to indicate a No answer (not critical) or red to indicate a Yes answer (critical).

Authorized users can define the questions that will be used for this analysis. If you want to edit the questions for the current project only, choose **Project > Management > Edit Project Properties**, go to the Configurable Settings page and click the **View/Edit Settings** icon to the right of the Risk Discovery Questions drop-down list.



If you want to define questions that could be applied to other projects also, use the Profiles/Library Manager to update the active library and then return to the Project Properties window and apply the questions to the current project. *See page 184 in Chapter 6.*

A Risk Discovery analysis using risk discovery questions is shown next.

Item Properties		Risk Discovery	
Label	Question	Response	Comments
New Technology	Will the design involve new technology?	No	
New Application	Will the design apply existing technology in a new way?	Yes	
Historical Problems	Is there a history of problems for a similar design?	No	
Safety Issues	Is there a potential for safety-related issues?	No	
Regulation Issues	Is there a potential for regulation-related issues?	Yes	
Mission-Critical	Is this a mission-critical item?	No	
Supplier Capability	Are there concerns about the supplier's capability?	No	
☐ Mark item for more detailed analysis			
Questions		Ratings	

- **Label:** A descriptive label that summarizes the issue and will appear in green or red highlighting based on the answer in the Response column. If the answer is No, the cell is highlighted in green. If the answer is Yes, the cell is highlighted in red.
- **Question:** A longer text string that contains a question that can be answered with Yes or No.
- **Response:** The Yes or No answer to the question. Clicking the cell changes the answer.
- **Comments:** A comment (up to 255 characters) that contains any additional information that is relevant to your response to the question. You can type directly in this field or click anywhere in the field to display the **Select Existing** icon. This icon opens the Select Existing window that allows you to choose comments used in other data sources. *See page 113 in Chapter 3.*



In the System panel, the Risk Discovery Details column will display the number of questions with “Yes” answers. More “Yes” answers indicates greater risk. Additionally, if the **Mark item for more detailed analysis** check box is selected, then the Risk Discovery icon will display in red.

To generate a report of the Risk Discovery data, choose **Home > Reporting > Reports**. In the Reports window, the Risk Discovery reports are located in the Risk Discovery section of the Available Reports area.

10.2 Using Ratings

If you have specified to use risk discovery ratings for the project, the Risk Discovery analysis allows you to rate the criticality of the item using a set of factors that are configurable via the Project Properties window. *See page 67 in Chapter 2.* For each category, there can be one or more factors to consider. For each factor, you can choose the rating from a predefined menu.

Authorized users can define the categories, factors and ratings that will be used for this analysis. If you want to edit settings for the current project only, choose **Project > Management > Edit Project Properties**, go to the Configurable Settings page and click the **View/Edit Settings** icon to the right of the Risk Discovery Questions drop-down list.



If you want to define ratings that could be applied to other projects also, use the Profiles/Library Manager to update the active library and then return to the Project Properties window and apply the ratings to the current project. *See page 184 in Chapter 6.*

A Risk Discovery analysis using risk discovery ratings is shown next.

Item Properties		Risk Discovery		
Category	Factor	Rating	Comments	Category Rating
Potential Risk Factors	New Technology	2 - Moderate Risk		11
	New Application	3 - Higher Risk		
	Historical Problems	1 - Lower Risk		
	Safety Issues	1 - Lower Risk		
	Regulation Issues	2 - Moderate Risk		
	Mission-Critical	1 - Lower Risk		
	Supplier Capability	1 - Lower Risk		
☐ Mark item for more detailed analysis				Overall Rating 11
Questions		Ratings		

- **Category:** The type of issue that the rating addresses.
- **Factor:** A short description of the particular issue being rated.
- **Rating:** A drop-down list of ratings that can be applied to the factor.
- **Comments:** A comment (up to 255 characters) that contains any additional information that is relevant to your rating for the factor. You can type directly in this field or click anywhere in the field to display the **Select Existing** icon. This icon opens the Select Existing window that allows you to choose comments used in other data sources. *See page 113 in Chapter 3.*



- **Category Rating:** The total rating for all factors within this category, which is calculated automatically based on the numerical values in the Rating column.

The **Overall Rating** field is the sum of all the ratings for all the factors, which is calculated automatically based on the numerical values in the Category Rating column.

In the System panel, the Risk Discovery Details column will display the sum of all the rating numbers selected in the analysis. Higher sums indicate greater risk. Additionally, if the **Mark item for more detailed analysis** check box is selected, then the Risk Discovery icon will display in red.

To generate a report of the Risk Discovery data, choose **Home > Reporting > Reports**. In the Reports window, the Risk Discovery reports are located in the Risk Discovery section of the Available Reports area.

Analysis Plans

11

The Analysis Plan utility allows you to:

- Specify the members and leaders of a project team - Section 11.1.1 (p. 262).
- Define the tasks involved in your analysis and keep track of their completion - Section 11.1.2 (p. 263).
- List the information that all members of the analysis team will use to make judgments in the analysis - Section 11.1.3 (p. 264).
- Track the time spent working on the analysis and the members who have attended the sessions - Section 11.1.4 (p. 265).
- Track team members' assessments of how effective the FMEA analysis process has been - Section 11.1.5 (p. 266).

You can assign an analysis plan to an item at any level of the system hierarchy. For instance, if you want the entire project to be covered by one plan, you could assign an analysis plan only to the top-level system. Conversely, you might prefer to have a separate analysis plan for each subsystem.

11.1 Analysis Plan Window

To access the Analysis Plan window, select the item in the System panel that the analysis plan will be applied to, then choose **Insert > Planning > Add Analysis Plan**.



You can manage analysis plans by clicking the Analysis Plan tab in the Analysis Panel.

The Analysis Plan window consists of five tabs. The information on these tabs is included in the Analysis Plans Summary and Analysis Plan Details reports created view in the Reports window. Each tab and its components are presented next.

Note that the name, description and status of the analysis plan are displayed at the top of all tabs. The status of the analysis plan is shown above the four dates fields and is based on the dates given in those fields:

- **Scheduled** - This indicates that a starting date for the project has been defined but the project has not started (i.e., the planned start date is later than the current date, and no start date or completion date has been entered).
- **Late Start** - This indicates that the planned starting date for the project has passed and the project has not started (i.e., the planned start date is later than the current data, and no actual start date or completion date has been entered).
- **In Progress** - This indicates that the project is in progress and the due date has not arrived (i.e., the actual start date is earlier than the current date, and there is no completion date).

- **Overdue** - This indicates that the project is in progress but the due date has passed (i.e., there is an actual start date, the current date is later than the due date, and there is no completion date).
- **Complete** - This indicates that the project has been completed (i.e., there is a completion date).

11.1.1 Team Tab

The Team tab of the Analysis Plan window allows you to specify the members of the team who are involved with the project.

1 - Equipment A: Analysis Plan

Name: FMEA for Equipment A

Description: A full-featured FMEA project to develop a scheduled maintenance plan for Equipment A

Complete

Planned Start Date: 2/1/2013

Actual Start Date: 2/1/2013

Due Date: 2/21/2013

Completion Date: 2/20/2013

Team | Analysis Checklist | Ground Rules and Assumptions | Work Sessions | Quality Survey

First Name	Last Name	Display Name	Title	Company	Phone	E-mail	Leader
Equipment	Designer	Equipment Designer	Product Engineer	ReliaSoft Corporation	+1.520.886-0140	RBI@ReliaSoft.com	No
Maintenance	Chief	Maintenance Chief	Maintenance Engineer	ReliaSoft Corporation	+1.520.886-0140	RBI@ReliaSoft.com	No
Reliability	Engineer	Reliability Engineer	Reliability Engineer	ReliaSoft Corporation	+1.520.886-0140	RBI@ReliaSoft.com	No
Team	Leader	Team Leader	FMEA Facilitator	ReliaSoft Corporation	+1.520.886-0140	RBI@ReliaSoft.com	Yes
							No

Buttons: Delete Row, Insert Row, Import Existing Users

OK, Cancel

Last Update Date: 10/21/2013 3:18 PM User: User Name

To add a team member, click inside a cell to enter their information. First Name, Last Name and Display Name are required fields. All others are optional. You can also import existing users as team members by clicking the **Import Existing Users** button. The Import Existing Users window will appear.

To mark whether a team member is a project leader, click inside the cell in the Leader column to select **Yes** or **No** using the drop-down list. More than one team member can be a project leader.

At the bottom of the Import Existing Users window is the **Show repository users only** check box. If this check box is selected, then only users who have access to the database are displayed. Clear the check box to display the users who have access to the database and all persons who have been added as a team member to any analysis plan in the database.

11.1.2 Analysis Checklist Tab

The Analysis Checklist tab allows you to define the tasks involved in your analysis and keep track of their completion.

1 - Equipment A: Analysis Plan

Name
FMEA for Equipment A

Description
A full-featured FMEA project to develop a scheduled maintenance plan for Equipment A

Complete
 Planned Start Date: 2/1/2013
 Actual Start Date: 2/1/2013
 Due Date: 2/21/2013
 Completion Date: 2/20/2013

Team **Analysis Checklist** Ground Rules and Assumptions Work Sessions Quality Survey

Task	Estimated Completion Date	Actual Completion Date	Notes
Identify the functions.	2/9/2013	2/10/2013	
Identify the functional failures/failure modes.	2/9/2013	2/10/2013	
Identify the effects of failure.	2/9/2013	2/10/2013	
Categorize the consequences of failure.	2/9/2013	2/10/2013	
Identify the causes of failure.	2/9/2013	2/10/2013	
Identify the current controls.	2/9/2013	2/10/2013	
Perform risk assessment and prioritization.	2/9/2013	2/10/2013	
Perform maintenance task selection.	2/13/2013		
Package maintenance tasks.	2/16/2013		
Generate and distribute report output.	2/21/2013		

Reset Checklist from Library
 Standard RCM

Completion Estimate (%) %
 Checklist 11 of 16 = 68.75
 Actions 0 of 0 =

Last Update Date: 10/21/2013 3:18 PM User: User Name

You can work from an analysis checklist in the active library by selecting a checklist from the **Reset Checklist from Library** drop-down list, or you can create your own. If you create your own analysis checklist or make changes to one from the library, you can click the **Save Checklist in Library** button to open the Save Checklist in Library window, which allows you to store your new checklist in the library for future use.

You can enter estimated and actual completion dates for each task in the checklist. When you click in a date cell, you can enter a date manually or click the calendar icon and select a date in the calendar that appears.

In the bottom right corner of the window, you can estimate the level of completion of the analysis, either by entering your own estimate in the **Completion Estimate** field or by reviewing the automatically generated values that show the number of checklist tasks completed or the number of actions completed for the item(s) to which the analysis plan applies. These figures will refresh automatically whenever you make changes to the actual completion dates or in the analysis plan.

11.1.3 Ground Rules and Assumptions Tab

The Ground Rules and Assumptions tab of the Analysis Plan window allows you to list the information that all members of the analysis team will use to make judgments in the analysis.

1 - Equipment A: Analysis Plan

Name
FMEA for Equipment A

Description
A full-featured FMEA project to develop a scheduled maintenance plan for Equipment A

Complete
 Planned Start Date: 2/1/2013
 Actual Start Date: 2/1/2013
 Due Date: 2/21/2013
 Completion Date: 2/20/2013

Team | Analysis Checklist | **Ground Rules and Assumptions** | Work Sessions | Quality Survey

Ground Rules and Assumptions

At least X members of the team must agree on the effect severity rating in order to proceed
 An item will be considered failed if...
 The team will assume that...
 The anticipated environmental conditions are

Delete Row | Insert Row | Move Up | Move Down

Reset Assumptions from Library
 Save Assumptions in Library

Last Update Date: 10/21/2013 3:18 PM User: User Name

You can work from a list of assumptions in the active library by selecting an assumptions list from the **Reset Assumptions from Library** drop-down list, or you can create your own. If you create your own list of assumptions or make changes to one from the library, you can click the **Save Assumptions in Library** button to open the Save Assumptions in Library window, which allows you to store your new assumption list in the library for future use.

11.1.4 Work Sessions Tab

The Work Sessions tab allows you to track the time spent working on the analysis and the members who have attended the sessions. The time can be entered using multiple formats (e.g., 8 AM, 3pm, 1700, etc.).

1 - Equipment A: Analysis Plan

Name
FMEA for Equipment A

Description
A full-featured FMEA project to develop a scheduled maintenance plan for Equipment A

Complete
 Planned Start Date: 2/1/2013
 Actual Start Date: 2/1/2013
 Due Date: 2/21/2013
 Completion Date: 2/20/2013

Team | Analysis Checklist | Ground Rules and Assumptions | **Work Sessions** | Quality Survey

Date	Start Time	End Time	Attendance	Notes
2/1/2013	8:00 AM	5:00 PM	- Equipment Designer - Maintenance Chief - Reliability Engineer - Team Leader	Note related to the particular work session, such as the purpose of the session, what was accomplished, plans for the next session, etc.
2/7/2013	8:00 AM	5:00 PM	- Equipment Designer - Maintenance Chief - Reliability Engineer - Team Leader	

Total Work Session Time (Hours) 18

Last Update Date: 10/21/2013 3:18 PM User: User Name

You can specify which members of the analysis team attended each work session listed by clicking the **Enter Attendance** button or by clicking a cell in the Attendance column to open the Enter Attendance window.

If you have made changes on the tab, the **Total Work Session Time (Hours)** field will update automatically. This calculation is based on the start and end times entered for each work session.

11.1.5 Quality Survey Tab

The Quality Survey tab allows you to track team members' assessments of how effective the FMEA analysis process has been.

1 - Equipment A: Analysis Plan

Name
FMEA for Equipment A

Description
A full-featured FMEA project to develop a scheduled maintenance plan for Equipment A

Complete
 Planned Start Date: 2/1/2013
 Actual Start Date: 2/1/2013
 Due Date: 2/21/2013
 Completion Date: 2/20/2013

Team | Analysis Checklist | Ground Rules and Assumptions | Work Sessions | **Quality Survey**

Category	Requirement	Average Rating
PROCESS IMPROVEMENTS	The FMEA drives Process Improvements as the primary objective, with emphasis on Error/Mistake Proofing solutions.	
HIGH RISK FAILURE MODES	The FMEA addresses all high risk Failure Modes, as identified by the FMEA team, with executable Action Plans. All other failure modes are considered.	
PROCESS CONTROL PLAN	The Process Control Plan considers the failure modes from the Process FMEA.	
INTEGRATION	The Process FMEA is integrated and consistent with the Process Flow Diagram and the Process Control Plan. The Process FMEA considers the Design FMEA as part of its analysis.	
LESSONS LEARNED	The FMEA considers all major "lessons learned" (such as high warranty, campaigns, etc.) as input to failure mode identification.	

Reset Survey from Library
 SAE Process FMEA

Average Rating:

Last Update Date: 10/21/2013 3:18 PM User: User Name

You can work from a survey in the active library by selecting a survey from the **Reset Survey from Library** drop-down list, or you can create your own. If you create your own survey or make changes to one from the library, you can click the **Save Survey in Library** button to open the Save Survey in Library window, which allows you to store your new survey in the library for future use.

Each user involved in the process may answer the survey questions after the analysis is complete. When you have the answers to the survey, click in the **Average Rating** cell for each question and enter the average rating, which must be a numerical value of zero or greater. The Overall Average Rating will update automatically based on your changes.

RBI Analysis

12

ReliaSoft's RBI software facilitates risk based inspection (RBI) analysis for the oil & gas, chemical and power plants in adherence to the principles and guidelines presented in the American Petroleum Institute's recommendations in the API RP 580 and RP 581 publications, as well as the American Society of Mechanical Engineers' recommendations in the ASME PCC-3-2007 publication. The following sections will discuss:

- An overview and general background for typical RBI analysis methods - Section 12.1 (p. 267).
- Defining the organization's risk tolerance (the same Risk Categories scales will be used for all RBI analyses in the same database) - Section 12.2 (p. 270).
- Defining the management systems evaluation score (which can be set separately for each analysis project) - Section 12.3 (p. 271).
- Building the RBI system hierarchy - Section 12.4 (p. 273).
- Using the Add RBI Component window and/or the RBI Properties tab to:
 - Set the general properties - Section 12.5.1 (p. 275).
 - Select the applicable damage factors - Section 12.5.2 (p. 276).
 - Set the damage factor properties - Section 12.5.3 (p. 277).
 - Set the consequence properties - Section 12.5.4 (p. 278).
- Viewing the RBI analysis results - Section 12.5.9 (p. 281).

RBI also provides special analysis treatment for two specific types of components: HEXTUBES (Section 12.6 on page 284) and Pressure Relief Devices (PRDs) (Section 12.7 on page 286).

12.1 RBI Background

The American Petroleum Institute (API) recommends to develop an inspection program using risk-based methods. You can use ReliaSoft's RBI software to record the data relating to the potential damage to specific equipment and components, and then forecast future physical and economic consequences of failure as well as the probabilities of failure for individual components, equipment and entire plants. In addition, you will be able to better plan when to inspect, maintain and replace weak components before failure occurs.

The program is primarily based on two publications: API RP 580 and API RP 581. Both provide guidance on developing a risk-based inspection program for fixed equipment in refining, petrochemical and chemical process plants. The documents are written to include RBI methods for pressurized fixed equipment such as pressure vessels, piping, tanks, pressure relief devices and heat exchanger tube bundles, among others.

Note: RBI corrects several errors that are present in the API RP 580 and API RP 581 standards so the results obtained in the RBI software may differ from those calculated using other methods. These changes included correcting several property values in tables (e.g., the nominal boiling point of NO₂ is 22°C and not the 135°C shown in the standard), correcting inconsistencies in equations and correcting some theoretical inconsistencies.

12.1.1 Introduction

The RBI software calculates the probability of failure and the consequence of failure for given components in a pressurized environment. These calculations are used to help plan inspections and reduce the risk of failure.

The API defines failure as the loss of containment from a pressure boundary resulting in leakage to the atmosphere or a rupture of the pressurized component. Throughout a given period of time, damage will accumulate within a pressured environment. That damage causes increased risk of failure to equipment and components. After a significant amount of damage, a predetermined risk target is exceeded and an inspection of that component is recommended to better understand and measure the damage.

12.1.2 Consequences of Failure

Within RBI, there are two types of consequence analyses: area and financial. The loss of containment by leakage, rupture or other causes can cause damage to nearby equipment, the environment and/or be harmful to personnel. Some components must have both types of consequence analysis performed, while others do not. The consequence properties help to rank components based on risk. *For more information, see Section 12.5.4 on page 278.*

The consequence analysis in the RBI software is modeled after API RP 581's Level 1 consequence analysis, which is a method used to evaluate the consequences of fluid or gas release.

12.1.3 Probability of Failure

In an RBI assessment, the probability of a component failing is based on several factors:

- Each component has its own set of internal properties including its *generic failure frequency* (GFF), which is the frequency of failure prior to any specific damage occurring from exposure to the operating environment. The RBI software calculates the GFF value using four different damage hole sizes and uses adjustment factors to reflect departures from industry data and to account for damage within a given component's normal operating environment. Hole sizes are Small, Medium, Large and Rupture.
- The **Management Systems Score** is an adjustment factor that accounts for the management influence of a given plant's supervisors and management on the mechanical integrity of the plant equipment. This factor helps to measure how likely it will be that management finds issues related to the plant's mechanical integrity. The factor is calculated based on a Management Score Survey that evaluates the facility's management systems and their effect on a given plant's risk. *See Section 12.3 on page 271.*
- Each **Damage Factor** is determined in accordance with API RP 581 and is based upon damage mechanisms relevant to construction, process services, current condition and prior damage inspections. According to API 581, the purpose of these damage factors is to provide a way to statistically evaluate the amount of damage that may be present as a function of time in service and effectiveness of an inspection activity to quantify damage. *See Section 12.5.2 on page 276.*

12.1.4 Program Parts

The API RBI program can be broken down into three parts:

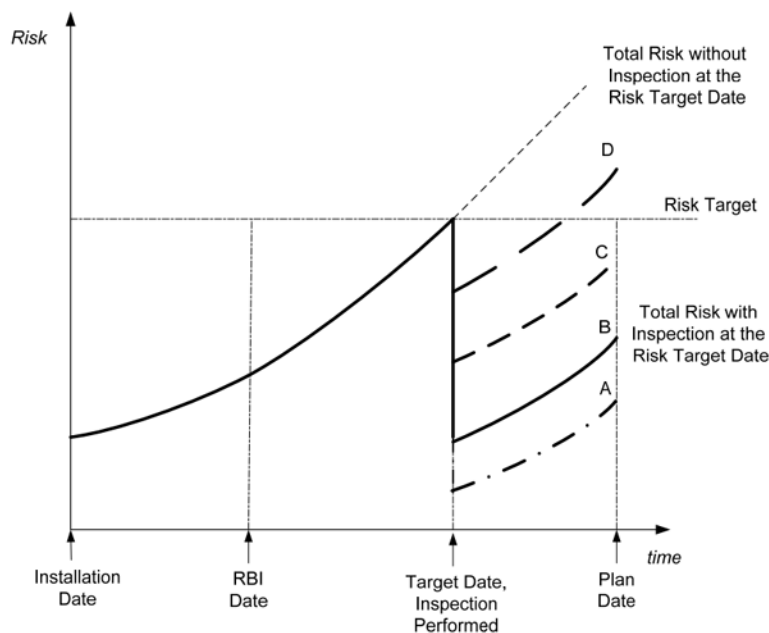
- Determining the Management Score. *See Section 12.3 on page 271.*
- Defining the probability of failure in an RBI Assessment. *See Section 12.5 on page 274.*
- Modeling the consequences in API RBI. *See Section 12.5.9 on page 281.*

12.1.5 Date Definitions

In a risk based inspection, the following dates are used:

- The *installation date* is the date the component was installed or replaced. This is set on the General Properties tab. *See Section 12.5.1 on page 275.*
- The *plan date* is the next date when the component is scheduled to undergo major maintenance or replacement. It is also set on the General Properties tab.
- The *RBI date* is the date when you perform the calculations. This is displayed on the Results tab. *See Section 12.5.9 on page 281.*
- If the RBI analysis indicates that inspections are needed before the plan date, then the *Target date* is the date when the inspections should be performed to reduce the risk to an acceptable level on the plan date. It is also displayed on the Results tab.

The following graphic shows the risk vs. time curve (i.e., the risk increases as time increases). When you perform an inspection, the risk should go down.



12.2 Risk Categories

The Risk Priority labels that are assigned on the Results tab (see Section 12.5.9 on page 281) from an RBI analysis (i.e., Low, Medium, Medium High and High) are determined based on two scoring matrices that can be customized to reflect the specific risk tolerance of your organization. Both scoring systems use the same 5-point scale to assign a rating based on the failure probability. In one, this is combined with a second 5-point scale that focuses on the financial consequences of failure (in terms of US\$). In the other, the second 5-point scale focuses on the size of the surrounding area that might be affected if a containment failure occurs (in terms of square meters).

To view or modify the rating scales that will be used for all RBI analyses in the current database, choose **System Hierarchy > Risk Based Inspection > Risk Categories**.



For each 5-point rating scale, you can set the **Range** of values that determine which rating will be applied in the RBI analysis results. For example, with the default settings shown in the picture below, the application assigns the lowest (best case) rating of **1** if the calculated failure probability is between 0 and 0.1; whereas, the application assigns the highest (worst case) rating of **5** if the probability is between 0.5 and 1.

You also have the option to customize the **Display** preferences for these rating scales. For example, with the default settings shown in the picture, the failure probability ratings will be displayed in the RBI analysis results as numbers from 1 to 5, but the consequence ratings will be displayed as letters from A to E. Therefore, if the analysis indicates that the failure probability and consequence both fall into the lowest (best case) rating, the results will display **1** for the failure probability and **A** for the consequence, while the highest (worst case) ratings will display **5** and **E**, and so on. The application then uses the scoring matrix table shown below to apply applicable Risk Priority label (Low, Medium, Medium High or High).

Failure Probability		
Category	Range (0 to 1)	Display
1	<= 0.1	1
2	<= 0.2	2
3	<= 0.3	3
4	<= 0.5	4
5	<= 1	5

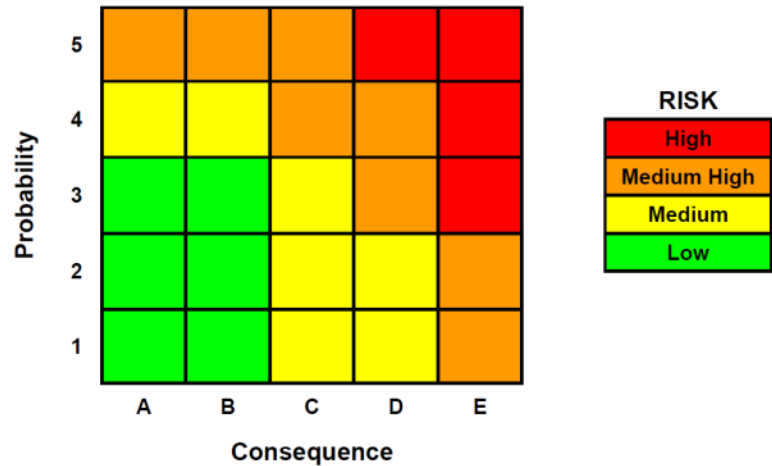
Area Consequence		
Category	Range (m ²)	Display
1	<= 9.29	A
2	<= 92.9	B
3	<= 279	C
4	<= 929	D
5	> 929	E

Financial Consequence		
Category	Range (\$)	Display
1	<= 10000	A
2	<= 100000	B
3	<= 1000000	C
4	<= 10000000	D
5	> 10000000	E

When you click **OK** to save the changes, any existing RBI analysis will be updated automatically.

12.2.1 The Scoring Matrix

The following table shows the scoring matrix.



12.3 Defining the Management Score

Each project must include a Management Systems Evaluation score, which is made up of 13 different types of questions and is used in the RBI evaluation results. There are a total of 101 questions with a maximum of 1,000 points. The questions pertain to the areas of plant management, operations, maintenance, safety, inspection, training and engineering. Typically this is done by auditors who are qualified to answer the specific questions.

To open the Management Systems Score window, choose **System Hierarchy > Risk Based Inspection > Management Score**.



The Management Systems Score window looks like this:

Management Systems Score (Project: Project 1)

Management Score Options

☐ Enter score from 1 to 1000 without answering questions
☐ Assume average score of 500
☒ Answer questionnaire and calculate score

Score
108

Categories				Questions				
#	Category	Possible Score	Actual Score	#	Question	Possible Score	Actual Score	Comments
1	Leadership and Administration	70	32	1	How often is a formal written assessment conducted of the facility's Process Safety Management system?	10	10 - Every year	
2	Process Safety Information	80	0	2	Has an action plan been developed to meet program needs as indicated by the last assessment?	10	10 - Yes	Action plan completed May 20, 2013.
3	Process Hazard Analysis	100	0		Based on the most recent assessment, did the assessment team include people with the following skills:			
4	Management of Change	80	0		Formal training in assessment techniques?	5		
5	Operating Procedures	80	0	3	In-depth knowledge of the process being assessed?	5	5 - Yes	
6	Safe Work Practices	85	0		Based on a review of the most recent assessment, was the breadth and depth of the assessment appropriate for the facility?	10	10 - Yes	
7	Training	100	0					
8	Mechanical Integrity	120	41					
9	Pre-Startup Safety Review	60	0					
10	Emergency Response	65	0					
11	Incident Investigation	75	0					
12	Contractors	45	0					
13	Management Systems Assessments	40	35					

OK Cancel

Management Systems Score (Project: Project 1)

In the **Management Score Options** area, choose one of the following options:

- If you already know what the score is, such as from a recent inspection, choose **Enter score from 0 to 1000 without answering questions** and enter a value in the **Score** field.
- If you decide not to or cannot conduct an audit, choose **Assume average score of 500**. In this case the **Score** field value is automatically set to 500.
- If you are ready to perform the audit, choose **Answer questionnaire and calculate score**, then do the following:
 - Select any row in the **Categories** area on the left. The **Questions** area on the right then displays the applicable questions.
 - The **Possible Score** column shows the maximum value (i.e., best case scenario) for each question while the **Actual Score** column allows you to select the applicable score from the drop-down lists.
 - If desired, you can use the **Comments** column to record any additional information that is relevant to your rating for the question (up to 255 characters). You can type directly in this field or click anywhere in the field to display the **Select Existing** icon. This icon opens the Select Existing window that allows you to choose comments used in other data sources. *See page 113 in Chapter 3.*



The **Score** field at the top of the window displays the sum of all the individual question scores.

12.4 Building the RBI System Hierarchy

For RBI analyses, you have the option to define systems and subsystems in the system hierarchy, if desired. However, the risk based inspection analysis can be performed only for specialized items that represent specific Equipment and Component types that are addressed in the API RP 580/1 guidelines. To perform an RBI analysis, the hierarchy must include:

- At least one piece of equipment that is eligible for RBI analysis. The Add RBI Equipment window provides a list of the equipment types that can be analyzed (e.g., compressor, heat exchanger, etc.).
- At least one component for each piece equipment. The Add RBI Component window provides a list of the component types that are available for the equipment type that is currently selected.

Note: The specific types of equipment and components are defined by the RBI methodology and may not be modified or deleted. You can have multiple instances of each type of equipment and component in the same project.

RBI items have the same item properties (*see page 213 in Chapter 7*) as other items in the system hierarchy and can have additional analyses attached (i.e., they can include FMEAs, Risk Discovery Analyses, etc.). They do have the following differences:

- While you can place an RBI item under a non-RBI item, you cannot place a non-RBI item under an RBI item.
- An RBI component item must always be under the relevant equipment type and cannot be placed or promoted above it.

12.4.1 Adding Equipment

When you add an RBI equipment item to the system hierarchy, it will be added to the bottom of the list.

- Select any item in the system hierarchy other than an RBI component item and choose **System Hierarchy > Risk Based Inspection > Add RBI Equipment**.



The command opens a window that displays the list of equipment types that have been predefined for RBI analysis. Use the check boxes to select one or more items to add to the system configuration and click **OK**.

12.4.2 Adding Component Items

When you add an RBI component item to a piece of equipment, it will be added to the bottom of the list for that equipment.

- Select an RBI equipment item and choose **System Hierarchy > Risk Based Inspection > Add Component**.



The command opens a window that displays the list of components for that type of equipment (based on the RBI standards). When adding a component, you have the option to create the item immediately or work through the wizard to define the general properties (*see Section 12.5.1 on page 275*) and damage factors (*see Section 12.5.2 on page 276*) first. If you choose not to define the properties when adding the component, you can still view/edit these properties at any time from the tabs in the Analysis panel.

12.4.3 Converting System Hierarchy Items to RBI Equipment

Starting in version 9.0.3, you can convert a non-RBI item in the system hierarchy to an RBI item if it is either at the lowest level in its branch or if it has no more than one level of dependents. In addition, the item must not have any RBI equipment items as dependents.

- Select the item and choose **System Hierarchy > Risk Based Inspection > Convert to Equipment**.



The command opens a window where you can choose which equipment type to convert the item to.

- If the item is at the lowest level in its branch, select the desired RBI equipment type and click **OK** to convert the item.
- If the item has dependents, select the desired RBI equipment type and then click **Next >**. On the second page, choose which RBI component type each dependent item will be converted to, then click **OK**.

All converted items retain the original item properties they had before the conversion. *See page 213 in Chapter 7.*

12.5 RBI Properties

When you have selected an RBI component in the system hierarchy, the RBI properties tab will be visible in the Analysis panel. There are five tabs at the bottom of the panel that lead you through the five steps in the RBI assessment process. For each component, you will be able to:

1. Define the general properties - Section 12.5.1 (p. 275).
2. Select which damage factors are relevant - Section 12.5.2 (p. 276).
3. Set the analysis properties for the relevant damage factors - Section 12.5.3 (p. 277).
4. Set the consequence properties - Section 12.5.4 (p. 278).
5. Generate and evaluate the results - Section 12.5.9 (p. 281).

Tip: You should perform these steps in the order listed as the selections you make in the earlier steps determine which properties you must set in the later steps.

You have the option to perform the first two steps when you are adding the RBI component item to the system hierarchy. You can then view and/or edit these properties in the Analysis panel at any time after the item is created.

12.5.1 General Properties

The General Properties tab contains properties that are later used both for the potential screening of possible damage factors and the screening of possible consequences, as well as for calculations of failure and consequence.

Property Name	Value
Material of Construction	Carbon or Low Alloy
Lining Present	No
Insulation Present	No
Exposed to Chloride and Water	No
Processed Fluid Type	
Operating Temperature (°C)	850
Operating Pressure (Pa)	800000
pH of the Process Fluid > 7.5	No
Date of Component Installation	2/1/1998
Plan Date	2/1/2018

Note: These properties also appear in the Add RBI Component window when adding a component to the system hierarchy. See Section 12.4.2 on page 273.

Note the following:

- The **Material of Construction** and **Processed Fluid Type** fields are optional. For each field, if you select an option, the software will hide the non-relevant damage factors on the Damage Factors Selection tab. If the applicable construction material or fluid type is not shown in the drop-down list, then leave the field blank.
- The **Operating Temperature (°C)** value must be ≥ -250 and $\leq 1,000$.
- The **Operating Pressure (Pa)** value must be $\geq 101,325$. If you accept the default (i.e., atmospheric pressure) then the component is treated as being non-pressurized.

Note: For Tank650 equipment, if a COURSE or TANKBOTTOM component is not pressurized then the analysis is simplified and has fewer consequence properties.

- Use the **Date of Component Installation** to specify when the component was installed in the system. It must be before the current date.
- Use the **Plan Date** to specify the date when the component is scheduled to be maintained. It must be later than the current date.

If desired, you can use the **Notes** column, , to record any notes about the information supplied. These notes only appear in the RBI Properties tab and do not display in any reports. Double-click inside the cell to open the Notes window. An icon in the cell indicates that notes have been saved for that field.

12.5.2 Damage Factor Selection

The Damage Factors Selection tab allows you to select which damage factors apply to the component. The list of factors that may be considered will depend on the component and your answers on the General Properties tab. For example, for a tank bottom, and assuming that the other values remain at their defaults, nine damage factors will be displayed if the material of construction is carbon or low alloy steel, but only three damage factors will be displayed if the material is austenitic stainless steel.

Properties		RBI Properties	Risk Discovery	
Damage Factor	Description	Applies?	Comments	
Thinning Damage Factor	This is a required factor that applies to all components.	Yes	This is a required damage factor.	
SCC Damage Factor-Caustic Cracking	The component is composed of a carbon or low alloy steel and there are any concentrations of caustic elements in the process environment.	No		
SCC Damage Factor-Amine Cracking	The component is composed of a carbon or low alloy steel and the process environment has any concentration present of acid gas treating amines (e.g., DIPA, MEA, etc.).	No		
SCC Damage Factor-Sulfide Stress Cracking	The component is composed of carbon or low alloy steel and it operates in an environment that contains any concentration of H2S and water.	Yes		
SCC Damage Factor-HIC/SOHIC-H2S	The component is composed of a carbon or low alloy steel and there is H2S and water in any concentration in the process environment.	Yes		
SCC Damage Factor-HSC-HF	The component is composed of a carbon or low alloy steel and it is exposed to any concentration of hydrofluoric acid.	No		
SCC Damage Factor-HIC/SOHIC-HF	The component is composed of a carbon or low alloy steel and it is exposed to any concentration of hydrofluoric acid.	No		
HTHA Damage Factor	The component is composed of a carbon or low alloy steel, the hydrogen partial pressure during operations is greater than 0.552 MPa and the component's operating temperature is greater than 204°C.	Yes		
Brittle Fracture Damage Factor	The material is composed of carbon steel or low-alloy steel (see the table in the help file for the available steel types) and the Minimum Design Metal Temperature is either unknown or known but the component may operate below it under normal conditions.	No		
General Properties	Damage Factors Selection	Damage Factors Properties	Consequence Properties	Results

Note: These factors also appear in the Add RBI Component window when adding a component to the system hierarchy. See Section 12.4.2 on page 273.

For each factor, click inside the **Applies?** column to answer Yes or No. If the factor applies, it will be highlighted in red and you will be prompted to specify the relevant properties on the Damage Factors Properties tab. See Section 12.5.3 on page 277.

Each factor also includes a **Comments** field where you can enter any additional information (up to 255 characters) that is relevant to your response to the damage factor. You can type directly in this field or click anywhere in the field to display the **Select Existing** icon. This icon opens the Select Existing window that allows you to choose comments used in other data sources. See page 113 in Chapter 3.



12.5.3 Damage Factor Properties

The Damage Factors Properties tab allows you to make the required inputs for the damage factors that are applicable for the component (based on your selections on the Damage Factors Selection tab).

Property Name		Value
Apply to Multiple Damage Factors		
Internal Cracking Present		No
pH of Process Fluid		5
H2S Content of Process Fluid		50 to 1000 ppm
Cyanide Present		No
Post-Weld Heat Treatment (PWHT)		No
Thinning Damage Factor		
Thinning Type		General Thinning - > 10%
Date of Last Wall Thickness Inspection		2/1/2008
Number of Inspections		2 - Inspections
Inspection Effectiveness		C - Fairly Effective
Last Inspection Thickness (mm)		24
Corrosion Rate of Base Metal (mm/yr)		0.12
Minimum Wall Thickness Per Code (mm)		21.2
Corrosion Allowance (mm)		4
Cladding Present		No
Type of Online Monitoring		Corrosion Coupons
Thinning Mechanism		Other Corrosion Mechanism
SCC Damage Factor- Sulfide Stress Cracking		
Date of Last Inspection		2/1/2008
Number of Inspections		1 - Inspection
Inspection Effectiveness		D - Poorly Effective
Max Brinnell Hardness		< 200
SCC Damage Factor- HIC/SOHIC-H2S		
HTHA Damage Factor		
Number of Inspections		1 - Inspection
Inspection Effectiveness		B - Usually Effective
HTHA Damage		No
Material		Carbon Steel
Partial Pressure of H2 (Pa)		560000
High Levels of Tramp Elements (As, Sb, Sn, P) Present		No

General Properties
Damage Factors Selection
Damage Factors Properties
Consequence Properties
Results

The properties are grouped into nodes based on the relevant damage factor. However, if a property applies to multiple damage factors, then it will appear in the **Apply to Multiple Damage Factors** node at the top of the tab and will only need to be specified once regardless of how many damage factors share the property.

All damage factor properties and consequences properties must be filled out before you can calculate the RBI results.

If desired, you can use the **Notes** column, , to record any notes about the information supplied. These notes only appear in the RBI Properties tab and do not display in any reports. Double-click inside the cell to open the Notes window. An icon in the cell indicates that notes have been saved for that field.

12.5.4 Consequence Properties

The Consequences Properties tab allows you to make the required inputs to evaluate the consequences of failure in terms of flammability, toxicity and financial loss. These properties apply regardless of the selected damage factors and damage factor properties.

Properties RBI Properties Risk Discovery		
Property Name	Value	
Flow Rates / Flammability		
Representative Process Fluid	C1-C2	
Storage Phase	Gas/Vapor	
Atmospheric Temperature (°C)	20	
Component Diameter (m)	5	
Detection Classification	B - Average	
Isolation Classification	B - Average	
Component Mass (kg)	2000	
Inventory Mass (kg)	15000	
Flammability Mitigation System	Inventory Blowdown, C...	
Toxicity		
Toxicity Mitigation Reduction (%)	0	
Mass Fraction Hydrofluoric Acid (HF)	0	
Mass Fraction Hydrogen Sulfide (H2S)	0.01	
Mass Fraction Ammonia (NH3)	0	
Mass Fraction Chlorine (Cl2)	0	
Mass Fraction Aluminum Chloride (AlCl3)	0	
Mass Fraction Carbon Monoxide (CO)	0.001	
Mass Fraction Hydrogen Chloride (HCl)	0	
Mass Fraction Nitric Acid (HNO3)	0	
Mass Fraction Nitrogen Dioxide (NO2)	0	
Mass Fraction Phosgene (COCl2)	0	
Mass Fraction Toluene Diisocyanate (TDI)	0	
Mass Fraction Ethylene Glycol Monoethyl Ether (EE)	0	
Mass Fraction Ethylene Oxide (EO)	0	
Mass Fraction Propylene Oxide (PO)	0	
Financial		
Component Material	Carbon Steel	
Equipment Outage Multiplier	1	
Personnel Density Within Unit (personnel/m ²)	0.0001	
Equipment Cost (\$/m ²)	5000	
Loss of Production Due to Component Downtime (\$/day)	1200000	
Cost Associated with Injury or Fatality of Personnel (\$)	100000	
Environmental Cleanup Cost (\$/bbl)	1E-05	
Risk Target for Consequence Area (m ²)	1000	
Risk Target for Financial Consequence (\$)	100000	
General Properties	Damage Factors Selection	Damage Factors Properties
		Consequence Properties
		Results

Note: For Tank650 equipment, if a COURSE or TANKBOTTOM component is not pressurized (i.e., the operating pressure is 101325 Pa) then the analysis is simplified and has fewer consequence properties.

RBI performs an API RBI RP Level 1 consequence analysis to calculate the risk based upon releases for common risk-causing fluids. Flammable and non-flammable consequence areas are calculated for each hole release rate based upon a given hole size within the component, and these are all combined based on the relative frequency of failure for each hole size. *See Section 12.5.8 on page 279 for more details.*

If desired, you can use the **Notes** column, , to record any notes about the information supplied. These notes only appear in the RBI Properties tab and do not display in any reports. Double-click inside the cell to open the Notes window. An icon in the cell indicates that notes have been saved for that field.

12.5.5 Flow Rates/Flammability

The Flow Rates/Flammability properties define the general properties of the process fluid and the storage/process area. Note the following:

- Use the **Representative Process Fluid** drop-down list to select the fluid that the component most often handles.
- In the **Atmospheric Temperature (°C)** field enter a value that must be ≥ -100 and ≤ 100 .
- In the **Component Mass (kg)** (i.e., the amount of material stored in the component) and **Inventory Mass (kg)** (i.e., the amount of material included in the component and that can flow into the component from other connected components) fields, enter values greater than 0.

12.5.6 Toxicity

The Toxicity properties are used to determine the physical damage from loss of containment or rupture that may occur to the surrounding equipment, components, personnel and environment. The impact areas may occur from pool fires, flash fires, fireballs, jet fires and/or vapor cloud explosions. Note the following:

- In the **Toxicity Mitigation Reduction (%)** field, enter a value greater than or equal to 0 that specifies the percentage by which the toxic effects are lessened due to mitigation systems.
- In the remaining fields, enter the specific mass fractions (i.e., the fraction of the process fluid that is composed of that compound) as decimal values that must be ≥ 0.0 and ≤ 1.0 .

12.5.7 Financial

The Financial properties are used to determine the monetary cost of failure. These calculations take into consideration or calculate the hole costs, material costs, plant downtime, cost of the equipment, the cost on the surrounding area and the personal injury costs.

12.5.8 Fluid List

The following table shows the risk-causing fluids that can be considered in the analysis.

Representative Fluid	Examples of Applicable Materials
C1 - C2	Fuel gas, methane, ethane, ethylene, LNG
C3 - C4	Propane, butane, isobutane, LPG
C5	Pentane
C6 - C8	Gasoline, naptha, light straight run, heptane
C9 - C12	Diesel, kerosene
C13 - C16	Jet fuel, kerosene, atmospheric gas oil
C17 - C25	Gas oil, typical crude oil
C25+	Residuum, heavy crude, lube oil, seal oil
Hydrogen (gas)	Hydrogen only
Hydrogen Sulfide (H ₂ S)	Hydrogen sulfide only
Hydrogen Fluoride	Hydrogen fluoride
Water	Water

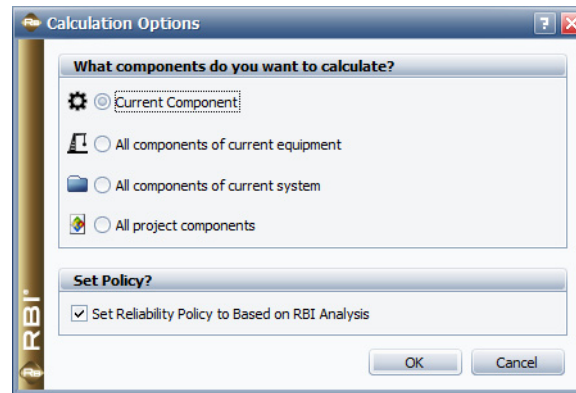
Representative Fluid	Examples of Applicable Materials
Steam	Steam
Acid (low)	Acid, caustic
Aromatics	Benzene, Toluene, Xylene, Cumene Note: Styrene is an aromatic and is treated as such for calculation purposes. (This is per API RP 581, page 3-50.)
Aluminum Trichloride	Aluminum Chloride
Pyrophoric	Pyrophoric Materials
Ammonia	Ammonia
Chlorine	Chlorine
Carbon Monoxide (CO)	Carbon Monoxide
Diethyl Ether	Diethyl Ether
Hydrogen Chloride (HCl)	Hydrogen Chloride
Nitric Acid	Nitric Acid
Nitrogen Dioxide	Nitrogen Dioxide
Phosgene	Phosgene
Toluene Diisocyanate (TDI)	Toluene Diisocyanate
Methanol	Methanol
Propylene Oxide	Propylene Oxide
Ethylene Glycol Monoethyl Ether Acetate	Ethylene Glycol Monoethyl Ether Acetate
Ethylene Glycol Monoethyl Ether	Ethylene Glycol Monoethyl Ether
Ethylene Glycol	Ethylene Glycol
Ethylene Oxide (EO)	Ethylene Oxide

12.5.9 RBI Results

After you have entered all of the component data, you can calculate the results by choosing **System Hierarchy > Risk Based Inspection > Calculate Risk**.



The Calculations Options window allows you to select which components to calculate.



If you select the **Set Reliability Policy to Based on RBI Analysis** check box, the software will use the created model from the RBI results as the reliability policy on the Properties tab of the Analysis panel. *See page 213 in Chapter 7.* This will also allow the generated model to be used in many additional places in your analysis. For example, you can use it in the Failure Modes and Reliability Analysis (FMRA) (*see Chapter 8*) to determine the reliability of the entire system (including synchronizing the hierarchy with BlockSim) or calculate the system availability and cost values (*see page 237 in Chapter 8*). It can be used with a Functional Failure Analysis (FFA) (*see page 297 in Chapter 13*) to generate the maintenance tasks (*see page 300 in Chapter 13*) for the component. And it can be used when performing simulations and cost calculations (*see page 302 in Chapter 13*).

If you already have an existing model for the component, you can clear the check box and base the reliability on it instead. (In other words, the model generated by the RBI software is best used in cases where you do not already have an established reliability model.)

Note: The models are always 2-parameter Weibull models with the time units set to Years. These models cannot be directly modified by any user. To change them, you must change the analysis and recalculate the model.

The results are displayed in the following nodes:

Properties	RBI Properties	Risk Discovery
Area and Financial Consequence Results		
RBI Date Results: 10/4/2013		
Plan Date Results: 2/1/2018		
Target Date Results: 10/4/2013		
Recommended Inspection(s)		
Number of Inspections Needed for Thinning		0
Number of Inspections Needed for SCC-Sulfide Stress Cracking		1
Effectiveness of the Inspections Needed for SCC-Sulfide Stress Cracking		D
Number of Inspections Needed for SCC-HIC/SOHIC-H2S		1
Effectiveness of the Inspections Needed for SCC-HIC/SOHIC-H2S		B
Number of Inspections Needed for HTHA		1
Effectiveness of the Inspections Needed for HTHA		B
Plan Date with Inspection Results: 2/1/2018		
Individual Damage Factor Results		
DF Thinning		1
DF SCC-SSC		5.01
DF SCC-HIC/SOHIC-H2S		5.01
DF HTHA		400
Governing Damage Factor Results		
DF Governing Thinning		1
DF Governing SCC		5.01
Overall Damage Factor and Probability of Failure		
Total DF (Plan Date w/Insp)		405.01
Probability Of Failure		0.01
Risk Analysis (Area)		
Area Based Risk (m^2)		24.29
Probability Category		1
ConsequenceCategory		E
Risk Priority		Medium High
Risk Analysis (Financial)		
Financial Based Risk (\$)		6.28E+05
Probability Category		1
ConsequenceCategory		E
Risk Priority		Medium High
History		
General Properties	Damage Factors Selection	Damage Factors Properties
	Consequence Properties	Results

- **Area and Financial Consequence Results:**
 - The **Area Consequence Results** node displays the estimated effect of a failure based on safety.
 - The **Financial Consequence Results** node displays the estimated monetary effect of a failure (i.e., the repair, clean-up, replacement and other costs).
- **RBI Date Results:** This node displays results on the date the results were calculated:
 - The **Overall Damage Factor and Probability of Failure** node displays the total damage factor associated with the component as well as the probability of failure associated with the total damage factor.
 - The **Risk Analysis (Area)** node displays the calculated *area at risk* (i.e., the total area value times the probability of failure at the given date) and the probability category of the component failing (as based on the Risk Category values (see Section 12.2 on page 270) for the project) at the given date. It also displays the calculated Risk Priority value based on the scoring matrix (i.e., Low, Medium, Medium High or High). See Section 12.2.1 on page 271.
 - The **Risk Analysis (Financial)** node displays similar information for the financial consequences of failure.
- **Plan Date Results:** This node displays the same type of results as the RBI Date Results node, but shows the risk values on the plan date (i.e., the date of the planned maintenance) assuming you do nothing until then.

- If the analysis indicates that an inspection is required before the plan date, the **Target Date Results** node specifies the target date (i.e., the date on which the component will exceed the maximum acceptable risk(s) and is therefore the date when the next set of inspection(s) should take place) and provides information about when you should inspect the component and the anticipated state of the component on that date.

If the risk on the plan date is less than the maximum acceptable risk, then no target date is given as no inspections are needed until the plan date.

- **Recommended Inspection(s):** If applicable, this node displays the number of inspections needed for each type of damage and the level of inspection that you will need to perform on the target date when you inspect the component to get your desired results.
- **Plan Date with Inspection Results:** This node displays the same type of results as the RBI Date Results node, but shows the risk values on the plan date assuming that the recommended inspections on the target date are carried out. If no inspections are needed, the node states that.

Generic Inspection Level Table

While the exact meaning of *effectiveness* varies depending on the component and what its properties are, the following table shows a generic version of the inspection levels that can be recommended to be performed.

Level	Generic Meaning
A	Highly Effective
B	Usually Effective
C	Fairly Effective
D	Poorly Effective
E	Ineffective

12.6 Configuring a HEXTUBE Component

Used in heat exchangers, HEXTUBES are used to carry gas and/or liquids from one side of the heat exchanger to the other. They only require that you define the general properties and then review the calculated results.

12.6.1 General Properties

The General Properties tab contains information about the HEXTUBE and is divided into two nodes: General and Financial.

Property Name		Value
General		
Bundle Material		Carbon Steel
Shell Inside Diameter (m)		1
Tube Bundle Length (m)		5
Initial HexTube Model		RBI_HTInitial_HEXTUBE_Model [WB2 (1,500, 20,000)]
Date of Component Installation		3/18/2003
Plan Date		3/18/2018
Planned Shutdown Date After Current Plan Date		3/20/2023
Financial		
Date of Last Inspection		8/5/2008
Inspection Effectiveness		C - Moderately Effective
Last Life Extension Method		Partial Retube
Next Life Extension Method		Total Retube
Daily Production Margin of the Unit (\$/day)		1200000
Percentage of Production Loss Due to Bypass		12.5
Days to Repair Bundle for Unplanned Failure		5
Days to Repair Bundle During Planned Shutdown		2
Environmental Cost (\$)		50000
Maintenance Cost (\$)		25000
Rate of Return Adjuster		1
Risk Target for Financial Consequence (\$)		100000

General Properties
Results

General

The properties in this node determine the basic properties of the HEXTUBE. Note the following:

- The **Initial HexTube Model** is optional and allows you to assign a model, which may represent a fixed time or a distribution, to describe the damage properties of the HEXTUBE. You can choose an existing model or create a new one. If no model is assigned, it is assumed that the HEXTUBE cannot fail. *See page 166 in Chapter 5.*

The model should be generated from previous inspection data of HEXTUBES in identical or similar process environments. If no previous data is available, you should create a model from whatever information is available, such as estimated corrosion rates and corrosion allowance information.

- Use the **Date of Component Installation** to specify when the HEXTUBE was installed in the system. It must be before the current date.
- Use the **Plan Date** to specify the date when the HEXTUBE is scheduled to be maintained. It must be later than the current date.
- Use the **Planned Shutdown Date After Current Plan Date** to specify the date of inspection (shutdown) following the plan date.

Financial

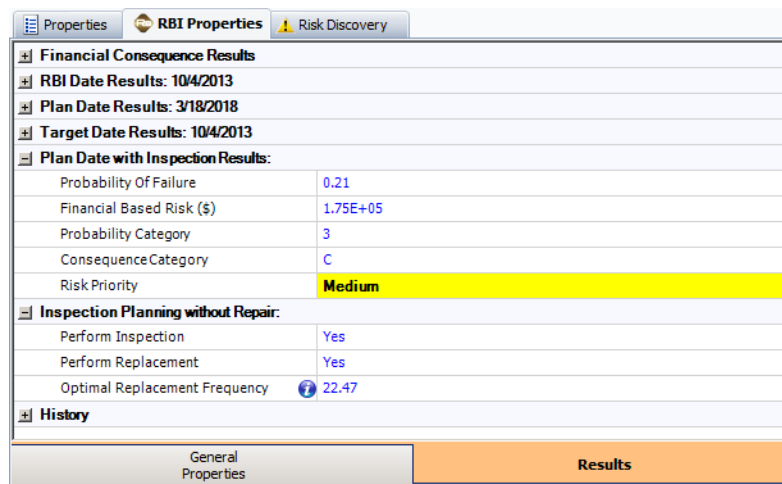
The Financial properties are used to determine the monetary cost of the HEXTUBE failing. These calculations take into consideration or calculate the hole costs, material costs, plant downtime, cost of the equipment, the cost on the surrounding area and the personal injury costs. Note the following:

- Use the **Date of Last Inspection** to indicate the last date that the component was inspected. If there was no inspection, use date the component was installed.

If desired, you can use the **Notes** column, , to record any notes about the information supplied. These notes only appear in the RBI Properties tab and do not display in any reports. Double-click inside the cell to open the Notes window. An icon in the cell indicates that notes have been saved for that field.

12.6.2 Results Properties

The results are displayed in the following nodes:



Financial Consequence Results	
RBI Date Results:	10/4/2013
Plan Date Results:	3/18/2018
Target Date Results:	10/4/2013
Plan Date with Inspection Results:	
Probability Of Failure	0.21
Financial Based Risk (\$)	1.75E+05
Probability Category	3
Consequence Category	C
Risk Priority	Medium
Inspection Planning without Repair:	
Perform Inspection	Yes
Perform Replacement	Yes
Optimal Replacement Frequency	22.47
History	

- The **Financial Consequence Results** node displays the total cost of the HEXTUBE if it breaks (i.e., the repair, clean-up, replacement and other costs).
- The **RBI Date Results** node displays the results as of the date the results were calculated:
 - The **Probability Category** displays the probability of the component failing (as based on the Risk Category values for the project) at the given date. *See Section 12.2 on page 270.*
 - The **Consequence Category** displays similar information for the financial consequences of failure.
 - The **Risk Priority** displays the calculated value based on the scoring matrix (i.e., Low, Medium, Medium High or High). *See Section 12.2.1 on page 271.*
- **Plan Date Results:** This node displays the same type of results as the RBI Date Results node, but shows the risk values on the plan date (i.e., the date of the planned maintenance) assuming you do nothing until then.
- If the analysis indicates that an inspection is required before the plan date, the **Target Date Results** node specifies the *target date* (i.e., the date on which the component will exceed the maximum acceptable risk(s) and is therefore the date when the next set of inspection(s) should take place) and provides information about when you should inspect the HEXTUBE and the anticipated state of the HEXTUBE on that date.

If the risk on the plan date is less than the maximum acceptable risk, then no target date is given as no inspections are needed until the plan date.

- **Plan Date with Inspection Results:** This node displays the same type of results as the RBI Date Results node, but shows the risk values on the plan date assuming that the recommended inspections on the target date are carried out. If no inspections are needed, the node states that.
- **Inspection Planning without Repair:** This node displays the recommended actions if you do not repair the HEXTUBE, but only inspect and replace it.
 - **Perform Inspection** displays **Yes** if you should inspect the HEXTUBE at the next plan date, or **No** if you should wait until following plan date to inspect the HEXTUBE.
 - **Perform Replacement** displays **Yes** if you should replace the HEXTUBE at the next plan date, or **No** if you should wait until following plan date to replace the HEXTUBE.
 - **Optimal Replacement Frequency** is the optimal time between replacements assuming no repairs are done.

12.7 Configuring a Pressure Relief Device

Pressure relief devices are used to relieve excess pressure build-up in a plant and they are the only pieces of RBI equipment that include RBI-specific properties.

12.7.1 General Properties

The General Properties tab contains information about the pressure relief device and is divided into three nodes: General, Financial and Demand.

General

The properties in this node determine the basic properties of the pressure relief device.

Property Name	Value
General	
Type of PRD	Conventional
Maximum Allowed Working Pressure (Pa)	1000000
Failure on Demand Model Available	No
Leakage Model Available	No
Fluid Severity	Moderate
History of Excessive Actuation	No
History of Chatter	No
Fluid Severity for Leakage	Moderate
PRD Contains Soft Seats (O-Rings)	Yes
Rupture Disk Upstream of the PRD	No
Installed Piping Vibration	No
Pulsating or Cyclical Service	No
Discharge Location	Discharge to Closed System
Last Installation/Inspection-Refurbish Date	4/12/2013
Plan Date	2/1/2018
Regulatory Inspection Interval (yrs)	3
Financial	
Demand	

Note the following:

- The **Maximum Allowed Working Pressure (Pa)** value must be greater than 101325.
- The **Failure on Demand Model Available** field allows you to specify that there is a model available that describes the failure properties of the pressure relief device. You can then use the **Reliability Model for PRD FOD** field to assign a model, which may represent a fixed time or a distribution. You can choose an existing model or create a new one. *See page 166 in Chapter 5.*

- The **Leakage Model Available** field allows you to specify that there is a model available that describes the leakage properties of the pressure relief device. You can then use the **Reliability Model for PRD POL** field to assign a model, which may represent a fixed time or a distribution. You can choose an existing model or create a new one.

If no models are available, then you must answer other several other questions that RBI uses to generate the internal models that will be used in the RBI calculations. (These internal models are not resources and cannot be modified by the user.)

- Use the **Last Installation Date/Inspection Re-furbish Date** to specify when the pressure relief device was installed or last refurbished. It must be before the current date.
- Use the **Plan Date** to specify the date when the pressure relief device is scheduled to be maintained. It must be later than the current date.
- Use the **Regulatory Inspection Interval (yrs)** to specify the maximum number of years allowed between the refurbishing of the pressure relief device.

Financial

The Financial properties are used to determine the monetary cost of failure. These calculations take into consideration or calculate the hole costs, material costs, plant downtime, cost of the equipment, the cost on the surrounding area and the personal injury costs.

Property Name	Value
General	
Financial	
Multiple PRD Present	No
PRD Rated Capacity (kg/hr)	5000
PRD Inlet Diameter (m)	0.0191 m ≤ Inlet Diameter ≤ 0.0381...
Leaking PRD Options	Leaking PRD Cannot be Tolerated Bu...
Number of Days to Repair PRD	2
Fluid Cost (\$/kg)	6
Cost to Cleanup Environment Due to PRD Leakage (\$)	0
Demand	

Demand

The Demand properties are used to determine the properties that relate to the various overpressure demands to which the pressure relief device can be subjected.

Property Name	Value
General	
Financial	
Demand	
Administrative Controls to Protect Overpressure Protection	Yes
OP Demand - Fire	Yes
OP Demand - Blocked Discharge	No
OP Demand - Thermal Relief	No
OP Demand - Liquid Overfill	No
OP Demand - Loss of Cooling Water Utility	No
OP Demand - Electrical Power Supply Failure	No
OP Demand - Control Valve Failure, Initiating Event is Same Dir. As CV Normal Fail Position	No
OP Demand - Control Valve Failure, Initiating Event is Opposite Dir. As CV Normal Fail Position	No
OP Demand - Tower P/A or Reflux Pump Failures	No
OP Demand - Runaway Chemical Reaction	Yes
Overpressure Multiplier	1.5
Numerical Value of Possible (%)	25
Numerical Value of Probable (%)	50
Risk Target for Consequence Area (m ²)	100
Risk Target for Financial Consequence (\$)	100000

Note the following:

- In the **Overpressure Multiplier** field, enter a value between 1 and 4, where 1 indicates the best case scenario and 4 indicates the worst case scenario (i.e., the component is expected to rupture).

If desired, you can use the **Notes** column, , to record any notes about the information supplied. These notes only appear in the RBI Properties tab and do not display in any reports. Double-click inside the cell to open the Notes window. An icon in the cell indicates that notes have been saved for that field.

12.7.2 Assigning Components

For each pressure relief device you must assign the components that are being protected by the device. Starting in 9.0.10, the possible component types that can be assigned are:

- All component types for the Compressor, Pipe, Pump and Vessel-FinFan equipment types.
- The HEXSS and HEXTS component types for the Heat Exchanger equipment.

Each assigned component must already have its properties defined in its parent piece of equipment before being used by the pressure relief device.

To assign a component to the PRD, while on the General Properties tab, choose **System Hierarchy > Risk Based Inspection > PRD Components > Assign Components**.



In the window that displays, select the applicable components. You can assign the same component to multiple pressure relief devices.

12.7.3 Results Properties

The displayed results include the following information:

Properties		RBI Properties		Risk Discovery	
Results					
Area - Based Risk (m^2)		4.25			
Financial - Based Risk (\$)		1.00E+05			
Target Date with PRD		8/16/2014			
History					
General Properties			Results		

- The **Area - Based Risk (m²)** and **Financial - Based Risk (\$)** fields display the risk at the next recommended inspection/refurbishment date.
- The **Target Date** displays the date of the next recommended inspection/refurbishment.

12.8 Table of Steel Types

The following table is derived from the API RP 581 document and provides information about materials that are made of either carbon steel or a low-alloy steel. It is used with several damage factors on the Damage Factor Properties tab. *See Section 12.5.3 on page 277.*

Group	Material (A), (B), (C)
1	1. All carbon and low alloy steel bars, plates and structural shapes not otherwise listed in this table. 2. SA-216: Grades WCC and WCB, and SA - 217: Grade WC6, if they are water-quenched or normalized, and tempered. 3. Obsolete material specifications: A7, A10, A30, A70, A113, A149, A150 (D). 4. Obsolete 1934 ASME Code, Section VIII material specifications: S1, S2, S25, S26, and S27 (E). 5. Steel made using A201 and A212 specifications unless it can be established that the steel was produced by a fine-grain practice (F).
2	1. SA-216: Grade WCA if water-quenched or normalized, and tempered. SA-216: Grades WCB and WCC if water-quenched and tempered, produced to a fine grain practice and the thickness does not exceed 2 inches. SA-217: Grade WC9 if tempered and normalized SA-285: Grades A and B and SA-414: Grade A SA-442: Grade 55 if normalized, not produced using a fine grain practice and is > 1 inch thick SA-442: Grade 60 if it is normalized and not produced using a fine grain practice SA-515: Grades 55 and 60 SA-516: Grades 65 and 70, SA-612 and SA-662: Grade B if not normalized 2. All materials from Group 1 that are produced using a fine grain practice and are normalized and are not listed in Groups 3 and 4 below. This does not apply for cast steels. 3. All fittings, forgings, pipes and tubing not listed in Groups 3 and 4 below. 4. If the parts were fabricated using the guidelines from paragraph UG-11, Section VIII, Division 1 of the ASME Code must be included in this group, regardless of which group they should otherwise be in. 5. Steel made using A201 and A212 specifications if it can be established that the steel was produced by a fine-grain practice.

Group	Material (A), (B), (C)
3	- SA-182: Grades 21 and 22, SA-336: Grades F21 and F22, and SA-387: Grades 21 and 22, if tempered and normalized SA-302: Grades C and D SA-442: Grades 55 < 1 in. if normalized and not produced using a fine grain practice SA-516: Grades 55 and 60 if not normalized SA-533: Grades B and C, SA-662: Grade A - All material of Group 2 if normalized and produced to fine grain practice and not listed in Group 4 below.
4	SA-203 SA-442, if normalized and produced using a fine grain practice SA-508: Class 1 SA-516, SA 612 and SA 662 if normalized SA-524 and SA 537: Classes 1 and 2 SA-738: Grade A
A. When a material sub-classification is not shown, all sub-classifications of the material are included. B. For all material assignment notes: - As permitted by the material specifications, all cooling rates faster than those by air, followed by tempering, are considered to be equal to tempering and normalizing heat treatments. - As described in SA-20, the production to fine grain practice is the necessary procedures for obtaining a fine austenitic grain size. C. Unless specific information to the contrary is available, all product forms containing materials made using obsolete specifications for pipes, tubes, castings, forgings and bars should be assigned to Group 1. D. Discontinued in 1956, the API Code for Unfired Pressure Vessels, 1st edition, included these ASTM specifications for carbon steel plates, which were intended to be used for structural steel for locomotives, bridges and rail cars. Additional uses included locomotive and stationary service boilers and firebox steel. The A149 and A150 ASTM codes were designed for pressure vessels containing high-tensile-strength carbon steel plates. E. The S1 and S2 forge welding, S26 and S27 carbon steel plates and S25 open-hearth iron standards were included in Section VIII of the 1934 edition of the ASME Code for steel specifications and the titles of some of these specifications are similar to those ASTM specifications given in the API Code for Unfired Pressure Vessels, 1934 edition. F. The four grades included in the ASTM A 515 and the four grades included in the ASTM 516 specifications replaced the A201 and A212 steels. In addition, steel that was made using the ASTM A 212 specification was made in strength grades equivalent to Grades 65 and 70, which have accounted for several know brittle failures. Unless it can be established that the steel was enhanced in toughness properties using the fine grain practice production method, steel made using the ASTM A 201 and A 212 specifications should be assigned to Group 1.	

RCM Analysis

13

ReliaSoft's RCM++ and RBI applications both offer a complete set of utilities to address the analysis steps specific to reliability centered maintenance (RCM).

The following sections will discuss:

- An overview and general background for typical RCM analysis methods - Section 13.1 (p. 291).
- Using the FMEA tab to record the functional failure analysis - Section 13.2 (p. 297).
- Performing the failure effect categorization (FEC) - Section 13.3 (p. 298).
- Using the Task Manager to select and assign recommended maintenance tasks - Section 13.4 (p. 300).
- Defining the maintenance task properties (and related Synthesis resources) - Section 13.6 (p. 306).
- Calculating the optimum replacement interval (based on the cost of planned vs. unplanned maintenance) - Section 13.10 (p. 324).
- Using the Scheduled Task Packaging utility to group tasks for the most efficient allocation of resources - Section 13.11 (p. 326).

Note About RCM Terminology: This application combines RCM and FMEA capabilities together in the same software interface. Although the property names within the software are fully configurable to fit the specific analysis terminology used by your organization, the Ribbon commands, icons and window names are the same for all projects. Therefore, regardless of whether you are performing an RCM analysis or an FMEA, all of the information related to the functions and failure modes will be displayed in the FMEA tab of the Analysis panel and you will use the commands in the FMEA Ribbon to manage this information. In other words, the term "FMEA" is often used within the software interface in place of "functional failure analysis."

In addition, when a name is not configurable, the term "Failure" is used to refer to the second level in the analysis hierarchy and the term "Cause" is used to refer to the fourth level. If you are performing an RCM analysis, you might refer to these levels as the "Functional Failure" and "Failure Mode." If you are performing an FMEA analysis, you might refer to these levels as the "Failure Mode" and "Cause."

13.1 RCM Background

Reliability Centered Maintenance (RCM) analysis provides a structured framework for analyzing the functions and potential failures for a physical asset (such as an airplane, a manufacturing production line, etc.) in order to develop a scheduled maintenance plan that will provide an acceptable level of operability, with an acceptable level of risk, in an efficient and cost effective manner.

According to the SAE JA1011 standard, which describes the minimum criteria that a process must comply with to be called “RCM,” a reliability centered maintenance process answers the following seven questions:

- What are the functions and associated desired standards of performance of the asset in its present operating context (functions)?
- In what ways can it fail to fulfill its functions (functional failures)?
- What causes each functional failure (failure modes)?
- What happens when each failure occurs (failure effects)?
- In what way does each failure matter (failure consequences)?
- What should be done to predict or prevent each failure (proactive tasks and task intervals)?
- What should be done if a suitable proactive task cannot be found (default actions)?

Although there is a great deal of variation in the application of RCM, this section provides a brief general overview of common RCM techniques and requirements.

13.1.1 Prepare for the Analysis

As with almost any project, some preliminary work will be required to prepare for the RCM analysis. Some important up-front activities include:

- **Assemble Analysis Team:** One of the first steps in performing an RCM analysis is to assemble a *cross-functional* team of knowledgeable individuals to perform the analysis. The team should be large enough to make sure that relevant viewpoints and knowledge are represented but not too large. If the team is too large, it will be difficult to have productive discussions during meetings and it will be a waste of an extremely valuable resource – the time and patience of your organization’s subject matter experts.

The composition of the team at any particular meeting may vary depending on the focus of the discussion. Team members should be familiar with the RCM analysis process, as it is practiced by the organization. In addition, a skilled facilitator can help to make sure that team meeting time is used effectively and the analysis is performed correctly.

- **Establish Ground Rules and Assumptions:** Identifying and documenting the ground rules and assumptions that will be followed can facilitate the analysis process by making sure that all members of the team understand and accept the conditions of the analysis. Issues to be discussed when preparing for the analysis may include:
 - Identify the scope of the analysis project and address other project management issues, such as schedule, budget, meeting procedures, etc.
 - Define the expected operational environment for the equipment and any other assumptions that may affect the analysis. For example, if the equipment is expected to be operated within a specific temperature/humidity range, will potential failures that occur beyond these ranges be considered in the analysis?
 - Agree on the definitions of failure that will be followed during the analysis.
- **Gather and Review Relevant Documentation:** The analysis team may identify existing references that will provide valuable input to the RCM analysis activity, such as operation manuals, previous maintenance plans, prior failure reports, etc.

Tip: You can use the analysis plan feature for a variety of project planning features, including the ability to document the members of the analysis team and the ground rules and assumptions.

13.1.2 Select the Equipment to Be Analyzed

Because RCM analysis requires an investment of time and resources, the organization may wish to focus analysis resources on selected pieces of equipment based on safety, legal, economic and other considerations. Two methods of equipment selection that are commonly employed are directly supported within the software.

The **Selection Questions** method consists of a series of yes/no questions that are designed to identify whether analysis is indicated for a particular piece of equipment. For example, the MSG-3 guideline, which is used to develop initial scheduled maintenance plans for the aircraft industry, proposes four questions (from the ATA MSG-3 Operator/Manufacturer Scheduled Maintenance Development guidelines, Revision 2003.1, Air Transport Association of America, 2003):

- Could failure be undetectable or not likely to be detected by the operating crew during normal duties?
- Could failure affect safety (on ground or in flight), including safety/emergency systems or equipment?
- Could failure have significant operational impact?
- Could failure have significant economic impact?

If the analysts answer “yes” for at least one of these questions, then detailed analysis is indicated for the equipment.

The **Criticality Factors** method consists of a set of rating scales designed to evaluate the criticality of the equipment in terms of relevant factors, such as safety, maintenance, operations and environmental impact. Each factor is rated according to a predefined scale where the higher ratings indicate higher criticality. The equipment’s overall criticality value can then be used as a ranking and/or as a threshold. For example, the analysis team may choose to start on the equipment with the highest criticality and proceed down the list as resources allow. Alternatively, the team may agree to perform detailed analysis for equipment with a criticality value higher than a specified threshold or to perform detailed analysis for all equipment with a criticality value in the top 20%.

Other methods may also be applied, such as Pareto analysis of equipment based on downtime, unreliability or another relevant metric. Whichever method (or combination of methods) is employed, the goal is to focus RCM analysis resources on the equipment that will provide the maximum benefit to the organization in terms of safety, legal, operational, economic and related priorities.

Tip: You can use the Risk Discovery (Equipment Selection) feature to apply the Selection Questions method or the Criticality Factors method.

13.1.3 Identify the Functions

One of the primary tenets of the RCM approach is that maintenance activities should be focused toward preserving equipment functionality. Therefore, it follows that the first step in analyzing a particular piece of equipment is to identify the functions it is intended to perform.

Many RCM references recommend including specific performance requirements in function descriptions, which will help to specifically identify functional failures. For example, “To provide hydraulic pressure of 3000 psi +/- 200 psi.”

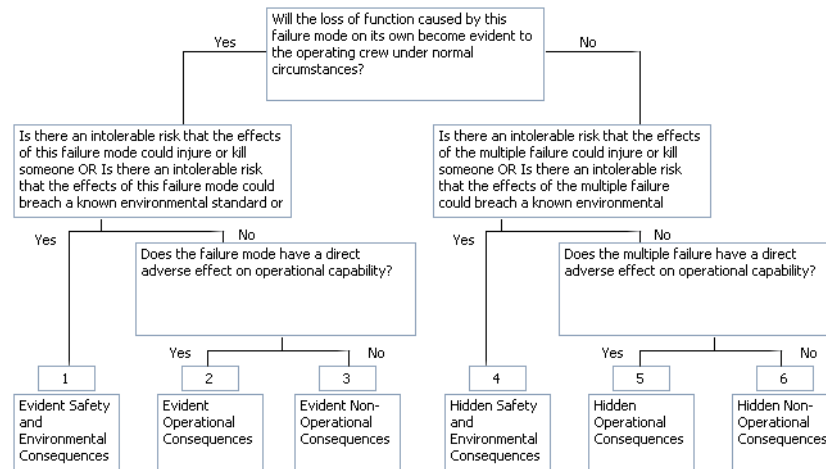
13.1.4 Identify the Functional Failures

Functional failures describe ways that the equipment may fail to perform its intended functions. This may include failure to perform a function, poor performance of a function, over-performance of a function, performing an unintended function, etc. As mentioned above, the performance limits that have been identified for the function may provide a guide to the functional failure description. For example, if the function is “To provide hydraulic pressure of 3000 psi +/- 200 psi” then the functional failures might include: “Provides hydraulic pressure of more than 3200 psi,” “Provides hydraulic pressure of less than 2800 psi,” etc.

13.1.5 Identify and Categorize the Effects of Failure

Identifying and evaluating the effects of failure will help the team to prioritize and choose the appropriate maintenance strategy to address a potential failure. Many RCM references contain logic diagrams that can be used to categorize the effects of failure. The following logic diagram is provided as an example in the SAE JA1012 “Guide to the Reliability-Centered Maintenance (RCM) Standard.” (From SAE JA1012 “A Guide to the Reliability-Centered Maintenance (RCM) Standard,” issued in January 2002) *Note: Only the Failure Effect Categorization portion of the logic is presented here. For the Task Selection portion, see Section 13.1.7 on page 295.*

This diagram has 5 questions with 6 failure effect categories. Other published logic diagrams may consist of 3 or 4 questions with 4 or 5 failure effect categories.



Tip: You can use any of the predefined logic diagrams that are shipped with the software or define your own custom logic diagram with 4, 5 or 6 categories. See Section 13.3 on page 298.

13.1.6 Identify the Causes of Failure (Failure Modes)

The cause of failure (sometimes also called failure mode) represents the specific reason for the functional failure at the actionable level (i.e., the level at which it will be possible to apply a maintenance strategy to address the potential failure). This determination is based on engineering judgment and relies on the team’s experience and skill with the RCM analysis process.

The SAE JA1012 guideline presents a useful demonstration of the many levels of detail that can be used to describe failure modes. For example (from SAE JA1012 “A Guide to the Reliability-Centered Maintenance (RCM) Standard,” issued in January 2002):

- Pump set fails
 - Pump fails
 - Impeller fails
 - Impeller comes adrift
 - Mounting nut undone
 - Nut not tightened correctly
 - Assembly error

The recommendation states that “failure modes should be described in enough detail for it to be possible to select an appropriate failure management policy, but not in so much detail that excessive amounts of time are wasted on the analysis process itself.”

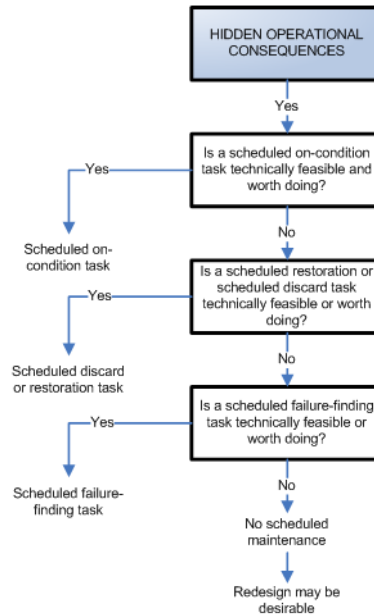
13.1.7 Select the Appropriate Maintenance Tasks

Once you have identified the ways that the equipment might fail to perform its intended functions and evaluated the consequences of these failures, the next step is to define the appropriate maintenance strategy for the equipment. Although there is variation among practitioners regarding the terminology used to describe the available maintenance techniques, the typical options that the RCM analysis team may recommend include:

- Run-to-Failure – fix the equipment when it fails but do not perform any scheduled maintenance actions.
- Scheduled Inspections
 - Failure Finding Inspections – inspect the equipment on a scheduled basis to discover hidden failures. If the equipment is found to be failed, initiate corrective maintenance.
 - On-Condition Inspections – inspect the equipment on a scheduled or ongoing basis (condition monitoring) to discover conditions that indicate a failure is about to occur. If the equipment is found to be about to fail, initiate preventive maintenance.
- Scheduled Preventive Maintenance
 - Service – perform lubrication or other minor servicing actions on a scheduled basis. These actions may renew the equipment to some extent but they are not expected to have the same effect as a full repair or replacement.
 - Repair – repair or overhaul the equipment on a scheduled basis.
 - Replace – replace the equipment on a scheduled basis.
- Design Change – re-design the equipment, select different equipment or make some other one-time change to improve the reliability/availability of the equipment.

The RCM analysis team’s decision of which strategy (or strategies) to employ for each potential failure may be based on judgment/experience, a predefined logic diagram (often connected to the failure effect categorization), cost comparisons, or some combination of factors. To continue with the SAE JA1012 example introduced in Section 13.1.5 on page 294, the following picture shows the questions to be considered for failures with effects that have been

categorized as “Hidden Operational.” The full logic diagram also includes a separate set of questions for each of the other five categories.



Tip: You can use one of the predefined sets of task selection questions that are shipped with the software or define your own custom questions and task types. See page 202 in Chapter 6.

Another approach is to compare normalized cost values and select the maintenance task that provides the desired level of availability for the minimum cost. For example, the team may recommend a run-to-failure maintenance strategy if a) the issue does not have an impact on safety, b) the run-to-failure approach provides an acceptable level of equipment availability (uptime) and c) the cost per uptime is less than it would be with a scheduled repair/replacement.

Tip: You can simulate the operation of the equipment for a specified period of time in order to make estimates about the cost and availability that you can expect from potential maintenance strategies. See Section 13.4.2 on page 302.

13.1.8 RCM References

- *Reliability-Centered Maintenance* by F. Stanley Nowlan and Howard F. Heap of United Airlines, issued in December 1978.
- ATA MSG-3 “Operator/Manufacturer Scheduled Maintenance Development,” updated in March 2003.
- NAVAIR 00-25-403 “Guidelines for the Naval Aviation Reliability-Centered Maintenance Process,” issued in February 2001.
- SAE JA1011 “Evaluation Criteria for Reliability-Centered Maintenance (RCM) Processes,” issued in August 1999.
- SAE JA1012 “A Guide to the Reliability-Centered Maintenance (RCM) Standard,” issued in January 2002.
- *Reliability-Centered Maintenance (2nd Edition)* by John Moubray, published in 1997.
- *Reliability Centered Maintenance: Gateway to World Class Maintenance* by Anthony M. Smith, published in 1993.
- “Practical Application of Reliability-Centered Maintenance” by the Reliability Analysis Center, issued in 2003.

- MIL-STD-2173(AS) “Reliability-Centered Maintenance Requirements for Naval Aircraft, Weapons Systems and Support Equipment,” issued in January 1986.
- “NASA Reliability Centered Maintenance Guide for Facilities and Collateral Equipment,” issued in February 2000.

13.2 Functional Failure Analysis (FFA)

After you have determined which pieces of equipment will be analyzed with RCM techniques, the next step is to perform a functional failure analysis on the equipment. You do this in a manner similar to creating a Failure Modes and Effects Analysis (FMEA), which is describe in Chapter 14.

Tip: This section provides basic instructions for this portion of the analysis. The “FMEA” chapter provides more detailed information about the features available in the Analysis panel, including alternative data entry options and a list of the properties that can be defined for each record type.

1. Select an item in the system hierarchy and choose **Insert > FMEA > Add FMEA**. The FMEA analysis tab will open in the Analysis panel. In addition, the FMEA icon (F) will appear in the FMEA column in the system hierarchy, if the column is displayed.



When working in the Analysis panel, you have a choice of several ways to enter and edit the information. To use one of these views, click its tab at the bottom of the Analysis panel.

- You can use the **Hierarchy** view, which displays the analysis records defined in your analysis (e.g., functions, actions, etc.) at a glance in a hierarchical tree structure. *For more information about using this view, see page 346 in Chapter 14.*
 - You can use the **Worksheet** view, which displays the functional failure analysis in a tabular format. The worksheet presents a column for each data field that has been enabled in the interface style for the project. *For more information about using this view, see page 348 in Chapter 14.*
 - You can use the **Filtered** view, which displays only records of a specific type (e.g., functions, tasks, etc.). Choose the record type that you want to view from the drop-down list at the upper right corner of the Analysis panel. *For more information about using this view, see page 351 in Chapter 14.*
2. Describe the functions the equipment is intended to perform.

To add a function to the analysis, choose **FMEA > FMEA Records > Functions** and then provide information about what functions the equipment is intended to perform (e.g., for an airplane fire extinguishing system, a function might be “Store extinguishing agent under pressure”).



3. Describe the potential functional failures.

To add a functional failure to the analysis, choose **FMEA > FMEA Records > Failures** and then provide information about the ways that the equipment might fail to perform its intended functions (e.g., for an airplane fire extinguishing system, a functional failure might be “Fails to maintain full quantity of agent at correct pressure”).



4. Describe the effects of each functional failure.

To add an effect to the analysis, choose **FMEA > FMEA Records > Effects** and provide information about the potential consequences if a failure occurs (e.g., for an airplane fire extinguishing system, an effect might be “Insufficient agent available in the Fire Extinguisher bottle for effective discharge”).



5. Describe the potential failure modes.

To add a failure mode to the analysis, choose **FMEA > FMEA Records > Causes** and provide information about the specific reason for the functional failure at the actionable level (e.g., for an airplane fire extinguishing system, a failure mode might be “Leakage from Fire Extinguisher bottle assembly”).



The following sections describe how to apply an RCM logic diagram and/or cost-based comparisons in order to determine the appropriate maintenance strategy to address the issues that have been identified in the functional failure analysis.

13.3 Failure Effect Categorization (FEC)

The Failure Effect Categorization window allows you to evaluate and categorize the effects of each functional failure, which can help the RCM analysis team to prioritize and choose the appropriate maintenance strategy to address the issues that have been identified.

Authorized users can define the questions and categories that will be used for this portion of the analysis. If you want to edit the questions and categories for the current project only, go to the Configurable Settings page of the Project Properties window (*see page 67 in Chapter 2*) and click the **View/Edit Settings** icon at the right side of the **FEC Logic** drop-down list.



If you want to define questions and categories that could be applied to other projects also, use the Profiles/Library Manager (*see page 200 in Chapter 6*) to update the active library and then return to the Project Properties window and apply the questions and categories to the current project. If you want the settings to apply only to the current project, change the settings in the Project Properties window only.

Note: As a reminder, settings are **copied** from the active library to each project, **not linked**. You can reselect a profile and have the most current settings applied to the project.

There are three ways to access the Failure Effect Categorization window, you can:

- Select an existing effect and choose **FMEA > FMEA Records > Effects > Effect Categorization**.
- Click the **View/Edit Effect Categorization** button that appears when you click the FEC field in the Effect Properties window. *See page 358 in Chapter 14.*



- In the Task Manager, click **Effect Categorization**. See Section 13.4 on page 300.



To begin the failure effect categorization process, answer Question 1 by selecting the **Yes** or **No** option. After doing so, the **Answer 1** field on the right side of the window becomes available. You can use this field to document the reasons why the team chose the answer they did. To save time and ensure consistency, you can select from responses that have been set for this question for other effects. Click the **Select Existing** button next to the input field to open the Select Existing window. See page 113 in Chapter 3.

Your answer to a question determines which of the following questions must be answered. Continue answering the rest of the applicable questions by selecting the **Yes** or **No** option and documenting the reasons, if desired. After you have answered the last question, the FEC category will be highlighted at the bottom of the window.

The FEC will also appear in the **Category** box on the right side of the window. You can select the category directly from the drop-down list in the Category box; doing this will automatically set the answers to the categorization questions and enable the appropriate answer fields.

Click **OK** to set the category. The failure effect categorization will also appear in the FEC column in the Analysis panel, if the column is displayed. To hide or display columns, right-click the column headers in the FMEA hierarchy view, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the FMEA Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed. See page 510 in Chapter 30.



Clear All clears all entries and selections made in the window.



Spelling checks the spelling in all text fields within the interface style. See page 114 in Chapter 3.

The status bar at the bottom of the window displays the date/time of the last change to the failure effect categorization and the user who made the change.

13.4 Task Manager

The Task Manager allows you to work with tasks assigned to causes within the FMEA and to choose an appropriate maintenance strategy by using one or both of the available task selection methods.

To open the Task Manager from the FMEA hierarchy, double-click the Tasks node associated with the relevant cause or right-click it and choose **Task Manager** from the shortcut menu.

Note: For a general explanation of how to create and edit task records, refer to Section 13.6 on page 306. For instructions on how to use simulation to compare potential maintenance strategies based on cost and/or availability, refer to Section 13.4.2 on page 302.

You can use the commands in the Tasks group of the Task Manager's Ribbon to add a new task to the cause's URD, add an existing task to the URD, edit a task already associated with the URD or delete (i.e., remove) a task from the URD. You can use the commands in the Related Records group to view and/or edit the associated URD, model and corrective task.

Task Selection

RBI's Task Manager supports two different methods that can help with the maintenance task selection portion of the analysis. One approach uses a series of questions that can guide you through the process of selecting an appropriate maintenance strategy. The other approach allows you to simulate the operation of the equipment with a given maintenance strategy in order to make estimates that can be used to compare tasks. You can choose to use one approach or the other, or a combination of both.

- **Using Maintenance Task Selection Logic:** For instructions on how to use a predefined set of questions to help you choose the appropriate maintenance strategy, refer to Section 13.4.1 on page 300.
- **Using Simulation and Cost Calculations:** For instructions on how to use simulation to compare potential maintenance strategies based on cost and/or availability, refer to Section 13.4.2 on page 302.

In addition, once you have determined which scheduled tasks are most appropriate to address each failure mode, you may wish to use RBI's built-in utility for calculating the optimum maintenance interval. *See Section 13.10 on page 324.*

Finally, once you have defined the maintenance tasks, you may wish to use the Scheduled Task Packaging window to review the entire maintenance plan and/or create groups of tasks. *See Section 13.11 on page 326.*

13.4.1 Using Maintenance Task Selection Logic

This section provides instructions on how to use a predefined maintenance task selection logic to choose the appropriate maintenance strategy.

Note: For a general explanation of how to create and edit task records, refer to Section 13.6 on page 306. For instructions on how to use simulation to compare potential maintenance strategies based on cost and/or availability, refer to Section 13.4.2 on page 302.

Maintenance task selection logic is shown in the Task Manager. *See Section 13.4 on page 300.* To use the maintenance task selection logic approach, you must first have performed failure effect categorization for the associated effect. *See Section 13.3 on page 298.* If this has already been done, the failure effect category of the

associated effect will be displayed at the top of the Task Manager. If it has not, you can click **Effect Categorization** to open the Failure Effect Categorization window.



The Task Manager window looks like this:

Task Manager

Buttons: Add Task, Add Existing Tasks, Edit Task, Delete Task, Edit URD, Edit Model, Edit Corrective Task, Effect Categorization, Simulate

FEC: 7 - Evident Economic

Question	Yes/No	Explanation
7A: Is a lubrication or servicing task applicable and effective?	No	Task is not applicable because there is no consumable to replenish.
7B: Is an inspection or functional check to detect degradation of function applicable and effective?	Yes	GVI for condition and security is applicable and effective.
7C: Is a restoration task to reduce failure rate applicable and effective?	No	Task is not applicable because item does not show degradation at an identifiable age.
7D: Is a discard task to avoid failures or to reduce the failure rate applicable and effective?	No	Task is not applicable because item does not show degradation at an identifiable age.

Run to Failure: Cost per Operating Time Availability

Tasks

Name	Type	Operating Cost	Cost per Operating Time	Availability
General Visual Inspection of Engine Wiring Harness Assembly.	RS			

OK Cancel

To begin the maintenance task selection process, answer the first question by clicking inside the **Yes/No** column. You can use the **Explanation** column to document the reasons why the team chose each answer. To save time and ensure consistency, you can select from responses that have been set for this question in other tasks. Click the input field and then click the **Select Existing** button next to the input field to open the Select Existing window. *See page 113 in Chapter 3.*

The answers to the questions will help you determine which type(s) of tasks will be applicable and effective to address the current failure mode.

Authorized users can define the questions that will be used for this portion of the analysis. If you want to edit the questions for the current project only, go to the Configurable Settings page of the Project Properties window (*see page 67 in Chapter 2*) and click the **View/Edit Settings** icon at the right side of the **Task Selection Logic** drop-down list.



If you want to define questions that could be applied to other projects also, use the Profiles/Library Manager to update the active library and then return to the Project Properties window and apply the questions to the current project. *See page 184 in Chapter 6.*

13.4.2 Using Simulation and Cost Calculations

This section provides instructions on how to use simulation to compare potential maintenance strategies based on cost and/or availability.

Note: For a general explanation of how to create and edit task records, refer to Section 13.6 on page 306. For instructions on how to use a predefined maintenance task selection logic to choose the appropriate maintenance strategy refer to Section 13.4.1 on page 300.

If you are using the simulation and cost calculations approach, you will be able to define different types of tasks, simulate the operation of the equipment for a specified time and then compare the results to select which task(s) will be most cost-effective in addressing the failure mode.

The following sections describe the steps for using this approach:

1. Define the URD for the failure mode.
 - A. Define the probability of occurrence for the failure mode.
 - B. Define the corrective maintenance scenario.
 - C. Define the preventive maintenance scenario(s).
2. Perform simulation.
3. Compare the maintenance strategies and assign the tasks.

Define the Probability of Occurrence for the Failure Mode

The model assigned to the cause record (via the URD assigned to the cause record) is used to define the probability that the item will fail due to the particular failure mode. *(For information about using the exponential distribution, refer to Section 13.4.4 on page 304.)*

Although models can be assigned at various levels in the analysis via the FMRA, you must have a model assigned at the failure mode level in order to use simulation to compare potential maintenance strategies based on cost and/or availability.

Define the Corrective Maintenance Scenario

The corrective maintenance scenario is defined by assigning a corrective task to the URD that is assigned to the cause record. This information is used to estimate the average availability and cost per operating time that could be expected from a run-to-failure maintenance strategy (i.e., performing corrective maintenance only) and it is also required for the simulations of any preventive maintenance strategies that you define.

The following corrective task properties are considered when simulating the run-to-failure maintenance strategy:

- Whether or not the failure mode is detectable. This is based on your selection in the **Start corrective task** field; select **Upon item failure** if the failure mode is detectable or **When found failed during an inspection** if the failure is undetectable.
- The **Task duration**, which is the amount of time that the equipment is expected to be down for each corrective maintenance action. This may include logistical delays and actual repair time.
- Whether the task brings the system down, in addition to bringing the item down. This is defined using the **Task Consequences** properties.
- How much the task restores the equipment, specified using the **Restoration** properties.
- The costs associated directly with the task, as specified in the **Additional Costs to Consider** properties. This may include downtime costs, labor costs, material costs and any other miscellaneous costs. (Note that if you have

provided information on crews (*see Section 13.7 on page 318*) and/or spare part pools (*see Section 13.8 on page 320*) for the task, then labor costs and material costs may be accounted for via those resources.)

Define the Preventive Maintenance Scenario(s)

In order to use simulation to compare potential maintenance strategies based on cost and/or availability, you will need to define a task record for each potential maintenance strategy that you are considering. Any scheduled task can be part of the preventive maintenance strategy. Authorized users can define the task types that will be used for this portion of the analysis. *See Section 13.5 on page 305.*

Scheduled tasks can be assigned to the URD that is assigned to the cause record either via the Task Manager (*see Section 13.4 on page 300*) or via the URD window *See page 164 in Chapter 5.*

Perform Simulation

Once you have defined the probability of occurrence for the failure mode, the corrective task and the possible scheduled tasks, you can click **Simulate** in the Task Manager. You will be asked to define the simulation settings. *See Section 13.4.3 on page 303.* RBI will then simulate the operation of the equipment for the specified operating time, given the reliability and maintainability characteristics that you have specified.

In the middle of the Task Manager, the cost per operating time and the average availability associated with a run-to-failure maintenance strategy will be displayed. At the bottom of the Task Manager, the table will display the same metrics for each proposed scheduled task.

Compare the Maintenance Strategies and Assign the Tasks

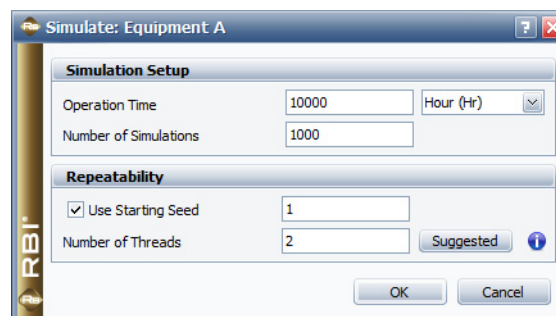
The final step when using the simulation and cost calculations method is to compare the results from the potential maintenance strategies and choose which task(s) will be performed. For each task that you choose not to add to the scheduled maintenance plan, you can either remove the task from the URD or, if it is not used anywhere else, you can delete the task resource entirely.

13.4.3 Simulation Settings

When using the simulation and cost calculations method, once you have defined the probability of failure and the maintenance scenarios for the failure mode, you can then define the simulation settings and run the simulation. To do this, click **Simulate** in the Task Manager.



The Simulate window will appear, allowing you to specify the settings used in simulation.



Note: The Simulate window is also used to specify simulation settings in order to predict system availability and operation costs at the system level in the FMRA. *See Chapter 8.* In this case, it is accessed by selecting the system that you want to simulate and choosing **FMRA > RAM Analysis > Simulate (Availability)**.

RBI uses the simulation engines from ReliaSoft's BlockSim software for system reliability, maintainability and availability analysis.

The following simulation settings are available:

- **Simulation Setup**

- **Operation Time:** Specify the amount of operating time to be simulated (i.e., the simulation time) and the time units. The value you enter here will change the system's operating time, shown in the item properties.
- **Number of Simulations:** Enter the number of simulations that will be performed. A higher number of simulations will take longer to process but may yield more accurate results.

- **Repeatability**

- **Use Starting Seed:** If you need your results to be repeatable, select this option and enter a seed, which specifies a starting point from which the random numbers used in simulation will be generated. The same random numbers and, therefore, the same simulation results will be generated when the same seed value is used.
- **Number of Threads:** You can run simulations in multiple threads, which may improve performance and save time when simulating complex configurations. In general, using twice as many threads as the number of cores in your computer is appropriate; a ratio of threads to cores greater than this 2:1 ratio is likely to degrade performance. To have the application automatically determine the number of cores in your system and set the number of threads accordingly, click the **Suggested** button beside the **Number of Threads** field.

The number of threads you use affects repeatability of results. In order for your results to be repeatable, you must use the same number of threads and the same seed each time you simulate the diagram. When you are using multithreading, the seed that you specify is the seed for the first thread; seeds for additional threads are sequential (e.g., if you are using 3 threads and your starting seed is 7, the threads will use 7, 8 and 9 as the starting points for random number generation).

Click **OK** to perform the simulation.

13.4.4 A Note About the Exponential Distribution (Failure Rate or MTBF)

When deciding whether an item should be replaced preventively, there are two requirements that must be met: the item's reliability must get worse with time (i.e., it has an increasing failure rate) and the cost of preventive maintenance must be less than the cost of the corrective maintenance. If both of these requirements are not met, then preventive maintenance will not be effective, either on a reliability basis or on a cost basis.

If you want to use mean time before/between failure (MTBF) or failure rate to describe the probability of failure, then you will be defining a constant failure rate (i.e., a rate that does not vary with time). In other words, you are assuming an exponential distribution. On the Settings page of the Application Setup, RBI provides two options for defining the exponential parameter: Lambda (which is also called failure rate) or Mean Time (which is also called MTBF). *See page 507 in Chapter 30.*

Therefore, it is important to note that if the equipment's failure behavior follows an exponential distribution, then preventive maintenance will not improve the overall reliability of the equipment. The following simple example illustrates this point.

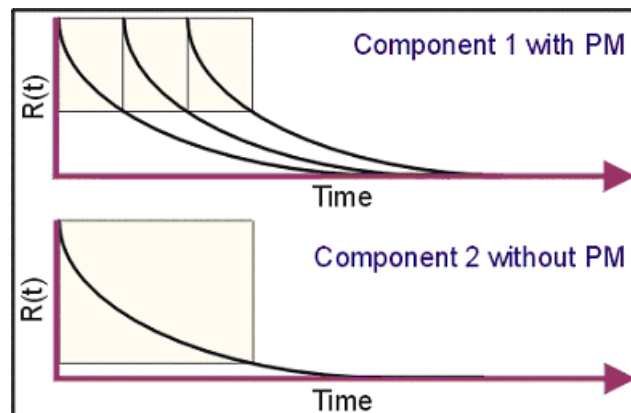
Suppose that two components follow an exponential distribution with MTBF = 100 hours (or failure rate = 0.01). Component 1 is preventively replaced every 50 hours, while component 2 is never maintained. If we compare the reliabilities of the two components from 0 to 60 hours:

- **Component 1, with PM:** With PM, the reliability from 0 to 60 hours is based on the reliability of the original item operating for 50 hours, $R(t=50)=60.65\%$, multiplied by the reliability of the new item operating for 10 hours, $R(t=10)=90.48\%$. The overall result is 54.88%.

- **Component 2, without PM:** Without PM, the reliability from 0 to 60 hours is based on the reliability of the original item operating to 60 hours, $R(60)=54.88\%$.

Likewise, if we compare the reliabilities of the two components from 50 to 60 hours:

- **Component 1, with PM:** With PM, the reliability from 50 to 60 hours is based on the reliability of the new item operating for 10 hours, $R(t=10)=90.48\%$.
- **Component 2, without PM:** Without PM, the reliability from 50 to 60 hours is based on the conditional reliability of the original item operating to 60 hours, having already survived to 50 hours, or $RC(T=60|50)=R(60)/R(50)=90.48\%$.



As this example demonstrates, both maintenance strategies result in the same reliability. In other words, the preventive maintenance does not improve the equipment's reliability. If you choose to perform preventive maintenance on equipment that does not exhibit an increasing failure rate (i.e., wearout), you may be wasting resources on maintenance actions that provide no benefit. In addition, the unnecessary maintenance may actually reduce the equipment's reliability by reintroducing infant mortality and/or introducing new failures due to maintenance errors.

13.5 Task Types in RCM++/RBI

RCM++ and RBI allow users to define a variety of task types for scheduled maintenance, so that the available task types match their organization's terminology. In order for simulation and cost calculation results in RCM++ and RBI to be accurate, it is necessary to map these task types to the three scheduled task classes used in URDs (i.e., preventive, inspection or on condition). Users with the "Manage other repository settings" permission can use the Define Task Types window to define the available task types, including their task class association, by choosing **File > Manage Repository > Task Types**.



The table in the window displays a list of the existing task types defined for the database. For each task type, you must specify a name, an abbreviation of up to three characters, and a task class that it corresponds to. Click the cell in the Task Class column to choose one of the three scheduled task classes from the drop-down list. You can have multiple task types that use the same task class. This can be helpful in indicating to users which properties should be defined for a given task. For example, a service task and a failure finding task could both be classified as inspection tasks for the purposes of the simulation; however, for the service task, a user will want to define a restoration factor, whereas for the failure finding task, no restoration occurs.

- To edit an existing task type, click inside the cell and either edit the text (in the Name and Abbreviation columns) or choose a new option from the drop-down list (in the Task Class column).
- To add a new task type to the bottom of the list, click inside the last row and enter the data.

- To delete a task type, select the row and click the **Delete** icon. *There is no undo for delete.*



- To insert a new task type above an existing one, select the existing row and click **Insert**.



- To move an existing option up or down in the list, select the row and click the **Move Up** or **Move Down** icon.



13.6 Task Properties

In Synthesis applications, maintenance activities are represented using shared resources that are available for use throughout the project and can be managed via the Resource Manager. *See page 169 in Chapter 5.* There are two basic kinds of tasks, which comprise four task classes:

- *Corrective tasks* are the action(s) taken to restore a failed component to operational status. These cannot be scheduled, as the component's exact failure time is not known before it happens. *See Section 13.6.1 on page 309.*
- *Scheduled tasks* can be performed on a known schedule, based on time, component condition or other factors. These include:
 - Preventive tasks - Section 13.6.2 (p. 311)
 - Inspection tasks - Section 13.6.3 (p. 313)
 - On condition tasks - Section 13.6.4 (p. 315)

Tasks are assigned to URDs, which are in turn used to represent a set of properties that can be applied to items in the System panel and to functions, failures and causes in the Analysis Panel.

The Maintenance Task window allows you to create, view and edit all classes of maintenance tasks. It can be accessed by double-clicking a task in the FMEA hierarchy or by clicking the **Create New** or **View/Edit** icon in the Task wizard, which is accessed from **Task** fields (e.g., the **Corrective Maintenance Task** field in the Universal Reliability Definition window, *see page 164 in Chapter 5*).



It can also be accessed from the Corrective Tasks and Scheduled Tasks pages of the Resource Manager by choosing **Home > Edit > New**, by selecting a task and choosing **Home > Edit > View** or by double-clicking a task.

For a new resource, a name will be proposed automatically based on the default naming criteria established for the current database in the Define Default Name Formats window. You can replace this with your own name of up to 150 characters, if desired. Remember that the name and identifiers are the primary way in which your team will be able to find the Synthesis resources you need for your analyses.

The following options must be configured for all classes of tasks. Configuration options that are specific to particular task classes are presented in the corresponding sections.

- The **Task Type** field allows you to specify the type of maintenance task (choose from a drop-down list). This field is available only for scheduled tasks. Each task type is associated with one of the task classes (i.e., preventive,

inspection or on condition); the task types, including their task class association, are defined via the Task Types window. *See Section 13.5 on page 305.* The task type determines the properties that will be available in the window and the inputs that will be used. For example, if you select a task type that is associated with on condition tasks, the properties for both the inspection part of the task and the preventive part of the task will be displayed. In addition, the task type is important if you are using the simulation and cost calculation method to compare potential maintenance strategies because the associated task class determines how the costs are calculated.

- **Basic Task Properties**

- **Task Duration** allows you to assign a model, which may represent a fixed time or a distribution, to describe the duration of the task. *See page 164 in Chapter 5.* You can choose an existing model or create a new one. If no model is assigned, it is assumed that the task has a duration of zero (i.e., immediate repair).
- **Crew for Task** allows you to choose or create one or more crews that can perform the task. If multiple crews are assigned to the task and a crew is needed, they will be checked for availability in the order in which they are displayed in this list. Use the **Priority Up** and **Priority Down** arrows that appear when you click a crew name in the list to move it up and down in the list. If a crew is needed and all crews are engaged, the crew with the shortest wait time is chosen to perform the task.

If no crew is assigned, it is assumed that the work will be done by some undefined crew that is always available.

- **Restoration:** These properties allow you to specify the degree to which the item will be restored after the performance of the task. In the **How much does this task restore the item?** field, you can specify that the item will be returned to as good as new condition (i.e., full repair, equal to a restoration factor of 1), to the same condition it was in when it failed (i.e., “as bad as old” or minimal repair, equal to a restoration factor of 0), or you can choose **Partial restoration**. This option provides you with the ability to model maintenance involving “used parts” or imperfect maintenance. The **Restoration amount** field will appear; you can specify the amount of restoration achieved by the task either by entering the value as a percentage or by clicking the arrow and using the slider bar that appears. If you specify anything other than 0% or 100%, you will need to specify what the restoration effect applies to (i.e., the restoration type). You can select:
 - **Only damage accumulated since last repair:** Each repair will remove only the damage since the last repair (i.e., the n th repair cannot remove the damage incurred before the $(n-1)$ th repair). Note that in this context any task is considered a repair and any damage that has occurred since the last event (corrective task, preventive task, inspection or on condition task) will be reduced.
 - **All accumulated damage:** Each repair can reduce any damage accumulated up to that failure.

For simulation, the application uses the restoration factor to determine the new age of the item after the maintenance action.

For example, consider an automotive engine that fails after 6 years. If the engine is rebuilt and the rebuilding task has a 50% restoration factor:

- If **Only damage accumulated since last repair** is selected, the initial rebuild has the effect of rejuvenating the engine to a condition as if it were 3 years old.

The engine fails again after 3 years (when it again reaches the effective “age” of 6 years), but the rebuild this time affects only the age accumulated after the first rebuild. Thus the engine has an effective age of 4.5 years after the second rebuild ($3 + 3 \times (1 - 0.5) = 4.5$).

After the second rebuild, the engine fails again after a period of 1.5 years (when it again reaches the effective age of 6 years) and a third rebuild is required. The effective age of the engine after the third rebuild is 5.25 years ($4.5 + 1.5 \times (1 - 0.5) = 5.25$).

- If **All accumulated damage** is selected, the initial rebuild has the effect of rejuvenating the engine to a condition as if it were 3 years old.

The engine fails again after 3 years (when it again reaches an effective age of 6 years) and another rebuild is required. This rebuild also rejuvenates the engine by 50%, thus making it effectively 3 years old again.

After the second rebuild, the engine fails again after a period of 3 years (when it again reaches the effective age of 6 years) and a third rebuild is required. The effective age of the engine after the third rebuild is 3 years.

Compare the following tables to see how the two options differ.

Only Damage Accumulated Since Last Repair

Time	Time Since Last Repair	Effective Age Before Repair	Effective Age After Repair
Start = 0	0	0	0
6 years	6	6	3
9 years	3	6	4.5
10.5 years	1.5	6	5.25

All Accumulated Damage

Time	Time Since Last Repair	Effective Age Before Repair	Effective Age After Repair
Start = 0	0	0	0
6 years	6	6	3
9 years	3	6	3
12 years	3	6	3

The ReliaWiki resource portal has more information on restoration factors at: http://ReliaWiki.org/index.php/Repairable_Systems_Analysis_Through_Simulation#Imperfect_Repairs.

- **Additional Costs to Consider** allows you to choose or create models to represent costs that are always associated with the task. **Cost per Task** uses a cost model, and **Downtime Rate** uses a cost per unit time model. If no models are assigned, it is assumed that there are no additional costs.
- **Identifiers** allows you to enter additional identifying information that can be used to search for this resource.
- **History** provides information about the creation and last modification of the resource. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the resource. *See page 70 in Chapter 2.*



You can collapse or expand all nodes in the hierarchy using the **Collapse All** and **Expand All** icons.



You can resize the columns by pointing to the column splitter. When the pointer becomes a double-headed arrow, drag the splitter to the desired location. You can restore the column widths to their original settings by clicking the **Restore Column Widths** icon.



For an existing resource, a link at the bottom of the properties window indicates how many times it is currently being used. If you need more information, click the link or the **Trace Usage** icon.

[Used by 1 item](#) 

This opens the Dependency Viewer, which allows you to explore both where the resource is being used and what other resources are associated with it. *See page 176 in Chapter 5.*

13.6.1 Corrective Tasks

Corrective maintenance consists of the action(s) taken to restore a failed component to operational status. Corrective maintenance is performed at unpredictable intervals because a component's failure time is not known a priori.

Corrective tasks:

- Always bring the block down.
- May bring the system down.
- Require spare parts.

In addition to the common task properties, (see *Section 13.6 on page 306*), the following options are used to configure corrective tasks in the Maintenance Task window:

- **Task Scheduling** allows you to specify when the corrective task will be performed.
 - If you choose **Upon item failure**, the task will be initiated upon failure of the component.
 - If you choose **When found failed during an inspection**, the task will be initiated if the component is found to be failed at the next scheduled inspection. This is useful in the case of “hidden failures” (i.e., failures that are not apparent until an inspection is performed) and in cases where the component is not considered mission-critical and repair can wait until the next scheduled maintenance.

- If a preventive task takes place before the next inspection, then preventive maintenance (not corrective maintenance) will be performed to restore the component. The downtime, etc. will depend on the preventive task properties.
- If a corrective task is performed upon inspection and an inspection finds the component failed, then the total downtime includes the full inspection duration followed by the corrective task duration.

If you have selected to perform a corrective task upon inspection and an inspection or preventive task does not occur after the failure, then the component will never be restored. This could happen under either of the following circumstances:

- Neither an inspection nor a preventive task is specified for the component.
and/or
- The conditions have not been met to perform an inspection or preventive task.
- **Basic Repair Properties > Spare Part Pool** allows you to choose or create a spare part pool that will be used in performing the task. If a spare part pool is not assigned, it is assumed that unlimited free spares are always immediately available. *For more on spare part pools, see Section 13.8 on page 320.*

For corrective and preventive tasks, a crew is not engaged unless/until the spare part is available. The total time for the task consists of:

- The time to complete corrective and preventive maintenance (based on the corrective task or preventive task properties).

PLUS

- The longer of the following times:

- The time to obtain the spare part (based on the spare part pool).

OR

- The time to obtain an available crew (based on crew availability) and any logistical delay time associated with the crew.

For example, if the component fails at 10 hours (on the system clock), the corrective task will take 5 hours, the time required to obtain the spare will be 48 hours and the logistical delay time associated with the crew is 8 hours, then:

- The spare will arrive at 58 hours (on the system clock).
- The crew will be engaged at 50 hours (on the system clock).
- The maintenance will be completed at 63 hours (on the system clock).
- The total time for the corrective maintenance will be 53 hours (48 for the spare plus 5 for the task).
- The crew will be engaged for 13 hours.

If the spare part is available without delay and all other conditions are the same, then:

- The crew will be engaged at 10 hours (on the system clock).
- The maintenance will be completed at 23 hours (on the system clock).
- The total time for the corrective maintenance will be 13 hours (8 for the crew plus 5 for the task).
- The crew will be engaged for 13 hours.

- **Task Consequences**

- **Does this task bring the system down?:** By default, corrective tasks will not bring the system down unless having the component down brings the system down based on the reliability-wise configuration in the diagram. If you answer Yes, the task will bring the system down even if the task has a zero duration. This forces the task to be included in the count of system downing events, regardless of the task's duration.

- **Does this task bring the item down?:** It is assumed that a component will always be down when a corrective task is performed, even a task with a zero duration; thus, this option cannot be changed.

13.6.2 Preventive Tasks

Preventive maintenance is the practice of repairing or replacing components or subsystems before they fail in order to promote continuous system operation or to avoid dangerous or inconvenient failures. The schedule for preventive maintenance is based on observation of past system behavior, component wearout mechanisms and knowledge of which components are vital to continued system operation. In addition, cost is always a factor in the scheduling of preventive maintenance. In many circumstances, it is financially more sensible to replace parts or components at predetermined intervals rather than to wait for a failure that may result in a costly disruption in operations.

Preventive tasks:

- Always bring the block down.
- May bring the system down.
- Require spare parts.

Maintenance Task

Task Name: A scheduled repair/replacement task to be performed

Task Class: Preventive

Task Properties

Task Scheduling

- When is this task performed? Fixed time frame based on calendar time
- Fixed interval 0.0246575342465753
- Unit Month (Mon)
- ☒ Override task scheduling properties with a task package
- Task Package 4 (Mon) [4 Month Maintenance]

Basic Task Properties

- Task duration (Hr) Fixed Duration [100]
- Crew for task
 - Crew (Priority 1) The crew name, skill level or other information related to the labor requirements for the repair_2
 - Logistic delay Default - Immediate Availability
- Spare Part Pool Spare part or other materials required to perform the corrective repair.
 - Spares in pool Unlimited
 - Logistic time for spare acquisition Default - Immediate Availability

Task Consequences

- Restoration
- Additional Costs to Consider
- RCM
- Identifiers
- History

Used by 1 item

OK Cancel

Editing scheduled task properties

In addition to the common task properties, (see *Section 13.6 on page 306*), the following options are used to configure preventive tasks in the Maintenance Task window:

- **Task Scheduling** allows you to specify the circumstances under which the task will be performed. See *Section 13.6.5 on page 317*.
- **Basic Task Properties > Spare Part Pool** allows you to choose or create a spare part pool to assign to the task. The spare part pool describes the conditions that determine whether a spare part will be available when needed and specifies the time and costs associated with obtaining the spare part. If a spare part pool is not assigned, it is assumed that unlimited free spares are always immediately available). See *Section 13.8 on page 320*.

For corrective and preventive tasks, the simulation does not engage a crew unless/until the spare part is available. For a complete explanation of how this affects the total time for the task, see *Section 13.6.1 on page 309*.

- **Task Consequences**

- **Does this task bring the system down?:** By default, preventive tasks will not bring the system down unless having the component down brings the system down based on the reliability-wise configuration in the diagram. If you answer Yes, the task will bring the system down, even if the task has a zero duration. This forces the task to be included in the count of system downing events, regardless of the task's duration.
- **Does this task bring the item down?:** It is assumed that a component will always be down when a preventive task is performed, even a task with a zero duration; thus, this option cannot be changed.
- **If bringing the item down causes the system to go down, do you still perform the task?:** If you answer Yes, the task will be performed even if doing so brings the system down, either because the task itself brings the system down or because the task brings the component down and the component being down causes the system to go down. If you answer No and the task brings the system down, the task will never be performed during simulation unless the system is already down for another reason. For instance, a preventive task that is specified to be performed upon system down will be performed even if it brings the system down regardless of your answer here. This is because the system is already down, which is what triggered the task in the first place.

A preventive task that does not bring the system down at the preventive maintenance time will still be factored into the simulation even if its duration will bring the system down at a later time.

For a preventive task that is scheduled to occur based on item age and for which you have answered No to this question, if the task is going to bring the system down, then it will not take place. If, however, the component reaches the age again (after restoration by a corrective action, inspection or another type of preventive maintenance) and this time it will not bring the system down, then it will be performed.

- **RCM properties** are text-based properties that are used to keep track of details that may be helpful in reliability centered maintenance analysis, but are not used in reliability/maintainability simulations. Whether these properties are shown in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. See *page 187 in Chapter 6*.
- **Status:** The status of the task (choose from a drop-down list). This setting could be used if you want to keep track of all tasks that have been considered, regardless of whether they end up in the actual maintenance plan (e.g., recommended, rejected, assigned).
- **Proposed Interval:** The interval that was initially proposed for the task. This may be different from the interval that is actually assigned to the task. For example, you may wish to use this property if the team originally suggests a particular interval for the task (perhaps the calculated optimum interval) but then decides to assign a different interval (perhaps an interval that is more convenient for packaging a group of tasks).
- **Reference Document:** A reference to another document that provides more detailed information about the task (e.g., procedure instructions).

- **Condition:** A description of the condition that indicates that a failure will occur (e.g., a threshold for a measurement of wear, vibration, etc). Typically, this field is used for on condition maintenance tasks.
- **Zone:** The zone of the system in which the task will be performed. Typically, this field is used for aircraft MSG-3 analyses.
- **Access:** The access that will be required in order to perform the task. Typically, this field is used for aircraft MSG-3 analyses.

Note: A preventive task with a restoration factor of 0 will generate a new failure with the current age.

13.6.3 Inspection Tasks

Inspections are used in order to uncover hidden failures (also called “dormant failures”). They are also used as part of on condition tasks to detect impending failures so that preventive maintenance can be performed.

In general, no maintenance action is performed on the component during an inspection unless the component is found failed, in which case a corrective maintenance action is initiated. However, there might be cases where a partial restoration of the inspected item would be performed during an inspection. For example, when checking the motor oil in a car between scheduled oil changes, one might occasionally add some oil in order to keep it at a constant level. This sort of restoration is not considered to be preventive maintenance; the deciding factor is that inspection tasks do not use spare parts. Note that an inspection task that triggers a corrective task will not restore the failed block. Only the corrective task will restore the block.

Inspection tasks (including the inspection and associated minor work):

- May bring the block down.
- May bring the system down; if the task brings the system down, it also brings the block down.

- Do not use spare parts.

The screenshot shows the 'Maintenance Task' dialog box. The 'Task Name' field is 'Detailed Inspection of Engine Fire Detection' and the 'Task Class' is 'Preventive'. Under 'Task Properties', the 'Task Scheduling' section shows 'When is this task performed?' as 'Fixed time frame based on calendar time', 'Fixed interval' as '1', and 'Unit' as 'Hour (Hr)'. The 'Basic Task Properties' section shows 'Task duration' as 'Default - Immediate Repair', 'Crew for task' as 'No crews are selected.', and 'Spare Part Pool' as 'Default - None'. The 'Task Consequences' section includes 'Restoration', 'Additional Costs to Consider', 'RCM', 'Identifiers', and 'History'. The status bar at the bottom indicates 'Used by 1 item'.

In addition to the common task properties, (see Section 13.6 on page 306), the following options are used to configure inspection tasks in the Maintenance Task window:

- **Task Scheduling** allows you to specify the circumstances under which the task will be performed. See Section 13.6.5 on page 317.
- **Task Consequences:** An inspection task will not bring the component down unless one of the following options is selected.
 - **Does this task bring the system down?:** If you answer **Yes**, when the task is performed, the system will be down, even if the task has a zero duration. If not selected, the task will bring the system down only if it brings the component down and having the component down brings the system down based on the reliability-wise configuration in the diagram. If this option is selected, even tasks with a zero duration will bring the system down. This forces the task to be included in the count of system downing events, regardless of the task's duration.
 - **Does this task bring the item down?:** If you answer **Yes**, when the task is performed, the component will be down. Even tasks with a zero duration will bring the component down in this case.
- **RCM** properties are text-based properties that are used to keep track of details that may be helpful in reliability centered maintenance analysis, but are not used in reliability/maintainability simulations. Whether these properties are shown in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. See page 187 in Chapter 6.

- **Status:** The status of the task (choose from a drop-down list). This setting could be used if you want to keep track of all tasks that have been considered, regardless of whether they end up in the actual maintenance plan (e.g., recommended, rejected, assigned).
- **Proposed Interval:** The interval that was initially proposed for the task. This may be different from the interval that is actually assigned to the task. For example, you may wish to use this property if the team originally suggests a particular interval for the task (perhaps the calculated optimum interval) but then decides to assign a different interval (perhaps an interval that is more convenient for packaging a group of tasks).
- **Reference Document:** A reference to another document that provides more detailed information about the task (e.g., procedure instructions).
- **Condition:** A description of the condition that indicates that a failure will occur (e.g., a threshold for a measurement of wear, vibration, etc). Typically, this field is used for on condition maintenance tasks.
- **Zone:** The zone of the system in which the task will be performed. Typically, this field is used for aircraft MSG-3 analyses.
- **Access:** The access that will be required in order to perform the task. Typically, this field is used for aircraft MSG-3 analyses.

To understand how inspections work during simulation, you should be aware of the following:

- Multiple non-downing inspections cannot occur on the same component at the same time.
- A non-downing inspection with a restoration factor greater than 0 restores the component based on the age of the component at the beginning of the inspection (i.e., the task duration is not restored).

13.6.4 On Condition Tasks

On condition maintenance relies on the capability to detect failures before they happen so that preventive maintenance can be initiated. If, during an inspection, maintenance personnel can find evidence that the equipment is approaching the end of its life, then it may be possible to delay the failure, prevent it from happening or replace the equipment at the earliest convenience rather than allowing the failure to occur and possibly cause severe consequences. In Synthesis applications, on condition tasks consist of an inspection task that triggers a preventive task when an impending failure is detected during inspection.

For on condition tasks, the Inspection properties allow you to configure the inspection portion of the task, and the options are identical to those available for configuring inspection tasks (*see Section 13.6.3 on page 313*). The On Condition Task (Upon Detection) properties allow you to configure the preventive portion of the task. The options are the same as those available for configuring preventive tasks (*see Section 13.6.2 on page 311*), except that the Task

Scheduling properties are not available. Instead, Failure Detection properties are used to specify the “warning period” that spans from the time when a potential failure can first be detected to the time when the failure occurs.

Maintenance Task

Task Name
A scheduled on-condition task to detect a

Task Class
On Condition

Task Properties

Inspection

Task Scheduling

- When is this task performed? Fixed time frame based on calendar time
- Fixed interval 0.00821917808219178
- Unit Month (Mon)
- ☒ Override task scheduling properties with a task package
- Task Package 4 (Mon) [4 Month Maintenance] ...

Basic Task Properties

- Task duration (Hr) Fixed Duration [100] ...
- Crew for task ...
- Crew (Priority 1) The crew name, skill level or other info related to the labor requirements for the inspection. ...
- Logistic delay Default - Immediate Availability ...

Task Consequences

Restoration

Additional Costs to Consider

Failure detection

- When is this task likely to detect an imminent failure? When a certain percentage of the life of the item has been consumed (i.e., failure detection threshold) ▼
- Percent of life 90

On Condition Task (Upon Detection)

RCM

Identifiers

History

Used by 1 item

OK Cancel

Editing scheduled task properties

To define the Failure Detection properties, first specify when the task is likely to detect an imminent failure. If you choose **When a certain percentage of the life of the item has been consumed**, you must then specify the percentage of the item’s life that must have elapsed in order for approaching failure to be detected. This is called the *failure detection threshold* (FDT). For example, if the FDT is 0.9 and the item will fail at 1,000 days, the approaching failure can begin to be detected at 900 days. If you choose **Within a fixed time frame prior to failure**, you must then specify the amount of time before a failure when the approaching failure can be detected by inspection. This is called the *P-F interval*. For example, if the P-F interval is 200 days and the item will fail at 1,000 days, the approaching failure can begin to be detected at 800 days.

Note the following simulation assumptions regarding on condition tasks:

- An inspection that finds a component at or beyond the failure detection threshold or within the range of the P-F interval will trigger the associated preventive task as long as preventive maintenance can be performed on that component.
- If a non-downing inspection triggers a preventive maintenance action because the failure detection threshold or P-F interval range was reached, no other maintenance task will be performed between the inspection and the triggered preventive task; tasks that would otherwise have happened at that time due to system age, system down or group maintenance will be ignored.

- A preventive task that would have been triggered by a non-downing inspection will not happen if the component fails during the inspection, as corrective maintenance will take place instead.
- If a failure will occur within the failure detection threshold or P-F interval set for the inspection, but the preventive task is only supposed to be performed when the system is down, the simulation waits until the requirements of the preventive task are met to perform the preventive maintenance.
- If the on condition inspection triggers the preventive maintenance part of the task, the simulation assumes that the maintenance crew will forego any routine servicing associated with the inspection part of the task. In other words, the restoration will come from the preventive maintenance, so any restoration factor defined for the inspection will be ignored in these circumstances.

13.6.5 Task Scheduling

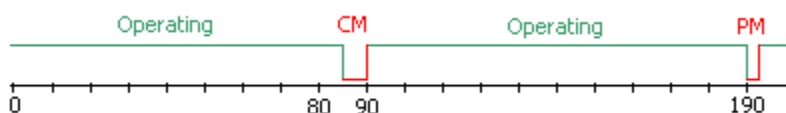
The following information applies to the task scheduling properties for preventive tasks, inspection tasks and the inspection portion of on condition tasks.

Click the arrow in the **When is this task performed?** field to define the criteria for performing the task. The remaining fields in the task scheduling properties will depend on your selection in this field. The task can be performed:

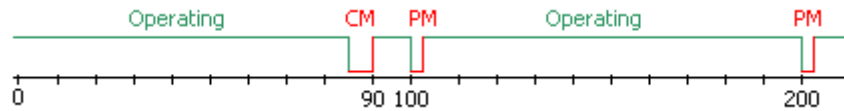
- **At certain intervals.** If you select this option, you must then specify:
 - Whether the interval is fixed or dynamic.
 - Whether the interval is based on the item's age or on calendar time.
- **Upon certain events.** If you select this option, you can choose for the task to be performed:
 - Whenever the system is down for any reason. No further task scheduling properties are required for this option.
 - Based on events in a maintenance group. The task will be performed when user-specified events occur in one or more user-specified maintenance groups. The item that the task is assigned to does not need to be part of the selected maintenance group(s).
 - When a maintenance phase in a BlockSim phase diagram starts. This option should be used only if simulation will be performed in BlockSim, via a phase diagram; if a task is scheduled to be performed upon the start of a maintenance phase and there is no maintenance phase, the task will never be performed.

The remaining task scheduling properties for each type of schedule are given next. For any interval that you specify, you will be asked to specify the time units used.

- **Fixed interval based on either item age or calendar time:** Enter the interval when the task will be performed (e.g., if you enter 100, the task will be scheduled for 100, 200, 300, etc.).
 - Item age refers to the accumulated age of the block, which gets adjusted each time the block is repaired (i.e., restored). If the block is repaired at least once during the simulation, this will be different from the elapsed simulation time. For example, if the restoration factor is 1 (i.e., "as good as new") and the assigned interval is 100 days based on item age, then the task will be scheduled to be performed for the first time at 100 days of elapsed simulation time. However, if the block fails at 85 days and it takes 5 days to complete the repair, then the block will be fully restored at 90 days and its accumulated age will be reset to 0 at that point. Therefore, if another failure does not occur in the meantime, the task will be performed for the first time 100 days later at 190 days of elapsed simulation time.



- Calendar time refers to the elapsed simulation time. If the assigned interval is 100 days based on calendar time, then the task will be performed for the first time at 100 days of elapsed simulation time, for the second time at 200 days of elapsed simulation time and so on, regardless of whether the block fails and gets repaired correctly between those times.



If the task is performed at fixed intervals, you can select the **Override task scheduling properties with a task package** option to assign the task to a task package, which is a group of tasks that are performed together at scheduled intervals. *See Section 13.11.5 on page 329.*

- **Dynamic interval based on either item age or calendar time:** The task will be performed at variable user-specified intervals. This can be used, for example, to schedule maintenance to be performed with increasing frequency as an item gets older. The **Dynamic Intervals** field shows the number of intervals specified. Click the button (...) to open the Intervals window, which allows you to enter the item age intervals when the task will be performed. The intervals are the actual time between maintenance (i.e., they are not cumulative).
- **Based on events in a maintenance group:** Specify the events that can trigger the task (i.e., a component fails; a corrective, preventive or inspection task starts; a component is restored to operation), and choose the maintenance group(s) in which the event(s) must occur in order to trigger the task.

Note: If a task has been assigned to a task package, either by the **Override task scheduling properties with a task package property** mentioned above or via the Scheduled Task Packaging window, the task scheduling properties will be disabled and displayed in italics. *See Section 13.11 on page 326.*

13.7 Crews

Crews are resources that are available for use throughout the project and can be managed via the Resource Manager. *See page 169 in Chapter 5.* You can assign the crews to maintenance tasks (*see Section 13.6 on page 306*).

The Crew window allows you to create, view and edit crews. It can be accessed by clicking the **Create New** or **View/Edit** icon in the Crew wizard, which is accessed from **Crew** fields in properties windows (e.g., the **Crew for task** field in the Maintenance Task window).



It can also be accessed from the Crews page of the Resource Manager by choosing **Home > Edit > New**, by selecting a crew and choosing **Home > Edit > View** or by double-clicking a crew.

For a new resource, a name will be proposed automatically based on the default naming criteria established for the current database in the Define Default Name Formats window. You can replace this with your own name of up to 150 characters, if desired. Remember that the name and identifiers are the primary way in which your team will be able to find the Synthesis resources you need for your analyses.

The following settings are available to configure the crew:

- **Crew**

- **Direct cost** allows you to choose or create a model to represent the direct cost per unit time to engage the crew (e.g., the hourly charge for the time that the crew spends performing the task). This field uses a cost per unit time model. If no model is assigned, it is assumed that there is no cost. *See page 166 in Chapter 5.*
- **Cost per incident** allows you to choose or create a model to represent the cost per incident to engage the crew (e.g., if you have to pay a fixed fee instead of or in addition to the hourly rate). This field uses a cost model. If no model is assigned, it is assumed that there is no cost.
- **Is there a limit to the number of tasks this crew can perform at the same time?:** If you answer **Yes**, you must specify the limit in the **Number of tasks** field. For example, if the crew can only fix 3 components at any given time and 4 components fail at the same time, then the crew will not be able to fix the fourth component until one of the other components has been restored.
- **Logistic delay** allows you to choose or create a model to describe the delay time before the crew can start the task. If no model is assigned, it is assumed that the crew can start the task immediately without any delays (i.e., immediate repair). The crew with the highest priority is always called upon first, regardless of logistic wait times for the crews. If a crew is needed and all crews are engaged, the crew with the shortest wait time is chosen to perform the task.

For a given simulation, a crew's logistic time is constant across that one simulation for the task. It is taken randomly from its distribution or from its fixed time.

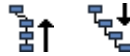
For on condition tasks, if the same crew performs the inspection and preventive maintenance and there are logistic delays associated with the crew, the logistic delays will be factored into the simulation for both parts of the task.

- **Identifiers** allows you to enter additional identifying information that can be used to search for this resource.

- **History** provides information about the creation and last modification of the resource. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the resource. *See page 70 in Chapter 2.*



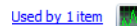
You can collapse or expand all nodes in the hierarchy using the **Collapse All** and **Expand All** icons.



You can resize the columns by pointing to the column splitter. When the pointer becomes a double-headed arrow, drag the splitter to the desired location. You can restore the column widths to their original settings by clicking the **Restore Column Widths** icon.



For an existing resource, a link at the bottom of the properties window indicates how many times it is currently being used. If you need more information, click the link or the **Trace Usage** icon.



This opens the Dependency Viewer, which allows you to explore both where the resource is being used and what other resources are associated with it. *See page 176 in Chapter 5.*

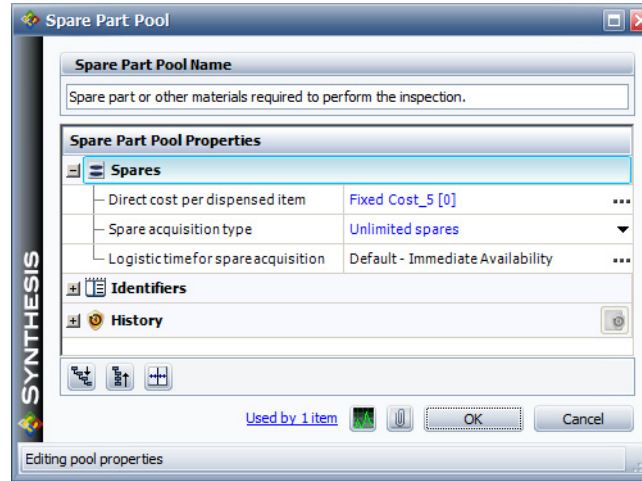
13.8 Spare Part Pools

Spare part pools are resources that are available for use throughout the project and can be managed via the Resource Manager. *See page 169 in Chapter 5.* A spare part pool describes the conditions that determine whether a spare part will be available when needed and specifies the time and costs associated with obtaining the spare part. You can assign the pools to maintenance tasks.

The Spare Part Pool window allows you to create, view and edit spare part pools. It can be accessed by clicking the **Create New** or **View/Edit** icon in the Spare Part Pool wizard, which is accessed from Spare Part Pool fields in properties windows (e.g., in the Maintenance Task window).



It can also be accessed from the Spare Part Pools page of the Resource Manager by choosing **Home > Edit > New**, by selecting a spare part pool and choosing **Home > Edit > View** or by double-clicking a spare part pool.



For a new resource, a name will be proposed automatically based on the default naming criteria established for the current database in the Define Default Name Formats window. You can replace this with your own name of up to 150 characters, if desired. Remember that the name and identifiers are the primary way in which your team will be able to find the Synthesis resources you need for your analyses.

The following settings are available to configure the spare part pool:

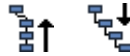
- **Spares**
 - **Direct cost per dispensed item** allows you to specify the direct cost of each spare part in the pool.
 - **Spare acquisition type:** You can select **Unlimited spares** to indicate that an unlimited number of spare parts exist in the pool (i.e., if a spare part is required, it will always be available). If you select **Limited number of spares**, the Pool Restock properties and the Emergency Spare Provisions properties will become available. In addition, you will need to define the following properties:
 - **Initial stock level** is the number of spare parts in the pool at the start of simulation.
 - **Holding cost (\$/Hour in pool)** allows you to choose or create a model to represent the cost of holding a spare part in the pool. The time unit used is the default unit for the database. *See page 62 in Chapter 2.* This field uses a cost per unit time model. If no model is assigned, it is assumed that there is no cost.
 - If you select the **Pool has maximum capacity** option, you will need to specify the maximum number of items that can exist in the spare part pool at any given time. The restock options will add parts only up to this maximum capacity. For example, suppose that the maximum capacity is 20 units and the restock quantity is 5 units. If the current stock level is 18 when a restock is triggered (either on a scheduled interval or because the stock fell to a specified level), then only 2 units will be added to the spare part pool, even though the restock options call for the addition of 5 units at each restock.
 - If you select **Fixed probability of stockout**, the Emergency Spare Provisions properties will become available. In addition, you will need to enter the probability of running out of stock as a decimal value.
 - **Logistic time for spare acquisition** allows you to choose or create a model to describe the amount of time required to obtain the part when it is required for maintenance, assuming that the part is in stock. This field uses a duration model. If no model is assigned, it is assumed that the spare part is available for use immediately.

- The **Pool Restock** properties allow you to define how the spare part pool will be restocked. These properties are available only if you have selected the **Limited number of spares** option in the **Spare acquisition type** field. You can select either or both of the following restock schemes:
 - If the **Scheduled restock** option is selected, the pool will be restocked at fixed intervals. The following properties will be available:
 - **Restock every** allows you to specify the time interval at which the pool will be restocked.
 - **Number added per restock** allows you to specify the number of parts that are added to the pool at every scheduled interval.
 - If the **Restock as needed (on condition restock)** option is selected, the pool will be restocked when the stock drops to a specified quantity. This option is available only if the initial stock level entered is at least 1. The following properties will be available:
 - **Restock when stock drops to** allows you to specify the number of parts in the pool that will trigger the restock (e.g., when the stock drops to 5, order more parts).
 - **Number added per restock** allows you to specify the number of parts that are added to the pool when the restock condition has been met.
 - **Required time for stock arrival** allows you to choose or create a model to describe the amount of time required for the new parts to arrive after the restock has been initiated. This field uses a duration model. If no model is assigned, it is assumed that the parts arrive immediately.
 - **Off-site spare part pool** allows you to assign an off-site spare part pool to the current pool. If specified, this pool is considered to be the source for restocking the current pool, which allows you to describe properties for the next level of spare parts that can be accessed when needed. If no off-site spares pool is specified, the parts are assumed to be ordered and no properties are described for the source.
- Tip:** Circular references between spare part pools are not permitted. In other words, if Pool 1 calls Pool 2 as its off-site spare part pool, and Pool 2 calls Pool 1 as its off-site spare part pool, the application will display a message notifying you of the problem upon simulation.
- The **Emergency Spare Provisions** properties allow you to define the circumstances when the spare part pool is empty but a spare part is required for a task. These properties are available only if you have selected either the **Limited number of spares** option or the **Fixed probability of stockout option** in the **Spare acquisition type** field. Selecting the **Can obtain emergency spares if needed** option indicates that a spare part can be obtained if required and the spare part pool is empty; otherwise, the repair will be delayed until more spare parts arrive in the spare part pool. Selecting this option makes the following properties available:
 - **Number added per emergency** allows you to specify the number of parts that are added to the pool when an emergency acquisition occurs.
 - **Additional costs for emergency spares** allows you to choose or create a model to represent a per incident cost for emergency acquisition of spares (e.g., there is a \$50 surcharge when emergency spares are required). This field uses a cost model. If no model is assigned, it is assumed that there is no cost.
 - **Required time for emergency spare** allows you to choose or create a model to describe the amount of time required for the emergency spare parts to arrive after the emergency acquisition has been initiated. This field uses a duration model. If no model is assigned, it is assumed that the parts arrive immediately.
 - **Off-site spare part pool** allows you to assign an emergency off-site spare part pool to the current pool. This allows you to create another level of spare parts that can be accessed for the emergency acquisition.
 - **Identifiers** allows you to enter additional identifying information that can be used to search for this resource.

- **History** provides information about the creation and last modification of the resource. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the resource. *See page 70 in Chapter 2.*



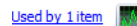
You can collapse or expand all nodes in the hierarchy using the **Collapse All** and **Expand All** icons.



You can resize the columns by pointing to the column splitter. When the pointer becomes a double-headed arrow, drag the splitter to the desired location. You can restore the column widths to their original settings by clicking the **Restore Column Widths** icon.



For an existing resource, a link at the bottom of the properties window indicates how many times it is currently being used. If you need more information, click the link or the **Trace Usage** icon.



This opens the Dependency Viewer, which allows you to explore both where the resource is being used and what other resources are associated with it. *See page 176 in Chapter 5.*

13.9 Maintenance Groups

Maintenance groups are resources that are available for use throughout the project and can be managed via the Resource Manager. *See page 169 in Chapter 5.* A maintenance group is a set of items where some event within the group can trigger maintenance for one or more items, either within the group or outside of it. You can use a maintenance group to trigger a scheduled task (i.e., a preventive task, inspection or on condition task) by setting the task to be performed based on events in one or more maintenance groups. Triggering events within the maintenance group can include item failure; start of corrective, preventive or inspection tasks; and/or item restoration. The task will be performed upon those triggering events, regardless of whether the block it is assigned to is part of those maintenance groups or not. For example, if you want to perform preventive maintenance on Component A every time you perform corrective maintenance on Component B, then you can assign Component B to Maintenance Group 1 and then set the preventive task assigned to Component A to be performed upon the start of corrective maintenance within Maintenance Group 1. *For more information on how tasks can be scheduled, see Section 13.6.5 on page 317.*

The Maintenance Group window allows you to create, view and edit maintenance groups. It can be accessed by clicking the **Create New** or **View/Edit** icon in the Maintenance Group wizard, accessed from the Properties tab in the Analysis panel).



It can also be accessed from the Maintenance Groups page of the Resource Manager by choosing **Main > Resource > New**, by selecting a maintenance group and choosing **Main > Resource > View** or by double-clicking a maintenance group.

At the top of the window, you can specify the maintenance group name. You can replace the default name with your own name of up to 150 characters, if desired. *See page 63 in Chapter 2.* You can also enter comments about the maintenance group in this window.

For an existing resource, a link at the bottom of the properties window indicates how many times it is currently being used. If you need more information, click the link or the **Trace Usage** icon.

[Used by 1 item](#) 

This opens the Dependency Viewer, which allows you to explore both where the resource is being used and what other resources are associated with it. *See page 176 in Chapter 5.*

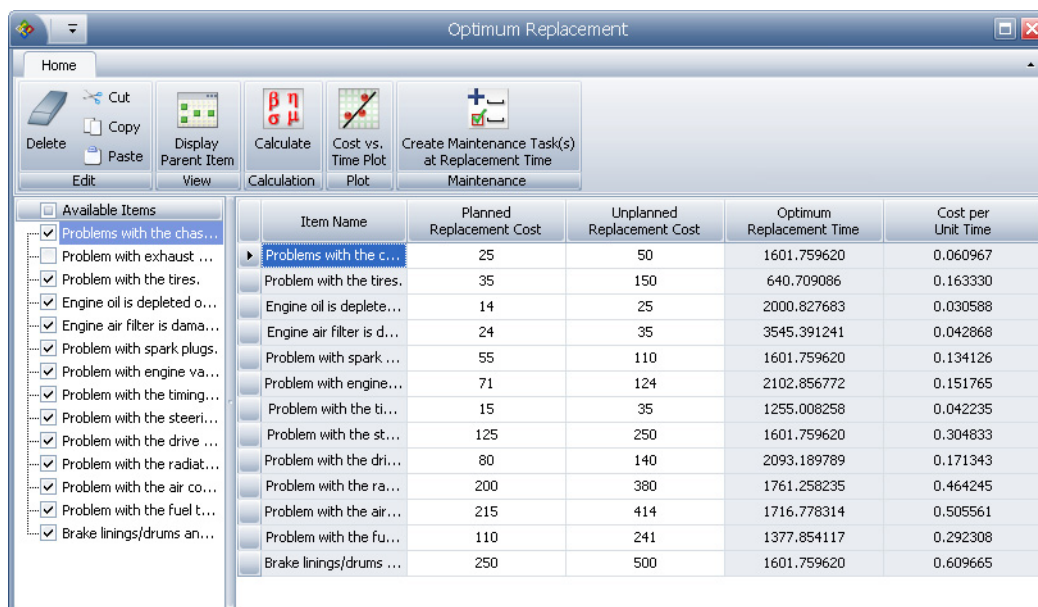
13.10 Optimum Replacement Window

Preventive maintenance is a logical choice if, and only if, the following two conditions are met:

- Condition #1: The failure rate of the component in question increases with time, implying wearout.
- Condition #2: The overall cost of the preventive maintenance action is less than the overall cost of a corrective action. (The overall cost for a corrective action should include ancillary tangible and/or intangible costs, such as downtime costs, loss of production costs, lawsuits over the failure of a safety-critical item, loss of goodwill, etc.)

If both of these conditions are met, then preventive maintenance makes sense. The Optimum Replacement window allows you to specify costs for planned (i.e., preventive) and unplanned (i.e., corrective) replacement tasks. It then uses this information to determine the most cost-effective time to perform the replacements, either individually or as a group.

To access the Optimum Replacement window, choose **FMRA > RAM Analysis > Optimum Replacement**.



The **Available Items** area on the left side of the window shows, for the current branch of the system hierarchy, any item, function, failure or cause that has an associated URD. The following requirements must be met for an item to be available for inclusion in the optimization calculations:

- Must have a failure distribution.
- The failure model must meet the following requirements.
 - Fixed reliability and exponential distributions are not allowed.
 - Weibull distributions must have $\beta > 1$.

- Gamma distributions must have $k > 1$.
- Loglogistic distributions must have $\text{std} < 1$.
- For generalized gamma distributions and mixed Weibull distributions, there must be an increasing failure rate within at least one time period. A local optimum can then be found within intervals with an increasing failure rate.

You can select an individual item's check box or drag it into the table on the right side of the window to include the item in the optimization calculations. You can also select the check box in the **Available Items** header to select all check boxes. To remove items from the optimization calculations, you must clear the check box(es); you cannot drag items out of the table.

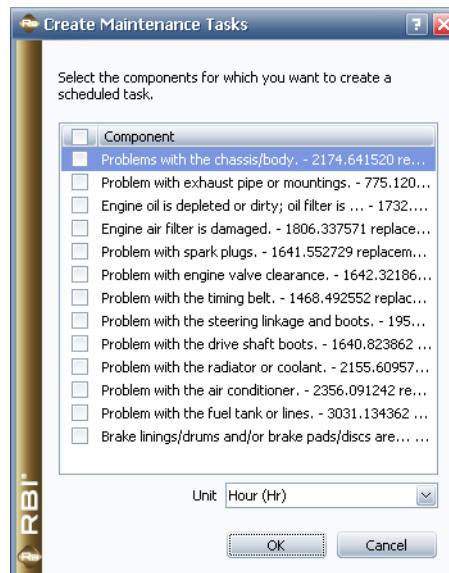
For each item that is included in the optimization calculations, you will need to specify the cost for a planned replacement and the cost for an unplanned replacement. This is done by entering the projected costs in the **Planned Replacement Cost** and **Unplanned Replacement Cost** columns of the table.

When you click **Calculate**, you can choose from the following options:

- Calculate the individual optimum replacement time for each item.
- Calculate a common optimum replacement time, which is the most cost-effective time to replace all of the selected items concurrently.
- Calculate clustered optimum replacement times, which allows you to specify a number of times to replace groups of the selected items. For example, if you enter 3 in the Number of clusters field, the software will determine the three best times to replace groups of items such that all of the selected items are replaced at one of the three times.

The software will calculate the optimum replacement time for the items based on their failure characteristics and on the defined costs. This value will be displayed in the Optimum Replacement Time column of the table. In addition, the Cost per Unit Time column will display the estimated cost per unit time for a replacement performed at the calculated optimum replacement time. Multiply the replacement time by the cost per unit time to obtain the cost of replacing the item at the optimum replacement time.

You can click **Create Maintenance Task(s) at Replacement Time** to create a preventive task for one or more of the items. The window that appears allows you to select which items to create tasks for. The preventive tasks created in this way restore the item to as good as new condition and are scheduled at fixed intervals based on item age, equal to the optimum replacement time.

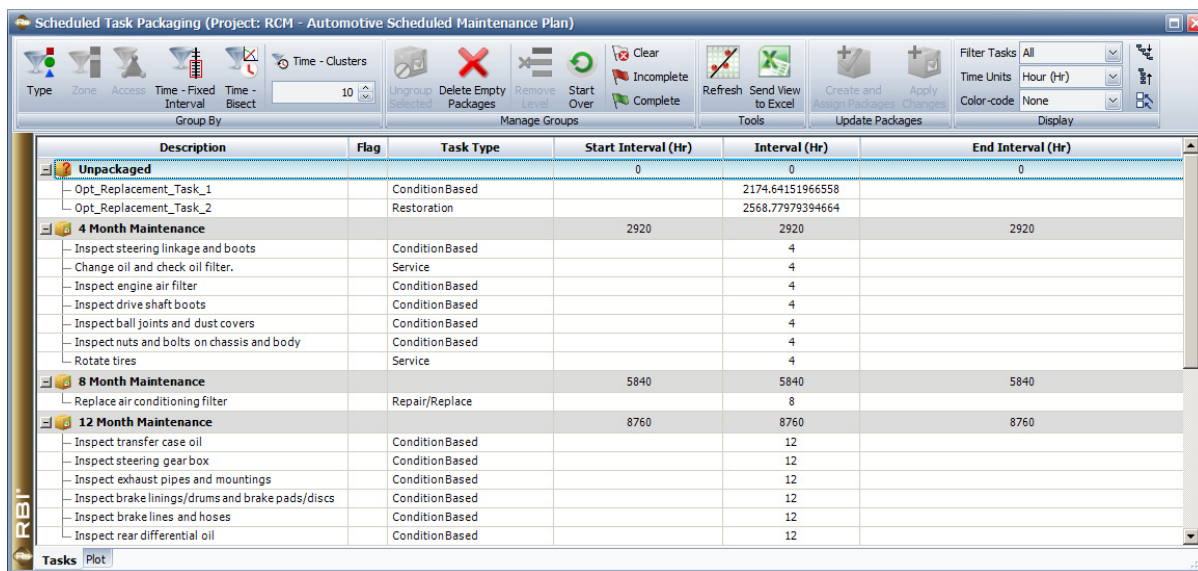


You can click **Cost vs. Time Plot** to show a plot of the results. If you have calculated individual optimum replacement times, the plot will show the cost for each item as a function of time. If you have calculated a common optimum replacement time, the plot will show the common cost as a function of time. If you have calculated clustered optimum replacement times, the plot will show the cost for each cluster as a function of time.

13.11 Scheduled Task Packaging Window

For a given project, you can use the Scheduled Task Packaging window to review all of the tasks that have been proposed to be performed at fixed intervals (based either on item age or calendar time), choose which ones to incorporate in the final maintenance plan and, if desired, group tasks into task packages for the most efficient allocation of resources. *For information about task packages, refer to Section 13.11.5 on page 329.*

To open this window, choose **Project > Synthesis > Task Packaging**.



This window consists of two tabs: the Tasks tab and the Plot tab. The Tasks tab allows you to group tasks according to a variety of criteria, and the Plot tab provides a graphical view of how the tasks are currently grouped. You can move tasks into and out of groups as many times as needed, until you come up with a configuration that meets your needs. None of the changes that you make in this window are permanent until you click one of the following:

- **Apply Changes** accepts all changes that you have made in the Scheduled Task Packaging window and commits them to the database.



- **Create Selected Packages** takes the groups that are currently selected in the window and commits them to the database as task packages.



You can tell the difference between a group (which is a proposed task package that has not yet been committed to the database) and a task package (which exists as a resource in the database) by looking at their icons.



Group



Package

To use the Scheduled Task Packaging window, first decide whether you want to view only unpackaged tasks, only packaged tasks or all tasks proposed to be performed at fixed intervals, and make the appropriate selection in the **Filter Tasks** field.

13.11.1 Grouping Tasks

You can select any group (including Unpackaged) or package and group the tasks that are in it. Tasks can be automatically grouped by:

-  Task type
-  Zone, provided this property is enabled for tasks in the interface style.
-  Access, provided this property is enabled for tasks in the interface style.
- Time, in three ways:
 - Clusters of time, based on Euclidean distance:
 -  Click **Time - Bisect** to divide the tasks into two groups.
 -  In the **Time - Clusters** field, specify the number of time clusters to group the tasks into and then click the button.
 -  Click **Time - Fixed Interval** to create a group scheduled to be performed at a specified interval.

In the window that appears:

- In the **Perform every** field, enter the length of the interval at which the tasks will be performed. You must specify time units for this value.
- The **Packaging Intervals** fields allow you to specify a range of scheduled intervals that will automatically be incorporated into the task package. The time units for these fields are the same as those specified for the Perform every field. For example, if you enter **150** hours in the **Start Time** field and **200** hours in the **End Time** field, then tasks that are scheduled to be performed at fixed intervals from 150 to 200 hours can automatically be included in the group to be performed at the scheduled time rather than at their individually scheduled times.

The groups that are created by automatic grouping are named according to the way in which they were created, but you can double-click a group to change its name.

You can also drag any task into a group or package. Note that you can do this regardless of whether the task meets any criteria that may have been used to create the group or package; it is the user's responsibility to determine whether or not the move is appropriate.

13.11.2 Managing Groups and Packages

The following commands are available for working with the groups and packages shown in the Scheduled Task Packaging window.

- To move all tasks out of a group or package and into the Unpackaged group, click **Ungroup Selected**. Note that if you move all tasks out of a group, the group is deleted. If you move all tasks out of a package, the package is not deleted but is empty. While groups may occasionally appear empty, such groups are automatically deleted the next time you perform any operation that refreshes the Tasks tab.



- To remove all empty packages, click **Delete Empty Packages**.



If you want to delete a single package, you can do so through the Resource Manager. *See page 169 in Chapter 5.*

- You can delete a group level by clicking **Remove Level**.



The effect of this command varies depending on what is selected.

- If you have selected a group that has subgroups, the selected level will be deleted, leaving all tasks within the subgroups that they are currently assigned to.
- If you have selected a group that has tasks assigned to it, the group and all of its “sibling” groups (i.e., all groups of that level that share the same parent group) will be deleted and the tasks will be moved up into the parent group. If there is no parent group (i.e., if the selected group is at the top level), the tasks will be moved into the Unpackaged group.

The reason for this behavior is that a group can contain tasks or it can contain subgroups; no group can ever contain both tasks and subgroups. Thus, if you delete one group and move its tasks into its parent group, the same operation must be performed for all of its sibling groups.

- You can return to the packaging state saved in the database by clicking **Start Over**. As mentioned above, no changes that you make in the Scheduled Task Packaging window are saved in the database until you click either **Apply Changes** (to accept all changes) or **Create Selected Packages** (to create only the package(s) currently selected).



- To mark groups and/or packages as complete or incomplete, select the groups and/or packages and then click **Complete** or **Incomplete**. A flag will appear in the Flag column for each selected group or package. You can remove the flag by selecting the group or package and clicking **Clear**.



13.11.3 Display Options

In addition to the **Filter** drop-down list, which allows you to specify whether you want to view only packaged tasks, only unpackaged tasks or all tasks, there are several other tools to help you control how information is displayed in the Tasks tab.

- You can use the **Time Units** drop-down list to change the units displayed in the window.
- The **Color Code** drop-down list allows you to apply a color-coding gradient to the tasks shown in the window, based on their assigned intervals, from green (shortest interval) to red (longest interval). Choose **Overall** to apply a single gradient to all tasks, regardless of their package. Choose **Within Packages** to apply a separate gradient to the tasks within each package. Remove all color-coding by choosing **None**.
- Click **Expand All** to show all levels of the hierarchy in the window, or **Collapse All** to show only the top level. Clicking **Collapse Tasks** collapses the tasks within each group or package, so that you see only the hierarchical structure of the groups/packages without seeing any of the associated tasks. This command is a toggle; if it is selected, you can expand a group or package, and the next time you perform an action that refreshes the Tasks tab, the tasks will be collapsed again.



13.11.4 Additional Tools

You can click **Send View to Excel** to send the current contents of the Tasks tab to a new Excel file. The file will then open automatically if the software is installed on your computer.



The Plot tab provides a graphical view of the task grouping/packaging, as it currently stands within the Task tab. Note that this is not a reflection of changes that have been committed to the database, but of the current proposed grouping. The features on the plot control panel are similar to the options available in the Plot Viewer control panel. *See page 455 in Chapter 25.* The following plot types are available for the Scheduled Task Packaging window:

- **Packages** displays the groups and packages with vertical lines demarcating their start and end intervals. Tasks assigned to each group are shown with a +, while unpackaged tasks are shown with an X. Note that tasks that share an assigned interval are plotted in the exact same location, so only one is visible. You can select **Include Interval** to display the interval at which each group is scheduled to be performed as an additional vertical line.
- **Packages - Horizontal** displays the groups and packages as horizontal lines with points demarcating their start and end intervals. Tasks assigned to each group are shown with a +. Note that tasks that share an assigned interval are plotted in the exact same location, so only one is visible. Unpackaged tasks are not shown in this plot. You can select **Include Interval** to display the interval at which each group is scheduled to be performed as an additional point on the group line.

13.11.5 Task Packages

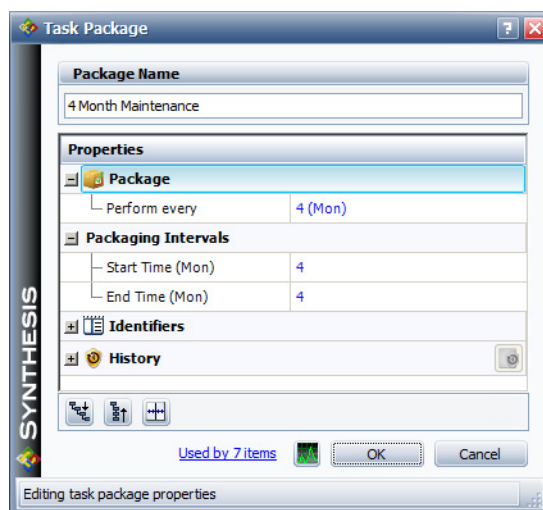
Task packages are resources that are available for use throughout the project and can be managed via the Resource Manager. *See page 169 in Chapter 5.* They represent groups of tasks that are performed together at scheduled intervals, for the most efficient allocation of resources and downtime management.

The Task Package window allows you to create, view and edit task packages. It can be accessed from the Scheduled Task Packaging window by clicking **Add New Package** or **Edit Selected Package** or double-clicking an existing package. It can also be accessed from the Maintenance Task window by clicking the **Create New** or **View/Edit** icon

in the Task Package wizard, which is accessed from the **Task Package** field that appears when you select the **Override task scheduling properties with a task package option** for a preventive, inspection or on-condition task that is scheduled to be performed at fixed intervals.



Finally, it can be accessed from the Task Packages page of the Resource Manager by choosing **Home > Edit > New**, by selecting a task package and choosing **Home > Edit > View** or by double-clicking a task package.



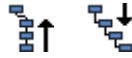
For a new resource, a name will be proposed automatically based on the default naming criteria established for the current database in the Define Default Name Formats window. You can replace this with your own name of up to 150 characters, if desired. Remember that the name and identifiers are the primary way in which your team will be able to find the Synthesis resources you need for your analyses.

The following settings are available to configure the task package:

- In the **Perform every** field, enter the length of the interval at which the task package will be performed. You must specify time units for this value.
- The **Packaging Intervals** fields allow you to specify a range of scheduled intervals suggested to be incorporated into the task package. The time units for these fields are the same as those specified for the **Perform every** field. For example, if you enter **150** hours in the **Start time** field and **200** hours in the **End time** field, then tasks that are scheduled to be performed at fixed intervals from 150 to 200 hours should be considered for inclusion in the task package to be performed at the scheduled time of the task package rather than at their individually scheduled times.
- **Identifiers** allows you to enter additional identifying information that can be used to search for this resource.
- **History** provides information about the creation and last modification of the resource. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the resource. *See page 70 in Chapter 2.*



You can collapse or expand all nodes in the hierarchy using the **Collapse All** and **Expand All** icons.



You can resize the columns by pointing to the column splitter. When the pointer becomes a double-headed arrow, drag the splitter to the desired location. You can restore the column widths to their original settings by clicking the **Restore Column Widths** icon.



Information about the creation and last modification of the task package is displayed at the bottom of the window.

For an existing resource, a link at the bottom of the properties window indicates how many times it is currently being used. If you need more information, click the link or the **Trace Usage** icon.

[Used by 1 item](#) 

This opens the Dependency Viewer, which allows you to explore both where the resource is being used and what other resources are associated with it. *See page 176 in Chapter 5.*

Failure Modes and Effects Analysis (FMEA) and Failure Modes, Effects and Criticality Analysis (FMECA) are methodologies designed to identify potential failure modes for a product or process, to assess the risk associated with those failure modes, to rank the issues in terms of importance and to identify and carry out corrective actions to address the most serious concerns.

The following sections will discuss:

- An overview and general background for typical FMEA analysis methods and how the FMEA integrates with some related analyses - Section 14.1 (p. 333).
- Choosing which hierarchical structure will fit your analysis process (Effects Before Causes, Grouped Effects Before Causes or Causes Before Effects) - Section 14.2 (p. 342).
- Adding an FMEA to a project and using four tabs to:
 - Define the header information that will be displayed at the top of report output - Section 14.3.1 (p. 345).
 - View/edit the analysis records in a hierarchical tree - Section 14.3.2 (p. 346).
 - View/edit the analysis records in a tabular worksheet (similar to Excel) - Section 14.3.3 (p. 348).
 - View a filtered and sortable list of all records of a particular type (e.g., all cause records sorted by RPN) - Section 14.3.4 (p. 351).
- Using the record properties windows to add, edit or delete FMEA records (e.g., function, failure, effects, etc.) - Section 14.4 (p. 351).

Tip: For information about how to use the FMEA tab to perform reliability centered maintenance analysis (RCM), see Chapter 13.

- View the unique failure modes and causes that have been defined in the FMEA - Section 14.5 (p. 365).
- View statistics about the FMEA - Section 14.6 (p. 366).
- View the effects in the FMEAs in the current project and send them to Excel - Section 14.7 (p. 367).
- Transfer projects - Section 14.8 (p. 368).

14.1 FMEA Background

Failure Mode and Effects Analysis (FMEA) is a methodology designed to:

- Identify and fully understand potential failure modes for a product or process.
- Assess the risk associated with those failure modes and prioritize issues for corrective action.
- Identify and carry out corrective actions to address the most serious concerns.

This section provides a brief, general overview of common principles and applications for Failure Mode and Effects Analysis (FMEA) and related analyses, such as Criticality Analysis (FMECA), design verification plans (DVP&Rs), process flow diagrams (PFDs), process control plans (PCPs) and design reviews based on failure mode (DRBFM).

14.1.1 FMEA Application and Benefits

Usually, the primary objective of an FMEA is to identify and mitigate risks in a product or process in order to improve the design. In addition, since the FMEA provides a central location for reliability-related information for the product or process, it can be used as a learning tool for new engineers, a resource when considering modifications to the design or developing a similar design, a resource for service personnel to identify possible corrective actions when problems occur in the field, and so on.

FMEA is often performed in conjunction with Design for Reliability (DFR), Design for Six Sigma (DFSS), ISO quality programs and other initiatives. It also may be performed to satisfy a customer or regulatory requirement.

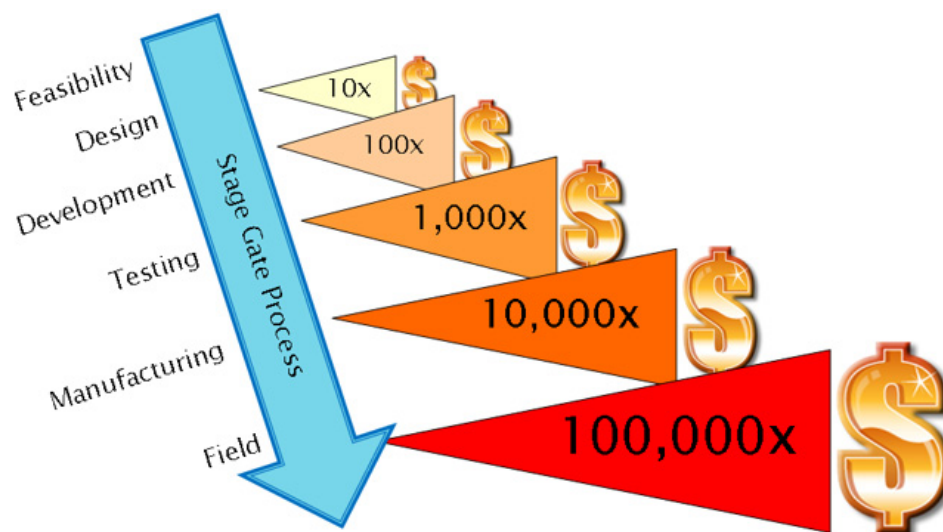
When performed effectively, an FMEA can contribute to improved designs for products and processes, resulting in higher reliability, better quality, increased safety, enhanced customer satisfaction and reduced costs.

14.1.2 When to Perform an FMEA

Many references cite three situations in which an FMEA commonly may be performed:

- Creating a new design or process
- Modifying an existing design or process
- Using an existing design or process in a new environment

The FMEA should be performed during the “window of opportunity” when it can most effectively impact the product or process design. In general, it should be an “up-front” activity, rather than “after-the-fact.” Citing the “factor of 10 rule,” most practitioners agree that it is more cost effective to correct reliability issues early in the process.



14.1.3 Basic Analysis Procedure for FMEA

This section introduces the basic analysis procedure for FMEAs. Of course, the specific implementation approach will vary among different organizations, practitioners and applications.

14.1.3.1 Determining the Scope

Before you can begin the FMEA, you must decide what you are going to analyze. Determining the scope of the analysis is an extremely important step because it helps to identify which FMEA(s) will be performed and then, for each particular FMEA, the boundaries for what issues will be considered and the approach that the analysts will take during the analysis. The determination of the scope may be based on a variety of factors, including (but probably not limited to) timing, complexity and characteristics of the design, risk/importance, available budget, customer requirements, etc. The tools available for determining the scope will vary depending on whether you are performing a design FMEA or a process FMEA.

If you are performing a **Design FMEA**, you may wish to start by defining the system configuration. Early in the design process, you may wish to perform a high-level FMEA on the entire system. As the design matures, it will be possible to perform more detailed FMEAs on individual assemblies or components. A change point analysis or preliminary risk assessment may help to focus the analysis effort on the aspects of the design that have the greatest risk and/or have the greatest potential benefit from design improvements. Factors may include:

- New technology or new application of existing technology
- Potential for safety or regulatory issues
- History of significant field problems
- Mission-critical applications
- Supplier capability
- Etc.

Tip: There are many different ways that the preliminary risk assessment can be performed. The Risk Discovery Analysis feature supports two possible methods: one based on a series of yes/no questions and another based on rating scales.

For each individual FMEA that you will perform, it may also be useful to define what components and interactions will be included in the analysis. A boundary diagram (or block diagram) shows the physical and logical relationships between the components in the system or assembly. It can identify relationships and dependencies between components as well as critical inputs and outputs.

Tip: You can use the Attachments feature to provide easy access to boundary/block diagrams that have been created with other software tools (such as Visio or PowerPoint). See *page 124 in Chapter 3*. Alternatively, you can use the FMEA Block diagram feature to create the diagram and link it to the rest of the analysis. See *page 483 in Chapter 28*.

If you are performing a **Process FMEA**, you may start by identifying the steps in the process and the operations that must be performed at each step. In most cases, the scope of the PFMEA will be the entire process. However, in some situations, the organization may choose to exclude low-risk portions of the process.

The process flow diagram (PFD) provides a logical, visual depiction of the process that is being analyzed. The diagram typically uses specific symbols to describe different types of activities (e.g., operation, decision, inspection, storage, etc.). It also may include an identification of the product or process characteristics that need to be monitored at each step (e.g., temperature of the oven, thickness of the wax, diameter of the hole, etc.) and the possible sources of variation (e.g., incorrect setup, contamination, machine maintenance, etc.). Such diagrams can be useful to determine

the steps in the process that will be analyzed in the PFMEA and to determine the functions and critical characteristics that will be considered in the analysis.

Tip: You can use the Attachments feature to provide easy access to process flow diagrams that have been created with other software tools (such as Visio or PowerPoint). *See page 124 in Chapter 3.* Alternatively, you can use the process flow diagram feature to create the diagram and link it to the rest of the analysis. *See page 485 in Chapter 28.*

14.1.3.2 Assemble the Team

One of the first steps in performing an FMEA is to assemble a cross-functional team of knowledgeable individuals to perform the analysis. The team should be large enough to make sure that relevant viewpoints and knowledge are represented but not too large. If the team is too large, it will be difficult to have productive discussions during meetings and it will be a waste of an extremely valuable resource – the time and patience of your organization’s subject matter experts. Team members should be familiar with the FMEA analysis process, as it is practiced by the organization. In addition, a skilled facilitator can help to make sure that team meeting time is used effectively and the analysis is performed correctly.

The composition of the team at any particular meeting may vary depending on the focus of the discussion. This may include representatives from Design, Analysis/Testing, Materials, Suppliers/OEM, Manufacturing/Assembly, Quality/Reliability, System Integration, Field Service, Maintenance, etc.

Tip: You can use the analysis plan feature to document the members of the analysis team for each FMEA.

14.1.3.3 Establish the Ground Rules and Assumptions

Before beginning the analysis, the team should discuss (and probably document) the underlying assumptions of the analysis and specific ground rules for how the analysis will be performed. Some of these guidelines may be determined already by the organization’s standard practices for FMEA and some may be specific to the particular analysis project. Some of the questions that might be considered include (but are not limited to) the following:

- What will be considered a failure?
- What are the assumed environmental and operating conditions?
- Will the analysis consider failures that result from abuse?
- What is the budget and timescale for the project and what are the project deliverables?
- What other activities within the organization will the team need to interact with and have the necessary communications been established?
- When and where will the team meet?
- Will there be a facilitator?
- How will decisions be made within the team and how will conflicts be resolved?
- What will be the format of the analysis worksheet and what rating scales will be used?
- How will the organization track the completion of recommended actions?
- And so on...

This list is provided as an example. Other issues may be applicable for your particular situation.

Tip: You can use the analysis plan feature to document the ground rules and assumptions for each FMEA.

14.1.3.4 Gather and Review Information (Pre-Work)

Taking the time to gather and review available information before the analysis meetings begin can help to make the most efficient use of team meeting time and achieve an analysis that is thorough and accurate. The appropriate resources will vary depending on the type of FMEA that you are performing and the specific product or process that you are analyzing. This may include:

- Bill of materials and/or process flow diagrams
- Customer requirements, business requirements, functional specs, technical specs
- Design schematics, drawings
- Feasibility studies or trade-off analyses
- Information from similar designs, including field data, FMEAs, etc.
- Documentation or contracts from suppliers
- Applicable government or safety regulations

This is an incomplete list that is provided as an example. Other resources may be applicable for your particular situation.

Tip: You can use the Attachments feature to provide easy access to supporting documentation that may be relevant to a particular analysis. See page 124 in Chapter 3.

14.1.4 Identify the Functions, Failure Modes, Effects, Causes and Controls

For each item or step that will be analyzed, the analysis team will use engineering and business judgment to identify the functions, failure modes, effects, causes and controls that will be considered in the analysis.

- **Function:** An intended function or purpose, as described by a required standard of performance.
- **Failure Mode:** The inability to perform a function within the specified limits.
- **Effect:** The anticipated consequences if the failure mode occurs.
- **Cause:** The specific reason for the failure. This may be found by asking “why” until the basic mechanism that brings about the failure is determined. In many cases, there are several levels of detail that could be used to describe the cause of failure. In general, it is best to choose the level at which the organization is able to control the condition and/or take corrective action.
- **Current Control:** A method or action that is planned or currently in place to reduce or eliminate the risk. In many cases, the current controls are classified as “Prevention” or “Detection,” where:
 - **Prevention Controls** are intended to reduce the likelihood that the problem will occur.
 - **Detection Controls** are intended to increase the likelihood that the problem will be detected before it reaches the end user.

Tip: In many situations, an existing document may contain information that would be useful to import directly into your FMEA analysis (such as a requirements document, a process flow diagram worksheet, an FMEA from a similar product/process or a predefined “phrase set”). The software provides numerous features to help you find and import this information. These features are described in the “Diagrams” chapter.

14.1.4.1 Evaluate Risk for Potential Failures

A typical FMEA incorporates some method to identify and evaluate the risk associated with the potential problems identified through the analysis. Risk Priority Numbers (RPNs) and criticality analysis are the most commonly used methods for this.

To use the **Risk Priority Number (RPN)** method, the analysis team must:

- Rate the severity of each effect of failure.
- Rate the likelihood of occurrence for each cause of failure.
- Rate the likelihood of detection for each cause of failure.
- Calculate the RPN by obtaining the product of the three ratings:

$$\text{RPN} = \text{Severity} \times \text{Occurrence} \times \text{Detection}$$

To use **Qualitative Criticality Analysis**, the analysis team must a) rate the severity of the potential effects of failure and b) rate the likelihood of occurrence of each potential failure mode. It is then possible to compare failure modes, via a Criticality Matrix, which identifies severity on the horizontal axis and occurrence on the vertical axis.

To use **Quantitative Criticality Analysis**, the analysis team considers the reliability/unreliability for each item at a given operating time and identifies the portion of the item's unreliability that can be attributed to each potential failure mode. For each failure mode, they also rate the probability that it will result in system failure. The team uses these factors to calculate the criticality for each potential failure and for each item.

Tip: The software provides an extensive array of features to support risk assessment based on RPN and related metrics. See *Chapter 15*.

Quantitative and qualitative criticality analysis patterned after the concepts in MIL-STD-1629A are also supported. See *Chapter 16*.

14.1.4.2 Identify and Assign Corrective Action(s)

The next step is to identify, assign and track the completion of recommended actions that will help to reduce the risk associated with potential failures. In some situations, it may be possible to take an action that will reduce the severity of the effect when the failure occurs but in most cases, the recommended actions will be designed to either reduce the likelihood that the failure will occur or to increase the likelihood that it will be detected and controlled before the problem reaches the end user. When selecting the actions to recommend, the team may consider:

- Existing controls.
- The relative importance (prioritization) of the issue.
- The cost and potential effectiveness of the corrective action.

Tip: One of the most costly mistakes among FMEA practitioners is the failure to follow up and track the completion of recommended actions. The software provides multiple features that will help to ensure that your organization implements the actions suggested by the analysis in order to achieve the benefits that come from improving the design and reducing the risk. See *page 101 in Chapter 3*.

14.1.4.3 Perform Corrective Actions and Re-evaluate Risk

In many cases, it may be appropriate to revise the risk assessment after the recommended actions have been completed (or based on the results that the analysis team expects to achieve when they are completed). This will provide an indication of the effectiveness of corrective actions and the benefits achieved by performing the FMEA. To use revised RPNs for this purpose, the analysis team will:

- Assign revised severity, occurrence and detection ratings.
- Calculate a revised RPN.
- Compare the initial and revised RPNs.

The % reduction in RPN can be calculated with the following equation:

$$\% \text{ Reduction in RPN} = \frac{RPN_i - RPN_r}{RPN_i}$$

14.1.4.4 Distribute, Review and Update Analysis Results

FMEAs are typically reported in a tabular (worksheet) format. The style varies depending on the standard/guidelines and the terminology used during the analysis. In addition to the worksheet, other tabular reports can be useful to support decision-making and communicate the results of the analysis, such as Assigned Actions, Causes Ranked By RPN, etc. Pareto (bar), pie and matrix charts also can help to visualize analysis results.

An FMEA is most effective when it is a “living” document. When completed, the analysis should be distributed as appropriate throughout the organization so that it can be used as a resource for other activities. Your organization invested too much effort and knowledge to bury the document in the file cabinet!

Tip: You can use the Reports window and the Query Utility to create the reports to distribute the results of your FMEAs. In addition, the Plot Viewer provides a variety of charts to present the information graphically.

In general, the FMEA should be reviewed and updated:

- When there is a change to the design.
- When other factors change (such as the operating conditions or the intended application).
- When new information from the field is available.

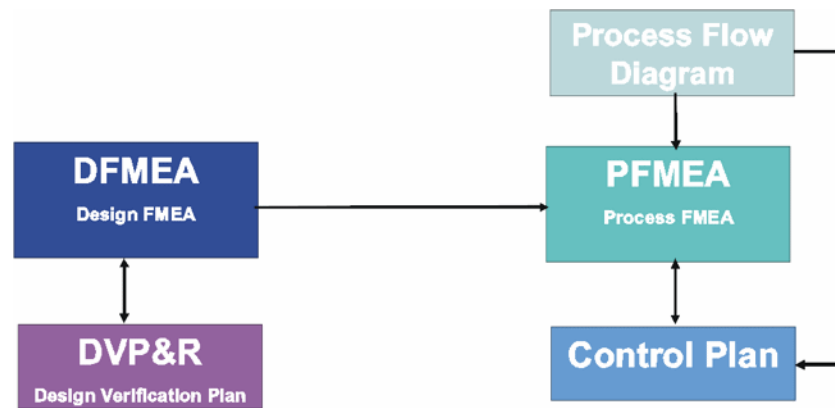
Tip: There are several ways to manage revisions to an existing analysis, including a formal Change Log that can automatically record all revisions to an existing analysis and facilitate a process for electronic approval tracking.

After the completion of an FMEA project, it can also be a good idea to have an expert in the FMEA methodology evaluate (audit) the FMEA. In addition, you may wish to solicit feedback from the team members who participated in the analysis in order to identify issues that should be addressed in future analysis projects. A suitable checklist could be obtained from the FMEA literature or your organization may choose to develop its own audit requirements.

Tip: You can use the analysis plan feature to document the results of the quality survey for each FMEA.

14.1.5 Integration with Other Analyses (Including APQP)

Within the automotive industry and some other industries, practitioners have integrated FMEA with other quality planning efforts, as shown in the following diagram and described next.



14.1.5.1 DFMEA and DVP&R

The design verification plan and report (DVP&R) is a worksheet that is used to track the progress of design verification tests. The lessons learned from the DFMEA can be a valuable input to the DVP&R (and vice-versa). For example: if the design FMEA indicates that Part X will fail if the incorrect wax thickness is applied for protection, then it may be appropriate to add a test to the design verification plan for determining the optimum wax thickness to be applied.

Tip: The DVP&R Analysis feature provides a configurable worksheet for design verification planning and reporting, including the ability to synchronize the DVP&R with information transferred from an existing FMEA.

14.1.5.2 DFMEA to PFMEA

The lessons learned from a design FMEA also can be a valuable input to the process FMEA. Analysts may wish to transfer relevant information between analyses, where:

- Causes in the DFMEA can become failures in the PFMEA.
- Failures in the DFMEA can become effects in the PFMEA.

For example, if the design FMEA indicates that Part X will leak if the hole diameter is too wide then the design FMEA will consider whether the specified hole diameter is appropriate while the process FMEA will consider aspects of the manufacturing process that may cause the hole diameter to vary from the specification.

- DFMEA: Failure = Leak; Cause = Hole too wide.
- PFMEA: Failure = Hole too wide; Effect = Leak.
 - Causes = ?
 - Controls = ?
 - Actions = ?

Tip: The Transfer Projects feature allows you to transfer selected data from an existing design FMEA to a new process FMEA. See Section 14.8 on page 368.

14.1.5.3 Process Flow Diagram, Process FMEA and Process Control Plan

As described in Section 14.1.3.1 on page 335, the process flow diagram (PFD) provides a logical, visual depiction of the process that is being analyzed and such diagrams can be useful to determine the steps in the process and the critical characteristics that will be analyzed in the PFMEA.

In addition, the process control plan (PCP) describes the actions that are required at each phase of the process to ensure that all process outputs will be in a state of control. The process flow diagram and the lessons learned from a process FMEA can be a valuable input to the process control plan. The linkages between these documents might be applied as follows:

- **Operation # and Description** flow from the Process Flow Diagram to the PFMEA to the control plan.
- **Significant Product Characteristics (and Classifications)** contribute to the definition of failure modes and/or causes in the PFMEA. They also flow to the control plan.
- **Current Controls** flow from the PFMEA to the control plan.

Tip: The PFD Worksheet feature (*described in Chapter 19*) provides integration with both the Process FMEA and the Process Control Plan worksheet. *See Chapter 20.*

14.1.5.4 Design Review Based on Failure Mode (DRBFM)

DRBFM is a methodology used to evaluate proposed changes to an existing design, using a worksheet that is usually similar to, but not identical to, an FMEA.

Although some organizations may choose to perform DRBFM instead of FMEA, most practitioners start with a baseline FMEA and then use the DRBFM worksheet for evaluating the risks that might be introduced by changes to the original design.

Tip: The DRBFM Analysis feature provides a configurable worksheet for design review based on failure mode, including the option to select functions that will be transferred from an existing FMEA and the ability to update the FMEA with new information from the DRBFM.

14.1.6 References

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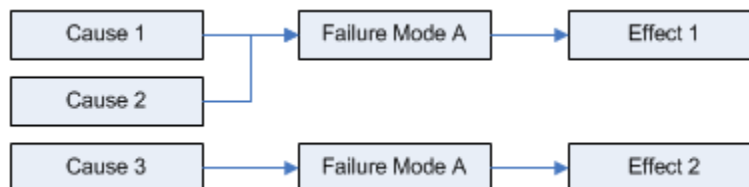
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14.2 Choosing the FMEA Structure

On the General page of the Project Properties window, *see page 67 in Chapter 2*, you use the **FMEA Structure** field to choose how you want to display Effect and Cause records in the FMEA hierarchy. You have three options:

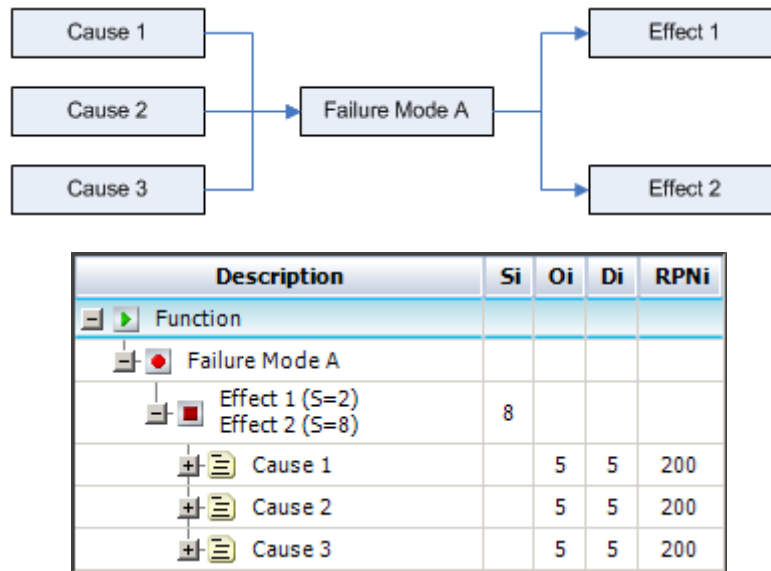
- If you want to display the FMEA records in the same way as previous versions of Xfmea/RCM++/RBI, choose **Effects Before Causes**. This flexible structure assumes that each effect of a failure mode may or may not depend on which cause(s) occurred. When using the RPN risk assessment method, this allows you to use different effect severity ratings for different causes that are associated with the same failure mode *if it is appropriate in the context of a particular analysis*.

For example, if you have defined a failure mode rather generally, you might encounter a situation like the one diagrammed below where, for the same failure mode, one effect may result if Cause 1 or Cause 2 occurs but a different effect may result if Cause 3 occurs.

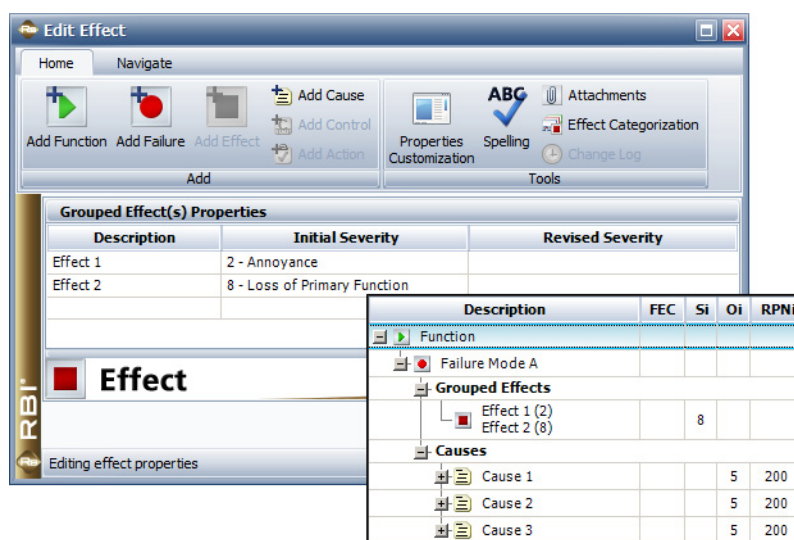


Description	Si	Oi	Di	RPNi
Function				
Failure Mode A				
Effect 1	2			
Cause 1		5	5	50
Cause 2		5	5	50
Effect 2	8			
Cause 3		5	5	200

It should be noted that a “best practice” FMEA analysis approach typically encourages failure modes to be defined more specifically (i.e., where any of the causes of the failure mode will result in any or all of the effects) and the “Effects Before Causes” structure also supports that type of data entry. You would simply define all of the effects together in the same record (using **CTRL+ENTER** to force linebreaks in the text box when needed) and then choose a single severity rating that you want to use to calculate the RPN for all of the causes (e.g., the severity of the most serious individual effect, the severity of the most likely effect, or the severity of all effects occurring together). The following picture shows the analysis based on the severity of the most serious effect.

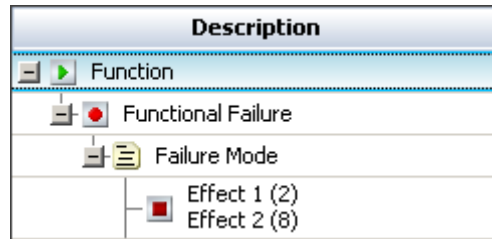


- If you will always be defining the failure modes more specifically (i.e., where any of the causes of the failure mode will result in any or all of the effects) and you want the software to display causes and effects at the same level of the hierarchy under the failure mode that they are both associated with, choose **Grouped Effects and Causes**. This allows you to define the causes and effects associated with a particular failure mode in any order (instead of requiring effects to be entered first as in the “Effects Before Causes” structure). It also stores a separate description and severity rating for each effect. When using the RPN risk assessment method, the software will automatically choose the highest severity rating to calculate the RPN for all of the causes associated with that failure mode.



- Choose **Causes Before Effects** if you are performing a reliability centered maintenance (RCM) analysis and/or you wish to enter information in the following order:
 - Functions
 - Functional Failures (i.e., the Failure record in Xfmea)
 - Failure Modes (i.e., the Cause record in Xfmea)
 - Effects

This structure assumes that the functional failures will be defined rather generally and requires that there can be only one effect record per cause. To describe multiple effects in the same record, use **CTRL+ENTER** to force linebreaks in the text box when needed.



14.2.1 Switching Between FMEA Structures

While you can switch the FMEA structures for a particular project, the following limitations apply:

- When switching from the “Causes Before Effects” structure to the “Effects Before Causes” structure, all records are converted without changes.
- When switching from the “Effects Before Causes” structure to the “Causes Before Effects” structure, each effect record is duplicated under each cause record.
- When switching from the “Grouped Effects and Causes” structure to the “Effects Before Causes” structure, all records are converted with the highest severity ratings being used for the new effects.
- When switching from the “Effects Before Causes” structure to the “Grouped Effects and Causes” structure, all effect records associated with a given failure are merged into one effect record. All cause records are associated with the new grouped effect record.
- You cannot directly switch between the “Causes Before Effects” structure and the “Grouped Effects and Causes” structure. You must first convert to the “Effects Before Causes” structure and then convert to the other structure.

14.3 FMEA Analysis Tab

To add an FMEA to a project, select an item in the System panel and choose **Insert > FMEA > Add FMEA**.



The FMEA analysis tab will open in the Analysis panel. *See page 111 in Chapter 3.* In addition, the FMEA icon will appear in the corresponding column in the System Hierarchy tab of the System panel (if that column has been selected for display on your computer). To hide or display columns, right-click the column headers in the System panel, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the System Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed.

There are four tabs at the bottom of the panel. The **Header** tab allows you to define the information that will be displayed at the top of the FMEA spreadsheet reports. *See Section 14.3.1 on page 345.* In addition, the software offers three complimentary views to the information contained in your FMEAs. It is easy to switch back and forth between the views so you can choose the display that is best suited for a specific task.

- The **Hierarchy** tab displays the analysis records in a hierarchical tree, which tends to be good for viewing a lot of information in a small amount of space. It can be especially useful when copying and pasting data or when scanning the analysis to find a particular section of the FMEA. *See Section 14.3.2 on page 346.*
- The **Worksheet** tab follows the traditional tabular format that most FMEA practitioners are familiar with. It allows you to type directly into the worksheet cells and tab through the analysis as you would in a spreadsheet application, such as Microsoft Excel. *See Section 14.3.3 on page 348.*
- The **Filtered** tab presents a sortable list of all records of a particular type. For example, you may wish to see all cause records sorted by RPN or all overdue actions. This view allows you to generate these lists on-the-fly as you work on the analysis. *See Section 14.3.4 on page 351.*

Tip: For information about how to use the FMEA tab to perform reliability centered maintenance analysis (RCM), see Chapter 13

14.3.1 FMEA Header

The information defined on the Header tab for an FMEA will be displayed at the top of the FMEA spreadsheet reports. This includes information such as document number, the name of the person who created the report, the revision date, etc.

The following fields may be found on the FMEA Header tab.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. The interface style can be modified via the Project Properties window. *See page 67 in Chapter 2.*

- **FMEA Type:** The type of FMEA. This field is a drop-down list.
- **Document Number:** A unique document identifier.
- **Key Date:** The date when the FMEA should be completed.
- **FMEA Date (Orig.):** The date when the FMEA is first completed.
- **FMEA Date (Rev.):** The latest revision date for the FMEA.
- **Prepared By:** The person who prepared the document.
- **Primary Approval:** The person who gave primary approval for the document.
- **Approval Date:** The date when the FMEA document was approved.
- **Product:** The product that the FMEA applies to.
- **Model Year(s)/Program(s):** The model year and/or program identifier that the FMEA applies to.
- **Mission:** The mission that the item is intended to perform.
- **Release Date:** The date when the design will be released.
- **Responsibility:** The person who is responsible for the design that is being analyzed.
- **Core Team:** The primary team of people who worked on the analysis.
- **Support Team:** The secondary support team for the analysis.

- **Others Affected:** Other people who were involved with or affected by the analysis.
- **User-Defined Fields:** Up to five text fields, two date fields, two number fields and two drop-down lists.
- **Last Updated:** The date when the FMEA header was last updated. This is populated by RBI.
- **Last Updated By:** The user who last updated the FMEA header. This is populated by RBI.

For text fields, you can click the **Select Existing** icon inside the field. *See page 113 in Chapter 3.* This will open a window that allows you to reuse text that has already been entered in this type of field.



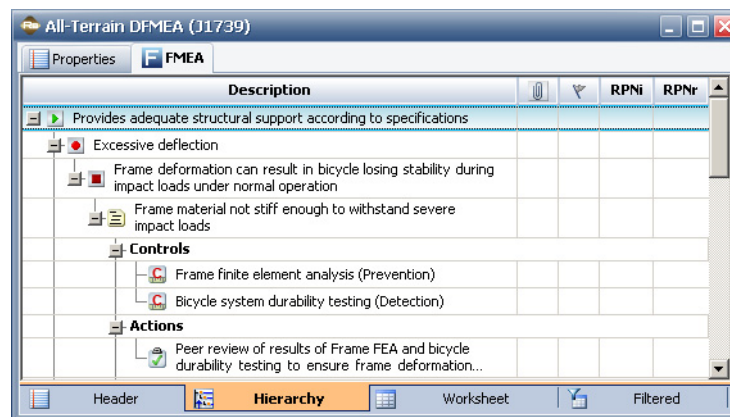
For date fields, you can click the field once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.

14.3.2 FMEA Hierarchy View

To view the FMEA in a hierarchical format, click the **Hierarchy** tab at the bottom of the Analysis panel.

This view, which is the default view of the FMEA analysis, displays the records defined in your analysis (e.g., functions, failures, etc.) at-a-glance in a hierarchical tree structure.

Note: The following image shows the default, Effects Before Causes, FMEA structure. The display will vary if you have selected one of the other FMEA structures. *For more information, see Section 14.2 on page 342.*



14.3.2.1 Using the FMEA Hierarchy View

The FMEA hierarchy view allows you to add, insert, edit, copy and paste the records in your analysis. You cannot edit text directly in this view. Instead, all editing in this view is done via properties windows that you can access by double-clicking a row in the hierarchy or by right-clicking a row and choosing **Edit** from the shortcut menu.

You can move the records in the FMEA hierarchy view up and down either by dragging them to the desired location or by using the **Up** and **Down** icons on the Home tab of the Ribbon.



These commands move the selected record down or up the list of records of the same type that are associated with the same record (e.g., move a failure up or down within the list of failures that have been defined for the same function).

14.3.2.2 Available Columns

To hide or display columns, right-click the column headers in the FMEA hierarchy view, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the FMEA Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed. *See page 510 in Chapter 30.*

The available columns include the following:

- **#** displays the record position number assigned by RBI based on the position of the record in the FMEA hierarchy. For example, if you insert a new function above an existing function, then the new function will take the number of the existing function and all functions below it will be renumbered. Likewise, if you delete a function, all functions below it will be renumbered automatically.
- **Description** displays the description of the record.
- **Record ID** displays the record ID, which is an identifier assigned by RBI. The record ID is unique among all records of that type that are defined in the database.
- **Attachment** displays a paper clip icon if one or more files have been attached to the record. *See page 124 in Chapter 3.*
- **FEC** displays the abbreviation generated in the Failure Effect Categorization window. *See page 298 in Chapter 13.*
- **Flag** displays a flag for the record. To insert a flag, right-click inside this column and select a flag from the shortcut menu that appears. The available flags are: Complete (indicated by a green flag), In Progress (indicated by a yellow flag) and Incomplete (indicated by a red flag). This flag is displayed in the interface only and does not affect reports.
- **Classification** displays an abbreviation of the classification that has been assigned to the cause, if any. This field is used to identify design characteristics that require special manufacturing control (e.g., Critical, Significant, Key Leading, etc.).
- **Observed Occurrences** displays the number of occurrences, as recorded in XFRACAS, of the failure mode/cause combination for the current system hierarchy item. This column is available only when you are working with a system hierarchy item that has a current association with a part in XFRACAS. The values in this column may be drawn from XFRACAS incidents, problems or failure analyses, depending on your selection on the FMEA Hierarchy page of the Application Setup.

For example, you might have a failure mode called “Bulb failed” that has two causes, “Filament burned” and “Shattered.” Assume you are basing failures on XFRACAS incidents. If there are 3 incidents in XFRACAS with the “Bulb failed - Filament burned” combination and 2 incidents with the “Bulb failed - Shattered” combination, then the Observed Occurrences column will display a value of 5 for the “Bulb failed” failure, a value of 3 for the “Filament burned” cause and a value of 2 for the “Shattered” cause.

There are also 16 columns that can be enabled to display RPN ratings and/or metrics. *See Chapter 15.* Each column will be displayed only if it has been selected in the Customize Columns window and is enabled in the interface style for the particular project. The lowercase letter “i” indicates an initial rating or metric while the letter “r” indicates a revised rating or metric.

- **S** displays the severity rating assigned to the effect.
- **O** displays the occurrence rating assigned to the cause.
- **D** displays the detection rating assigned to the cause.
- **RPN** displays the calculated Severity x Occurrence x Detection.
- **SxO** displays the calculated Severity x Occurrence.

- **SOD** displays the severity, occurrence and detection ratings in the following format: [Severity][Occurrence][Detection]. For example, if the severity is 7, the occurrence is 5 and the detection is 6, then the resulting SOD will be 756. When the issues are sorted in descending order, they will be prioritized first by severity, then by occurrence and then by detection.
- **SD** displays the calculated Severity x Detection, which is similar to the SOD metric described above.
- **RR** displays the risk ranking for the cause. This column will be displayed only if risk ranking is enabled and risk ranking columns are selected for use in the interface style for the project.

You also can use the **Highlight Priority** command to highlight the records in the FMEA hierarchy view based on the risk assessment ratings. Choose **FMEA > Tools > Highlight Priority** to toggle the priority highlights on and off. *For more information about how to setup the priority highlights, refer to page 371 in Chapter 15.*

14.3.3 FMEA Worksheet View

To view the FMEA in a tabular format, click the **Worksheet** tab at the bottom of the Analysis panel.

The FMEA worksheet presents a column for each data field that has been enabled in the interface style for the project. Pointing to a column header in the worksheet displays descriptive information about the column in a tooltip form. These tooltips also depend on the interface style settings that have been defined for the current project.

Note: Regardless of your choice of the FMEA structure for the hierarchy (see *Section 14.2 on page 342*), the order of the columns in the worksheet depends on the order set in the Worksheet Columns page of the project's interface style. *For more information, see page 190 in Chapter 6.*

Function	Potential Failure Mode	Potential Effect(s) of Failure	SEV	Potential Cause(s) of Failure
Provides adequate structural support according to specifications	Excessive deflection	Frame deformation can result in bicycle losing stability during impact loads under normal operation	9	Frame material not stiff enough to withstand severe impact loads
	Complete structural failure	Frame can break apart and cause accident	10	Frame diameter insufficient for severe impact loads
Provides proper dimensional support for the entire frame subassembly.	Improper frame length	Bicycle will not perform in terms of stability and handling as intended	6	Proper analysis of the contribution of upper frame to overall bicycle stability was not done

You can split the worksheet view, creating two areas that scroll separately. This feature allows you to view text at one side of the worksheet without losing sight of text at the other side. To insert a split bar, right-click a column header and choose **Split**. The split will be inserted to the left of the selected column. To remove the split bar, right-click again and choose **Remove Split**.

You can resize the columns and rearrange the order in which the columns are displayed. You also have the option to select whether the worksheet will display controls in two columns based on type (e.g., detection controls and prevention controls) or will display all control descriptions in the same column and use the second column to identify the control type. All these options are set via the interface style. *See page 187 in Chapter 6.*

You also can use the Highlight Priority command to highlight the records in the FMEA worksheet view based on the risk assessment ratings. Choose **FMEA > Tools > Highlight Priority** to toggle the priority highlights on and off. *For more information about how to set up the priority highlights, refer to page 371 in Chapter 15.*

14.3.3.1 Adding and Editing Records in the Worksheet

When you are in the worksheet view, you can easily add records to the FMEA the same way that you do in the hierarchy view. For example, to add a new effect to the analysis, simply choose **FMEA > FMEA Records > Effects**. A new cell will appear in the worksheet in the Effect column with a blinking cursor and a **Select Existing** icon, as shown next, indicating that you are in edit mode.



Type the description for the record or click the **Select Existing** icon, which will open the Select Existing window. *See page 113 in Chapter 3.* This window allows you to set the description by selecting from existing descriptions in the current database and/or from active phrase sets.

When you are in edit mode, you also can add new records to the analysis by pressing **ENTER**. For example, when you are editing an existing function, press **ENTER** to add a new function. A new function will be added to the next row in the Function column. You can add failures, effects, causes, controls and actions in the same manner.

When you are in edit mode:

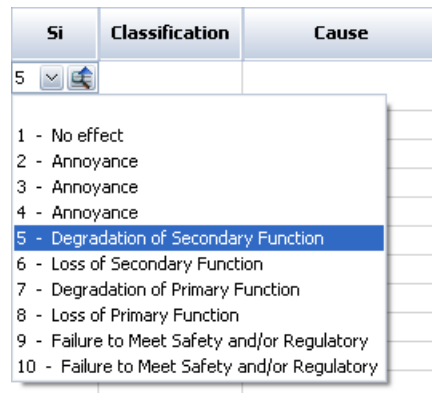
- Press **TAB** to navigate to the next column on the same row.
- Press **SHIFT+TAB** to navigate to the previous column on the same row.
- Press **ENTER** to navigate down to the next row. If you press **ENTER** from the last record in a column, the software prepares a new row so that you can create a new record.

To save your changes and exit the edit mode, press **ALT**. To exit the edit mode without saving your changes, press **ESC**. When a cell is selected and you are not in edit mode, use the arrow keys for navigation.

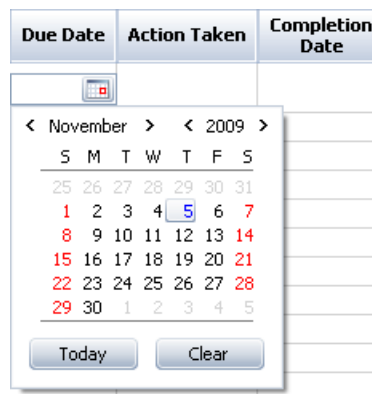
You also have the ability to copy/paste records in the worksheet view. To do this, make sure you are not in edit mode (i.e., the currently selected cell should not have a blinking cursor); you can save your changes and exit the edit mode by pressing **ALT**. Navigate to the record you wish to copy using the arrow keys. Copy the record by choosing **Home > Clipboard > Copy** or by pressing **CTRL+C**. Navigate to the record you want to paste under (e.g., if you are copying an effect, navigate to the failure you want to paste it to) and paste the record by choosing **Home > Clipboard > Paste** or by pressing **CTRL+V**.

To edit text fields in the worksheet view, double-click inside the cell to enter edit mode. You can use the **HOME**, **END** and arrow keys to move through the text in the cell. Make the desired modifications to the description or use the Select Existing window, then press **ENTER** or **TAB** or click somewhere outside of the cell to save the changes. To insert a line break within the cell, press **CTRL+ENTER**. When using the edit mode to work in a cell, if you want to copy and paste text, you can either use the keyboard shortcuts (**CTRL+C** and **CTRL+V**) or right-click and use the commands on the shortcut menu.

To edit a cell that contains a rating or a drop-down list (e.g., severity rating or classification), double-click the cell to display a list with the available options, as shown next.



To edit a date field (e.g., target completion date, etc.), click the cell to display a calendar.



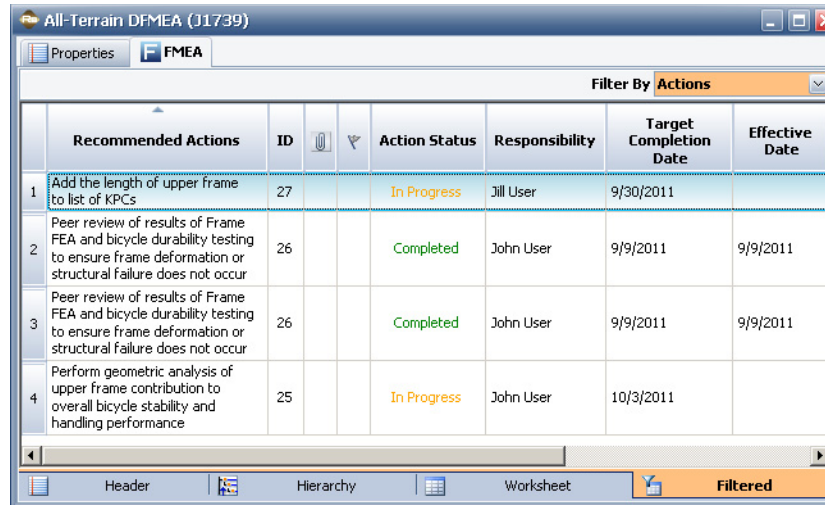
You also can click the cell again to type the date. You can enter the date in the format set in your region and language settings. *See page 13 in Chapter 1.*

Note that the changes you make in most cells will be directly reflected in the relevant properties window.

Finally, to open a properties window, you can right-click any of the record columns and choose the **Edit** command from the shortcut menu that appears. You also can click the record column and choose the Edit command from the FMEA Records group of the FMEA tab of the Ribbon (e.g., **FMEA > FMEA Records > Functions > Edit Function**).

14.3.4 FMEA Filtered View

When working in the FMEA, you can use the filtered view to show only records of a specific type (e.g., functions, failures, etc.). To use the filtered view, click the **Filtered** tab at the bottom of the Analysis panel. You can then choose the record type that you want to view from the **Filter By** drop-down list in the upper right corner. The Analysis panel will change to display only the records of the specified type, as shown next for recommended actions.



	Recommended Actions	ID	Action Status	Responsibility	Target Completion Date	Effective Date
1	Add the length of upper frame to list of KPCs	27	In Progress	Jill User	9/30/2011	
2	Peer review of results of Frame FEA and bicycle durability testing to ensure frame deformation or structural failure does not occur	26	Completed	John User	9/9/2011	9/9/2011
3	Peer review of results of Frame FEA and bicycle durability testing to ensure frame deformation or structural failure does not occur	26	Completed	John User	9/9/2011	9/9/2011
4	Perform geometric analysis of upper frame contribution to overall bicycle stability and handling performance	25	In Progress	John User	10/3/2011	

The columns that can be displayed in the filtered view will depend on the record type you selected in the drop-down list and the fields enabled in the interface style for the current project. To further customize the display by hiding specific columns and/or changing the column order, right-click inside any of the column headers and choose **Customize Columns**. These preferences are stored per computer/username.

You can sort the records that appear in this view by clicking the column header. You also can use the **Highlight Priority** command to highlight the records in the FMEA filtered view based on the risk assessment ratings. Choose **FMEA > Tools > Highlight Priority** to toggle the priority highlights on and off. *For more information about how to set up the priority highlights, refer to page 371 in Chapter 15.*

When you are in the filtered view, you can easily edit many of the descriptions and settings by double-clicking inside the cell. The properties window for the corresponding record will appear, allowing you to make any necessary changes. You cannot create new records or change the sequence of the records in the filtered view.

14.4 FMEA Records

When adding a new record (i.e., function, failure, effect, cause, control or action), RBI will assign a unique record identifier and a record position number using the following rules:

- RBI assigns the unique record identifier (the ID column in the FMEA Hierarchy) as a sequential number for records of a given type across all projects in a single database, regardless of who created the record or how the record was created. When pasting records, RBI assigns new numbers to the record identifiers.
 - For example, if you create a function in Project 1, while another user pastes a function in Project 2, followed by you creating a second function in Project 1, your second function will have ID number 3.

- RBI assigns a record position number based on the location of the record in the FMEA hierarchy (the # column in the FMEA Hierarchy). These numbers are unique within a particular FMEA only and they help to provide some information about how the record fits within the rest of the FMEA hierarchy.
 - For example, if you have three failures associated with the second function in an analysis, the record position number of the third failure will be 3. When you use the Query Utility to search for failure records, the Failure # will be shown in terms of the full context within the analysis. In this case, the number will be 2.3, where the 2 represents the record position number of the function and 3 represents the record position of the failure.

Note: These values are not displayed in the FMEA record properties window, but can be displayed in the Analysis panel and they are also used in the Query Utility, and in Reports. To hide or display columns, right-click the column headers in the FMEA hierarchy view, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the FMEA Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed. See page 510 in Chapter 30.

14.4.1 FMEA Record Properties Window

The FMEA record properties windows can be used to add, insert and edit FMEA records and to view all of the record properties. These windows all have a similar format and contain several common elements, which are presented in this section. For example, the Function properties window looks like this:

Function	
Function	Function 1
Short Description	Function 1
Requirements	

User-Defined	
Function User Text 1	
Function User Date 1	
Function User Number 1	
Function User Drop-Down 1	

Associated Records	
Current Item	System 1

History	
Created By	User Name
Date Created	10/23/2013 1:46 PM
Last Updated By	User Name
Last Updated	10/23/2013 1:46 PM

Function	

Each window includes the following areas:

- The **Record** area which includes all record-specific fields that are specifically supported by the software and can be disabled or renamed via the project's interface style. (The interface style can be modified via the Project Properties window. *See page 67 in Chapter 2.*) Note that the name of this area is the same as the record type (e.g., if you have a function open this is the Function area and if you have a control open this is the Control area).
- The **User-Defined** area includes all user-defined record-specific fields. Each record may contain up to five user-defined text fields, two user-defined date fields, two user-defined number fields and two user-defined drop-down lists. This area displays only if there are user-defined fields enabled for the record in the interface style.
- The **Associated Records** area provides the analysis context for the record by allowing you to view the full descriptions for the item and higher-level FMEA records that it is associated with.

In addition, every window has a **History** area that displays information about the creation and last modification of the record. If the history log has been activated at the project level, you can click the **View Item History** icon to open the Record History Log for the record.

In the hierarchy and filtered views, you can click anywhere in the FMEA analysis to view/edit the properties for different records without having to open and close the properties window for each record.

When you open a properties window from the hierarchy view, a Ribbon is displayed at the top of the window, which contains two tabs:

- The **Home** tab provides commands for adding records, with the available options depending on which FMEA record is currently selected. When applicable, it also provides the following tools:



Properties Customization opens the FMEA Properties (This Project) window where you can adjust the record properties. The available options are the same as those in the interface style as defined in the Project Properties window. *See page 67 in Chapter 2.*



Spelling checks the spelling in all text fields within the window. *See page 114 in Chapter 3.*



Attachments opens the Attachments window, which allows you to manage the linked and attached files for the record. *See page 124 in Chapter 3.*



Effect Categorization opens the Failure Effect Categorization window, which allows you to identify and evaluate the effects of the functional failure. This displays for effect records only. *See page 298 in Chapter 13.*



Task Manager opens the Task Manager window, which allows you to work with tasks assigned to causes within the FMEA and to choose an appropriate maintenance strategy by using one or both of the available task selection methods. This displays for cause records only. *See page 300 in Chapter 13.*



Change Log opens the Record Change Log window, which displays the changes that have been made to the current record. *See page 388 in Chapter 17.* This option is available only if a change log has been activated for the FMEA and only if changes have been made to this record since the change log was activated.

- The **Navigate** tab allows you to quickly switch to another record in the FMEA hierarchy. For example, if you want to quickly scan through the properties for all of the functions, you can open the properties window for the first one and then keep clicking the **Next Function** command until you reach the bottom of the list. The commands enabled will depend on the record that is currently displayed in the properties window.

Tip: The Failure Modes and Reliability Analysis (FMRA) chapter, [Chapter 8, describes how to define the reliability/maintenance characteristics for the functions, failures and/or causes that have been defined for any item in the system hierarchy. These characteristics will be applicable if you wish to perform criticality analysis, use the FMEA occurrence ratings to calculate a preliminary baseline estimate of the system reliability, share system configuration/reliability data between RBI and BlockSim or perform RCM cost/availability calculations.

14.4.2 Functions

Functions are FMEA records that state what the item or process is intended to do, usually to a given standard of performance or requirement. *For more information about FMEA records, see Section 14.4 on page 351.*

The following topics are discussed here:

- Adding and inserting functions
- Editing functions
- Copying and pasting functions
- Function properties

Tip: You can specify for a default function to be created for all new items added to the System panel by choosing **File > Application Setup** and selecting the **Create Default Function for New Items** option on the Settings page of the Application Setup. *See page 507 in Chapter 30.*

Adding and Inserting Functions

To add or insert functions into an FMEA, choose **FMEA > FMEA Records > Functions**, then select one of the following options:



Add Function adds a new record to the bottom of the list.



Insert Function inserts a new function above the one that is currently selected.



Import Functions opens the Import Existing Functions window (*see page 217 in Chapter 7*) so you can choose to copy one or more existing functions into this FMEA. There is no link to the original record(s) (i.e., changes made in one record will not automatically update the other(s)), and you have the choice to import with or without dependents (e.g., associated failures, effects, causes, etc.).

Editing Functions

To edit an existing function in the FMEA, either edit it directly in the worksheet view or use the properties window. To open the properties window, select the function and choose **FMEA > FMEA Records > Functions > Edit Function** or double-click the function in the hierarchy or filtered view.



Copying and Pasting Functions

If you have copied a function, there are two options when you choose **Home > Clipboard > Paste**:



Paste (CTRL+V) pastes the function(s) and all dependent records (e.g., associated failures, effects, causes, etc.).

Paste Without Dependents pastes only the function(s) without any dependent records.

Function Properties

The properties enabled (and their display names) will depend on the interface style for the current project. To view or change these settings, choose **Project Management > Configurable Settings > Interface Style**. See page 187 in Chapter 6.

Note the following:

- The **Function Description** is required.
- The **Short Description** is a shortened version of the record description that will be used in locations where the full description would be too long to display (e.g., diagrams). If the field is blank when you save the record, the application automatically populates it based on the first 50 characters of the full description.

Tip: If you need to define the reliability/maintainability characteristics for this record, use the FMRA tab. See Chapter 8. These characteristics will be applicable if you wish to perform criticality analysis, use the FMEA occurrence ratings to calculate a preliminary baseline estimate of the system reliability, share system configuration/reliability data between RBI and BlockSim or perform RCM cost/availability calculations.

14.4.3 Failures (Functional Failures)

Failures (typically called *functional failures* in RCM analysis) are FMEA records that state the manner in which the item or operation fails to meet or deliver the intended function and its requirements. *For more information about FMEA records, see Section 14.4 on page 351.*

The following topics are discussed here:

- Adding and inserting failures
- Editing failures
- Copying and pasting failures
- Failure properties

Adding and Inserting Failures

To add or insert failures into an FMEA, select the function that the failure will be associated with and choose **FMEA > FMEA Records > Failures**, then select one of the following options:



Add Failure adds a new record to the bottom of the list for this function.



Insert Failure inserts a new failure above the one that is currently selected.



Import Failures opens the Import Existing Failures window (*see page 217 in Chapter 7*) so you can choose to copy one or more existing failures into this FMEA. There is no link to the original record(s) (i.e., changes made in one record will not automatically update the other(s)), and you have the choice to import with or without dependents (e.g., associated effects, causes, etc.).

Editing Failures

To edit an existing failure in the project, either edit it directly in the worksheet view or use the properties window. To open the properties window, select the failure and choose **FMEA > FMEA Records > Failures > Edit Failure** or double-click the failure in the hierarchy or filtered view.



Copying and Pasting Failures

If you have copied a failure, there are two options when you choose **Home > Clipboard > Paste**:



Paste (CTRL+V) pastes the failure(s) and all dependent records (e.g., associated effects, causes, etc.).

Paste Without Dependents pastes only the failure(s) without any dependent records.

Failure Properties

The properties enabled (and their display names) will depend on the interface style for the current project. To view or change these settings, choose **Project Management > Configurable Settings > Interface Style**. See page 187 in Chapter 6.

Note the following:

- The **Failure Description** is required.
- The **Short Description** is a shortened version of the record description that will be used in locations where the full description would be too long to display (e.g., diagrams). If the field is blank when you save the record, the application automatically populates it based on the first 50 characters of the full description.

The following fields will be available if they are enabled on the FMEA > Criticality page of the project's interface style. Note that the application will not fully validate these factors until you perform the criticality analysis. See Chapter 16.

- The **Failure Probability** value rates the likelihood that the failure will occur and is used in qualitative criticality analysis.
- The **Severity Class** value rates the severity for the failure. This is for qualitative criticality analysis, and also is required to generate a criticality matrix for the quantitative analysis.

Tip: If you need to define the reliability/maintainability characteristics for this record, use the FMRA tab. See Chapter 8. These characteristics will be applicable if you wish to perform criticality analysis, use the FMEA occurrence ratings to calculate a preliminary baseline estimate of the system reliability, share system configuration/reliability data between RBI and BlockSim or perform RCM cost/availability calculations.

14.4.4 Effects

Effects are FMEA records that state the consequence of the failure on the system or end user. Some of the features for working with effects will depend on the FMEA structure that has been selected for the current project. *For more information about FMEA records, see Section 14.4 on page 351.*

The following topics are discussed here:

- FMEA Structure and Effects
- Adding and inserting effects
- Editing effects
- Copying and pasting effects
- Effect properties

FMEA Structure and Effects

As discussed in Section 14.2 on page 342, you can use the **FMEA Structure** field on the General page of the Project Properties window to choose how you want to display effect and cause records in the FMEA hierarchy. Note the following:

- If the FMEA structure is **Causes Before Effects**, you are limited to only one effect for each cause and you cannot add or insert additional effects.
- If the FMEA structure is **Grouped Effects and Causes**, the properties window will be divided into two sections. In the table at the top of the window, you can enter a separate description and severity rating for each potential effect.

Grouped Effect(s) Properties		
Description	Initial Severity	Revised Severity
First possible effect.	7 - Major effect	7 - Major effect
Second possible effect.	5 - Moderate effect	5 - Moderate effect
Third possible effect.	3 - Slight effect	3 - Slight effect

When this effect is displayed in a hierarchy or worksheet, all of the descriptions will be combined into a single cell. The individual severity ratings will be shown in parentheses and the highest rating will always be used for the purpose of RPN calculations.

End Effect	Si
First possible effect. (7) Second possible effect. (5) Third possible effect. (3)	7

Adding and Inserting Effects

To add or insert effects into an FMEA, select the failure that the effect will be associated with and choose **FMEA > FMEA Records > Effects**, then select one of the following options:



Add Effect adds a new record to the bottom of the list for this failure.



Insert Effect inserts a new effect above the one that is currently selected.



Import Effects opens the Import Existing Effects window (*see page 217 in Chapter 7*) so you can choose to copy one or more existing effects into this FMEA. There is no link to the original record(s) (i.e., changes made in one record will not automatically update the other(s)), and you have the choice to import with or without dependents (e.g., associated causes, controls, etc.).

Editing Effects

To edit an existing effect in the project, either edit it directly in the worksheet view or use the properties window. To open the properties window, select the effect and choose **FMEA > FMEA Records > Effects > Edit Effect** or double-click the effect in the hierarchy or filtered view.



Copying and Pasting Effects

If you have copied an effect, there are two options when you choose **Home > Clipboard > Paste**:



Paste (CTRL+V) pastes the effect(s) and all dependent records (e.g., causes, controls, etc.).

Paste Without Dependents pastes only the effect(s) without any dependent records.

Effect Properties

Effect	
Effect	Loss of fire detection/overheat signal from loop A or B. Alternative loop is still available.
Short Description	Loss of fire detection/overheat signal from loo...
FEC	E0

Associated Records	
Current Item	Fuel Delivery System
Function	Deliver x gallons per hour fuel on demand
Failure	Fails to provide Zone 1 & Zone 2 fire detection/overhead signal to the airframe.

History	
Created By	User Name
Date Created	10/23/2013 2:39 PM
Last Updated By	User Name
Last Updated	10/23/2013 2:39 PM

Effect

OK Cancel

Editing effect properties

The properties enabled (and their display names) will depend on the interface style for the current project. To view or change these settings, choose **Project Management > Configurable Settings > Interface Style**. *See page 187 in Chapter 6.*

Note the following:

- The **Effect Description** is required.
- The **Short Description** is a shortened version of the record description that will be used in locations where the full description would be too long to display (e.g., diagrams). If the field is blank when you save the record, the application automatically populates it based on the first 50 characters of the full description.
- The **Initial Severity** and **Revised Severity** ratings are numerical values that indicate how serious the consequences will be if the failure occurs. The options in these drop-down lists are based on the severity scale that has been assigned in the Project Properties window. A severity rating must be defined in order for the RPN to be calculated automatically.
- The **FEC** field displays the current Failure Effect Categorization rating that is used for traditional RCM analysis. *See page 298 in Chapter 13.*

14.4.5 Causes (Failure Modes)

Causes (typically called *failure modes* in RCM analysis) are FMEA records that state the specific reason for the failure, preferably found by asking “why” until the root cause is determined. Some of the features for working with causes will depend on the FMEA structure that has been selected for the current project. *For more information about FMEA records, see Section 14.4 on page 351.*

The following topics are discussed here:

- FMEA Structure and Causes
- Adding and inserting causes
- Editing causes
- Copying and pasting causes
- Cause properties

FMEA Structure and Effects

As discussed in Section 14.2 on page 342, you can use the **FMEA Structure** field on the General page of the Project Properties window to choose how you want to display effect and cause records in the FMEA hierarchy. Note the following:

- If the FMEA structure is **Causes Before Effects** or **Grouped Effects and Causes**, each cause will be associated with a failure record.
- If the FMEA structure is **Effects Before Causes**, the cause will be associated with an effect record.

Adding and Inserting Causes

To add or insert causes into an FMEA, select the failure or effect that the cause will be associated with and choose **FMEA > FMEA Records > Causes**, then select one of the following options:



Add Cause adds a new record to the bottom of the list.



Insert Cause inserts a new cause above the one that is currently selected.



Import Causes opens the Import Existing Causes window (*see page 217 in Chapter 7*) so you can choose to copy one or more of the existing causes into this FMEA. There is no link to the original record(s) (i.e., changes made in one record will not automatically update the other(s)), and you have the choice to import with or without dependents (e.g., associated effects, causes, etc.).

Editing Causes

To edit an existing cause in the project, either edit it directly in the worksheet view or use the properties window. To open the properties window, select the cause and choose **FMEA > FMEA Records > Causes > Edit Cause** or double-click the cause in the hierarchy or filtered view.



Copying and Pasting Causes

If you have copied a cause, there are two options when you choose **Home > Clipboard > Paste**:



Paste (CTRL+V) pastes the cause(s) and all dependent records (e.g., controls, actions, etc.).

Paste Without Dependents pastes only the cause(s) without any dependent records.

Cause Properties

The 'Edit Cause' dialog box displays the following information:

Cause	
Failure Mode	Pump failure
Short Description	Pump failure

Associated Records	
Current Item	Fuel Delivery System
Function	Deliver x gallons per hour fuel on demand.
Failure	Delivery below 20% or above 10% of x gallons per hour on demand.
Effect	Engine will not start.

History	
Created By	ReliaSoft Corporation
Date Created	12/21/2011 8:29 AM
Last Updated By	ReliaSoft Corporation
Last Updated	12/21/2011 8:29 AM

At the bottom of the dialog, there are 'OK' and 'Cancel' buttons. The status bar at the bottom indicates 'Editing cause properties'.

The properties enabled (and their display names) will depend on the interface style for the current project. To view or change these settings, choose **Project Management > Configurable Settings > Interface Style**. *See page 187 in Chapter 6.*

Note the following:

- The **Cause Description** is required.
- The **Short Description** is a shortened version of the record description that will be used in locations where the full description would be too long to display (e.g., diagrams). If the field is blank when you save the record, the application automatically populates it based on the first 50 characters of the full description.
- Use **Classification** to identify design characteristics that require special manufacturing control (e.g., Critical, Significant, Key Leading, etc.).
- The options in the following drop-down lists are based on the occurrence scale that has been assigned in the Project Properties window. The RPN will be calculated automatically if you have defined a Severity rating for the effect, and Occurrence and Detection ratings for the cause.
 - The **Initial Occurrence** and **Revised Occurrence** ratings are numerical values that estimate the probability of occurrence for the potential failure cause.
 - The **Initial Detection** and **Revised Detection** ratings are numerical values that estimate the probability that the problem will be detected before it reaches the customer or end user.

Tip: If you need to define the reliability/maintainability characteristics for this record, use the FMRA tab. These characteristics will be applicable if you wish to perform criticality analysis, use the FMEA occurrence ratings to calculate a preliminary baseline estimate of the system reliability, share system configuration/reliability data between RBI and BlockSim or perform RCM cost/availability calculations.

14.4.6 Controls in FMEAs

Controls are Synthesis resources that can be used multiple times in different locations, if appropriate. Any changes made to the control properties will be reflected in all locations where the same resource is used. Controls will be available in FMEAs only if the **Enable Controls for Causes** option is selected in the current project's interface style. They can also be created and used in control plans and PFD worksheets.

The following topics are discussed here:

- Adding and inserting controls in FMEAs
- Using “Replace with Existing” and “Make Unique”
- Copying and pasting controls in FMEAs
- Deleting controls from an FMEA
- Control properties

Adding and Inserting Controls in FMEAs

To add or insert controls into the FMEA, select the Controls node under the relevant failure cause — or another control that's already defined for that cause — and choose **FMEA > FMEA Records > Controls** then select one of the following options:



Add Control adds a new record to the bottom of the list for this cause.



Insert Control inserts a new record above the one that is currently selected.



Add Existing Controls opens the Select Resource window so you can choose one or more of the existing resources to use again in the current location. *See page 175 in Chapter 5.*

Replace with Existing and Make Unique

If you have selected an existing control, the following options may also be available:

Replace with Existing opens the Select Resource window so you can choose a different resource to be used in the current location.



Make Control Unique creates a new resource that is no longer associated with (linked to) the existing one. The description of the new resource will be incremented automatically so it remains unique (e.g., “Do this and that” might become “Do this and that_1”).

Copying and Pasting Controls in FMEAs

If you have copied a control, there are two options when you choose **Home > Clipboard > Paste**:



Paste (CTRL+V) pastes another instance of the same resource into the new location.

Paste as Unique (CTRL+SHIFT+V) pastes a new record that is no longer associated with (linked to) the existing resource. The description of the new record will be incremented automatically so it remains unique (e.g., “Do this and that” might become “Do this and that_1”).

Deleting Controls from an FMEA

To delete a control from a specific location in an FMEA, select the control and press **Delete** or right-click the control and choose **Delete** from the shortcut menu.



This removes the control from the current location, but the resource remains in the project so it can continue to be used in other places. If a resource is not being used in any other locations, an authorized user (i.e., the project owner or any user with the “Create/edit/delete all resources” permission) can delete it via the Resource Manager. *See page 169 in Chapter 5.*

Control Properties

The properties enabled in the Control window (and their display names) will depend on the interface style for the current project. To view or change these settings, choose **Project Management > Configurable Settings > Interface Style**. *See page 187 in Chapter 6.*

Note the following:

- The **Control Description** is required.
- The **Short Description** is a shortened version of the record description that will be used in locations where the full description would be too long to display (e.g., diagrams). If the field is blank when you save the record, the application automatically populates it based on the first 50 characters of the full description.
- The options in the **Control Type** drop-down list depend on the current project's interface style. By default:
 - **Detection** controls will help to detect the failure before it reaches the end user.
 - **Prevention** controls will help to prevent the failure from occurring.

In the FMEA worksheet view, these controls can be displayed in either one or two columns depending on the project's settings for the **Number of Controls in Worksheet View** option in the interface style.

14.4.7 Actions in FMEAs

Actions are Synthesis resources that can be used multiple times in different locations, if appropriate. Any changes made to the action properties will be reflected in all locations where the same resource is used.

Actions will be available in FMEAs only if the **Enable Actions for Causes** option is selected in the current project's interface style. They can also be created and used in DFR plans and My Portal.

The following topics are discussed here:

- Adding and inserting actions in FMEAs
- Using “Replace with Existing” and “Make Unique”
- Copying and pasting actions in FMEAs
- Deleting actions from an FMEA

For information about the action properties and other general considerations that are applicable wherever the action may be used, see page 101 in Chapter 3.

Adding and Inserting Actions in FMEAs

To add or insert actions into the FMEA, select the Actions node under the relevant failure cause — or another action that's already defined for that cause — and choose **FMEA > FMEA Records > Actions** then select one of the following options:



Add Action adds a new record to the bottom of the list for this cause.



Insert Action inserts a new record above the one that is currently selected.



Add Existing Actions opens the Select Resource window so you can choose one or more of the existing resources to use again in the current location. *See page 175 in Chapter 5.*

Replace with Existing and Make Unique

If you have selected an existing action, the following options may also be available:

Replace with Existing opens the Select Resource window so you can choose a different resource to be used in the current location.



Make Action Unique creates a new record that is no longer associated with (linked to) the existing resource. The description of the new record will be incremented automatically so it remains unique (e.g., “Do this and that” might become “Do this and that_1”).

Copying and Pasting Action in FMEAs

If you have copied an action, there are two options when you choose **Home > Clipboard > Paste**:



Paste (CTRL+V) pastes another instance of the same resource into the new location.

Paste as Unique (CTRL+SHIFT+V) pastes a new resource that is no longer associated with (linked to) the existing one. The description of the new resource will be incremented automatically so it remains unique (e.g., “Do this and that” might become “Do this and that_1”).

Deleting Actions from an FMEA

To delete an action from a specific location in an FMEA, select the action and press **Delete** or right-click the action and choose **Delete** from the shortcut menu.



This removes the action from the current location, but the resource remains in the project so it can continue to be used in other places. If a resource is not being used in any other locations, an authorized user (i.e., the project owner, the action creator or any user with the “Create/edit/delete all resources” permission) can delete it via the Resource Manager. *See page 169 in Chapter 5.*

14.5 Failure-Cause Matrix

The Failure – Cause Matrix allows you to view the unique failure modes and causes that have been defined in the FMEA. This matrix helps to see when the same cause has been identified for more than one failure mode. To do this, open the FMEA and then choose **FMEA > Tools > Failure – Cause Matrix**.



The matrix will appear, as shown next.

	Cause 1.1.1.1	Cause 1.1.1.2	Cause 1.2.1.1	Cause 1.2.1.2
Failure 1.1	X	X		
Failure 1.2			X	X

In the matrix, the failures associated with the selected item will appear by row (i.e., vertically) and the unique causes will appear by column (i.e., horizontally). An X will appear in the intersecting cell when the failure is associated with the cause. You may have to scroll through the window to view all failures and causes associated with the selected item.

This report is not saved within the software. It is automatically generated based on current data each time you open the window. If desired, click **Send to Excel** to save the current report to an Excel spreadsheet.

14.6 FMEA Statistics

The FMEA Statistics window displays statistics about the FMEA, including the number of causes, the percentage of causes that have RPN ratings assigned, the number of actions, etc. To view these statistics, open the FMEA and then choose **FMEA > Tools > FMEA Statistics**.



The information will be displayed in a window like the one shown next.

1 - All-Terrain Bicycle System: FMEA Statistics					
Database:	C:\RBI9_Examples.rsr9				
Project:	Design FMEA - All-Terrain Bike (J1739)				
Selected Item:	1 - All-Terrain Bicycle System				
Parent System:	N/A				
Next Higher Assembly:	N/A				
# of Items in Next Level:	Total	with at least one function			
	9	9 (100%)			
# of Functions:	Total	with Records Assigned Below	with Rating	with Criticality	with RCM Logic
	15	15 (100%)			
# of Failures:	32	22 (68.75%)		N/A	
# of Effects:	22	22 (100%)	22 (100%)		0 (0%)
# of Causes:	50	40 (80%)	47 (94%)		
# of Controls:	Total				
	65				
# of Actions:	Total	Overdue	Due	Complete	Reviewed and Approved
	47	47 (100%)	0 (0%)	0 (0%)	0 (0%)

Send to Excel ☒ Include sub-items Close

Information about the database, project and item is displayed at the top of the report. In addition, the report presents the following statistics. If the **Include sub-items** option is selected, the totals represent the records associated with the FMEA for the selected item and the FMEAs for all of its sub-items. If this option is not selected, the totals represent the records in the current FMEA only.

- **# of Items in Next Level:** The total number of items in the next level of the system hierarchy below the current item (i.e., sub-items) and the number of those items that have at least one function defined.
- **# of Functions:** The total number of functions that have been defined for the current item and the number/percentage of those functions that have at least one associated failure.
- **# of Failures:** The total number of failures that have been defined for the current item and the number/percentage of those failures that have at least one associated effect. Also, if criticality analysis is enabled for the project, the number/percentage of those failures that have at least one of the criticality factors defined.
- **# of Effects:** The total number of effects that have been defined for the current item and the number/percentage of those effects that have at least one associated cause. Also, if RPNs have been enabled for the project, the number/percentage of those effects that have the severity rating defined.
- **# of Causes:** The total number of causes that have been defined for the current item and the number/percentage of those causes that have at least one action or control defined. Also, if RPNs have been enabled for the project, the number/percentage of those causes that have the occurrence and detection ratings defined.
- **# of Controls:** The total number of controls that have been defined for the current item.
- **# of Actions:** The total number of actions that have been defined for the current item and the number/percentage of those actions that are in each status: Overdue, Due, Complete or Reviewed and Approved.

This report is not saved within the software. It is automatically generated based on current data each time you open the window. Click **Send to Excel** to save the current report to an Excel spreadsheet.

14.7 Diagnostic Logic Assistant (DLA)

The product knowledge recorded in an FMEA can be a valuable resource for many other activities in the product life cycle. One practical application for this data is to assist in the development of diagnostic/repair/troubleshooting documentation that may be provided in repair manuals and used by customer care agents.

Starting in version 9.0.2, the Diagnostic Logic Assistant window makes it easy to extract relevant data from the FMEA into Microsoft Excel, where you can organize and filter it as needed when preparing supporting documentation. To access the utility, choose **Home > Reporting > DLA**.



The table displays all of the effects from all of the FMEAs in the current project. The Component column indicates which item's FMEA the effect appears in, while the **Failure** and **Cause** columns identify the possible failure modes that might result in this outcome.

You can use the check boxes at the top of the window to determine whether the table will also display the occurrence and detection ratings that were assigned to these potential failure modes in the FMEA (if any).

For example, the following picture shows fictional data from the FMEAs performed on the components of a chandelier, and the partial troubleshooting guide that might be developed based on the data for the "No light" effect.

Diagnostic Logic Assistant

Display Options

☐ Show initial ratings ☐ Show revised ratings

Effect	Component	Failure	Cause
No light	Bulb	Filament burns	Evaporates during use
No light	Bulb	Base fails to make contact	Cap fails to screw all the way
No light	Bulb	Bulb shatters	Spike in voltage
No light	Bulb	Bulb shatters	Overheat
No light	Socket	Fails to make contact	Solder connection failure, deterioration of solder connection
No light	Socket	Short	Corrosion inside the socket
No light	Socket	Fails to make contact	Dirty contacts
No light	Socket	Short	Presence of foreign conductive material in contacts
No light	Wiring	Series arcing	Loose terminal or dirt in a connection
No light	Wiring	Terminal point connection failure	Frequent manipulation, ingress of fluids and dirt
No light	Wiring	Delamination	Failure of the bond
No light	Wiring	Chafing	Swinging and loose

Send to Excel...

Troubleshooting Guide:

If there is No Light, then first:

- Check the Bulb
 - Is it shattered?
 - Is it screwed in?
- ...
- Check the Wiring
 - ...
- Check the Socket
 - ...

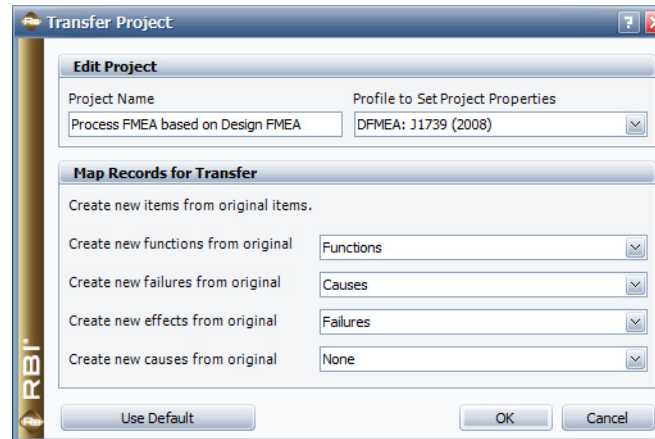
Note that this report is not saved within the Synthesis repository. It is automatically generated based on current data each time you open the window. Click **Send to Excel** to save the current report to an Excel spreadsheet.

14.8 Transfer Projects

The Transfer Project utility allows you to create a new project with FMEA data transferred from an existing project. This might be used, for example, to create a new process FMEA with data transferred from an existing design FMEA.

Note: This utility is intended to be used for transferring FMEA data from one project to another. Related analyses, such as design verification plans, control plans, etc. will not be transferred.

When you select an existing project in the project list and choose **Project > Management > Transfer Project**, the Transfer Project window will be displayed.



In the **Edit Project** area, type the name of the new project and choose the profile that will be used to set the configurable settings for the new project.

In the **Map Records for Transfer** area, select options from the drop-down lists to define how the data will be “mapped” from the original project to the new project. If you click **Use Default** to reset all of the menus to their defaults, the new project will have all of the same items and functions from the original project. However, the failures in the new project will be based on the causes from the original project, the new effects will be based on the original failures and no causes will be created in the new project. You can then use the new project as a starting point for a new analysis.

If the default selections do not meet your needs, you can choose other options from the lists to specify how each type of record in the new project will be created.

Risk Priority Numbers (RPNs)

15

RBI supports both of the risk assessment methods that are commonly used in conjunction with FMEAs: Risk Priority Numbers (RPNs) and criticality analysis. This chapter describes RBI's capabilities for RPNs and related metrics such as SxO, SOD and SD. Chapter 16 presents RBI's support for criticality analysis patterned after the MIL-STD-1629A guidelines.

Depending on how you have configured the analysis project, RBI allows you to use predefined rating scales in order to:

- Rate the severity of each effect.
- Rate the likelihood of occurrence for each cause.
- Rate the likelihood of detection for each cause.

For each rating scale, the higher value represents the greater seriousness or risk. For example, with 10-point scales, a severity rating of 10 might indicate that the consequences of failure are very serious, an occurrence rating of 10 might indicate that the failure is very likely to occur and a detection rating of 10 might indicate that the failure is very unlikely to be detected before it reaches the end user.

Based on the ratings that have been defined for the effects and causes in the FMEA, you can configure the analysis project to calculate and display any of the following metrics:

- **RPN:** This is the product of severity x occurrence x detection.
- **SxO:** This is the product of severity x occurrence.
- **SOD:** This is not a calculated value. Rather, it is the result of displaying three values in the following format: [Severity][Occurrence][Detection]. For example, if the severity is 7, the occurrence is 5 and the detection is 6, then the resulting SOD will be 756. When the issues are sorted in descending order, they will be prioritized first by severity, then by occurrence and then by detection.
- **SD:** This is similar to SOD except that it displays Severity and Detection only.

Finally, RBI's **Risk Ranking** feature allows you to define a more complex logic for ranking issues based on rating scales and/or metrics. There are many different ways that this logic could be configured. For example, you might wish to configure the analysis project to label the issue "High Priority" if the RPN is $\Rightarrow$ XXX AND the severity rating is $\Rightarrow$ Y. Alternatively, you might wish to label the issue "Action Required" if the severity rating is $\Rightarrow$ X, the occurrence rating is $\Rightarrow$ Y and the detection rating is $\Rightarrow$ Z. And so on.

This chapter describes how to:

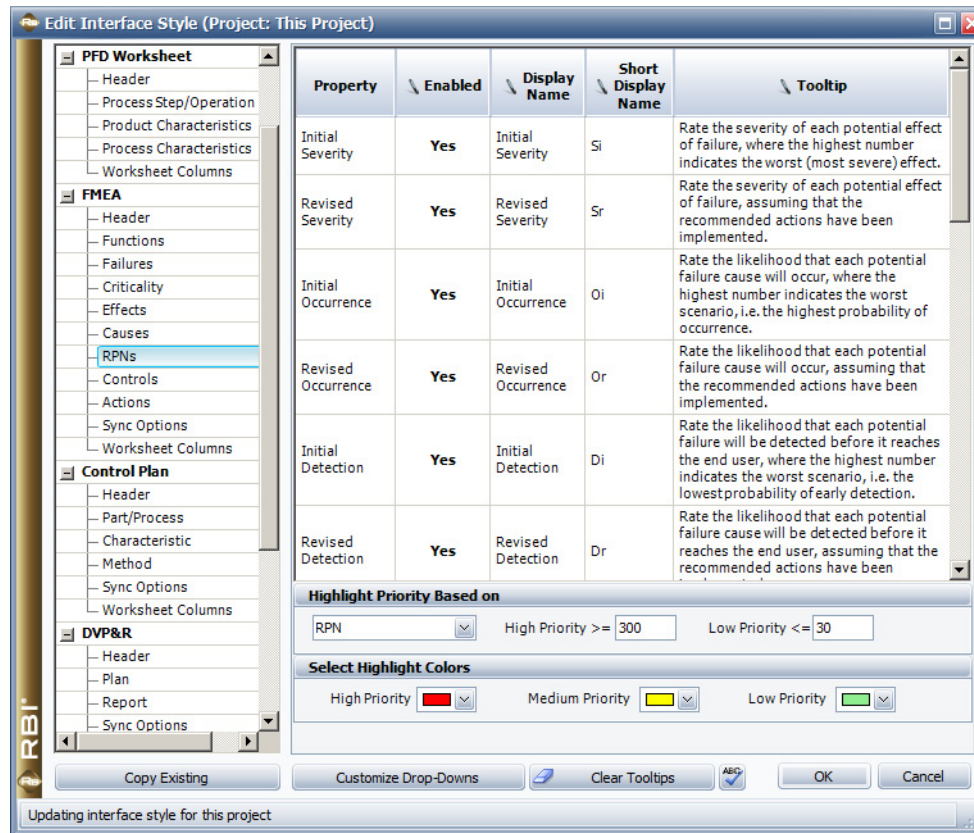
- Define rating scales and enable RPN metrics - Section 15.1 (p. 370).
- Display RPN metrics in the analysis panel - Section 15.2 (p. 371).

- Display RPN metrics in queries and reports - Section 15.3 (p. 371).
- Display RPN metrics in the plot viewer - Section 15.4 (p. 372).

15.1 Defining Rating Scales and Enable RPN Metrics

In order to use RPNs or related metrics with your FMEAs, you must:

- Define severity, occurrence and detection rating scales for the project.
- Enable at least one of the metrics on the RPNs page in the interface style for the project.



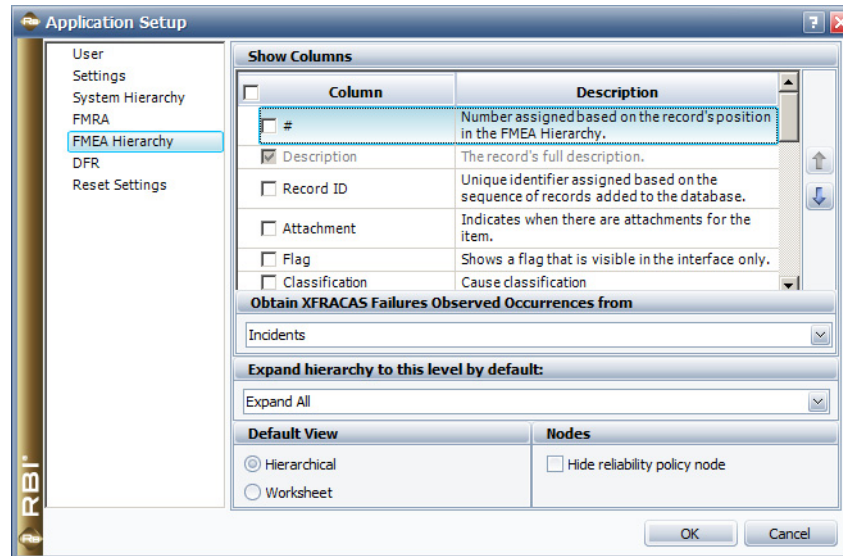
The predefined profiles and libraries that are shipped with RBI provide a variety of rating scales that have been published in the literature and FMEA standards. Authorized users also can create custom rating scales and interface styles for use in any project. *These options are described in Chapter 6.*

Note: On the RPNs page in the interface style, the RPN, SxO, SOD or SD metrics can be enabled or disabled within the property table (similar to any other configurable data field). However, if you want to use the customizable Risk Ranking feature, you must choose **Risk Ranking** from the drop-down list in the **Highlight Priority Based on** area and then click the **Risk Ranking Logic** button to define your particular preferences.

15.2 Displaying RPN Metrics in the Analysis Panel

When you are working with an FMEA in the Analysis Panel, all of the RPN metrics that have been enabled for a project will be displayed in the FMEA Worksheet tab.

If you want to display these metrics in the FMEA hierarchy view and filtered view, choose **File > Application Setup** and click the FMEA Hierarchy page as shown next.



Select or clear the check boxes to display or hide columns for the RPN metrics that have been enabled for the project.

In the FMEA filtered view, when you choose **Causes** from the **Filter By** drop-down, the software will display a list of all causes that have been defined in the FMEA. You can sort the list in ascending or descending order by clicking any of the column headers. For example, you can use this feature to create a list of causes sorted by RPN or SxO.

In all three FMEA views, you also have the option to use color to highlight issues based on priority. Choose **FMEA > Tools > Highlight Priority** to turn the colors on or off.

The logic used to determine the priority for each issue is configurable and can be defined on the RPNs page in the interface style for the project. *See page 190 in Chapter 6.*

15.3 Displaying RPN Metrics in Queries and Reports

Any of the RPN metrics that have been enabled in the project can be used in the queries and reports that you create. For example, if you want to create a report that lists all causes in the FMEA that have an initial RPN greater than 200, do the following:

- Choose **Home > Reporting > Queries** to open the Query Utility.
- Choose **FMEA Causes** from the drop-down list at the top of the window.
- In the row for **Initial RPN**, choose **is greater than** from the first column under Criterion 1 and then enter **200** in the second column.
- Click **Run Query** to display the results when the query is applied to the current data. If the table on the **Results** tab does not exactly meet your needs for the custom report, you can go back to the Criteria tab and use the **Include in Results** column to hide or display particular fields. You also can click the **Headers Customization** tab if you want to change the order or widths of the columns.

- Click the **Run Query** button again to see the effects of your changes. When you are satisfied with the results, click the **Save Query** icon and provide a name for the query template (e.g., “High Priority Causes”).



- Close the Query Utility and then choose **Home > Reporting > Reports** to open the Reports window.
- When you scan through the list of **Available Reports**, you can see that your new query template appears under **FMEA Records**.
- To create a report document that includes the full FMEA spreadsheet and the list of causes with an RPN greater than 200, select one of the options under **FMEA Spreadsheet** and then double-click the option to add it to the list of selected reports. Do the same for the custom query that you just created.
- In the **Select Output Type** area in the bottom-left of the window, choose the output type (Word or Excel) and then click **Generate Report** to create the document.

You can follow a similar procedure to create other types of queries and reports that will display the analysis information in ways that will support the decisions that need to be made.

15.4 Displaying RPN Metrics in the Plot Viewer

RBI also provides a variety of graphical charts based on RPN metrics. Choose **Home > Reporting > Plots** and then choose at least one item with FMEA data that will be displayed in the charts. The following charts are based on RPN ratings or metrics:

- **RPN (Pareto)**: a bar chart of causes ranked by initial and/or revised RPN.
- **RPN % Reduction Pareto**: a bar chart of causes ranked by % reduction in RPN.
- **Occurrence/Severity Matrix**: a matrix chart that displays the severity ratings on the horizontal axis and occurrence ratings on the vertical axis and then plots each cause at the position of its severity and occurrence ratings. Diagonal lines delineate high, medium and low priority areas.
- **SxO Pareto**: a bar chart of causes ranked by SxO.
- **Effect Severity Pareto**: a bar chart of effects ranked by severity rating.
- **Cause Occurrence Pareto**: a bar chart of causes ranked by occurrence rating.
- **Cause Detection Pareto**: a bar chart of causes ranked by detection rating.
- **Effect Severity Pie**: a pie chart that shows the percentage of effects that have been assigned to each severity rating (e.g., 20% of the effects in the FMEA have a severity rating of 7 or higher).
- **Cause Occurrence Pie**: a pie chart that shows the percentage of causes that have been assigned to each occurrence rating.
- **Cause Detection Pie**: a pie chart that shows the percentage of causes that have been assigned to each detection rating.

For more information about the Plot Viewer, refer to Chapter 25.

Criticality Analysis

16

With the release of the Synthesis version, ReliaSoft introduced a new methodology for quantitative criticality analysis that is patterned after MIL-STD-1629A but uses a more general approach that overcomes several inherent limitations and simplifications present in the military standard (including the assumption of a constant failure rate). For details about the new approach, see http://www.ReliaWiki.org/index.php/Criticality_Analysis.

In Version 9, users have the option to use the updated method (which is integrated directly into the FMRA and FMEA interfaces) or the original method (which has a dedicated utility that can be enabled via the Application Setup, if desired).

This chapter discusses the following:

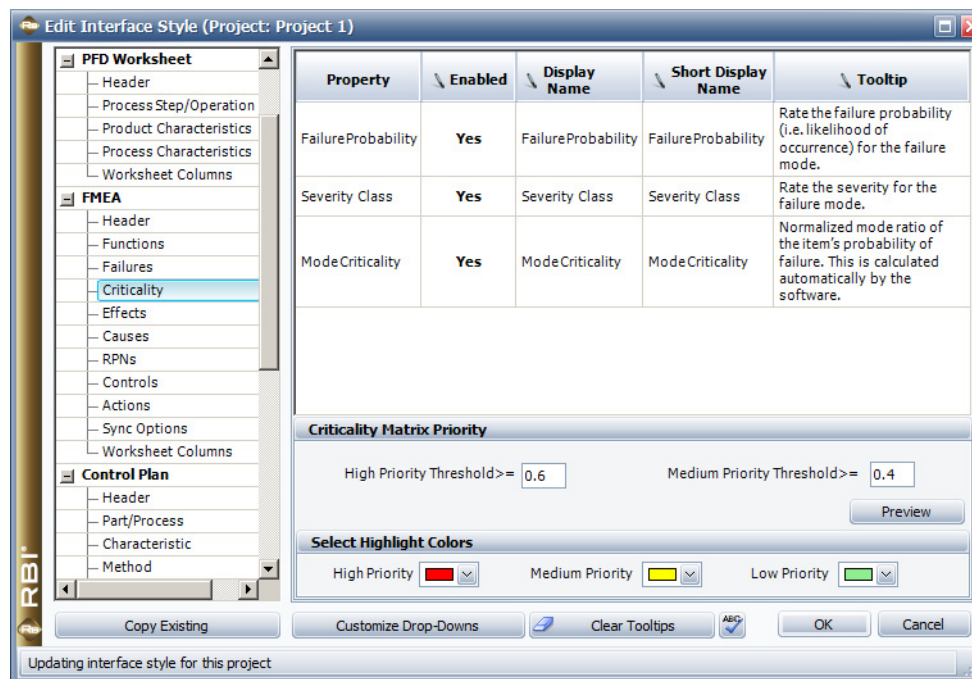
- How to enable the criticality analysis fields for the project. This is required for any type of criticality analysis you may wish to perform - Section 16.1 (p. 374).
- How to perform qualitative criticality analysis based on rating scales - Section 16.2 (p. 375).
- How to perform quantitative criticality analysis directly in the FMRA - Section 16.3 (p. 376).
- How to enable and use the MIL-1629A Criticality Analysis window, if desired - Section 16.4 (p. 379).

RBI also provides flexible support for the RPN risk assessment approach. *For more details, see Chapter 15.*

16.1 Enabling Criticality Analysis Fields

Criticality analysis fields will be enabled by default when you use the “MIL-STD-1629A” or “Comprehensive” profiles that have been predefined and shipped with the RBI software. You also can create your own custom profile with the criticality fields enabled, or simply modify the properties for a particular project.

You can make most of these selections on the **FMEA > Criticality** page of the interface style.



Qualitative Analysis

The **Failure Probability** and **Severity Class** fields are required for qualitative criticality analysis. *For more information, see Section 16.2 on page 375.*

Quantitative Analysis

The **Mode Criticality** field is required for quantitative criticality analysis. *For more information, see Section 16.3 on page 376.* The **Severity Class** also is applicable if you choose to generate the quantitative criticality matrix report.

Tip: If desired, you can also enable the **Failure Probability** field if you plan to use this rating scale to automatically set the Reliability Policy for the failure mode.

Enable Mission Phase/Operational Mode for MIL-STD Style Reports

If you plan to use one of the predefined MIL-STD report templates for criticality analysis (i.e., “Criticality Analysis (MIL-STD Qualitative)” or “Criticality Analysis (MIL-STD Quantitative)”), you may also wish to enable the **Mission Phase/Operational Mode** field on the **FMEA > Failures** page of the interface style.

16.2 Qualitative Criticality Analysis

To perform a qualitative criticality analysis in RBI, do the following:

- Make sure that the applicable criticality analysis fields have been enabled for the project. *See Section 16.1 on page 374.*
 - Qualitative analysis uses **Failure Probability** and **Severity Class**, as well as **Mission Phase/Operational Mode**, if desired.
- Define the item(s) that will be included in the analysis.
- For each item, create an FMEA and define the functions, failure modes, effects and causes. *See Chapter 14.*
- Define the following for each failure mode. These factors can be specified via the Failure Properties window, the FMEA worksheet or the FMRA. (They can also be viewed/defined in the MIL-1629A Criticality Analysis window if you have selected to enable that feature. *See Section 16.4 on page 379.*)
 - **Mission Phase/Operational Mode** is a description of the conditions when the failure mode might occur. For example, in an airplane, a failure might occur during takeoff, while flying or during landing. This is not required for the analysis but it is usually displayed as a column in MIL-STD style reports.
 - **Failure Probability** rates the likelihood that the failure mode will occur, according to a predefined scale. The available ratings are based on the Failure Probability rating scale that has been defined for the Project Properties. *See page 196 in Chapter 6.*
 - **Severity Class** rates the severity of the potential effects of failure, according to a predefined scale. The available ratings are based on the Severity Class rating scale that has been defined for the Project Properties.
- To generate a report, choose **Home > Reporting > Reports** to open the Reports window and select all of the items you wish to include in the analysis. Then select the desired criticality reports, which are located under the Criticality node, as shown next.

Criticality		
	Criticality Analysis (Standard)	(1)
	Criticality Analysis (MIL-STD Quantitative)	(2)
	Criticality Matrix (MIL-STD Quantitative)	(3)
	Criticality Analysis (MIL-STD Qualitative)	(4)
	Criticality Matrix (MIL-STD Qualitative)	(5)
	Criticality Ranks	(6)

The following reports are applicable for qualitative criticality analysis:

- (4) shows the qualitative criticality analysis in a traditional tabular format.
- (5) shows a matrix with the Severity Class on the horizontal axis and the Failure Probability on the vertical axis.

Reports (1), (2), (3) and (6) are used with quantitative criticality analysis.

(These reports can also be generated from the MIL-1629A Criticality Analysis window if you have selected to enable that feature.)

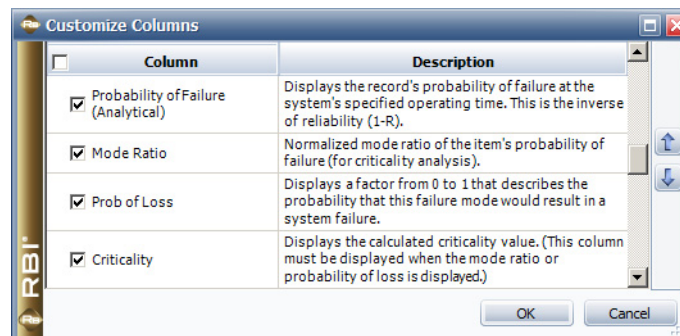
16.3 Quantitative Criticality Analysis

This section describes how to perform the new methodology for quantitative criticality analysis that was introduced in the Synthesis version of RBI. This method is patterned after the concepts in MIL-STD-1629A, but has been modified to use a more general (and more appropriate) approach that overcomes several inherent limitations and simplifications present in MIL-STD-1629A, including the assumption of a constant failure rate. Furthermore, and instead of dealing with an arbitrary number, it presents the computed criticality number in terms of the probability “that a failure will be caused by the current mode,” which is significantly more meaningful and powerful. For specific details on this approach, see http://www.ReliaWiki.org/index.php/Criticality_Analysis.

This analysis is performed directly in the FMRA with report output generated from the Reports window. If your organization is obligated to use the original method instead, see Section 16.4 on page 379.

To perform a quantitative criticality analysis in the FMRA, do the following:

- Make sure that the applicable criticality analysis fields have been enabled for the project. *See Section 16.1 on page 374.*
 - Quantitative analysis requires at least **Mode Criticality** for the quantitative calculation options to become available in the software.
- Define the item(s) that will be included in the analysis.
- For each item, create an FMEA and define the functions, failure modes, effects and causes. *See Chapter 14.*
- If the FMRA is not already displayed in the System panel, choose **View > FMRA > Show FMRA** to make it visible. *See Chapter 8.*
- If the criticality analysis columns are not already displayed in the FMRA hierarchy, right-click any of the column headers, then click **Customize Columns**. Select the four columns shown next and click **OK** to save the changes.



- Click the first failure mode in the FMRA hierarchy to display its reliability-related properties in the Analysis panel. The following fields may be applicable for quantitative criticality analysis:
 - **Mission Phase/Operational Mode** is a description of the conditions when the failure mode might occur. For example, in an airplane, a failure might occur during takeoff, while flying or during landing.
 - This is not required for the analysis but it is typically displayed as a column in MIL-STD style reports.
 - **Failure Probability** rates the likelihood that the failure mode will occur, according to a predefined scale. The available ratings are based on the Failure Probability rating scale that has been defined for the Project Properties. *See page 196 in Chapter 6.*
 - This is not required for quantitative criticality analysis but you have the option to use the ratings in this field to automatically assign the quantitative probability of failure model, if desired. (See the **Reliability Policy** discussion below.)

- **Severity Class** rates the severity of the potential effects of failure, according to a predefined scale. The available ratings are based on the Severity Class rating scale that has been defined for the Project Properties.
 - This is not required for quantitative criticality analysis but it is needed if you want the failure mode to appear in the Criticality Matrix report form.
- **Mode Ratio** is the probability that the item's failure will be due to the failure mode under consideration. In other words, this represents the percentage of all failures for the item that will be due to the given mode. This will be calculated automatically by the software based on all of the failure probabilities that have been defined for the analysis.
- **Probability of Loss (Model)** is a factor from 0 to 1 that describes the probability that this failure mode would result in a system failure. By default, this is set to 1 (Actual Loss). To enter a different value, double-click inside the field to display the Model Wizard.¹
- **Reliability Policy** allows you to specify how the software will calculate the failure mode's probability of failure. In the **Type** drop-down list you can choose:
 - **Based on Failure Probability:** If the Failure Probability rating scale is enabled for this project and if you have selected a rating for this mode, then the software can automatically assign a quantitative model based on the specified rating. For example, if the failure mode uses the “Level E - Extremely Unlikely” rating in the MIL-STD-1629A scale, which has a quantitative value of **0.0005**, then RBI will create a model with a constant failure probability of 0.05% to be used for the quantitative analysis.
 The software will automatically update the model when you change the rating. *For more information on how the quantitative model is calculated, see page 232 in Chapter 8.*
 - **Define at this level:** If you know the probability for this failure mode, you can either create a new model or select an existing model to define it here.
 - **Inherit:** If you have defined the probabilities for all of the associated causes, the software can automatically calculate the probability that the failure mode will occur. *For details, refer to page 229 in Chapter 8.*
- Once you have defined the criticality analysis factors for all of the failure modes in the analysis, the next step is to specify the relevant Operation properties, especially the operating time that is of interest for the probability of failure calculations.

To set the Operation properties, select the top-level item in the FMRA hierarchy to display its properties in the Analysis panel.

Operation		
	Operating Time	750 (Hr)
	Current Age	0 (Hr)
	Duty Cycle	1
	Maintenance Group	

¹. Note that the software also allows you to define this factor with a time-dependent distribution for situations when the probability of loss increases as the operating time increases. In this case, the software will calculate the decimal based on the distribution/parameters and the operating time you have specified for the criticality analysis. To switch from a constant to a distribution (and vice-versa), click the buttons in the top-right corner of the Model Wizard. When a constant model is displayed in the wizard, the **New Distribution** icon allows you to switch to a distribution. When a distribution is displayed, the **New Constant** icon allows you to switch to a constant.

The **Operating Time** field must be entered by the user.

Note: The operating time can be defined only for top-level (system) items in the hierarchy, and this time applies to all of the system's dependents. Thus, if your criticality analysis considers the failure modes associated with only one system, and if you want to compare the failure modes, then you only need to define the operating time for that system. However, if your criticality analysis considers multiple systems that you want to compare, then, to make a valid comparison, you need to enter the same operating time for each system.

By default, RBI assumes that the item was new at the beginning of the mission (Current Age = 0) and it will operate for 100% of the operating time (Duty Cycle = 1), but you can adjust these factors if desired.

The Maintenance Group field is not relevant for criticality analysis calculations.

- Finally, to perform the calculations, choose **FMRA > RAM Analysis > Calculate (Reliability)**.



The Calculation Options window provides the following options:

- **What items do you want to calculate?:** If the project contains more than one top-level item, you can choose to perform the analysis only for the system that is currently selected, or for all systems defined in the hierarchy.
- **Calculation Method:** If the FMRA is synchronized with BlockSim, you can choose to use BlockSim's version to calculate the probabilities of failure; otherwise you must use RBI's calculations, which assume a reliability-wise series configuration among all the records in the FMRA hierarchy.

When you click **OK**, the software will calculate the probability of failure for each failure mode and automatically determine the Mode Ratios based on all of the failure modes that have been defined for each item. (To give a very simple example, if the item has two failure modes that both have the same probability of failure, then they will both contribute equally to the item's probability of failure, and therefore they both have Mode Ratio = 0.5.)

Then the software will calculate the mode criticality and item criticality, and the results will be displayed in the Criticality column of the FMRA hierarchy.

Tip: To specify the displayed math precision for the calculated values, choose File > Application Setup then define your preferences on the Settings page.

- To generate a report, choose **Home > Reporting > Reports** to open the Reports window and select all of the items you wish to include in the analysis. Then select the desired criticality reports, which are located under the Criticality node, as shown next.

Criticality	
— Criticality Analysis (Standard)	(1)
— Criticality Analysis (MIL-STD Quantitative)	(2)
— Criticality Matrix (MIL-STD Quantitative)	(3)
— Criticality Analysis (MIL-STD Qualitative)	(4)
— Criticality Matrix (MIL-STD Qualitative)	(5)
— Criticality Ranks	(6)

The following reports are applicable for quantitative criticality analysis:

- (1) or (2) will show the quantitative criticality analysis in a traditional tabular format.
- (3) shows a matrix with the Severity Class on the horizontal axis and Mode Criticality on the vertical axis.

- (6) displays the items/failure modes ranked by item criticality and then by mode criticality.

Reports (4) and (5) are not applicable here because they're used with qualitative criticality analysis.

16.4 MIL-1629A Criticality Analysis

This section describes how to enable and use the MIL-1629A Criticality Analysis utility. If you prefer to use the criticality analysis methods that are performed directly in the FMRA, see Section 16.2 on page 375 or Section 16.3 on page 376.

Enabling and Accessing the Utility

If you wish to be able to access the MIL-1629A Criticality Analysis window on your computer, select the **Enable MIL-1629A Criticality** check box on the Settings page of the Application Setup window. *See page 507 in Chapter 30.* When this option is selected, the **MIL-1629A Criticality** command will be visible on the Home tab of the Ribbon.



This command will be available only if at least one criticality analysis field is enabled in the project. *See Section 16.1 on page 374.* Furthermore, in order to be able to calculate results, there must be at least one failure mode defined for each item before you open the window.

Using the Utility

When you open the utility, use the Select Items window to select one or more items from the current project that you want to include in the criticality analysis and click **OK**.

When the MIL-1629A Criticality Analysis window opens, the worksheet will display the specific data fields from the item, function and failure mode properties that are relevant for criticality analysis.

Note the following:

- For most of the fields that are editable in the worksheet, you will be able to view/edit the property in either the MIL-1629A Criticality Analysis window or the Item Properties/FMEA/FMRA. Any changes made in one location will be visible in the others. The only exceptions are the **Mode Ratio** and **Prob of Loss** columns. These properties can be entered and viewed only via the MIL-1629A Criticality Analysis window. The values that you enter are saved with the failure mode (and visible the next time you view this failure mode in the MIL-1629A Criticality Analysis window), but they are not visible in the Failure properties window in the FMEA or FMRA.

For the **Prob of Loss**, if you want to assume a total loss, accept the default setting of 1 (actual loss). If you want to enter a specific decimal value (e.g., 0.3 or 0.73), click in the field and select or create a constant model defined with the appropriate value.

- The reliability type for each item must be set to **Define at this level**.
- The sum of the values in the **Mode Ratio** column must be equal to 1 for each item. For example, if an item has four failure modes, the ratios could be something like: Mode A - 0.1, Mode B - 0.3, Mode C - 0.45, Mode D - 0.15 (i.e., $0.1 + 0.3 + 0.45 + 0.15 = 1$).
- The cells with a green background color will display the calculated results after you enter all required inputs and click the **Calculate** button.

The **Display Options** at the bottom of the window allow you to customize the worksheet to meet your specific needs:

- Select the **Show Duty Cycle and Current Age** option if you are using those properties in the item reliability calculations. If the Current Age is 0 and the Duty Cycle is 1 (i.e., the item operates continuously and is subjected to the same loads and/or stresses as the rest of the system), these fields are not relevant and do not need to be displayed. *For details, see page 237 in Chapter 8.*
- Select the **Include Causes with Failures** option if you want to display the cause descriptions in the same column with the failure modes. If only the failure modes are displayed, you will be able to edit the descriptions directly in the MIL-1629A worksheet, if desired. If both the failure mode and cause descriptions are displayed in the same cell, you will not be able to edit the text without closing the MIL-1629A Criticality Analysis window and returning to the FMEA/FMRA.
- Select the **Show Columns for Qualitative Analysis** option if you want to display the Mission Phase/Operational Mode and Failure Probability columns, which are applicable only if you are performing qualitative analysis.

When the worksheet displays all of the required inputs for quantitative criticality analysis, click **Calculate** to perform the calculations. You can then click **Send to Excel** to export all of the information currently displayed in the worksheet to an Excel file, or click **Reports** to select from a set of predefined report forms that can be generated in either Word or Excel.

Change Log

17

RBI allows authorized users to activate a change log for a particular FMEA or DVP&R. The change log utility controls when users will be able to edit the analysis and records a history of the revisions made to the analysis since the change log was activated, along with a list of the specific changes that were made in each revision. Depending on the settings, the change log can record:

- The date and time of the change.
- The user who made the change.
- The type of change (i.e., Add, Edit, Delete).
- The record that was changed.
- The property that was changed.
- The value before the change and the value after the change.
- The reason (or justification) that the user provided at the time of the change.

If desired, the change log utility can also be used to facilitate an electronic approval tracking process by storing an electronic record of the users who have reviewed and approved each version of the analysis.

17.1 General Information About Change Logs

This section describes some of the characteristics of change logs that all users should be aware of. Note that while the examples given are for FMEAs, the commands are similar for DVP&Rs:

- **Only authorized users can activate and manage a Change Log:** In enterprise databases and in standard databases with login security enabled, the ability to activate and manage a change log is restricted to project owners and to users with the “Manage all projects” permission. For standard databases without login security enabled, all users are authorized to activate, configure and maintain change logs in the database.
- **A Change Log applies to a particular FMEA:** The change log records changes only within the FMEA with which it is associated.

- **Icons indicate that a Change Log is active and whether a revision has been started:** When a change log has been activated for an analysis, the icon in the FMEA column in the System panel will indicate that the change log is in one of two states:



No Revision Started: This icon shows that the FMEA associated with the item is locked and that no revision has started. In this case the FMEA is read-only for all users.



Revision Started: This icon shows that the FMEA associated with the item is open for modifications because an authorized user has started a revision.

Note: Regardless of whether an analysis under change log control is locked or open for modifications, all users can view the changes made since the log was activated and export the change log to an Excel spreadsheet, if desired.

- **When a Change Log is active in an analysis, the changes are displayed in the FMEA Change Log window and the Record Change Log window:** To view the version history and the change log for the entire analysis, choose **FMEA > Change Log > View Change Log**. *See Section 17.4 on page 385.* To view the changes that have been recorded for a particular record in the analysis, click the **Change Log** button in the Properties window to open the Record Change Log window. *See Section 17.5 on page 388.*



- **RBI stores only the most recent version of the analysis in a state that can be edited, reported or queried against:** The software does not automatically maintain a complete copy of the analysis as it was at a given time prior to subsequent modification. However, there are several ways to manually store a complete copy of the analysis at any point in time. For example, you can:
 - Use the Restore Points feature to store a complete backup of the project at a given time. *See page 68 in Chapter 2.*
 - Create a duplicate of the project each time a version has been completed and provide specific details about the duplicate project in the Project Properties window. *See page 67 in Chapter 2.*
 - Generate reports for each version and attach them to the item via the Attachments window. *See page 124 in Chapter 3.*
 - Copy and paste the item within the project or to another project. *See page 212 in Chapter 7.*
- **The software interface (and this documentation) uses the terms “original,” “revision” and “version” in specific ways:**
 - “Original” refers to the analysis at the time when the change log was activated.
 - “Revision” refers to a tracked set of modifications made to the analysis, with a specific start and end date/time and a unique name and number that are assigned by an authorized user through the change log utility.
 - “Version” refers to either the original analysis or any of the subsequent revisions.
- **A Change Log may or may not require a reason for change:** If the users who manage a change log have selected Require reason for change in the Change Log window, then each time that a user edits the analysis during a tracked revision, the Reason for Change window will appear so that the user can provide the reason the change was made. *See Section 17.6 on page 389.*
- **A Change Log may or may not utilize electronic approval tracking:** If the users who manage a change log have assigned approvers for a version of the analysis, then after a version has ended, the assigned approvers will need to electronically record their approval of the analysis in the Approve Version window before the next revision can begin. *See Section 17.7.2 on page 391.*
- **A Change Log does not track changes to URDs:** Changes made to universal reliability definitions (URDs) and to models are not tracked by the Change Log. *See page 164 in Chapter 5.*

17.2 Activating and Configuring Change Logs

For standard databases with login security enabled and for enterprise databases, authorized users can activate and manage the change logs. For standard databases without login security enabled, every user is an authorized user.

If a change log does not yet exist for an FMEA or DVP&R, an authorized user can choose **[FMEA/DVP&R] > Change Log > Activate Change Log**. When you activate a change log, the application displays a window reminding you that activating the change log for the FMEA means that changes to the analysis can be made only when a revision is in progress. Click **Yes** to activate the change log. The Change Log window will then appear with the date and time of the change log activation recorded in the top left portion and the name of the authorized user who activated the change log.

The software provides two options for you to manage the change log. They are displayed in the top portion of the window:

- Select the **Require reason for change** check box to require all users to justify each change made in a revision.
- Click **Deactivate Change Log** to deactivate the change log regardless of whether or not a revision has started. A warning message will alert you that selecting this option will clear the change log and that this action cannot be undone. Click **Yes** to delete both the change log and version history of the analysis.

IMPORTANT: To retain a record of any changes, you must export them to an Excel spreadsheet before de-activating the log. See Section 17.4.3 on page 387.

17.3 Starting and Ending Revisions

When a change log is first activated, the FMEA or DVP&R is automatically locked so that no changes can be made until a revision has been started by an authorized user. The analysis is also locked between revisions. While the analysis is locked, it is read-only for all users.

- To start a revision, open the Change Log window for the analysis. Click the **Start Revision** button, which opens the Version Details window, where you specify certain details about the revision. After you enter the version information and click **OK**, the software records the date and time that the revision started and the name of the authorized user who initiated it. All the changes made to the analysis are logged until an authorized user chooses to end the revision. Note that simply closing the project or the database will not end a revision.
- To end a revision, open the Change Log window for the analysis and click the **End Revision** button. A confirmation message will appear, telling you that users will not be able to make any more changes to this version of the analysis unless an authorized user chooses to re-open the revision. Click **Yes** to confirm that you wish to proceed with ending the revision; the software records the revision's end date and time.
- If there are more changes to be made later, you can re-open a revision, as long as a subsequent revision has not been started. To do this, open the Change Log window for the analysis, select the revision in the Version History table and click the **Edit Details** button. In the Version Details window, click the **Re-Open Revision** button.

Note: If you choose to re-open the revision later, the end date and time, along with the electronic approvals for this version, if any, will be cleared.

17.3.1 Version Details Window

The Version Details window allows an authorized user to define and edit details about an analysis version. To open the Version Details window, open the change log for the analysis and click the **Start Revision** button (to start a new revision), the **Edit Details** button (for details about an existing version) or double-click the version directly in the Version History table.

- **Major/Minor** allows you to specify whether the revision will be numbered as a major revision to the previous version (e.g., from 1.0 to 2.0) or as a minor revision to the previous version (e.g., from 1.0 to 1.1). This option is not used for the original version of an analysis, which is not numbered. In addition, the first revision started for a change log will always be 1.0. After starting a revision, you cannot change this setting. Note that for new revisions, the software automatically updates the value in the # field with the number of the revision reflecting whether the Major or Minor option was selected.
- **Version Label** allows you to enter the name of the version of the analysis. It is also displayed in the Version History table and can be edited at a later time if necessary.
- **Comments** allows you to enter additional descriptive information about the analysis version. It is displayed in the Version History table and can be edited at a later time if necessary.

- **Assign Approvers** opens the Assign Approvers window, which allows you to assign users who are required to approve the analysis before the next revision can be started. *See Section 17.7.1 on page 390.* This option is available only for standard databases with login security enabled and for enterprise databases. You can assign approvers to only the most recent revision.
- **Re-Open Revision** allows you to re-open the revision for further modification. The End Date for the revision and any existing approvals will be cleared. You can re-open only the most recent revision.

17.4 Change Log Window (for Entire Analysis)

The Change Log window allows you to view the change log details for the entire analysis. This includes the version history details and the specific changes that were made to the analysis. The window also allows authorized users to activate and configure the Change Log for an analysis.

If a change log does not yet exist for an FMEA or DVP&R, an authorized user can choose **[FMEA/DVP&R] > Change Log > Activate Change Log** to open the FMEA Change Log window and active the change log. Once a change log is active, any user can open the window by choosing **[FMEA/DVP&R] > Change Log > View Change Log**.

FMEA Change Log: 1 - Engine Fire Detection

Change Log Activation

3/5/2012 2:41:42 PM User Name ☐ Require reason for change De-Activate Change Log

Version History

#	Version	Comments	Initiated By	Start Date/Time	End Date/Time	Approved Date/Time
1.0	Revision 1	This is the first major update to the original analysis, called "Revision 1."	User Name	3/5/2012 2:47 PM		

Start Revision... End Revision Edit Details... Approve Version...

Change Log

	Revision	Date/Time	User	Change Type	Record Type	Record Description	Record ID	Property	Value Before	Value After
1	1.0	3/5/2012 2:57:58 PM	User Name	Edit	Controls	Safety margins	250	Control Type	Prevention	Detection
2	1.0	3/5/2012 2:57:13 PM	User Name	Edit	Causes	Improper friction adjustment.	411	Short Description	Change to the cause description.	Improper friction adjustment.
3	1.0	3/5/2012 2:57:13 PM	User Name	Edit	Causes	Improper friction adjustment.	411	Cause	Change to the cause description.	Improper friction adjustment.
4	1.0	3/5/2012 2:55:59 PM	User Name	Add	Actions	Conduct design of experiments	258			
5	1.0	3/5/2012 2:55:27 PM	User Name	Edit	Causes	Friction, abnormal	413	Initial Detection	6	5

Revision: 1.0 Date Range: 3/4/2012 To 3/5/2012 Change Type: All Record Type: All User: All

Export Version History... Export Change Log... Remove Filters Close

The Change Log window is divided into three main areas:

- The Change Log Activation area displays information about the change log and provides options for authorized users to configure the change log. *See Section 17.4.1 on page 386.*
- The Version History table displays information about each version of the analysis. *See Section 17.4.2 on page 386.*
- The Change Log table displays some or all of the modifications made to the analysis since the change log was activated. *See Section 17.4.3 on page 387.*

17.4.1 Change Log Activation Area

The Change Log Activation area shows the date and time that the change log was activated, along with the name of the authorized user who activated the change log. In addition, authorized users can use the following options to configure the change log. For standard databases with login security enabled and for enterprise databases, the authorized users are the project owner and users with the “Manage all projects” permission. For Standard databases without login security enabled, every user is an authorized user.

- Click the **Require reason for change** check box to require all users to justify each change made in a revision. *See Section 17.6 on page 389.*
- Click **Deactivate Change Log** to deactivate the change log regardless of whether or not a revision has started. A warning message will alert you that selecting this option will clear the change log and that this action cannot be undone. Click **Yes** to delete both the change log and version history of the analysis.

17.4.2 Version History Table

The Version History table provides an at-a-glance display of the details for all versions of the analysis since the change log was activated (i.e., the “original” version and each subsequent revision), as shown next.

Version History						Start Revision... End Revision Edit Details... Approve Version...
#	Version	Comments	Initiated By	Start Date/Time	End Date/Time	
-	Original	This was when the change log was activated.	Angus Davion		3/5/2012 2:28 PM	
1.0	Revision 1	This is the first major update to the original analysis, called "Revision 1."	Angus Davion	3/28/2012 10:19 AM		

- **#** displays the automatically generated number that uniquely identifies the version.
- **Version** displays the name of the version as defined in the Version Label field in the Version Details window.
- **Comments** displays the comments about the version, if specified in the Version Details window.
- **Initiated By** displays the name of the authorized user who activated the change log (for the original version listed in the first row) or started a revision (for each subsequent row).
- **Start Date/Time** displays the automatically recorded date and time that the revision was started. This does not apply to the original version.
- **End Date/Time** displays the automatically recorded date and time that the change log was activated (for the original version listed in the first row) or the revision was ended (for each subsequent row). If the revision has not ended, this column will be blank.

If the electronic approval tracking option is being used, then the Version History table will display four additional columns, as shown next. *Electronic Approval Tracking is presented in Section 17.7 on page 389.*

Version History						Start Revision... End Revision Edit Details... Approve Version...
End Date/Time	Approved By	Approver Role	Approved Date/Time	Approval Comments		
3/5/2012 2:28 PM						
3/28/2012 10:22 AM	Angus Davion		3/28/2012 10:22 AM	Approved		

- **Approved By** displays the name of the assigned approver who electronically “signed off” on the version. If there are multiple assigned approvers, the names of all of those who have approved the revision are displayed on separate lines.
- **Approver Role** displays the role of the assigned approver, if specified.

- **Approved Date/Time** displays the date and time of the electronic approval made by the corresponding assigned approver.
- **Approval Comments** displays any comments entered by the assigned approver at the time of approval.

In addition, this area of the window contains the **Start Revision**, **End Revision** and **Edit Details** buttons, which can be used by authorized users to manage revisions, and the **Approve Version** button, which allows an assigned approver to electronically sign off on a revision.

17.4.3 Change Log Table

The Change Log table displays all modifications that were made to the analysis after the change log was activated. The change log records details of each modification at the time it is made, including:

	Revision	Date/Time	User	Change Type	Record Type	Record Description	Record ID	Property	Value Before	Value After
1	1.0	3/5/2012 3:13:01 PM	User Name	Edit	Effects	Rough handling	195	Effect	Rough	Rough handling
2	1.0	3/5/2012 3:12:45 PM	User Name	Delete	Actions	Redesign	257			
3	1.0	3/5/2012 2:57:58 PM	User Name	Edit	Controls	Safety margins	250	Control Type	Prevention	Detection
4	1.0	3/5/2012 2:57:13 PM	User Name	Edit	Causes	Improper friction adjustment.	411	Short Description	Change to the cause description.	Improper friction adjustment.
5	1.0	3/5/2012 2:57:13 PM	User Name	Edit	Causes	Improper friction adjustment.	411	Cause	Change to the cause description.	Improper friction adjustment.
6	1.0	3/5/2012 2:55:59 PM	User Name	Add	Actions	Conduct design of experiments	258			

- **Revision** displays the number of the revision in which the modification was made.
- **Date/Time** displays the date and time when the modification was made.
- **User** displays the name of the user who made the modification.
- **Change Type** displays the type of modification that was made:
 - **Add** indicates that the record was added to the analysis. This includes records that were inserted, pasted or imported. Which records are listed is subject to the following conditions:
 - If you pasted records, all items are listed.
 - If you imported existing records from the current project, the current database or another database, all items are listed.
 - If you imported data from an Excel spreadsheet, the change log lists the addition of the functions only. Any lower level records from the hierarchy are not listed.
 - **Edit** indicates that the record's details were changed.
 - **Delete** indicates that the record was deleted from the analysis. Related records, if any, will also have been deleted. However, the change log lists only the deletion of the top record.
- **Record Type** displays the type of record to which the modification was made (e.g., functions, failures, etc.).
- **Record Description** displays the description of the record to which the modification was made.
- **Record ID** displays the unique ID assigned to the record to which the modification was made.
- **Property** displays the data field of the record to which the modification was made, if applicable.

Note: As you can change multiple properties at the same time, (e.g., for a cause record, you can modify the Initial Occurrence and Initial Detection values at the same time), each change to a property is listed separately. Also, if the **Require reason for change** check box was selected when the change was made, the same "Reason for Change" text displays for each property.

- **Value Before** displays the value of the record property before the modification was made, if applicable.
- **Value After** displays the value of the record property after the modification was made, if applicable.
- **Reason for Change** displays the justification that the user supplied when making the change. This is *recorded* only if the **Require reason for change** check box was selected at the time the change was made. It is *displayed* only if the **Require reason for change** check box is currently selected.

Filters at the bottom of the Change Log table allow you to view only those changes that fit the criteria you specify. These filters include:

- **Revision** allows you to view only the modifications made during a specified revision. If you select **All**, the most recent changes will appear at the top by default.
- **Date Range** allows you to view only the modifications made to the analysis during a specified date range. You can enter the start and end dates in the format set in your region and language settings. You also can click the Date button next to the start and end date fields to open a calendar, which will allow you to choose the dates for these fields.
- **Change Type** allows you to view only modifications of a specified type (i.e., Add, Edit, Delete).
- **Record Type** allows you to view only modifications made to a specified type of record (e.g., function, failure, effect, etc.).
- **User** allows you to view only modifications made by a specified user.

Clicking the **Remove Filters** button returns the Change Log table to the normal view in which all records are displayed. You can sort the log by any column by clicking the column header.

17.4.4 Exporting the Change Log

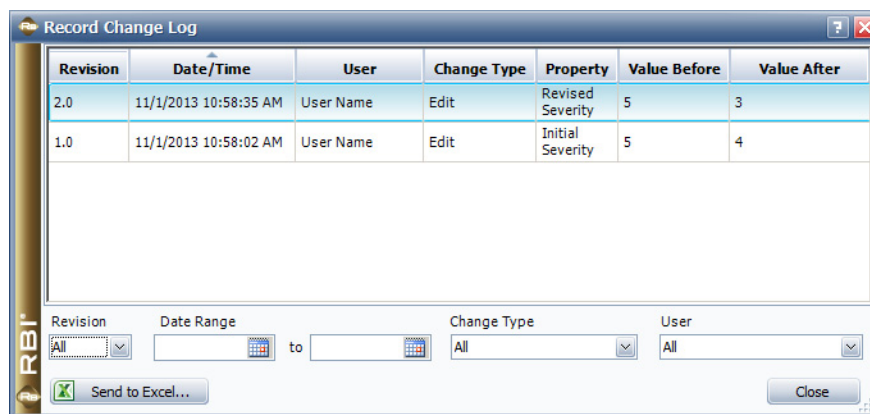
Any user can use the two buttons at the bottom of the window to export the Version History table and the Change Log table to Excel spreadsheets. Click the **Export Version History** button to export all of the data in the Version History table. Click the **Export Change Log** button to export all of the data currently displayed in the Change Log table based on the filter settings you set.

17.5 Record Change Log Window (for Specific Records)

Any user can view the portion of the change log that pertains to a particular record. At the top of the record's Properties window, click the **Change Log** icon.



The Record Change Log window will appear.



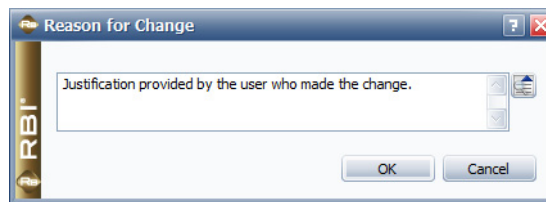
This window displays the same information that is recorded in the Change Log window's Change Log table, but shows only the modifications made to the specific record.

Filters at the bottom of the Record Change Log window allow you to view changes to the record fitting the criteria you specify (i.e., changes made during a particular revision, changes within a specified date range, changes of a specified type or changes made by a specified user). These are the same options available in the FMEA Change Log window.

Click the **Send to Excel** button to export all of the data currently displayed in the Record Change Log window to an Excel file, showing all of the changes defined by the filter selections.

17.6 Reason for Change Window

If change log for an analysis is active and the Require reason for change check box has been selected by an authorized user, then every time a user adds, modifies or deletes a record in the analysis the Reason for Change window will open automatically before saving the change to the record.



Enter the reason for the change in the field and then click **OK** to record the reason.

IMPORTANT: If an authorized user who is managing the change log changes the option setting, some changes in a revision may require a reason while others in the same revision may not.

Note the following items when changing a record in a Synthesis application while the **Require reason for change** check box is active:

- If you are changing more than one Action or Control at the same time in the Resource Manager window, then the reason for change will automatically be recorded as either “Editing Multiple Controls” or “Editing Multiple Actions.” This will display only once, regardless of how many times the Action or Control is used in the analysis.
- If you are making changes to a mirrored Cause, then the reason for change will display only once, regardless of how many times the Cause is used in the analysis.
- If you are changing the analysis in the FMRA view in BlockSim, then the system will automatically record the change as being “Changed in BlockSim.”

17.7 Electronic Approval Tracking

Your organization may decide that it needs to keep an electronic approval record of the users who reviewed and approved any given version of the analysis. In such cases, an authorized user assigns the approvers for the version while the version is being worked on. *See Section 17.7.1 on page 390.* Once the version has been closed, the application sends a notification e-mail to the assigned approvers that the version is ready to be approved and prompts them to review and “sign off” on the version if it is acceptable.

An authorized user can add or remove assigned approvers for any reason at any time starting from when the current revision is started and continuing until the next revision is started. Approvers can record their approval of the version at any time after the revision has ended. The software does not enforce a sequence in which the approvals must be submitted for a particular version. If a sequenced approach is preferred, it must be enforced by the organization's processes (e.g., following an established chain of command).

Note: Electronic approval tracking in the change log is not the same as the Primary Approval field that is used in the FMEA Header tab. See page 345 in Chapter 14. Any user who is able to edit the analysis can edit the text in the FMEA Header Primary Approval field, whereas electronic approval tracking in the change log is controlled by the software, as described here.

17.7.1 Assign Approvers Window

The electronic approval tracking feature allows an authorized user to specify one or more users as assigned approvers of a version of the analysis. In order to be listed as an assigned approver, the user must have RBI installed, a valid user account in RBI (i.e., a license to use the software) and access to the database and project.

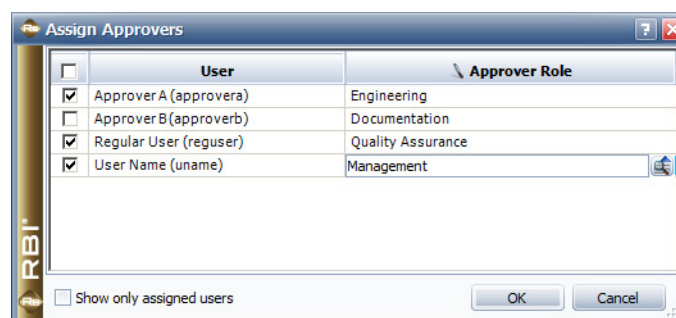
Note: This feature is not available for standard databases without login security enabled.

To assign users to approve a version of the analysis, open the Version Details window and click the **Assign Approvers** button, which opens the Assign Approvers window.

If the **Show only assigned users** option is not selected, then the User column displays the names of all users with access to the project. If the **Show only assigned users** option is selected, the User column displays only the names of the assigned approvers.

The Approver Role column displays the user's role in approving the analysis. Click a cell to edit the text. Once you have clicked in a cell, you also can click the **Select Existing** button to choose an existing role from the Select Existing window.

Note that the next revision cannot begin until all approvals have been submitted for the current version. For instance, if Approver A in the example below opens the project and approves the version, another revision still cannot be started until Approver B opens the project and approves the version as well. If for any reason it is decided that this secondary approval is not necessary, an authorized user can open the Assigned Approvers window and clear the check box next to Approver B's name. Once all assigned approvers have approved the version, you will be able to start the next revision.



17.7.2 Approve Version Window

If you are an assigned approver and you receive the notification e-mail, you should do the following:

- Log in to the application and review the analysis.
- If you are reviewing a version and think changes are necessary before you can approve it, you should ask an authorized user to re-open the version.
- If the analysis is acceptable, choose **[FMEA/DVP&R] > Change Log > View FMEA Change Log**.
- In the Change Log window, click the **Approve Version** button, which opens the Approve Version.



- In the **Comments** field, record any comments about your review of the version and then click **OK** to close the window. You will then be prompted to re-enter your username and password before the application saves the approval and records the approval comments in the Version History.

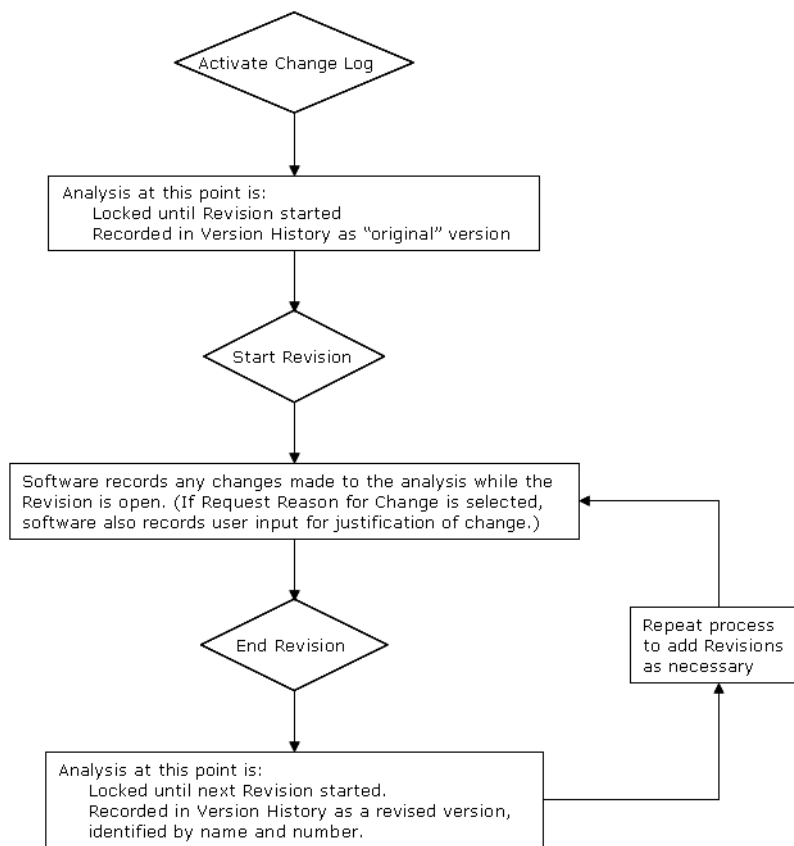
17.8 Workflow Overview for Using a Change Log

There are two general approaches to activating a change log and managing revisions, depending on whether or not you are using the electronic approval tracking feature.

Note that while electronic approval tracking is available only for standard databases with login security enabled and for enterprise databases, it is possible to use both approaches for the same analysis branch when appropriate. In other words, authorized users can assign approvers for specified versions and not others within a single change log, if desired.

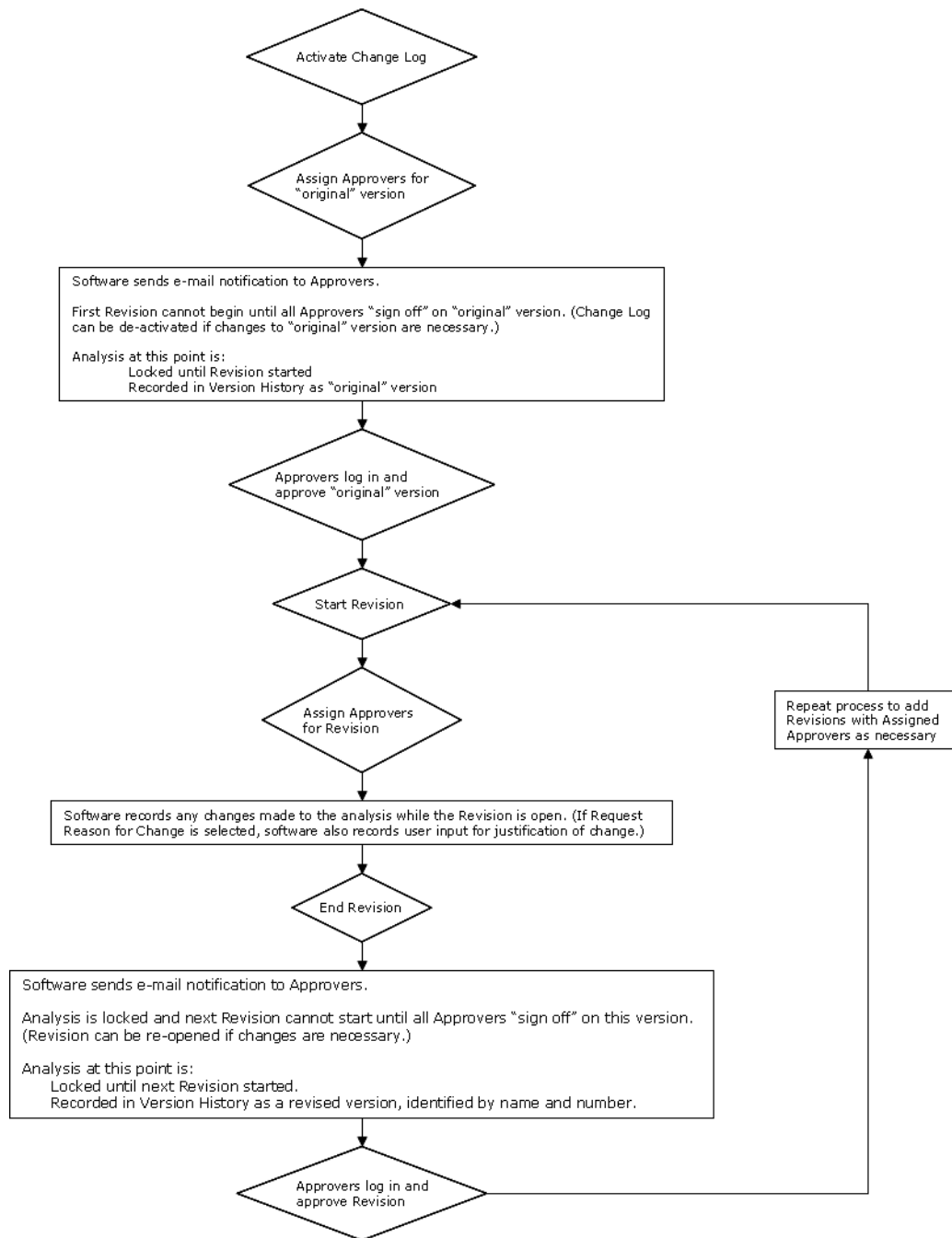
17.8.1 Without Electronic Approval Tracking

The overall process for authorized users to activate and manage a change log without electronic approval tracking is as follows:



17.8.2 With Electronic Approval Tracking

The overall process for authorized users to activate and manage a change log with electronic approval tracking is as follows:



Design Verification Plans (DVP&Rs)

18

RBI allows you to add a design verification plan and report (DVP&R) analysis for any item in the system hierarchy. A DVP&R is a worksheet that is used to track the progress of design verification tests. The lessons learned from the design FMEA can be a valuable input to the DVP&R (and vice-versa).

To add a DVP&R, select an item in the System panel then choose **Insert > Other > Add DVP&R**.



The DVP&R analysis tab will open in the Analysis panel. In addition, the DVP&R icon will appear in the corresponding column in the System Hierarchy tab of the System panel (if that column has been selected for display on your computer). To hide or display columns, right-click the column headers in the System panel, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the System Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed. *See page 508 in Chapter 30.*

The DVP&R analysis contains two tabs: a Header tab and a Worksheet tab. The Header tab contains general information about the entire analysis that will be displayed in the header of the report output while the Worksheet tab contains the analysis data. A DVP&R can have zero, one or many plan records. Each plan can be associated with one or many report records. The background color in each cell of the DVP&R worksheet identifies the record type (plan = blue and report = green).

Typically, DVP&Rs are used in one of two ways:

- As a stand-alone analysis. In this case, you:
 - Add the DVP&R analysis.
 - Define the header information on the Header tab.
 - Use the Worksheet tab to record all of the test plans and reports that need to be tracked.
- In tandem with a Design FMEA. In this case, you:
 - Create an FMEA for the item.
 - Add the DVP&R analysis to the item. RBI automatically transfers the controls and/or actions from the FMEA to be the starting point for the new DVP&R. *See Section 18.3 on page 398.*
 - Define the header information on the Header tab.
 - Use the Worksheet tab to record all of the test plans and reports that need to be tracked. This may require that you edit or add to the data transferred from the DFMEA.

18.1 DVP&R Header

The following fields may be found on the DVP&R Header tab.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **DVP&R Number:** A unique document identifier.
- **Date (Orig.):** The original DVP&R completion date.
- **Date (Rev.):** The latest DVP&R revision date.
- **Revision Level/Description:** The revision identifier for the DVP&R document.
- **Part Number:** The part number for the item that the DVP&R applies to.
- **Latest Change Level:** The latest change level for the part number.
- **Part Name/Description:** The name and description for the item that the DVP&R applies to.
- **Specification/Drawing Number:** The specification or drawing number for the item that the DVP&R applies to.
- **Model Year(s)/Program(s):** The model year and/or program identifier that the DVP&R applies to.
- **Supplier/Plant:** The supplier/plant that will be manufacturing the item.
- **Supplier Code:** An identifying code for the supplier/plant.
- **Key Contact:** The primary contact for the DVP&R.
- **Key Contact Phone:** The phone number of the primary contact for the DVP&R.
- **Core Team:** The primary team involved with preparing the DVP&R.
- **Engineer1/2/3Approval:** An engineer who approved the DVP&R.
- **Engineer1/2/3 Approval Date:** The date when the engineer approved the DVP&R.
- **User-Defined Fields:** Up to two text fields, one date field, one number field and one drop-down list.
- **Last Updated By:** The date when the DVP&R header was last updated. This is populated by RBI.
- **Last Updated:** The user who last updated the DVP&R header. This is populated by RBI.

For text fields, you can click the **Select Existing** icon inside the field. *See page 113 in Chapter 3.* This will open a window that allows you to reuse text that has already been entered in this type of field.



For date fields, you can click the field once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.

- To generate a report of the DVP&R data, choose **Home > Reporting > Reports**. In the Reports window, the DVP&R reports are located in the DVP&R Spreadsheet and DVP&R Records sections of the Available Reports area.
- To split the worksheet view so that you can view text at one side of the worksheet without moving the text at the other side, right-click a column header and choose **Split**. A split bar will be placed to the left of the column. To remove the bar, right-click any column header and choose **Remove Split**. (For example, you use this to see the test request number while working on the reports.)
- To rearrange the order in which the columns are displayed, select a column header and drag it to the place in the worksheet area you want it to appear. This updates the interface style for the project. You also can change the column order through the Interface Style window. *See page 190 in Chapter 6.*
- To change the descriptive information about each column that displays in tooltip form when you move the pointer over the column headers, open the Project Interface Style window and change the text in the appropriate DVP&R pages.

18.3 DVP&R Worksheet Columns

This section describes the fields found on the Worksheet tab of the DVP&R worksheet. *For a description on how to use the Worksheet tab to document the process steps, see Section 18.2 on page 397.*

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Plan Records**
 - **Test Request #:** The number of the test that needs to be performed. This is a required column.
 - **Test Identifier (Name):** A short name for the test that needs to be performed.
 - **Test/Specification Method:** A short description of the test that needs to be performed. This is a required column.
 - **Acceptance Criteria:** The criteria that must be met in order to pass the test.
 - **Requirement Source:** The source of the requirement that must be met in order to pass the test.
 - **Requirement:** The requirement that must be met in order to pass the test.
 - **Specification Type:** The type of specification that must be met in order to pass the test.
 - **Classification:** The special characteristic classification.
 - **Planned Test Location:** The location where the test will be performed.
 - **Planned Test Phase:** The phase of development in which the test will be performed.
 - **Planned Sample Size:** The sample size that is planned for the test.
 - **Planned Sample Type:** The type of sample that is planned to be used for the test.
 - **Planned Test Duration:** The planned duration of the test.
 - **Planned Start:** The planned start date for the test.
 - **Planned End:** The planned end date for the test.
 - **Assigned To:** The person or group responsible for performing the test.

- **Notes (Plan):** Any notes related to the planned test.
- **User-Defined Fields:** Up to three text fields, one date field, one number field and one drop-down list.
- **Report Records**
 - **Test Report #:** The number of the report for the completed test. This is a required column.
 - **Test Report Identifier:** A short name for the report for the completed test.
 - **Status:** The status of the test report (e.g., “active” or “replaced by test YYY,” etc.).
 - **Actual Start:** The actual start date for the test.
 - **Actual End:** The actual end date for the test.
 - **Actual Sample Size:** The actual sample size that was used in the test.
 - **Test Results:** The results of the test. This is a required column.
 - **Completed By:** The person or group who completed the test.
 - **Notes (Results):** Any notes related to the completed test.
 - **User-Defined Fields:** Up to three text fields, one date field, one number field and one drop-down list.

18.4 Synchronizing a DVP&R with a DFMEA

You can choose to transfer data automatically from the FMEA each time that you create a DVP&R analysis. In this case, the logic is set in the interface style that has been defined for the project. You can also manually sync at any time. In this case, the logic is set in the Synchronization Options window. *See Section 18.4.2 on page 401.*

Please note that the data is transferred, not linked. Changes made in the FMEA do not appear automatically in the DVP&R and vice versa. The synchronization functionality is intended to provide you with a starting point for the DVP&R by transferring relevant data from the FMEA. You can then make any necessary modifications and additions to the DVP&R.

The following data from the analysis can be transferred to the header or worksheet area in the DVP&R.

FMEA	DVP&R
Item Number/Item Name	Part Name/Description (Header tab)
Model Year(s)/Program(s)	Model Year(s)/Program(s) (Header tab)
Control Number or Action Number	Test Request # (Worksheet tab)
Current Design Controls or Recommended Actions	Test/Specification Method (Worksheet tab)
Cause Class	Classification (Worksheet tab)
Action Due Date	Planned Start (Worksheet tab)
Action Person Responsible	Assigned To (Worksheet tab)

18.4.1 Sync Options for New DVP&Rs

The following options are available on the DVP&R > Sync Options page of the interface style when you select the **Integrate New DVP&Rs with FMEA** check box, as shown next.

When you choose to transfer data automatically from the FMEA to the DVP&R, you have the option to:

- Create new Test Plan records in the DVP&R by transferring control and/or action descriptions from the FMEA.
 - If the Control Category property is enabled for the project (from the FMEA > Controls page of the interface style) or if the **Controls where type** = field is empty, then all controls descriptions will be transferred to the DVP&R. If the Control Category property is enabled, you can use the **Controls where type** = field to limit the transfer to only those controls descriptions with the specified categories. To define multiple control categories, use commas to separate the labels.
 - If the Action Category property is enabled for the project (from the FMEA > Actions page of the interface style) or if the **Actions where category** = field is empty, then all action descriptions will be transferred to the DVP&R. If the Action Category property is enabled, you can use the **Actions where category** = field to limit the transfer to only those action descriptions with the specified categories that you select. To define multiple action categories, select multiple items. Or you can select the **No Actions** option to not transfer any actions.
- Transfer the cause description along with each control or action description. For example, if the **Incorporate cause description with controls and actions transferred to DVP&R** check box is selected and the cause description in the FMEA is “Failure cause” and the control description is “Design control” then the transferred test plan will be “Design control : Failure cause.”

18.4.2 Sync Options for Existing DVP&Rs

You can choose **DVP&R > Sync > Sync with FMEA** to update the DVP&R with new data transferred from the FMEA. The Synchronization Options window will appear, as shown next.



- **Header**
 - To clear all of the information on the Header tab of the DVP&R and replace it with data from the associated FMEA, select the **Clear the header and replace from FMEA** option.
 - To leave the data in the header as-is, select the **Do not change the header** option.
- **Worksheet**
 - To clear all of the information in the worksheet area of the DVP&R and replace it with the data from the associated FMEA, select the **Clear the worksheet and replace from FMEA** option.
 - To add the data from the FMEA to the end of the existing data in the DVP&R worksheet, select the **Append data from FMEA to end of worksheet** option.
- **Transfer Controls/Actions Options**
 - To transfer all eligible data (i.e., controls and actions) from the FMEA to the DVP&R, select the **All Controls** and **All Actions** options.
 - To transfer only the data that meet the desired requirements, select the **Controls where Type =** and/or **Actions where Category =** option and then select the desired options.
 - To further limit the transfer, enter as many criteria elements as desired in the following fields:
 - **Classification** transfers only the data with the selected classification. Select **All** if you want all data, no matter the classification, to be transferred. This includes data with no classification. Select **Any** if you want to transfer the record if any classification has been assigned to it. If there is no classification assigned to it, the data will not be transferred.
 - **Cause RPN (Initial) >=** transfers only the data with an initial cause RPN that is greater than or equal to the value that you specify in the input box.

- **Cause RPN (Revised)** >= transfers only the data with a revised cause RPN that is greater than or equal to the value that you specify in the input box.
- **Cause Initial SxO** >= transfers only the data with an initial cause severity x occurrence rating that is greater than or equal to the value that you specify in the input box.
- **Cause Revised SxO** >= transfers only the data with a revised cause severity x occurrence rating that is greater than or equal to the value that you specify in the input box.
- To transfer the cause description along with each control or action description, select the **Cause Description with Controls and Actions** check box. For example, if this check box is selected and the cause description in the FMEA is “Failure cause” and the control description is “Design control,” then the transferred test plan will be “Design control : Failure cause.”
- After making your selections, click **OK** to transfer the data from the FMEA to the DVP&R.

PFD Worksheets (Process Flow Diagrams) 19

In RBI, there are two kinds of process flow diagrams (PFDs): a graphical process flow diagram, which is a high level chart of a process; and a PFD worksheet, which integrates the chart into a worksheet that records more detailed information about what the product goes through in each step of the manufacturing or assembly process. This includes the processing of individual components, transportation of materials, storage, etc. Also recorded are descriptions of the process and product characteristics that are affected in each step of the process, how these characteristics are controlled and what needs to be achieved at each step. For example, a process characteristic may be the temperature range for wax that will be sprayed onto the finished vehicle and a product characteristic may be the required wax thickness.

To add a PFD worksheet, select an item in the System panel then choose **Insert > Other > Add PFD Worksheet**.



The PFD worksheet will open in the Analysis panel. In addition, the PFD worksheet icon will appear in the corresponding column in the System Hierarchy tab of the System panel if that column has been selected for display on your computer. (To hide or display columns, right-click the column headers in the System panel, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the System Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed.)

19.1 Setting up a PFD Worksheet

The PFD worksheet contains two tabs: a Header tab and a Worksheet tab. Use the Header tab to enter general information about the entire analysis, and use the Worksheet tab to enter descriptions about the process steps and the characteristics of the product.

You may also use PFD worksheets as starting points for preparing process FMEAs (PFMEAs) and control plans. For example, in the PFMEA, you evaluate each step in the process as defined by the PFD worksheet, making sure to consider the critical characteristics that have already been identified. In turn, the critical characteristics that were determined from the PFD worksheet and PFMEA form the basis for creating a control plan, which puts checks in place to ensure that the desired product characteristics stay in the required range during the entire process. Put very simply, the PFD worksheet defines the process, the PFMEA looks for ways to prevent or mitigate risk in the process and the control plan records the strategy for controlling the critical characteristics that have been identified. *For an example on how to use the data from a PFD worksheet in a PFMEA or control plan, see Section 19.5 on page 407.*

19.2 PFD Worksheet Header

The Header tab contains information that may be displayed in the header of a report output. This section describes the fields found on the Header tab of a PFD worksheet.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Product:** The name of the item being analyzed.
- **Revision Date:** The latest revision date for the PFD worksheet.
- **Prepared By:** The name of the person who prepared the PFD worksheet.
- **Part Number:** The part number for the item being analyzed.
- **Alternate Part Number:** The alternate part number, if any, for the item being analyzed.
- **User-Defined Fields:** Up to three text fields, one date field, one number field and one drop-down list.
- **Last Updated By:** The name of the last user who updated the PFD worksheet header.
- **Last Updated:** The date and time of the last update to the PFD worksheet header.

For text fields, you can click the **Select Existing** icon inside the field. *See page 113 in Chapter 3.* This will open a window that allows you to reuse text that has already been entered in this type of field.



For date fields, you can click the field once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.

19.3 PFD Worksheet Tab

This section describes how to enter data in the Worksheet tab. *For a description of all columns that could be displayed in a PFD worksheet analysis, see Section 19.4 on page 406.*

The Worksheet tab provides the structure for documenting each step that a product goes through in a manufacturing or assembly process. There are three types of records in the analysis: operation records, product characteristics records and process characteristics records. The following figure shows an example of a PFD worksheet based on the Standard FMEA profile that is shipped with the software. You can vary the format of the PFD worksheet based on

your company's guidelines and standards. If you have the permissions necessary to edit the project properties, you can choose which columns will be enabled for each type of record and what they will be called. This includes user-defined fields and the ability to define the options in the configurable drop-down lists, when applicable.

Properties		PFD Worksheet					
Op Seq Number	Symbol	Changeover	Operation Description	Class	Significant Product Characteristics (Outputs)	Class	Significant Process Characteristics (Inputs)
1.2.5	△	P	Get set of wheel spokes from parts presentation device		Correct wheel spoke set selected		Correct spokes are in parts presentation device
1.2.6	○	T	Orient and place wheel spokes in wheel assembly fixture		Correct number of wheel spokes		Correct kit of 36 wheel spokes
					Correctly oriented spokes properly connected in wheel assembly fixture		Error-proofed wheel assembly fixture
1.2.7	◇		Attach and tighten spokes to wheel rim and wheel hub	KPC	Spokes correctly tightened to required specs	KCC	Spoke tightening gun correctly calibrated
1.2.8	◇		Adjust spoke tightness to ensure wheel rim is round to specs	KPC	Wheel roundness meets specifications		Correct spoke adjustment procedure
1.2.9	△	P	Get tire liner from parts presentation device		Correct tire liner selected		Correct tire liners in parts presentation device
Header				WorkSheet			

Example of a PFD worksheet based on the Standard FMEA profile that is shipped with the software.

When using the PFD worksheet, you have the following options:

- To enter or edit data, double-click the cell.
 - For text columns, you can use the **HOME**, **END** and arrow keys to move through the text in the cell. For date columns, you can click the column once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.
 - After entering the desired information, either press **ENTER**, **TAB** or click somewhere outside of the cell to save the changes.
- The following options apply to operation, product characteristics and process characteristics records. While the examples given are for operation records, the commands are similar for each record type:
 - To add an operation, choose **PFD Worksheet > Operation > Add Operation**.
 - To insert an operation above the currently selected one, choose **PFD Worksheet > Operation > Insert Operation**.
 - To copy, select the operation in the worksheet area and choose **Home > Clipboard > Copy**. To paste a copied operation, choose **Home > Clipboard > Paste**.
 - To move a record up or down one place in the list of operations, select the operation in the worksheet area, then right-click the worksheet and choose **Up** or **Down** from the shortcut menu or choose **Home > Move Record > Up** or **Home > Move Record > Down**.
 - To delete, select the operation in the worksheet area and either choose **Home > Edit > Delete** or press **DELETE**. *There is no undo for delete.*
- To import data from an Excel spreadsheet, choose **Home > Excel > Excel > Import from Excel**. To export data from the PFD worksheet to an Excel spreadsheet, choose **Home > Excel > Excel > Export to Excel**. *See Chapter 22.*

- To generate a report of the PFD worksheet data, choose **Home > Reporting > Reports**. In the Reports window, the PFD worksheet reports are located in the “PFD Spreadsheet” and “PFD Records” sections of the Available Reports list.
- To split the worksheet view so that you can view text at one side of the worksheet without losing sight of text at the other side, right-click a column header and choose **Split**. To remove the split bar, right-click a column header and choose **Remove Split**. (For example, you could use this to see the Operation Description column while working with the Process Characteristic column.)
- To rearrange the order in which the columns are displayed, select a column header and drag it to the place in the worksheet area you want it to appear. This updates the interface style for the project. You also can change the column order through the PFD Worksheet > Worksheet Columns page of the Interface Style window. *See page 190 in Chapter 6.*
- To change the descriptive information about each column that displays in tooltip form when you move the pointer over the column headers, open the Interface Style window and change the text in the appropriate PFD worksheet pages. *See page 187 in Chapter 6.*

19.4 PFD Worksheet Columns

This section describes the fields found on the Worksheet tab of the PFD worksheet. *For a description on how to use the Worksheet tab to document the process steps, see Section 19.3 on page 404.*

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Process Step/Operation Records**
 - **Sources of Variation:** A description of the process inputs or variables that affect the results in each process step, such as improper setup, machine calibration and maintenance, contamination of materials, etc.
 - **Op Seq Number:** The reference number for the process step. This is a required column.
 - **Operation Type:** The type of process or activity, such as an assembly, an inspection, a fabrication, etc. The drop-down list in this column can be configured per project.
 - **Operation Type Symbol:** The graphic symbol associated with the type of process or activity; for example, inspection procedures may be represented by a square symbol. The symbols can be configured per project.
 - **Deliverables:** A description of the results of each process step.
 - **Changeover:** Allows you to flag the process steps that are affected by changeover activities. The drop-down list in this column can be configured per project.
 - **Operation Description:** A description of the process step from the product's perspective. The process that the product goes through must be described step by step. This is a required column.
 - **User-defined fields:** Up to five text fields, two date fields, two number fields and two drop-down lists.
- **Product Characteristics Records**
 - **Classification:** An abbreviation of the classification that has been assigned to the product characteristic, if any. This field is used to identify characteristics that require special manufacturing control (e.g., Critical, Significant, Key Leading, etc.).
 - **Product Characteristics Description:** A description of the product characteristics (outputs) that are affected by each process step; for example, thread depth, wax thickness, length of a cut, etc.
 - **User-defined fields:** Up to three text fields, one date field, one number field and one drop-down list.

- **Process Characteristics Records**

- **Classification:** An abbreviation of the classification that has been assigned to the process characteristic, if any. This field is used to identify design characteristics that require special manufacturing control (e.g., Critical, Significant, Key Leading, etc.).
- **Process Characteristics Description:** A description of the process characteristics (inputs) that require control to ensure that the product characteristics meet the specification; for example, furnace temperature, flow pressure, coolant concentration, etc.
- **User-defined fields:** Up to three text fields, one date field, one number field and one drop-down list.

19.5 Sync Options for PFD Worksheets

In order to provide continuity in your analyses, the software includes a synchronization feature that allows you to transfer data from a PFD worksheet to a process FMEA and to a process control plan. Please note that data are transferred, not linked. Changes made in one analysis worksheet do not automatically appear in the related worksheets and vice versa. The synchronization functionality is intended to provide you with a starting point for a new analysis by transferring relevant data. You can then make any necessary modifications and additions to the worksheet after the sync process.

There are several ways that you might use the synchronization features. This section outlines the recommended approach for synchronizing PFD worksheets, process FMEAs and process control plans. All synchronized worksheets are linked via the reference number (operation sequence number) for the process steps. For example, a process step with reference number 1.2.1 will have the same reference number in the PFD worksheet, process FMEA and process control plan.

Note: The descriptions in this section are based on the default names of the fields. Your worksheet may have different fields depending on the interface style settings that have been defined for the current project. If you have the permissions necessary to edit the project properties, you can enable, hide or rename any of the fields in the worksheets that are part of the synchronization process via the Interface Style window.

1. Define and organize the process steps

First, use the system hierarchy to define and organize the different steps that compose the overall process. The following example shows a bicycle assembly process that is defined in the system hierarchy.

Note: You could choose to define a single item in the system hierarchy and then enter the process steps directly in the PFD worksheet. This approach recommends using the system hierarchy to organize all the steps because it allows you to enter the descriptions in a tree-based structure, which allows for easy visualization.

Name	
	All-Terrain Bicycle Assembly
	Frame Subassembly
	Frame Welding - position and secure tubes into assembly fixture.
	Frame Welding - Initiate weld sequence.
	Remove frame assembly
	Move to clean and paint rack.
	Front Wheel Subassembly
	Get wheel hub from parts presentation device.
	Orient and place wheel hub in wheel assembly fixture.
	Get wheel rim from parts presentation device.
	Orient and place wheel rim in wheel assembly fixture.

You can then create a PFD worksheet for any item in the system hierarchy (usually the top-level item). The descriptions stored for the item and all of its dependents are automatically copied by default to the new PFD worksheet. The following table shows a summary of the information that will be transferred when you create a new PFD worksheet.

From System Hierarchy Item	To PFD Worksheet Tab
Reference Number	Op Seq Number
Item Name	Operation Description

If you add new dependents to the system hierarchy item or modify the item names or reference numbers, you can copy the changes to the existing PFD worksheet by choosing **PFD Worksheet > Sync > Sync with System Hierarchy**.



New items will be appended to the bottom of the PFD worksheet, and any modifications to the reference numbers and item names will be reflected in the existing records. Deleted system hierarchy items will not be automatically deleted from the PFD worksheet, and any new steps that you add to the PFD worksheet will remain after you resync. In addition, if you reorganize the steps in the system hierarchy, the new positions of the steps will not be reflected in the PFD worksheet; however, you can manually edit their positions.

2. Analyze the process steps

The next step is to use the PFD worksheet to identify the product and process characteristics that are affected by each step in the process. An example of a product characteristic is the required air pressure for the bicycle tires, and a process characteristic could be the calibration of the air pressure gun. Completing the PFD worksheet will help you to start thinking about the characteristics that are critical to the quality of the manufactured item, and determine the issues that will need to be analyzed in a process FMEA and monitored via a process control plan.

3. Failure modes and effects analysis

Next, create a process FMEA (PFMEA). Use the PFMEA to identify the potential failure modes in the process and assess the risks associated with those modes. Using the same example for the bicycle tires, a potential failure mode could be insufficiently inflated tires, and the cause of the failure mode could be a de-calibrated pressure gauge.

You can choose to automatically sync data from either the PFD worksheet or system hierarchy. The setting must be set up in advance, before you create the PFMEA; therefore, it is important to be consistent about your workflow. If you have the permissions necessary to edit the project properties, you can select the sync option via the FMEA > Sync Options page of the Interface Style window.

The following tables show summaries of the information that will be automatically transferred to a new PFMEA, based on the chosen sync option.

Sync with System Hierarchy Option

From System Hierarchy Item	To PFD Worksheet Tab
Reference Number	Op Seq Number
Item Name	Function Description

Sync with PFD Worksheet Option

From PFD Worksheet tab	To FMEA Worksheet Tab
Op Seq Number	Op Seq Number
Operation Description	Function Description

If you choose the PFD worksheet as your sync option, the product and process characteristics that have already been defined in the PFD worksheet should be considered when you identify the failures and causes in the FMEA. The definitions from the PFD worksheet will be available when you click the **Select Existing** icon inside the Failure and Cause fields in the FMEA worksheet.

Tip: The PFD worksheet includes a Changeover column that allows you to flag the process steps that are affected by changeover activities. The data in that column are not included in the sync process; however, you could use the information to identify changeover failure modes that may need to be considered in the PFMEA.

4. Control strategy

The next step is to create a process control plan. *See Chapter 20.* Use it to record the controls that should be in place during the process to ensure that the critical product and process characteristics will be within the required specification or tolerance. Using the same example for the bicycle tires, one control strategy might be to schedule routine inspections to ensure that the calibration of the air pressure gauge is maintained.

You have the option to create the control plan based on either the PFD worksheet or the PFMEA. You can set up the sync option to automatically transfer data each time you create a new control plan. The automatic transfer must be set up in advance via the Control Plan > Sync Options page of the Interface Style window. For an existing control plan, you can synchronize (or re-synchronize) at any time by choosing **Control Plan > Sync > Sync with PFD Worksheet or Sync with FMEA**. *See page 415 in Chapter 20.*

There are two choices for synchronizing data:

- Choose the PFD worksheet as your sync option if you want the new control plan to be based on the process steps and product/process characteristics that were defined in the PFD worksheet. Note that:
 - If the item has an existing PFMEA, the controls descriptions from the PFMEA will be available when you click the **Select Existing** icon inside the Control Method field in the control plan worksheet.
 - In addition, the failure descriptions and cause descriptions from the existing PFMEA will be available when you click the **Select Existing** icon inside the Product Characteristic and Process Characteristic fields in the control plan.

The following table shows a summary of the information that will be transferred from the PFD Worksheet to the control plan.

From PFD Worksheet Tab	To Control Plan Worksheet Tab
Op Seq Number	Part/Process Number
Operation Description	Process Name/Operation Description
Product Characteristics Description	Product Characteristic
Process Characteristics Description	Process Characteristic
Classification (choose either to transfer all classifications or only the classification of the process characteristics. The preference must be set up in advance via the Control Plan > Sync Options page. <i>See page 194 in Chapter 6.</i>)	Special Characteristic Class

- Choose the PFMEA as your sync option if you want the new control plan to contain all of the controls that were defined in the PFMEA. Note that:
 - If you have chosen to synchronize the functions in the PFMEA with the process steps in the PFD worksheet, and you choose to synchronize the process/operation records in the control plan with the functions from the PFMEA, then the process/operation descriptions will be the same in all analyses.
 - If the item has an existing PFD worksheet, the product and process characteristics descriptions from the PFD worksheet will be available when you click the **Select Existing** icon inside the Product Characteristic and Process Characteristic fields in the control plan worksheet.

The following table shows a summary of the information that will be transferred from the FMEA to the control plan.

From FMEA Worksheet Tab	To Control Plan Worksheet Tab
Op Seq Number or the system hierarchy Reference Number	Part/Process Number
Function Description or the system hierarchy Item Name	Process Name/Operation Description
Cause Description	Choose to transfer to either the Product Characteristic column, Process Characteristic column, or to not transfer any data
Classification (of the cause description)	Special Characteristic Class
Control Description (choose either only prevention controls, only detection controls, or both types of controls)	Control Method

Control Plans

20

Control plans are used to track critical characteristics that must be kept in control during a manufacturing or assembly process and record the methods for maintaining control. Examples of critical process characteristics are the temperature range for wax that will be sprayed onto the finished vehicle, uniformity of a cut, calibration for a machine tool, and the like. These characteristics may be kept under control by performing inspections, maintenance procedures, error-proofing and other methods.

To add a control plan, select an item in the System panel then choose **Insert > Other > Add Control Plan**.



The Control Plan tab will open in the Analysis panel. In addition, the control plan icon will appear in the corresponding column in the System Hierarchy tab of the System panel if that column has been selected for display on your computer. (To hide or display columns, right-click the column headers in the System panel, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username on the System Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed.)

20.1 Setting up a Control Plan

The control plan analysis contains two tabs: a Header tab and a Worksheet tab. Use the Header tab to enter general information about the entire analysis and use the Worksheet tab to enter descriptions about the manufacturing or assembly process, the associated characteristics that need to be tracked and the strategy for controlling the characteristics that have been identified.

You can also develop a control plan based on the critical issues that have already been identified in process FMEAs (PFMEA) or PFD worksheets. *See Section 20.5 on page 415.*

20.2 Control Plan Header

The Header tab contains information that may be displayed in the header of a report output. The following fields may be found on the Header tab of a Control Plan.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Control Plan Type:** The type of control plan.
- **Control Plan Number:** A unique identifier for the control plan document.
- **Date (Orig.):** The original completion date for the control plan.

- **Date (Rev.):** The latest revision date for the control plan.
- **Part Number:** The part number for the item.
- **Latest Change Level:** The latest change level for the part number.
- **Part Name/Description:** The name and description for the item.
- **Supplier/Plant:** The supplier/plant that will be manufacturing the item.
- **Supplier Code:** An identifying number for the supplier/plant.
- **Key Contact:** The primary contact for the control plan.
- **Key Contact Phone:** The phone number for the primary contact.
- **Core Team:** The primary team involved with preparing the control plan.
- **Approval Fields:** Up to four approval fields that allow you to identify the representative who approved the control plan.
- **Approval Date Fields:** Up to four approval data fields that allow you to enter the date when the representative approved the control plan.
- **User-Defined Fields:** Up to two text fields, one date field, one number field and one drop-down list.
- **Last Updated:** The date when the control plan header was last updated. This is populated by RBI.
- **Last Updated By:** The user who last updated the control plan header. This is populated by RBI.

For text fields, you can click the **Select Existing** icon inside the field. *See page 113 in Chapter 3.* This will open a window that allows you to reuse text that has already been entered in this type of field.



For date fields, you can click the field once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.

20.3 Control Plan Worksheet

This section describes how to enter data in the Worksheet tab. *For a description of all columns that could be displayed in a Control Plan worksheet analysis, see Section 20.4 on page 414.*

The Worksheet tab provides the structure for documenting the characteristics that will be tracked in the control plan and the strategy for keeping those characteristics under control. There are three types of records in the control plan Worksheet tab: part/process records (purple fields), characteristic records (green fields) and method records (tan fields). The following figure shows an example of a control plan. Note that you can vary the format of the control

plan based on the needs of your analysis. If you have the permissions necessary to edit the project properties, you can choose which columns will be enabled for each type of record and what they will be called. This includes user-defined fields and the ability to define the options in the configurable drop-down lists, when applicable.

Op. #	Process Name/Operation Description	Machine, Device, Jig, Tools for Mfg	Characteristic #	Process Characteristic	Control Method
1.2.1	1.2.1 Get wheel hub from parts presentation device	Station A.1	1	Correct tubes are in parts presentation device.	Standardized Work - material handling Bar code scan & verification
					Receiving part verification Second party verification of material stocked in cell
1.2.2	1.2.2 Orient and place wheel hub in wheel assembly fixture	Station B	2	Fixture does not allow incorrect hub placement.	Operator to set and check Visual inspection.
					Error proof fixture design
1.2.3	1.2.3 Get wheel rim from parts presentation device	Station A.2	3	Correct wheel rims are in parts presentation device.	Standardized Work - material handling Bar code scan & verification
					Receiving part verification Second party verification of material stocked in cell
1.2.4	1.2.4 Orient and place wheel rim in wheel assembly fixture	Station B	4	Fixture does not allow incorrect wheel rim placement	Operator to set and check Visual inspection.

Example of the data-entry columns that you could enable or configure in a control plan

When using the control plan worksheet, you have the following options:

- To enter or edit data, double-click the cell.
 - For text columns, you can use the **HOME**, **END** and arrow keys to move through the text in the cell. For date columns, you can click the column once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.
 - After entering the desired information, either press **ENTER**, **TAB** or click somewhere outside of the cell to save the changes.
- The following options apply to the part/process, characteristic and method records. While the examples given are for the part/process records, the commands are similar for each record type:
 - To add a part/process record, choose **Control Plan > Part/Process > Add Part/Process**.
 - To insert a part/process record above the currently selected one, choose **Control Plan > Part/Process > Insert Part/Process**.
 - To copy, select the part/process record in the worksheet area and choose **Home > Clipboard > Copy**. To paste a copied part/process record, choose **Home > Clipboard > Paste**.
 - To move a record up or down one place in the list of parts/processes, select the record in the worksheet area, then right-click the worksheet and choose **Up** or **Down** from the shortcut menu or choose **Home > Move Record > Up** or **Home > Move Record > Down**.
 - To delete, select the part/process record in the worksheet area and choose either **Home > Edit > Delete** or press **DELETE**. *You can undo the last deletion only.*
- To import data from an Excel spreadsheet, choose **Home > Excel > Excel > Import from Excel**. To export data from the control plan worksheet to an Excel spreadsheet, choose **Home > Excel > Excel > Export to Excel**. See Chapter 22.

- To generate a report of the control plan data, choose **Home > Reporting > Reports**. In the Reports window, the control plan reports are located in the “Control Plan Spreadsheet” and “Control Plan Records” sections of the Available Reports area.
- To split the worksheet view so that you can view text at one side of the worksheet without moving the text at the other side, right-click a column header and choose **Split**. A split bar will be placed to the left of the column. To remove the bar, right-click any column header and choose **Remove Split**. (For example, you could use this to see the Process Name/Operation Description column while working on the Reaction column.)
- To rearrange the order in which the columns are displayed, select a column header and drag it to the place in the worksheet area you want it to appear. This updates the interface style for the project. You also can change the column order on the Control Plan > Worksheet Columns page of the Interface Style window. *See page 190 in Chapter 6.*
- To change the descriptive information about each column that displays in tooltip form when you move the pointer over the column headers, open the Interface Style window and change the text in the appropriate control plan pages.

20.4 Control Plan Worksheet Columns

This section describes the fields found on the Worksheet tab of the control plan. *For a description on how to use the Worksheet tab to build a control plan, see Section 20.3 on page 412.*

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Part/Process Records**
 - **Part/Process Number:** The reference number for the part or process step. This is a required column.
 - **Process Name/Operation Description:** The process name and/or a description of the operation. This is a required column.
 - **Machine, Device, Jig, Tools for Mfg:** The name or a description of the device where the operation is performed.
 - **User-Defined Fields:** Up to two text fields, one date field, one number field and one drop-down list.
- **Characteristic Records**
 - **Characteristic Number:** The identifying number for the characteristic that must be controlled. This is a required column.
 - **Product Characteristic:** A description of the product characteristics that need to be tracked; for example, thread depth, wax thickness, length of a cut, etc.
 - **Process Characteristic:** A description of the process characteristics that require control to ensure that the product characteristics meet the specification; for example, furnace temperature, flow pressure, coolant concentration, etc.
 - **Special Char. Class:** An abbreviation of the classification that has been assigned to the process characteristics, if any. This field is used to identify characteristics that require special manufacturing control (e.g., Critical, Significant, Key Leading, etc.).
 - **User-Defined Fields:** Up to two text fields, one date field, one number field and one drop-down list.

- **Method Records**

- **Specification/Tolerance:** A description of the specification or tolerance that will be used to evaluate the characteristic.
- **Evaluation/Measurement Technique:** A description of the measurement method that will be used to make sure the characteristic meets the specification/tolerance.
- **Sample Size:** When sampling is required, the number of units that will be sampled.
- **Sample Frequency:** When sampling is required, the frequency at which the units will be sampled.
- **Control Method:** A description of how the operation will be controlled, including procedure numbers when applicable. This is a required column.
- **Reaction Plan:** A description of the corrective actions that will occur if the characteristic does not meet the specification/tolerance.
- **Responsibility:** The person or group responsible for carrying out the reaction plan.
- **Remarks:** Any remarks related to the control method.
- **User-Defined Fields:** Up to three text fields, one date field, one number field and one drop-down list.

20.5 Sync Options for Control Plans

In order to provide continuity in your analyses, the software includes a synchronization feature that allows you to transfer data from an existing PFD worksheet or process FMEA (PFMEA) to a control plan. *For more information about PFD worksheets, refer to Chapter 19.* Please note that the data are transferred, not linked. Changes made in the PFD worksheet or PFMEA do not automatically appear in the control plan and vice versa. The synchronization functionality is intended to provide you with a starting point for the control plan by transferring relevant data. You can then make any necessary modifications and additions to the control plan. If necessary, you can also re-synchronize later to append any new data from the original analysis.

There are two methods for synchronizing data with a control plan:

- **Automatic transfer.** To automatically transfer data each time that you create a control plan, you must set up the preference in advance via the Control Plan > Sync Options page of the Interface Style window. *See page 194 in Chapter 6.* You can choose to automatically sync with an existing FMEA, PFD worksheet or disable the sync process.
- **Manual transfer.** To sync or re-sync the data manually, the following options are available:
 - To sync with an existing PFD worksheet, choose **Control Plan > Sync > Sync with PFD Worksheet**.



You will be given the option to either overwrite the existing data in the control plan with the data from the PFD worksheet or append the new data.

- To sync with an existing process FMEA, choose **Control Plan > Sync > Sync with FMEA**.



This opens the Synchronization Options window, as shown next.

In the Synchronization Options window, the following settings are available:

- In the **Header** area, select whether to leave the data in the Header tab of the control plan as-is or replace it with data from the associated FMEA.
- In the **Worksheet** area, select whether to replace all of the information in the Worksheet tab of the control plan with data from the associated FMEA or append the FMEA data to the end of the existing data in the worksheet.
- In the **Map Records for Transfer** area, select how you want to transfer data to the control plan:
 - In the **Part/Process** list, select how you want the part/process records to be created. If you stored descriptions of the process steps in the system hierarchy, then select the **Transfer from Items** option. If, however, you stored descriptions of the process steps as functions in the FMEA, use the **Transfer from Functions** option.
 - In the **Characteristic** list, select how you want to transfer the cause records from the FMEA. You can specify whether the cause records are more likely to be product characteristics or process characteristics, which determines which column the data will need to be transferred to. If your cause records do not have data that would be a good starting point for defining the characteristics in the control plan, then you could leave the characteristic records blank.
- In the **Transfer Controls Options** area, Select the **All Controls** option to transfer all the controls from the FMEA to the control plan. To transfer only the controls that meet the desired requirements, select the **Controls where Type=** option and then select the required control type from the drop-down list.

- The **Limiting Criteria** area allows you to specify which data to transfer to the control plan by using any of the following criteria:
 - **Classification** transfers only the cause data with the selected classification. Select **All** if you want all cause data, no matter the classification, to be transferred. This includes cause data with no classification. Select **Any** if you want to transfer the record if any classification has been assigned to it. If there is no classification assigned to it, the cause data will not be transferred.
 - **Cause RPN (Initial) >=** transfers only the data with an initial cause RPN that is greater than or equal to the value that you specify in the input box.
 - **Cause RPN (Revised) >=** transfers only the data with a revised cause RPN that is greater than or equal to the value that you specify in the input box.
 - **Cause SxO (Initial) >=** transfers only the data with an initial cause severity x occurrence rating that is greater than or equal to the value that you specify in the input box.
 - **Cause SxO (Revised) >=** transfers only the data with a revised cause severity x occurrence rating that is greater than or equal to the value that you specify in the input box.

After making your selections, click **OK** to transfer the data from the FMEA to the control plan.

Design Reviews Based on Failure Mode (DRBFMs) 21

Design Review Based on Failure Mode (DRBFM) is a methodology used to evaluate proposed changes to an existing item. It was developed by Tatsuhiko Yoshimura, working with Toyota Motor Corporation. DRBFM uses a worksheet modeled after the FMEA worksheet, but some of the relevant differences include:

- DRBFM usually focuses on changes to an existing design.
- DRBFM focuses on “points of concern” to the engineers.
- DRBFM follows the GD3 philosophy:
 - Good Design
 - Good Discussion
 - Good Design Review
- The structure of the DRBFM analysis worksheet is somewhat different than the typical worksheets for FMEA.

Although some organizations may choose to perform DRBFM instead of FMEA, most practitioners start with a baseline FMEA and then use the DRBFM worksheet for evaluating the risks that might be introduced by changes to the original design.

To add a DRBFM, select an item in the System panel then choose **Insert > FMEA > Add DRBFM**.



The DRBFM analysis tab will open in the Analysis panel. In addition, the DRBFM icon will appear in the corresponding column in the System Hierarchy tab of the System panel (if that column has been selected for display on your computer). To hide or display columns, right-click the column headers in the System panel, then click **Customize Columns** to select which columns you want to display. These settings are stored per computer/username in the System Hierarchy page of the Application Setup, so any project that you open on this computer will have the same columns displayed. *See page 508 in Chapter 30.*

The DRBFM analysis contains two tabs: a Header tab and a Worksheet tab. The Header tab contains general information about the entire analysis that will be displayed in the header of the report output while the Worksheet tab contains the analysis data.

21.1 DRBFM Header

The following fields may be found on the DRBFM Header tab.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. See page 187 in Chapter 6.

- **DRBFM Type:** The type of DRBFM (choose from menu).
- **Document Number:** A unique document identifier.
- **Key Date:** The date when the DRBFM should be completed.
- **DRBFM Date (Orig.):** The original DRBFM completion date.
- **DRBFM Date (Rev.):** The latest DRBFM revision date.
- **Prepared By:** The person who prepared the document.
- **Primary Approval:** The person who approved the document.
- **Approval Date:** The date when the document was approved.
- **Product:** The product that the DRBFM applies to.
- **Model Year(s)/Program(s):** The model year and/or program identifier that the DRBFM applies to.
- **Mission:** The mission that the item is intended to perform.
- **Release Date:** The date when the design will be released.
- **Responsibility:** The person who is responsible for the design that is being analyzed.
- **Core Team:** The primary team of people who worked on the analysis.
- **Support Team:** The support team for the analysis.
- **Others Affected:** Other people who were involved with or affected by the analysis.
- **User-Defined Fields:** Up to five text fields, one date field, one number field and one drop-down list.
- **Last Updated By:** The date when the DRBFM header was last updated. This is populated by RBI.
- **Last Updated:** The user who last updated the DRBFM header. This is populated by RBI.

For text fields, you can click the **Select Existing** icon inside the field. See page 113 in Chapter 3. This will open a window that allows you to reuse text that has already been entered in this type of field.



For date fields, you can click the field once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.

21.2 DRBFM Worksheet

The Worksheet tab displays the records that will be tracked with the DRBFM. If you have the permissions necessary to edit the project properties, you can choose which fields will be enabled and what they will be called. For example, you can include user-defined fields and define the options in the user-defined drop-down menus, when applicable.

Part/Change to Design or Environment	Function	Concerns Related to Change	Potential Effects of Concern	Si	Class	Potential Cause of Concern	Oi
List the part and the change that is being made to the design or the operating conditions.	List the functions that might be affected by the change.	List concerns related to the change, as identified by the Design Engineer.	List the potential effects if the concern (failure) occurs.	5	S	List the potential causes for concern, as identified by Design Engineer.	5
		Failure 2	Effect 2	4	KLg	Cause 1	5
					C	Cause 2	7
					C	Cause 3	8
		Failure 3	Effect 3	7	KLg	Cause 4	3
					KLd	Cause 5	3
	Function 2	Failure 4	Effect 4	3	KLg	Cause 6	8
					S	Cause 7	4

RBI provides two different “views” for the worksheet; one is intended to be used by the Design Engineer who performs the first draft of the analysis and the other is intended to be used by the entire Review Team to modify and expand upon the initial draft. Use the options at the top of the worksheet to toggle between the two views.

- Select **Design Engineer** to hide the Other Concerns, Other Causes and Actions columns in the worksheet.
- Select **Review Team** to display all enabled columns in the worksheet.

Note: If the Severity, Occurrence and Detection columns are enabled in the FMEA, then those columns are also displayed in the DRBFM Worksheet along with the initial and revised RPNs. *See page 190 in Chapter 6.*

When using the DRBFM worksheet, you have the following options:

- To enter or edit data, double-click the cell.
 - For text columns, you can use the **HOME**, **END** and arrow keys to move through the text in the cell. For date columns, you can click the column once to open a calendar or twice to type the date. You must use the mm/dd/yy or mm/dd/yyyy format.
 - To save the changes, either press **ENTER** or **TAB** or click somewhere outside of the cell.
- The following options apply to parts, functions, concerns, effects, causes, controls and actions. While the examples given are for parts, the commands are similar for each record type:
 - To add a part, choose **DRBFM > Records > Parts/Functions > Add Part/Function**.
 - To insert a part above the currently selected one, choose **DRBFM > Records > Parts/Functions > Insert Part/Function**.
 - To copy, select the part in the worksheet area and choose **Home > Clipboard > Copy**. To paste a copied part, choose **Home > Clipboard > Paste**.

- To move a record up or down one place in the list of parts, select the part in the worksheet area, then right-click the worksheet and choose **Up** or **Down** from the shortcut menu or choose **Home > Move Record > Up** or **Home > Move Record > Down**.
- To delete, select the part in the worksheet area and either choose **Home > Edit > Delete** or press **DELETE**. *You can undo the last deletion only.*
- To import functions from the FMEA, choose **DRBFM > Sync > Get Functions from FMEA**. To export the functions to the FMEA, choose **DRBFM > Sync > Send Functions to FMEA**. *See Section 21.3 on page 425.*
- To import header properties from the FMEA, choose **DRBFM > Sync > Get Header from FMEA**. To export the header properties to the FMEA, choose **DRBFM > Sync > Send Header to FMEA**. Performing either action makes the headers identical.
- To import data from an Excel spreadsheet, choose **Home > Excel > Excel > Import from Excel**. To export data from the DRBFM worksheet to an Excel spreadsheet, choose **Home > Excel > Excel > Export to Excel**. *See Chapter 22.*
- To generate a report of the DRBFM data, choose **Home > Reporting > Reports**. In the Reports window, the DRBFM reports are located in the DRBFM Spreadsheet and DRBFM Records sections of the Available Reports area.
- To split the worksheet view so that you can view text at one side of the worksheet without moving the text at the other side, right-click a column header and choose **Split**. A split bar will be placed to the left of the column. To remove the bar, right-click any column header and choose **Remove Split**. (For example, you use this to see the function number while working on the actions.)
- To rearrange the order in which the columns are displayed, select a column header and drag it to the place in the worksheet area you want it to appear. This updates the interface style for the project. You also can change the column order through the Project Interface Style window. *See page 190 in Chapter 6.*
- To change the descriptive information about each column that displays in tooltip form when you move the pointer over the column headers, open the Project Interface Style window and change the text in the appropriate DRBFM pages.

21.2.1 Parts/Functions Columns

The following fields may be found in the parts/functions columns of the Worksheet tab of the DRBFM.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Part/Change to Design or Environment:** List the part and the change that is being made to the design or the operating conditions. This is a required column.
- **Function:** List the functions that might be affected by the change. This is a required column.
- **User-Defined Fields:** Up to one text field, one date field, one number field and one drop-down list.

21.2.2 Concerns Columns

The Concerns Related to Change and Other Concerns columns are similar to the “Failure” description in an FMEA. The Concerns Related to Change column is intended for the Design Engineer, but may be used by the Review Team. The Other Concerns column can be used only by the Review Team. Therefore, while information cannot be entered in both columns on the same row, each row must contain a description, which could be in either column.

The following fields may be found in the concerns columns area of the Worksheet tab of the DRBFM.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Concerns Related to Change:** List concerns related to the change, as identified by the Design Engineer. This is a required column for the Design Engineer.
- **Other Concerns:** List other concerns related to the change, as identified by the Review Team. This is a required column.
- **User-Defined Fields:** Up to one text field, one date field, one number field and one drop-down list.

21.2.3 Effects Columns

The following fields may be found in the effects columns area of the Worksheet tab of the DRBFM.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Potential Effects of Concern:** List the potential effects if the concern (failure) occurs. This is a required column.
- **User-Defined Fields:** Up to one text field, one date field, one number field and one drop-down list.

21.2.4 Causes Columns

The Potential Cause of Concern column is intended for the Design Engineer, but may be used by the Review Team. The Other Causes column can only be used by the Review Team. Therefore, while information cannot be entered in both columns on the same row, you must enter information in one of the columns.

The following fields may be found in the Causes columns area of the Worksheet tab of the DRBFM.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. *See page 187 in Chapter 6.*

- **Class:** Special characteristic classification, if applicable.
- **Potential Cause of Concern:** List the potential causes for the concern, as identified by the Design Engineer. This is a required column for the Design Engineer.

- **Other Causes:** List other potential causes for the concern, as identified by the Review Team. This column is required if the Potential Cause of Concern field is empty.
- **User-Defined Fields:** Up to one text field, one date field, one number field and one drop-down list.

21.2.5 Controls Columns

The following fields may be found in the controls columns area of the Worksheet tab of the DRBFM.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. See page 187 in Chapter 6.

- **Current Design Controls Detection:** List the controls that are currently in place to improve the likelihood that the cause will be detected before it reaches the end user. This is a required column.
- **Current Design Controls Prevention:** List the controls that are currently in place to reduce the likelihood that the cause will occur.
- **User-Defined Fields:** Up to one text field, one date field, one number field and one drop-down list.

21.2.6 Actions Columns

The following fields may be found in the actions columns area of the Worksheet tab of the DRBFM.

Note: The fields that are enabled in the interface and the options available in configurable drop-down lists will depend on the interface style settings that have been defined for the current project. You can choose **Project > Management > Configurable Settings > Interface Style** to open the Edit Interface Style (This Project) window and change the settings for the current project. See page 187 in Chapter 6.

Note: You can view and change the data in the Action columns only if the Review Team view is selected.

- **Recommended Action Design:** List the design-related actions that could be taken to reduce the risk associated with the issue. This is a required column.
- **Recommended Action Design - Responsibility:** The person (or department) responsible for completing each design-related action.
- **Recommended Action Design - Due Date:** The date when each design-related action must be completed.
- **Recommended Action Validation / Test:** List the testing-related actions that could be taken to reduce the risk associated with the issue.
- **Recommended Action Validation / Test - Responsibility:** The person (or department) responsible for completing each testing-related action.
- **Recommended Action Validation / Test - Due Date:** The date when each testing-related action must be completed.
- **Recommended Action Manufacturing / Supplier:** List the manufacturing-related actions that could be taken to reduce the risk associated with the issue.
- **Recommended Action Manufacturing / Supplier Responsibility:** The person (or department) responsible for completing each manufacturing-related action.
- **Recommended Action Manufacturing / Supplier Due Date:** The date when each manufacturing-related action must be completed.

- **Recommended Action Manufacturing / Supplier:** List the manufacturing-related actions that could be taken to reduce the risk associated with the issue.
- **Actions Taken:** The actions taken (or result) for each action. This is a required column.
- **User-Defined Fields:** Up to one text field, one date field, one number field and one drop-down list.

21.3 Transferring Data Between a DRBFM and a FMEA

Data in the DRBFM can be transferred to and from the associated FMEA.

Please note that changes made in the FMEA do not appear automatically in the DRBFM and vice versa.

21.3.1 Sending FMEA Data to the DRBFM

You can synchronize the document headers and/or transfer selected functions from the FMEA to the DRBFM. For example, if you want to use the DRBFM to evaluate the risks that might be introduced by changes to an existing design, you can transfer the specific FMEA functions that might be affected by the change as a starting point for the new DRBFM.

- **Synchronize the Document Headers**

To send the FMEA header data to the DRBFM header, choose **DRBFM > Sync > Get Header from FMEA**.



- **Sending FMEA Functions to the DRBFM**

To transfer selected FMEA functions, choose **DRBFM > Sync > Get Functions from FMEA**. You can choose functions from the current item only, or from the current item and all of its sub-items.



21.3.2 Sending DRBFM Data to the FMEA

You can synchronize the document headers and/or append selected DRBFM functions (and related records) to the end of the FMEA. For example, if the DRBFM identifies additional risks that may be introduced by changes to an existing design, you can transfer the specific information back to the main FMEA if desired.

- **Synchronize the Document Headers**

To send the DRBFM header data to the FMEA header, choose **DRBFM > Sync > Send Header to FMEA**.



- **Sending DRBFM Record Data to the FMEA**

To transfer DRBFM records to the FMEA, choose **DRBFM > Sync > Send Functions to FMEA**, then select the specific functions to transfer.



When sending DRBFM data to the FMEA, the following rules apply:

- The **Part/Change to Design or Environment** column will not be transferred because data in this column is exclusive to the DRBFM.
- The **Function** column will transfer as function descriptions.

- The **Concerns Related to Change** and **Other Concerns** columns will transfer as failure descriptions.
- The **Potential Effects of Concern** column will transfer as effect descriptions.
- The **Potential Cause of Concern** and **Other Causes** columns will transfer as cause descriptions.
- The **Current Design Controls** columns will transfer as control descriptions with the appropriate Control Type (i.e., detection or prevention).
 - The **Detection** column will transfer to the first Control Type defined for the project and the **Prevention** column will transfer to the second Control Type. If the Control Type settings in your project differ, you can adjust them in the project's interface style so that Detection is first and Prevention second.
 - If there are two controls per row in the DRBFM worksheet, any associated **User Defined** field information will transfer to both controls in the FMEA.
- The **Recommended Action** columns (i.e., Recommended Action - Design, Recommended Action - Validation/Test and Recommended Action - Manufacturing/Supplier) will transfer as separate action descriptions.
 - If there are multiple actions per row, the associated **Actions Taken** and **User Defined** field information will transfer to each of those actions in the FMEA.

Excel Templates for Import/Export 22

RBI allows you to import and export records via an Excel spreadsheet. This includes the ability to import and export data in the following formats:

- System hierarchy items
- System hierarchy items and FMEA data (There are some considerations for validating system hierarchy items. *Refer to Section 22.4 on page 431 for more information.*)
- FMEA worksheet data
- Control plan worksheet data
- DVP&R worksheet data
- DRBFM worksheet data
- PFD worksheet data

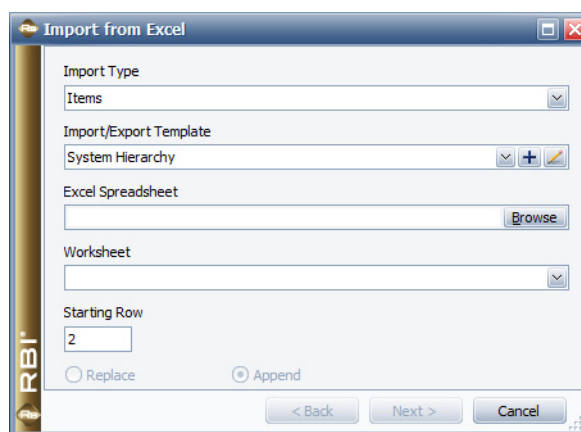
The instructions for importing and exporting data via Excel are presented next. While the options described here are for importing/exporting system hierarchy items, the steps are the same for all data types.

22.1 Instructions to Import Data via Excel

1. Select an item in the System panel and choose **Home > Excel > Excel > Import from Excel**.



The Import from Excel window appears.



2. Select the type of data to import from the **Import Type** drop-down list.

3. Choose an import mapping template. You can:

- Choose a previously defined template from the drop-down list.
- Click the **Add Template** icon to add a new template for the currently selected import type. *See Section 22.3 on page 429 for more information.*



- Choose a previously defined template from the drop-down list and click the **Edit Selected Template** icon to edit that template.



4. Click **Browse** and select the Excel file (*.xls) that contains the data that you want to import.
5. Choose a worksheet from the **Worksheet** drop-down list.
6. Enter the number of the first row in the Excel worksheet that contains the data you want to import.
7. If you are importing data into the Analysis Panel only, do one of the following:
 - To replace the data in the analysis with the data from the Excel file, select the **Replace** option.
 - To append the data from the Excel file to the end of the analysis, select the **Append** option.
8. Click **Next** to view a preview of the source file with the import template applied.

Line #	Level	Item ID	Item Name
1	1	88	System 1
2	2	93	Subsystem 1.1
3	3	96	Component 1.1.1
4	1	89	System 2
5	2	94	Subsystem 2.1
6	1	90	System 3
7	2	95	Subsystem 3.1
8	3	97	Subsystem 3.1.1
9	4	100	Component 3.1.1.1
10	3	98	Subsystem 3.1.2
11	4	102	Component 3.1.2.1

9. If the preview shows the desired results, click **Finish** to import the data. If it does not, click **Back** to return to the previous page and edit your choices. You may find it particularly informative to examine the farthest right columns; if the values there are not the expected ones, this is a clear indication that the mapping is off by one or more columns.

Tip: If you are importing data for an analysis type that is not already present for the currently selected item, importing the data creates the analysis for the item.

22.2 Instructions to Export Data via Excel

1. If you wish to export only a specific branch from the system hierarchy, or the analysis data associated with a particular item, first select the item in the System panel and then choose **Home > Excel > Excel > Export to Excel**.



2. Select the type of data to export in the **Export Type** drop-down list.
3. Choose an export mapping template. You can:
 - Choose a previously defined template from the drop-down list.
 - Click the **Add Template** icon to use the Import/Export Template window to add a new template for the currently selected export type. *See Section 22.3 on page 429 for more information.*



- Choose a previously defined template from the drop-down list and click the **Edit Selected Template** icon to edit that template.



4. If you are exporting system hierarchy data, choose either the **Items and dependents** option to export only the current item and its sub-items or the Entire system hierarchy option to export all of the system hierarchy data.
5. Click **OK**. The Save As window will appear. Provide a name for the export file, then click **Save**.

22.3 Creating and Managing Import/Export Templates

Saved import/export templates can be managed from within the Templates Manager. To open the Templates Manager, choose **File > Manage Repository > Profiles and Templates > Templates Manager**. If a standard database (*.rsr9) is currently open, you will be managing the templates stored in a local template library (*.xrt8) that is active for your computer, and you will be able to browse for another template library, if desired. If an enterprise database (SQL Server or Oracle) is currently open, you will be managing the templates stored within the enterprise database itself.

The Import/Export Template window allows you to add a new import/export template or edit an existing one. It is accessed by clicking the **Add** button or the **Edit** button on the Import/Export Templates page of the Templates Manager. It also can be accessed from within the Import from Excel window or from the Export to Excel window by clicking the **Add Template** icon. *See Section 22.1 on page 427 and Section 22.2 on page 429.*

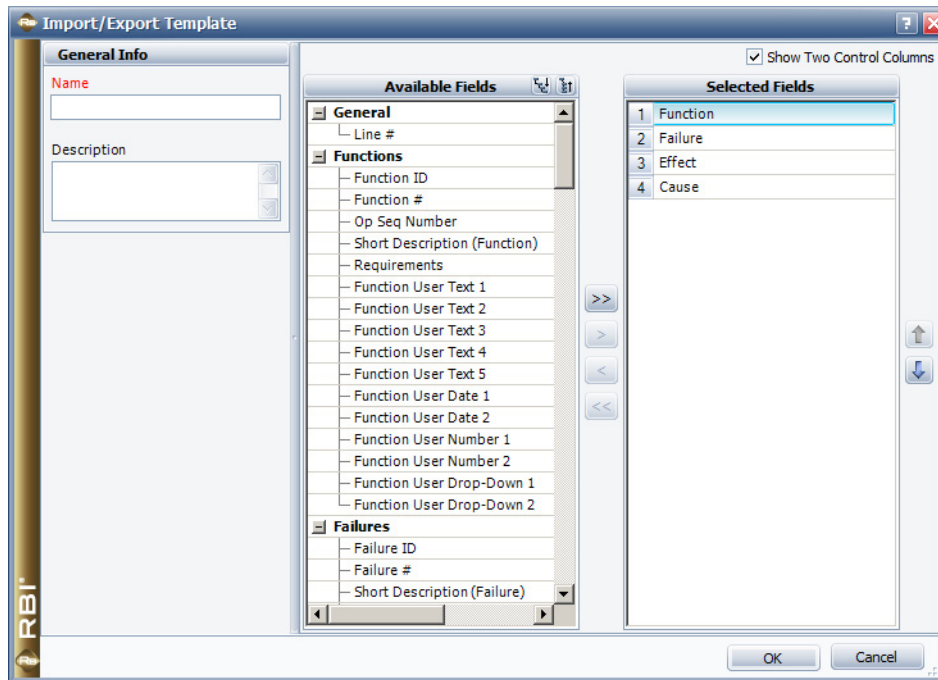


You also can choose an import/export template to edit and click **Edit Selected Template** icon to edit that template.



Each import/export template is associated with a particular data type. If you are adding a new template from the Import from Excel window or from the Export to Excel window, the Import/Export Template window is automatically set up to work on a new template for the selected data type (e.g., if you are creating a template for

FMEA data, the window shows the FMEA fields). If you are adding a new template from the Templates Manager window, you will be prompted to choose an import type that specifies the type of data you want to import. Note that if you are editing an existing template, you cannot change the data type that it is associated with.



On the left side of the window, specify a name for the template and, if desired, enter a description.

The Import/Export Template window is divided into two sections:

- The **Available Fields** area displays all of the fields available for inclusion in the template. The fields are presented in a tree structure. Click the plus (+) button to open a group and display the fields within that group. Click the minus (-) button to close a group and hide the fields within the group. You can use the **Expand Tree** and **Collapse Tree** icons in this area to expand or collapse the tree.



To select a field for inclusion in the template, you can do one of the following:

- Double-click the field in the **Available Fields** area.
- Select the field in the **Available Fields** area and then click the **Include** icon (>) between the two sections.
- Drag the field from the **Available Fields** area to the desired location in the **Selected Fields** area.

For the first two methods, the field will be added to the bottom of the list in the **Selected Fields** area. When you drag a field, it will be placed in the position where it is dropped.

You can select multiple fields for inclusion in the template by clicking the first field in the **Available Fields** area and then pressing **CTRL** and clicking additional fields or by clicking the first field and then pressing **SHIFT** and clicking another field to select all fields between the two. Then click the **Include** icon (>) to move all highlighted fields to the **Selected Fields** area.

- The **Selected Fields** area displays the fields that have been selected for inclusion in the template, in the order in which they appear in the source file. To change the order of the fields, you can:
 - Click and drag the selected field to the desired location.
 - Select the field in the **Selected Fields** area and then use the arrows at the right of the area to move the field up one position or down one position with each click.

Note that if you are creating a template that includes FMEA data, you can include separate columns for Prevention and Detection controls by selecting the **Show Two Control Columns** check box. To include the descriptions for both types of controls in the same column and include the control type in another column, clear the **Show Two Control Columns** check box. *For more information about controls, refer to page 362 in Chapter 14.*

Once you have arranged the import/export template to suit your needs, click **OK**. Your new template will now be available in the drop-down list in the Import from Excel window or from the Export to Excel window.

22.4 Validating Data for Import

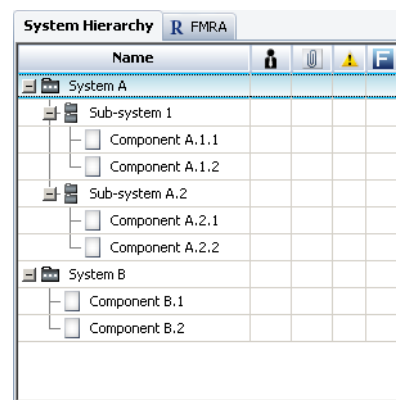
When importing data from Excel, for most of the columns in the spreadsheet, the only validation is to make sure that the data meet the RBI database requirements for the fields. For example, if the text is too long to fit the field, it will be truncated. If it is the wrong format (e.g., there is text where a number is required), it will be ignored.

When importing items into the system hierarchy, the following additional validation requirements apply:

- The Level column identifies the position of the item in the system hierarchy. 1 indicates a top level (system) item. 2 indicates a sub-item below the nearest Level 1 item above, 3 indicates a sub-item below the nearest Level 2 item above, and so on.

An example of how the rows in the import spreadsheet translate to the system configurations in RBI is shown next.

Level	Item #	Item Name
1	1	System A
2	1	Sub-system A.1
3	1	Component A.1.1
3	2	Component A.1.2
2	2	Sub-system A.2
3	1	Component A.2.1
3	2	Component A.2.2
1	2	System B
2	1	Component B.1
2	2	Component B.2



- If the Level column is not present, then all items are imported as systems.
- The position of the row in the import spreadsheet determines the position of the item in the RBI system hierarchy. In order to identify the appropriate “parent” item in the hierarchy, you must enter all items for a given branch of the hierarchy before moving on to the next branch. For example, if the system consists of two subsystems and each subsystem has three components, list the system first (Level 1), then the first subsystem (Level 2), then the three components of the first subsystem (Level 3), then the second subsystem (Level 2), then the three components of the second subsystem (Level 3).

- The row will be considered invalid if the “Level” column does not contain a whole number or contains a number that is greater than one more than the previous level number (e.g., Level 5 can be entered below Level 4 but cannot be entered below Level 3). For example, the level numbers 1, 2, 2, 1, 2, 3, 4, 1, 1, 2, 3, 3, 4 are valid. The numbers 1, 2, 4, 6 are not. The reason is that a lower number indicates another item on a previous level (which can always be added) but a higher number indicates an item on the next level and you cannot skip a level. Some examples of valid and invalid “Level” entries are presented below.

Row	Level
1	1
2	2
3	3
4	3
5	2
6	3
VALID	

Row	Level
1	1
2	2
3	3
4	3
5	4
6	4
VALID	

Row	Level
1	1
2	2
3	3
4	5
5	2
6	4
INVALID	

Row	Level
1	2
2	2
3	3
4	3
5	4
6	4
INVALID	

- If a validation issue is detected in the middle of the import, then the remaining records in that branch will be imported as systems. You can then use the Promote/Demote, Drag and Drop and/or Cut/Paste functionality in the System panel to correct the configuration.

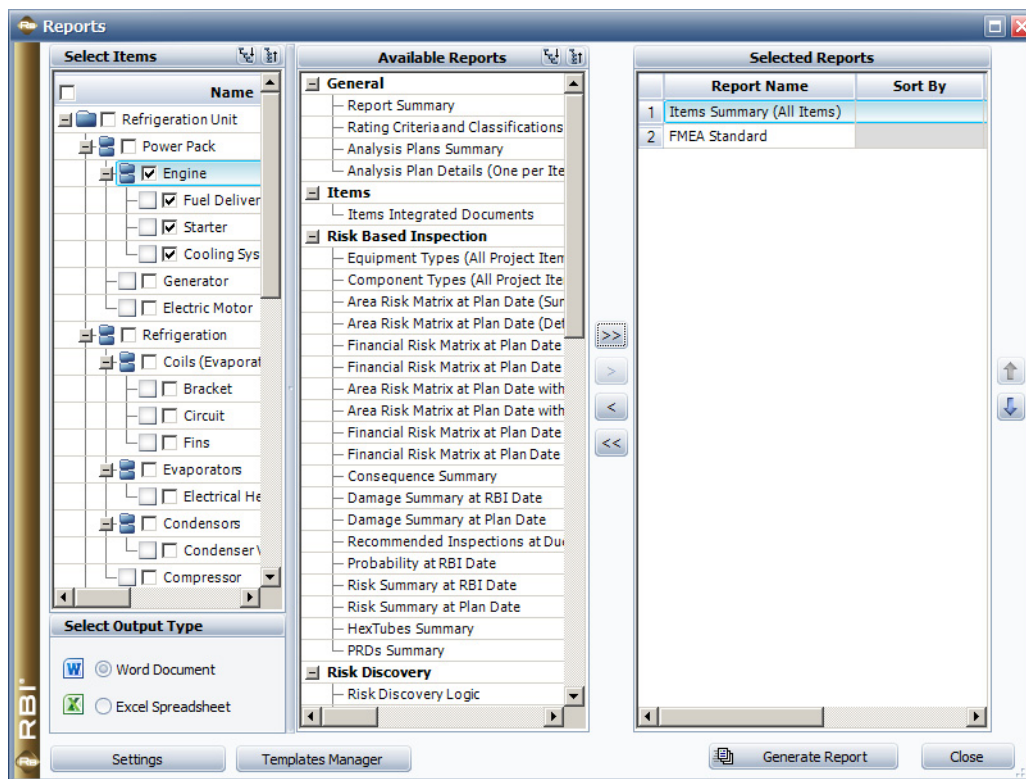
Reports

23

RBI provides a complete set of print-ready reports for your analysis, as well as offering you the ability to create your own reports and save them as templates for later re-use. Reports can be generated in Microsoft Word and/or Excel. This provides maximum flexibility for customization and distribution as well as the ability to create HTML and PDF versions of the reports, as desired. To open the Reports window, choose **Home > Reporting > Reports**.



The Reports window will appear, as shown next.



23.1 Using the Reports Window

In the **Select Items** area, specify the items from the system hierarchy that will be included in the report. You can generate a report that contains data from a single analysis or from multiple analyses together. By default, the item selected in the System panel when you open the Report Generation window is selected, along with its sub-items. You can use the **Expand Tree** and **Collapse Tree** icons in this area to expand or collapse the tree.



Note: Selecting or clearing the check box for an item in this list does not automatically select or clear its sub-items. If you would like to select or clear an item and all of its sub-items, right-click the item for a shortcut menu that allows you to select or clear all items in the node.

In the **Select Output Type** area, select whether you want to generate the report in either Microsoft Word or Microsoft Excel. Most report forms are available in both formats, although the appearance, especially headers and footers, may be different.

The Available Reports area displays all of the report forms available for inclusion in the generated report in a hierarchical tree structure. This list includes the standard report forms that are shipped with the software, as well as any custom report templates and any custom queries that you have created. *For information on standard report forms, see Section 23.2 on page 435. For information on custom report templates, see Section 23.7 on page 443. For information on queries, see Chapter 24.* You can click the plus (+) button to open a group and display the items within that group and click the minus (-) button to close a group and hide the items within that group. You also can use the **Expand Tree** and **Collapse Tree** icons in this area to expand or collapse the entire tree. To select a report form for inclusion in the generated report, do one of the following:

- Double-click the form in the **Available Reports** area.
- Select the form in the **Available Reports** area and then click the **Include** icon (>) between the **Available Reports** area and the **Selected Reports** area.
- Drag the form from the **Available Reports** area to the desired location in the **Selected Reports** area.

For the first two methods, the form will be added to the bottom of the list in the **Selected Reports** area. When you drag the form, it will be placed in the position where it is dropped.

To select multiple forms for inclusion in the report, you can:

- Select multiple forms in this area by clicking the first form and then pressing **CTRL** and clicking additional forms or by clicking the first form and then pressing **SHIFT** and clicking another form to select all forms between and including the two and then click the **Include** icon (>) or drag the forms to the desired location in the **Selected Reports** area.
- Click the **Include All** icon (>>) to move all available forms to the **Selected Reports** area.

The **Selected Reports** area displays the forms that have been selected for inclusion in the generated report, in the order in which they will appear. To change the order of the forms, you can:

- Drag the selected form to the desired location.
- Select the form in the **Selected Reports** area and then use the arrows at the right of the **Selected Reports** area to move the form up one position or down one position.

The **Selected Reports** area also allows you to specify how the contents of certain report forms will be sorted. Choose how you want to sort the report form from the drop-down list in the Sort By column and specify the order in the Ascending column (choosing **Yes** sorts the report form in ascending order, choosing **No** sorts it in descending order).

When you click **Generate Report**, you will be prompted to specify the name and location where the report file will be saved. Specify the pathname/filename and then click **Save**. RBI will generate a main report with the individual forms selected. Once the report has been generated, it will open automatically in either Microsoft Word or Microsoft Excel. For reports created in Word, the individual report forms will be separated by section breaks. For reports created in Excel, the individual reports will be placed on separate worksheets within the same Excel file.

Note: If the FMEA Records - Action Details (One per Action) report is selected for inclusion, the Select Actions for Detail Report window will appear when you click **Generate Report**.

The **Settings** button at the bottom of the window opens the Report Customization/Settings window, which allows you to create and save custom settings for selected report forms and also to establish your preferences for configurable reporting options. *See Section 23.4 on page 440.*

To create or work with custom report templates, click the **Templates Manager** button at the bottom of the window. *See Section 23.7 on page 443.*

23.2 Standard Report Forms

The following forms can be included in reports.

- **General**
 - **Report Summary** presents a list of the report forms that are included in the main report.
 - **Rating Criteria and Classifications** presents the calculation method, rating criteria and classification options used in the analysis.
 - **Analysis Plans Summary** presents full information for each analysis plan.
 - **Analysis Plan Details (One per Item)** presents the details for each analysis plan associated with one of the selected items.
- **Items**
 - **Items Summary** presents the hierarchy for the items selected to be included in the report in addition to a full summary of the properties for each item. If more than one item has been selected that is the top selected item in a branch of the hierarchy, the hierarchy for the first top-level item will be displayed followed by the summaries for the item and any sub-items, then the hierarchy for the second top-level item will be displayed, and so forth.
 - **Items Integrated Documents** includes any integrated documents attached to each item. Integrated documents are attached via the Attachments window. This option is available only for reports generated in Microsoft Word.
- **Risk Based Inspection**
 - **Equipment/Component Types (All Project Items)** displays the RBI equipment types or RBI component types in the system and how many there are of each type.

- **Risk Matrix Reports** are a group of eight reports that display either the area risk scoring matrix or the financial risk scoring matrix as of the plan date. The following types of reports are available:
 - To see the total number of items in the project that fall into each cell of the matrix, generate the “All Project Items” report. If you want to see the names of only the selected items, generate the “Selected Items” report.
 - The basic report shows the results as of the plan date, assuming that you do nothing until then. To generate a matrix with the results as of the plan date assuming that the recommended inspections on the target date are carried out, generate the “Results Assuming Inspections Performed” report.
- **Consequence Summary** displays information about the possible damage consequences for each non-HEXTUBE and non PRD component.
- **Damage Summary at RBI Date/Plan Date** displays the calculated damage summary values at the applicable date for each non-HEXTUBE and non PRD component.
- **Recommended Inspections at Due Date** lists the number of suggested inspections and the needed effectiveness ratings for each damage factor for each non-HEXTUBE and non PRD component.
- **Probability at RBI Date** lists the probability of failure and financial consequences at the RBI date for each non-HEXTUBE and non PRD component.
- **Risk Summary at RBI Date/Plan Date** lists the financial risk details at the applicable date for each non-HEXTUBE and non PRD component.
- **HexTubes Summary** displays information about each HEXTUBE component.
- **PRDs Summary** displays information about each pressure relief device.
- **Risk Discovery**
 - **Risk Discovery Logic** presents the risk discovery questions and ratings used in the analysis.
 - **Risk Discovery Summary (with Questions)** presents the answers given to questions in the risk discovery analysis, if any.
 - **Risk Discovery Summary (with Ratings)** presents the risk discovery ratings specified in the risk discovery analysis, if any.
 - **Risk Discovery Details (One per Item)** presents a separate report for each selected item showing the answers given to the risk discovery questions and the risk discovery ratings specified in the risk discovery analysis.
- **PFD Spreadsheet**
 - **PFD Standard** presents planning for design data, if any, in the traditional tabular format. As discussed in Section 23.3 on page 439, the number of separate forms generated will depend on the items selected at the top of the window. Of course, reports will be generated only for selected items that have an associated PFD analysis.
- **PFD Records**: There are no standard report forms for PFD records. This category may contain any custom report templates and/or any custom queries that you have created that relate to PFD records.
- **FMEA Spreadsheet** presents the FMEA data in the traditional tabular format. The number of separate forms generated will depend on the items selected in the **Select Items** area. The following styles are available:
 - **FMEA Standard** creates an FMEA spreadsheet that includes information from the most basic elements of most FMEA analyses. This is a very basic style and should only be used when you are not required to meet published guidelines for the current profile.
 - **AIAG Form A** through **AIAG Form E** create FMEA spreadsheets that are consistent with the examples published in the Automotive Industry Action Group (AIAG) guidelines.
 - **J1739 (2002)** and **J1739 (2009)** create FMEA spreadsheets that are consistent with the examples published in the 2002 and 2009 revisions of the Society of Automotive Engineers (SAE) guidelines.

- **MIL-STD-1629A** creates an FMEA spreadsheet that is consistent with the example published in the military standard.
- **VDA-86** and **VDA-96** create FMEA spreadsheets that are consistent with the examples published in the VDA Volume 4 guidelines used by the German automotive industry.

Note: The application will not prevent you from, for example, performing the analysis with the J1739 interface style and then generating the FMEA Spreadsheet in the MIL-STD-1629A style. Although this may result in some inconsistencies in the reports, it will provide you with maximum flexibility to customize the report to meet your particular needs.

- **FMEA Records**

- **VDA Action Tracking** presents an actions summary report that has been configured to match the “Action Tracking” template in the VDA Volume 4 guidelines used by the German automotive industry.
- **Action Details (One per Action)** presents a separate report for each action that has been defined for the selected items. If this report form is selected for inclusion in the generated report, the Select Actions for Detail Report window will appear when you click Generate Report.

	☐ Recommended Actions	Action ID	Function	Potential Failure Mode	Potential Effect(s) of Failure	Potential Cause(s) of Failure
1	☒ Add pedal feel to overall bicycle design review agenda	7	The bicycle must be easy to use by the defined customer profile, including easy to mounting, dismo...	Difficult to operate the pedals	User may not be able to propel the bicycle forward	Pedal material too slippery
2	☐ Add rigorous tire durability testing to tire test regimen	23	The bicycle must provide safe and reliable transportation, including safe stopping distances a...	Does not stop in required distance	Potential accident or injury to bicycle operator without warning.	Insufficient friction delivered by hand brake subsystem b...
3	☐ Add rigorous tire durability testing to tire test regimen	23	Provide a durable enclosure for tire tube that seats securely on the wheel rim and generates required f...	Tire rupture	Exposes tire tube to potential failure which can destabilize bicycle resulting in accident	Incorrect tire material
4	☐ Add rigorous tire durability testing to tire test regimen	23	Provide a durable enclosure for tire tube that seats securely on the wheel rim and generates required f...	Tire rupture	Exposes tire tube to potential failure which can destabilize bicycle resulting in accident	Tire wall too thin

This window presents a list of all actions associated with the selected items. Select the actions for which you want to see a detailed report. You can select or clear all of the actions by selecting/clearing the check box in the column header. You can sort this list by any column by clicking the column header.

- **Functions, Failures, Effects, Causes, Controls** and **Actions** are report templates that were created by ReliaSoft and saved in the default Standard templates file, XRUT.xrt8, which is located by default in C:\Documents and Settings\username\My Documents\ReliaSoft\Common. These templates will be available only if the default Standard templates file is selected in the Templates Manager.

- **Criticality**

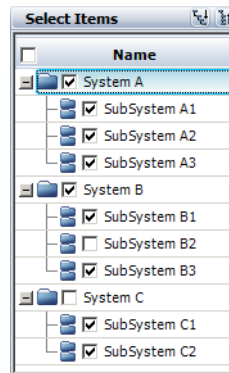
- **Criticality Analysis (Standard)** presents the quantitative criticality analysis in a tabular format that is based on MIL-STD-1629A but includes some modifications to the header information and uses customized column headings.
- **Criticality Analysis (MIL-STD Quantitative)** presents the quantitative criticality analysis in a tabular format that is based more closely on MIL-STD-1629A.

- **Criticality Matrix (MIL-STD Quantitative)** presents the quantitative criticality analysis matrix, as defined in MIL-STD-1629A with Severity Classification on the horizontal axis and Mode Criticality on the vertical axis.
- **Criticality Analysis (MIL-STD Qualitative)** presents the qualitative criticality analysis in a tabular format that is based on MIL-STD-1629A.
- **Criticality Matrix (MIL-STD Qualitative)** presents the qualitative criticality analysis matrix, as defined in MIL-STD-1629A with Severity Classification on the horizontal axis and Failure Probability on the vertical axis.
- **Criticality Ranks** presents the items and failure modes, ranked by item criticality and then by mode criticality.
- **RCM**
 - **Functional Failure Analysis** presents the functions, functional failures, effects and causes (failure modes) that have been identified for all selected items.
 - **Failure Effect Categorization (One per Effect)** presents a separate report for each failure effect showing the FEC logic diagram decisions, along with any notes/remarks.
 - **Maintenance Task Selection (One per Cause)** presents a separate report for each maintenance task that has been defined for the selected items.
 - **Tasks** is a report template that was created by ReliaSoft and saved in the default Standard templates file, XRUT.xrt8, which is located in C:\Documents and Settings\username\My Documents\ReliaSoft\Common. It lists the tasks and related details that have been defined for the selected items. This template will be available only if the default Standard templates file is selected in the Templates Manager.
- **Control Plan Spreadsheet**
 - **Control Plan Standard** presents control plan data, if any, in the traditional tabular format. As discussed below, the number of separate forms generated will depend on the items selected at the top of the window. Of course, reports will be generated only for selected items that have an associated control plan analysis.
- **Control Plan Records:** There are no standard report forms for control plan records. This category may contain any custom report templates and/or any custom queries that you have created that relate to control plan records.
- **DVP&R Spreadsheet**
 - **DVP&R Standard** presents design verification plan data, if any, in the traditional tabular format. As discussed below, the number of separate forms generated will depend on the items selected at the top of the window. Of course, reports will be generated only for selected items that have an associated DVP&R analysis.
- **DVP&R Records:** There are no standard report forms for DVP&R records. This category may contain any custom report templates and/or any custom queries that you have created that relate to DVP&R records.
- **DRBFM Spreadsheet**
 - **DRBFM Standard** presents design review based on failure mode analysis data, if any, in the traditional tabular format. As discussed below, the number of separate forms generated will depend on the items selected at the top of the window. Of course, reports will be generated only for selected items that have an associated DRBFM analysis.
- **DRBFM Records:** There are no standard report forms for DRBFM records. This category may contain any custom report templates and/or any custom queries that you have created that relate to DRBFM records.

23.3 Sub-Item Data Combined or Separated

When you select any FMEA Spreadsheet report form in the Reports window, and when you select the Control Plan Standard, DVP&R Standard or DRBFM Standard report form, the number of separate forms generated will depend on the items selected at the top of the window. Specifically, the utility will generate a separate spreadsheet for each selected item that is the top selected item in a branch of the hierarchy. The analysis for the selected sub-items will be included in the same spreadsheet as the top item in the branch. The header in each form will display the information that has been defined for the top level item for that spreadsheet.

For example, consider the item selections in the following picture:



Based on these selections, the utility will generate four separate report forms:

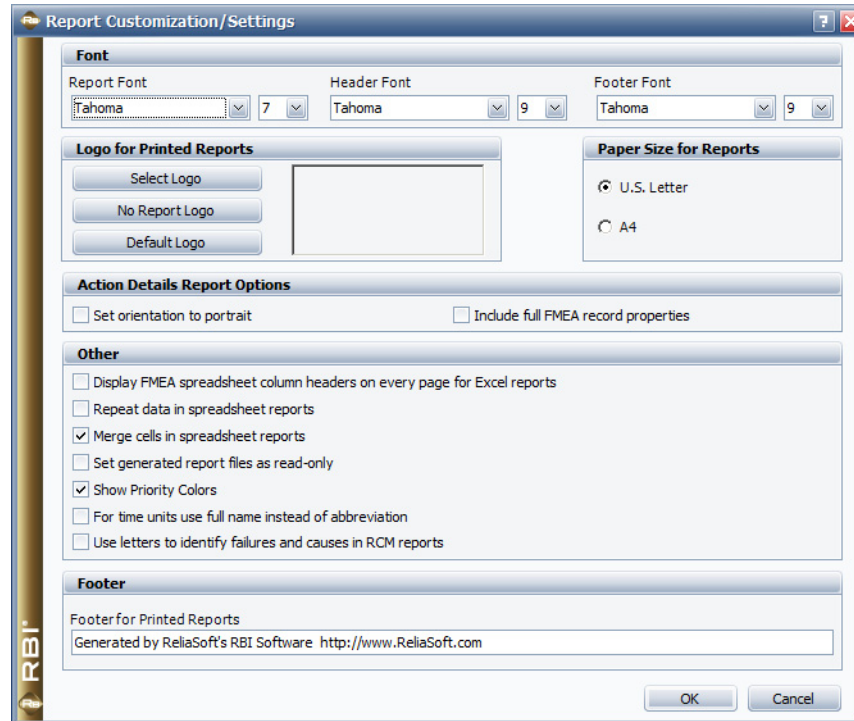
- The first form will have a header based on the properties defined for System A and will contain the analysis data for System A, followed by the analysis data for Subsystem A1, followed by the analysis data for Subsystem A2, followed by the analysis data for Subsystem A3. A grey row with the item's name will separate each item's analysis within the same spreadsheet.
- The second form will have a header based on the properties defined for System B and will contain the analysis data for System B, followed by the analysis data for Subsystem B1, followed by the analysis data for Subsystem B3. The data for Subsystem B2 will not be included in the report because it was not selected in the Report Generation window.
- The third and fourth forms will have headers based on the properties defined for Subsystems C1 and C2, respectively, and will contain analysis data for each single item by itself. A report will not be generated for System C because it was not selected in the Report Generation window.

When the report is generated in Excel, each separate form will be placed in a separate worksheet and named based on the type of form (i.e., FMEA, control plan, DVP&R or DRBFM) and the top level item for that sheet. If the selected items have the same name, then the name of the second worksheet will have a 2 added to it to make it unique, the name of the third worksheet will have a 3 added to it, and so on.

23.4 Report Customization/Settings Window

The Report Customization/Settings window allows you to establish your preferences for configurable reporting options, such as the logo to be displayed in report documents, the font style and size, etc.

To open the utility, click the **Settings** button in the Reports window.



- **Report Font, Header Font and Footer Font** allow you to select the font and size for the text in the body, header and footer of the reports that you generate from your computer. Please note that there are specific limitations for some fonts and sizes, as discussed below.
- **Logo for Printed Reports** allows you to specify the logo, if any, to appear on the printed reports.
 - **Select Logo** allows you to import a graphic for the printed reports. A preview of the selected graphic will be displayed to the right of the command buttons. The available formats are *.bmp, *.dib, *.gif, *.jpg, *.wmf, *.emf, *.ico and *.cur.
 - **No Report Logo** displays no logo on the printed report.
 - **Default Logo** displays the default RBI graphic that was shipped with the application on the printed reports.
- **Paper Size for Reports** allows you to specify whether the Word and Excel documents for printed reports will be configured for U.S. Letter or A4-sized paper.
- **Action Details Report Options**
 - **Set orientation to portrait** will print the report in portrait orientation (top edge along the short side of the page). If this option is not selected, the report will be printed in landscape orientation (top edge along the long side of the page).
 - **Include full FMEA record properties** will include any other enabled properties for the associated Function, Failure, Effect and Cause records in the report. For example, if the analysis uses three levels of effects (according to the interface style), then all three fields will be included in the report. If this option is not selected, then only the required description will be displayed for each of these records.

- **Other**

- **Display FMEA spreadsheet column headers on every page for Excel reports:** Repeats the rows up to and including the column headers on every page of FMEA spreadsheet reports generated in Excel.
- **Repeat data in spreadsheet reports:** Each row in the FMEA Spreadsheet report will contain all FMEA information related to that row, even if some of the information is repeated from the row above and would otherwise have been “merged” within the table. For example, if there are two causes for the same failure, then the report will display the same function, failure and effect data in both rows. This option is useful if, for instance, you need to be able to sort the rows in the generated report or if you need to copy a single line of the report for external use.
- **Merge cells in spreadsheet reports:** The blank cells below a record in a column will be merged with that cell. For example, if there are two failures for the same function, the blank cell below the function, in the row containing the second failure, will be merged with the cell containing the function.
- **Set generated report files as read-only:** The Word and Excel documents for printed reports will be set to “Read-only” on the General page of the document Properties window.
- **Show Priority Colors:** The FMEA records will be highlighted based on the priority categories specified in the interface style defined for the project.
- **Use letters to identify failures and causes in RCM reports:** RCM reports will use letters to identify failures and causes. If selected, the software will use letters only for the first 26 failures or causes and then revert to numbers.

- **Footer**

- **Footer for Printed Reports** allows you to specify the text displayed in the footer of all reports.

Font Size and Style Considerations

Although the grid used in the Report Customization/Settings window has been designed to match as closely as possible with the report output in Microsoft Excel, there are some differences in the way the two applications handle very small font sizes that may result in minor inconsistencies between the column headings as shown in the Customization grid and the report as displayed in Excel. For example, if you choose to generate reports in 7 pt Arial (from the Settings page of the Report Customization/Settings window), column heading text will not be displayed as bold in the report customization grid, while the column heading text will be bold in the Excel report. To ensure adequate width for the column headings in your report, you could temporarily change the font from Arial 7 pt to a font that can be rendered bold in the grid, even at the 7 pt font size. For example, you could temporarily set the font to Tahoma 7 pt, adjust the column widths as needed and then set the font back to Arial 7 pt.

In addition, please note that the software allows you to select the font size as small as 6 pt even though Excel may be unable to properly render certain fonts at sizes that small. This limitation tends to apply to more ornate fonts (e.g., Lucida Calligraphy). If you encounter a situation where the report generated by the software does not display in the font that you have selected, it is recommended to increase the font size to 8 pt or higher and generate the report again.

23.5 Notes About Report Generation

This section provides some general notes about generating reports in either Microsoft Word or Excel.

For Excel and Word, the Microsoft Office 2000 or higher is required.

The number of forms in your report cannot exceed the maximum supported by Microsoft Excel. RBI will include as many forms as possible up to the limit, which will vary depending on the version of Excel that you are using, and will omit the rest.

If you have set your computer to use large fonts, you will need to set your screen display to 1152x864 in order for all forms to display correctly. If you have set your computer to use small fonts, you will need to set your screen display to 600x800 for all forms to display correctly.

If you have enabled the “Check spelling as you type” and “Check grammar as you type” options in Microsoft Word and you have a very large number of spelling/grammar issues in your data set, then Microsoft Word may stop responding during report generation, resulting in a blank document and possibly error messages such as “RPC Server Unavailable.” If this occurs, you can temporarily disable these options in Word and re-generate the report.

The regional settings for Windows and Microsoft Office (Word and/or Excel) must be compatible when generating reports in RBI.

Displaying Column Heads on Every Page of a Generated Report Using Word

If you generate a Word report using RBI, you may have cases where a report table splits across multiple pages. By default, Word does not repeat the header rows at the top of every page. However, you can force Word to do so by using the following instructions.

Note: The following instructions are for Word 2010; if you are using another version of Word, the options may vary.

- Generate the report in Word.
- On the first page of the table, select the column headings and then choose **Layout > Data > Repeat Header Rows**.

If you experience problems with the bottom border not displaying properly for a row that spans across two pages, then you can do the following:

- Generate the report in Word.
- Select the first data row in the FMEA spreadsheet table then choose **Layout > Rows & Columns > Insert Above**. This row is going to be used to assure that there is always a bottom border for the heading rows, even if the data rows span across pages.

Note: If the inserted row appears with a background color, you will want to clear the color before proceeding.

- Select this row and the rows above (i.e., the column headings) and choose **Layout > Data > Repeat Header Rows**.
- Select the row that you inserted and choose **Layout > Table > Properties**.
- On the Row tab, specify **0.001** and **Exactly** for the **Row Height**, then click **OK**.

23.6 Templates Manager in Xfmea, RCM++ and RBI

In Xfmea/RCM++/RBI only, the Templates Manager allows a user to manage the configurable templates that can be used for customized reports, saved queries or importing/exporting data via Excel. If a standard database (*.rsr9) is currently open, you will be managing the templates in the Standard templates file (*.xrt8) that is currently active for your computer. If an enterprise database (SQL Server or Oracle) is currently open, you will be managing the templates stored within the Enterprise database itself.

To open the utility, choose **File > Manage Repository > Templates Manager**.



The utility has three tabs, one for report templates, one for query templates and another for import/export templates.

To work with a template, do the following:

- To add a new template, click the **Add** button.
- To edit one of the templates, double-click the template or select the template and click the **Edit** button.
- To delete a template, select the row and click the **Delete** button or press **DELETE**. *There is no undo for delete.*
- To import a template, click the **Import** button to open the Import Templates window, which is described below.

When a standard database (*.rsr9) is currently open, the **Reset Templates** button will be displayed at the bottom of the window. This button resets the templates file to the default file that is shipped with the software (XRUT.xrt8). This will not replace whatever file currently exists. Rather, it will create a new Standard templates file in the ReliaSoft folder under My Documents on your computer (e.g., My Documents\ReliaSoft\Common). If a file with the name XRUT.xrt8 already exists in this location, then the new filename will have an increment at the end (e.g., XRUT1.xrt8).

Import Templates Window

The Import Templates window is accessed by clicking the **Import** button on the Templates Manager. It allows you to import templates from another templates file (*.xrt8) or enterprise database.

In the **Template Files to Import From** field do one of the following:

- Select the Standard template *.xrt8 file that the templates will be imported from.
- Select the Enterprise database *.rsrp file that the templates will be imported from.

The table in the window displays a list of the templates that have been defined in the selected file or database. Select the templates that you want to import. You can select or clear the check box in the Name column header to select or clear all of the templates. Click **OK** to start the import.

23.7 Report Templates

If you have reporting needs that are not met by the standard report forms included with RBI, you can create custom report templates. These report forms will be shown in the list of available report forms in the Reports window and can be included in your generated reports.

The Report Template window allows you to create your own report templates from scratch or to edit existing user-defined templates. It is accessed by clicking the **Add** button or the **Edit** button on the Report Templates tab of the Templates Manager. *See Section 23.6 on page 442.* On the left side of the window, specify a name for the template and, if desired, enter a description of the template. The rest of the window is made up of three tabs.

- The Fields tab allows you to choose and configure the fields to be shown in the body of the report.
- The Column Header Customization tab allows you to configure the column headers shown in the report.
- The Preview tab displays an approximate preview of the template incorporating the settings you have specified on the other two tabs.

Once you have configured all options to suit your needs, click **OK**. If a standard database (*.rsr9) is open when you save a report, it will be stored in the Standard templates file (*.xrt8) that is active for your computer, and it will be

available for use in other databases. If an enterprise database (SQL Server or Oracle) is open, the report will be stored within the enterprise database itself.

Note: Report templates can be used to generate reports for projects that use any interface style. For this reason, all fields are available for use in the Report Template window, regardless of whether they are enabled in the current project's interface style. When the report is generated, only those fields that are enabled in the current project's interface style will appear in the report.

Specifying What is Included in the Report Template

On the Fields tab of the Report Templates window, the **Available Fields** area displays all of the items (i.e., properties) available for inclusion in the report in a hierarchical tree structure. The items that appear in this list will vary depending on the report template type. Click the plus (+) button to open a group and display the items within that group. Click the minus (-) button to close a group and hide the items within that group. To select an item for inclusion in the report, do one of the following:

- Double-click the item in the **Available Fields** area.
- Select the item in the **Available Fields** area and then click the **Include** icon (>) between the **Available Fields** area and the **Selected Fields** area.
- Drag the item from the **Available Fields** area to the desired location in the **Selected Fields** area.

For the first two methods, the item will be added to the end of the list in the **Selected Fields** area. When you drag the item, it will be placed in the position where it is dropped.

To select multiple items for inclusion in the report, you can:

- Select multiple items in this area 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 and then click the **Include** icon (>) or drag the items to the desired location in the **Selected Fields** area.
- Click the **Include All** icon (>>) to move all items in the group to the **Selected Fields** area.

Note: Each query to the database can include a maximum of 225 fields. If your query exceeds this number, you will see a message that notifies you of the issue and asks you to reduce the number of fields and try again.

The **Selected Fields** area displays the items that have been selected for inclusion in the report, in the order in which they will appear. To change the order of the items, you can:

- Click and drag the selected item to the desired location.
- Select the item in the **Selected Fields** area and then use the arrows at the right of the **Selected Fields** area to move the item up one position or down one position.

For the FMEA Hierarchy and the FMEA Spreadsheet with Items report template types, the **Show Two Control Columns** option will appear above the **Selected Fields** area. Select the check box if you want prevention and detection controls displayed in separate columns.

Customizing Column Headers in the Report Template

Each field that you have selected for inclusion in the report template on the Fields tab will appear in the table on the Column Header Customization tab. For each property (i.e., field) shown in the table, you can specify in the Column Width Type column how the column width for the property will be calculated. You can set the column to fit the header, to fit the data in the field, to fit the widest item (both header and data) in the column or to a constant, user-defined width. If you choose to use a user-defined width, specify the width of the column, in characters, in the User

Defined Column Width column. If you want the column header to use text other than that shown in the Property Name column, enter that text in the Overwrite Default Header Text column.

Once you have configured all options to suit your needs, you can go to the Preview tab to see what the report template looks like. You can also click **OK** to save the report template.

23.8 Other Options to Output Data

RBI provides a variety of ways to output data from your analysis. In addition to the predefined reports that are available in the Report Generation window, this includes:

- **Send to Excel:** You can choose **Home > Excel > Excel > Send Current View to Excel**. This allows you to send the information currently displayed in the System panel or the Analysis panel to an Excel spreadsheet. This includes any formatting changes that you have made to the display, such as changing the position of the columns, setting the column width, etc.
- **Export to Excel:** You can choose **Home > Excel > Excel > Export to Excel** to open the Export to Excel window, which allows you to export data from the system hierarchy and/or analyses to an Excel spreadsheet. You can choose an existing template or create a new template that determines how the data will be “mapped” from RBI to the Excel file. *See page 429 in Chapter 22.*
- **Queries:** You can choose **Home > Reporting > Queries** to open the Query utility, which allows you to query the current project or the current database for the records that meet your specific query criteria. You can select which fields (columns) will be included in the results and send those results to an Excel spreadsheet. You also can save and re-use queries, either within the Query utility or in the Reports window. This allows you to create ad-hoc reports for specific information of interest, such as “all actions that are due and have an RPN greater than X,” and so on. *See Chapter 24.*

Query Utility

24

The Query utility can be a powerful analysis tool that makes it easy to find and open specific sections of the analysis. It is also a flexible custom reporting tool that allows you to create and manage saved queries that meet your particular presentation requirements.

To access the Query utility, choose **Home > Reporting > Queries**.



Use the left panel to specify the data source (either selected items from the active project or selected projects from the entire database). Use the right panel to choose the type of query (items, FMEA causes, etc.) and specify the criteria/output preferences. Then click **Run Query** to view and use the results.

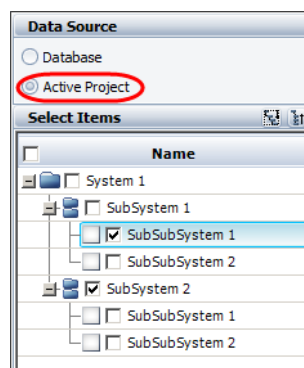
The following sections provide more information about how to:

- Specify the data source.
- Select the query and specify the criteria.
- Customize the column headings for query output.
- View and use the query results.
- Create and use saved query templates.

24.1 Specify the Data Source

Use the panel on the left side of the Query window to specify the data source for the query. This can be either selected item(s) from the active project, or selected project(s) from the entire database.

- **Active Project:** With this option, you can query any or all of the items in the project that is currently active.



- **Database:** With this option, you must specify a **Profile** and **FMEA Structure**. You can then select to query any or all of the projects in the current database that use the specified FMEA structure (i.e., grouped effects and causes, causes before effects, etc.). The criteria and results will use the property names from the selected profile.

Data Source	
☒ Database	☐ Active Project
Limit by FMEA Structure	
Effects Before Causes	
Profile	
DFMEA: AIAG-4	
Select Projects	
Name	Profile
☒ Gadget DFMEA	DFMEA: AIAG-4
☒ Gizmo DFMEA	DFMEA: AIAG-4
☐ Widget DFMEA	DFMEA: AIAG-4

24.2 Specify the Query Criteria

After you have selected the data source in the left panel of the Query window, you can use the right panel to specify the query criteria and output preferences.

First use the drop-down list at the top of the panel to choose which type of record you wish to query (items, FMEA causes, etc.). This will automatically update the Criteria tab to display all of the relevant properties for the selected record type. (If you're searching multiple projects that may have different configurable settings, this will be determined by the profile specified in the left panel.)

Then specify whether the query results will match the conditions from **All rows** in which criteria are specified (i.e., AND) or from **Any row** in which a criterion is specified (i.e., OR).

Then use the table to enter the criteria and choose which columns will be displayed in the results.

As an example, the following picture shows a query for system hierarchy items where the item name contains “bulb” AND the supplier name contains either “Acme” OR “Sterling.” The Name, Part Number and Supplier columns will be included in the results.

Select the type of record you wish to query

Query

Items

Criteria Headers Customization Results

Match the criteria from: ☒ All rows ☐ Any row

Property Name	Include in Results	Criterion 1	And/Or	Criterion 2
Level	☐	is greater than or equal to	AND	is less than or equal to
Item ID	☐	is greater than or equal to	AND	is less than or equal to
Item #	☐	is greater than or equal to	AND	is less than or equal to
Name	☒	Contains bulb	OR	Contains
Reference Number	☐	Contains	OR	Contains
Part Number	☒	Contains	OR	Contains
Supplier	☒	Contains Acme	OR	Contains Sterling
URD	☐			

Select which columns to display in the results

Specify criteria to limit the query results

24.3 Customize Column Headings

After you have specified the query criteria in the Query window, you can use the Headers Customization tab to determine how the selected properties will be displayed in the query results.

Use the up and down arrows to set the desired column order.



There are four options for the column width:

- fit the label in the column heading
- fit the widest label in the column data
- fit the widest label in either the heading or data
- use a fixed width (as specified in the **User-Defined Column Width (Characters)** column)

By default, the column headings will use the names shown in the **Property Name** column. You can overwrite that by entering text in the **Overwrite Default Header Text** column.

For example, the following picture shows a query where the Part Number column will be exactly 15 characters wide while the Item and Supplier columns will be as wide as the heading text. In addition, the heading of the supplier column will display as “Manufacturer.”

Query				
Items ☐ ☐ ☐ ☐ Show Project				
Criteria Headers Customization Results				
	Property Name	Column Width Type	User-Defined Column Width (Characters)	Overwrite Default Header Text
1	Item	Fit Heading		
2	Part Number	User-Defined	15	
3	Supplier	Fit Heading		Manufacturer

24.4 View and Use the Query Results

Once you have configured the query criteria and the column headings to suit your needs, click **Run Query** to display the results on the Results tab.

To go to a specific record, either double-click the record in the table or select the record and click the **Go To** icon.



The Query utility will remain open, but the focus will change to the Project window and the record will be selected in the System panel (for queries on system hierarchy items) or in the Analysis panel (for queries on all other records).

To save the results table to an Excel spreadsheet, click the **Send to Excel** icon.



Special Consideration for Action and Control Query Results

Actions and controls are resources that can be used multiple times within the same FMEA or across FMEAs. When you search for actions or controls, note that matching records may be repeated in the query results if applicable. Specifically:

- If you have considered only the action/control record properties, each matching record will be displayed only once in the results (even if it is used in multiple different locations).
- However, if you have considered properties from any of the parent records (e.g., causes, items, etc.), the results will include a separate row for each relevant instance.

For example, the following picture shows query results from a situation in which the exact same action is recommended in two locations within the same FMEA. The record is shown twice in the results because the query has been configured to include details about where the action is used (in this case, Failure Cause and Item Name).

Criteria	Headers Customization	Results			
	Action ID	Action	Due Date	Failure Cause	Item Name
1	2	This action is used in multiple locations.	11/28/2014	One possible failure cause.	Bulb
2	2	This action is used in multiple locations.	11/28/2014	Another possible failure cause.	Bulb

24.5 Query Templates

Query templates allow you to save a great deal of time if you have particular queries that you run repeatedly. Saved query templates are also listed in the **Available Reports** area of the Reports window and can be included in generated reports.

If a standard database (*.rsr9) is open when you save a query, it will be stored in the standard templates file (*.xrt8) that is active for your computer, and it will be available for use in other standard databases that you open from this computer. If an enterprise database (SQL Server or Oracle) is open, then the query will be stored within the enterprise database itself.

This section explains how to manage query templates, including:

- Using a saved template in the Query utility.
- Saving new templates from the Query utility.
- Adding and editing templates via the Query Template window.

Using a Saved Template in the Query Utility

To use a saved template in the Query window, click the **Open Saved Query** icon.



The Select Existing Query window will display all saved templates for the type of query that was selected in the Query window (items, FMEA causes, etc.). If you want to search for a different record type, use the drop-down list to update the table.

To select a template, double-click the row or select it and click **OK**.

The settings on the Criteria and Headers Customization tabs of the Query utility will change to reflect the settings used in the saved query. It is important to understand the following:

- If you change the criteria in the Query utility after applying a template, your changes will not affect the saved template. (If you want to update an existing query, use the **Edit** command in the Templates Manager, or simply delete the old template and replace it with a new one.)
- If the saved template contains criteria for a property that is not enabled for the current data source, that part of the query will be ignored. For example, if the saved template searches for items where the **Name** contains “bulb” AND the **Supplier** contains “ACME,” but the current data source has the Supplier field disabled, then the query will return items where the name contains “bulb.”

Saving New Templates from the Query Utility

To create a template from within the Query utility, configure all of the desired options on the Criteria and Headers Customization tabs and then click the **Save Query** icon.



In the Save Query window, provide a name for the query and, if desired, a description and then click **OK**.

The saved template includes all of the settings specified on the Criteria and Headers Customization tabs. It can then be applied to any data source.

Adding and Editing Templates via the Query Template Window

You can also create or edit query templates from the Templates Manager. (*See page 442 in Chapter 23.*) To open the manager, choose **File > Manage Repository > Templates Manager**.



Then click either the **Add** button or the *Edit* button on the Query Templates tab. The Query Template window works in the same way as the Query utility, with the following exceptions:

- You cannot specify the data source, as the query template can be used with any data source and any interface style. For this reason, all properties are available for use in the Query Template window.
- On the panel on the left side of the window, you must specify a name and, if desired, a description for the query template.
- Instead of a Results tab, the Query Template window has a Preview tab that displays an approximate preview of the query results table that incorporates the settings you have specified on the other two tabs.

Plot Viewer

25

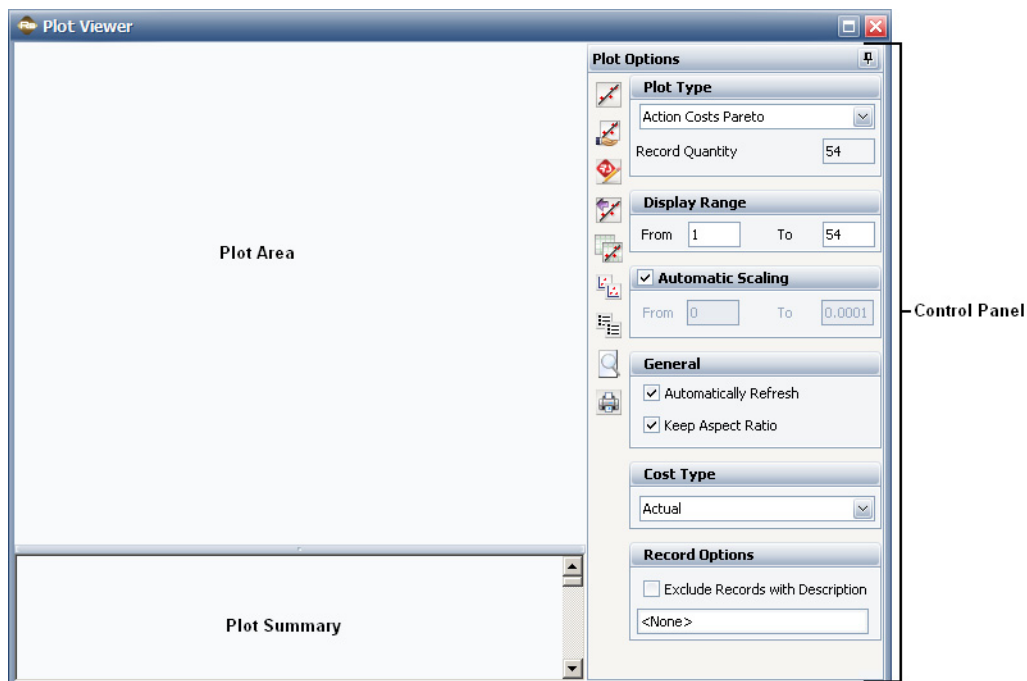
The Plot Viewer window provides a complete array of plots and charts for graphical presentation of your FMEA and RCM analysis results. You can view a variety of plots and charts “on the fly” while you are working with a particular analysis. You can then save your plots in a variety of graphic file formats (*.jpg, *.gif, *.png or *.wmf) for use in other documents, if desired.

Note: Plots are available only for FMEA and RCM analyses. If the items you select in the Select Items window do not include any FMEA or functional failure analysis information in the FMEA tab of the Analysis panel, then the plots will not display any data.

To open the Plot Viewer utility, choose **Home > Reporting > Plots**.



In the Select Items window that appears, select one or more items from the current project that you want to include in the plots/charts and click **OK**. The Plot Viewer utility will appear.



To select a plot type, choose one from the **Plot Type** drop-down list on the control panel. See Section 25.1 on page 454 for more information.

While all plot types are available for all FMEA analyses, some plots may not display any results if your analysis does not include those items (e.g., if your analysis does not include any actions, then those plots will not show any details). Note that the included elements are based on the default settings shipped with the application.

25.1 Types of Plots

This section deals with the plot types that are available in the Plot Viewer.

- **RPN (Pareto)** shows the Risk Priority Numbers (RPNs) of the causes ranked from highest to lowest. You can view the initial RPNs only, the revised RPNs only, or both values in combination. If you view both values, you can select to sort by either initial or revised values.
- **RPN % Reduction Pareto** shows the reduction in the RPNs of the causes, from the initial values to the revised values, ranked from the greatest percentage reduction to the lowest percentage reduction.
- **Occurrence/Severity Matrix** displays the severity ratings on the horizontal axis and occurrence ratings on the vertical axis and then plots each cause at the intersection of its severity and occurrence ratings. You can specify whether you want to view the initial or the revised ratings, and you can use the **Priority Area Coordinates** area of the control panel to specify the end points for the high and low priority lines.

Note: Pointing to a point on the generated occurrence/severity matrix will display information about the cause, including its severity and occurrence ratings. Note that if your analysis contains a very large number of cause descriptions, pointing to a symbol in the matrix may not display all of the causes represented by that point. However, all causes are still displayed in the Plot Summary.

- **SxO Pareto, Effect Severity Pareto, Cause Occurrence Pareto and Cause Detection Pareto** show the applicable values ranked from highest to lowest. You can view the initial values only, the revised values only, or both values in combination. If you view both values, you can select to sort by either initial or revised values.
- **Effect Severity Pie, Cause Occurrence Pie and Cause Detection Pie** show the percentage of the effects or causes in the selected analysis that are represented by the rating value displayed in the plot legend. You can view the initial values or the revised values.
- **Classification Pie** shows the percentage of the causes in the selected analysis that are represented by each special design manufacturing characteristic displayed in the plot legend.
- **Action Costs Pareto** shows the cost values of the actions ranked from highest to lowest. You can view the actual values only, the estimated values only, or both values in combination. If you view both values, you can select to sort by either initial or revised values.
- **Action Status Pie, Action Category Pie and Action Priority Pie** show the percentage of the actions in the selected analysis that are represented by each type displayed in the plot legend.

Note: For the “Action” plots, to exclude actions with a specific description, such as “None,” you can select the **Exclude Records with Description** check box, then enter the specific values in the field.

- **Control Type Pie** shows the percentage of the controls in the selected analysis that are represented by each control type displayed in the plot legend.
- **RD Questions Pie** shows the percentage of the selected items that have a “Yes” answer to each risk discovery question displayed in the plot legend.
- **RD Ratings Pareto** shows the risk discovery rating values of the items ranked from highest to lowest.
- **Effect FEC Pie** shows the percentage of the effects in the selected analysis that are represented by each failure effect categorization type displayed in the plot legend.

25.2 Plot Viewer Control Panel

The Plot Viewer control panel allows you to control the options that go along with the plot.

- The **Plot Type** drop-down list provides a choice of applicable plots. For pareto and pie charts, this field also displays a **Record Quantity** indicator that shows how many records of the specified type are available.
- **Display Range** (available only for pareto charts) allows you to specify the number of records you want to be displayed in the plot. For example, in the Effect Severity Pareto plot, if there are 20 effect records in your analysis, you can specify to view effect records 1 through 10, 5 through 15, etc.
 - **From** allows you to specify the number of the first record that you want displayed on the plot.
 - **To** allows you to specify the number of the last record that you want displayed on the plot.
- **Automatic Scaling** (available only for pareto charts): The Plot Viewer uses the minimum and maximum data values of the displayed FMEA records to set the scaling of the dependent axis. The values are calculated based on the **Display Range** and other settings on the control panel. If not selected, you can change these values in the **From** and **To** scaling boxes.
- **Priority Area Coordinates** (available only for the Occurrence/Severity Matrix) allows you to specify the end points for the high and low priority lines. All of the coordinates are required.
- **Type** (available only for certain plots) allows you to specify the type of ratings to be displayed on the plot (i.e., initial, revised or a combination of initial and revised).
- **Auto Refresh** automatically refreshes the plot if any changes are made in the control panel.
- **Keep Aspect Ratio**: The proportion of horizontal size to vertical size will remain constant when you resize the plot. Note that changing this option will also change it in the Page Setup window for the plot.
- **Record Options** (available only for Action plots)
 - **Exclude Records with Description**: Select this option to exclude records with a specific description from the plot. After selecting the check box, enter the description in the text box below the check box

The folio tools are arranged on the left side of the control panel:



Redraw Plot updates the plot to reflect any changes that have been made.



Plot Setup opens the Plot Setup, which allows you to customize most aspects of the plot. *See Chapter 26.*



RS Draw launches ReliaSoft Draw, which allows you to annotate your plot and view your plot in greater detail. *See Chapter 27.*



Export Plot Graphic allows you to export the current plot graphic in one of the following formats: *.jpg, *.gif, *.png or *.wmf.



Copy Plot Data copies the plot data to the Clipboard. You can then paste the data into another application.



Copy Plot Graphic copies the plot graphic to the Clipboard. You can then paste the graphic into another application. The way the plot is copied will depend on your selection in the **Plot Copy Type** field in the Synthesis Setup window. *See page 503 in Chapter 30.*



Copy Plot Summary copies the data in the plot summary area to the Clipboard. You can then paste the summary into another application.



Print Preview opens the Print Preview window, which allows you to preview the printed page before it is sent to the printer. *See page 502 in Chapter 29.*

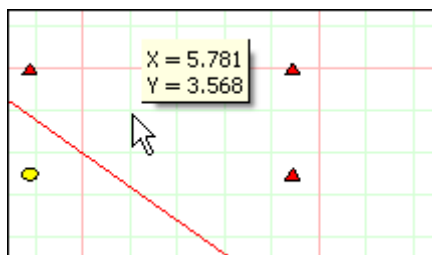


Print sends the plot and associated plot summary information to the printer.

25.3 Tips on Working with Plots

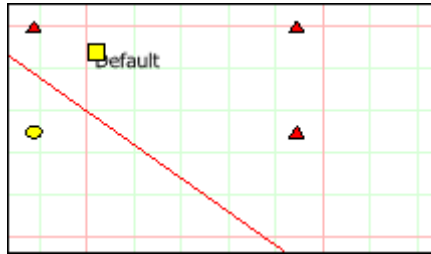
There are several additional commands that you can use when you are working with plots.

- To show the coordinates of any location on a matrix, press **SHIFT** and click in the plot. A box displaying the coordinates of the selected location will appear, as shown next.



You can release the **SHIFT** key once the coordinates are displayed. The coordinates will continue to be displayed as long as you hold down the mouse button. You can move the pointer around in the plot and the coordinates will change to reflect its current location.

- To add a custom label to the plot, press **CTRL** and click in the plot. A new label will appear in the plot, as shown next.



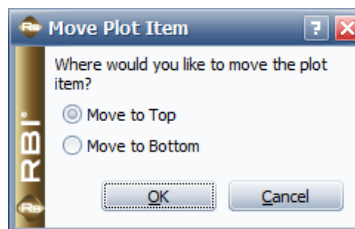
The yellow box at the upper left corner of the label indicates that the label is selected. When the label is selected, you can edit the label text directly in the plot, and you can also click the box and drag it to a new location, if desired. Clicking elsewhere in the plot will de-select the label.

- To add a label that displays coordinates on the matrix, position the pointer at the location you want labeled then press **CTRL+ALT** and click the location. A coordinate label will be added to the matrix, as shown next.



Note that a coordinates label includes a < sign pointing to the location that the coordinates refer to.

- On a matrix plot, pressing **ALT** and clicking a plotted line or point will open the window shown next.



You can choose to bring a line or group of points to the front or send them to the back, which is useful in cases where lines or points are obscuring one another.

- You can click any plot element (i.e., point, line, etc.) to open the Plot Setup window. *See Chapter 26.* The pointer will change from an arrow to a pointing hand when you move it over an element for which this is possible. Note that the element you clicked is automatically selected on the last page of the Plot Setup.

25.4 Using Plots in Other Documents

You can save the plots that you create in RBI's Plot Viewer utility in JPEG graphic (*.jpg) format, CompuServe Graphics Interface (*.gif) format, Portable Network Graphics (*.png) format or Windows Meta File (*.wmf) format which you can view and edit in other applications. You can also copy/paste both the plot graphic and the legend information directly into another document, such as a report document that you have generated in Microsoft Word or Excel via the Report Generation window. Both processes are presented next.

25.4.1 Saving the Plot Graphic

RBI allows you to save a plot graphic generated by the Plot Viewer in one of four formats: JPEG graphic (*.jpg), CompuServe Graphics Interface (*.gif), Portable Network Graphics (*.png) or Windows Meta File (*.wmf) graphic.

To do this, click the **Export Plot Graphic** icon on the Plot Viewer control panel. The Save As window will appear, which allows you to specify the file name, file type and location for the graphic.



You can also use ReliaSoft Draw, a metafile graphics editor, to annotate your plot and then save it as a Windows metafile (*.wmf). *See Chapter 27.*

25.4.2 Copying/Pasting the Plot Graphic and Plot Summary

RBI allows you to add the plot graphic and plot summary to other documents, such as the print-ready reports created by the Reports window. *See Chapter 23.*

- To copy the plot graphic, click the **Copy Plot Graphic** icon on the Plot Viewer control panel. Next, open the document that you want to paste the plot graphic to and paste it.



- To copy the plot data, click the **Copy Plot Data** icon on the Plot Viewer control panel. Next, open the document that you want to paste the plot data to and paste it.



- To copy the plot summary, click the **Copy Plot Summary** icon on the Plot Viewer control panel. Next, open the document that you want to paste the plot summary to and paste it.



Plot Setup

26

The software allows you to customize plots to meet your needs. Depending on the size and resolution of your monitor, you may find that different setups work better for you or you may simply prefer settings other than those shipped with the application. The Plot Setup window gives you full control over the settings used both for individual plots and the default settings for all new plots.

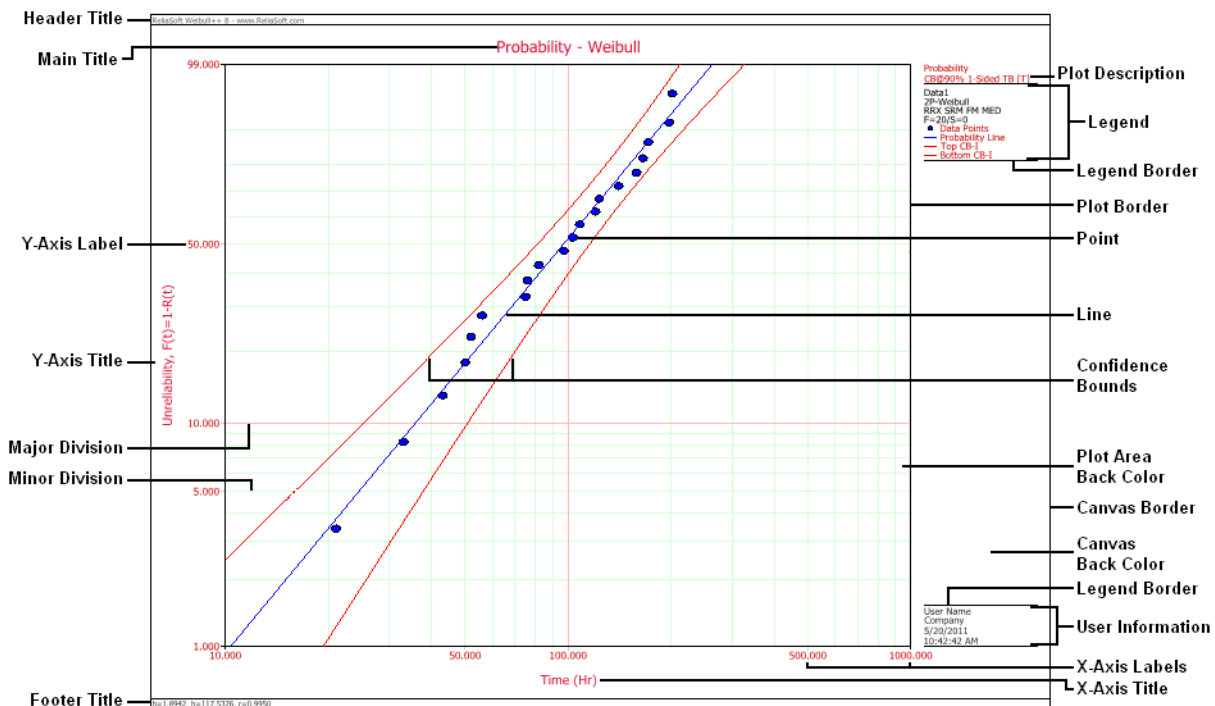
Open the Plot Setup window by clicking the **Plot Setup** icon on the Plot control panel.



In addition, clicking an element (e.g., point, line, etc.) in the plot will open the Plot Setup window.

Each time you open the Plot Setup window, the changes that you make will apply only to the current plot unless you specify otherwise. To specify settings to be used as defaults for all subsequent plots or to re-apply default settings to the current plot, click the **Defaults** button to open the Plot Defaults window. *See Section 26.11 on page 470.*

The Synthesis applications that include plots use the applicable plot elements (e.g., there are no confidence bounds in Lambda Predict plots, so those lines will not be shown on plots.) For your reference, the following picture shows a line plot with its components labeled. (Note that the plot is generated from Weibull++, but the components settings are the same for all Synthesis applications.)



You can change these settings on the pages of the Plot Setup window.

26.1 Plot Titles Page

The Plot Titles page allows you to define the main, header and footer titles used in the plot and to change the text font and color.

Select or clear the **Show** check box to determine whether the title will be shown on the plot. Click the **Set Font** button next to the corresponding input box to open the Font window, which allows you to set the font type, style, size, color and text orientation.

Each asterisk (*) represents the default title text. For the main title, this is defined on the Titles Text page of the Plot Defaults window. (See Section 26.11.1 on page 471.) If you want to append additional text to the default title, keep the asterisk and add the additional text before or after it. For example, “* (Product A)” will result in a plot title like “Default Main Title (Product A).” If you want to completely replace the default title, delete the asterisk before typing the new text.

You can use the **ENTER** key to add additional lines to the header title and the footer title.

To add an image file to the header title or footer title, click **Select Image** then browse for the file you want to include. Click **Open**. (You can select an image that uses one of the following formats: *.bmp, *.gif, *.jpg, *.jpeg, or *.ico.) The selected image appears next to the **Select Image** button. The image will also appear at the left side of the header or footer text. To remove the image, click **Clear Image**.

26.2 Axis Titles/Labels Page

The Axis Titles/Labels page allows you to define the information used with the x-axis and y-axis, including the titles, axis labels and the numbers displayed in the axis labels. This page is not available when you are working with a pie chart.

The options on this page will vary depending on the plot style you are working with. The image above shows the options for a line chart.

- **Axis Titles**

- Select or clear the **Show** check box to determine whether the title will be shown on the plot. Click the **Set Font** button next to the corresponding input box to open the Font window, which allows you to set the font type, style, size, color and orientation of the text.

Each asterisk (*) represents the default title text. If you want to append additional text to the default title, keep the asterisk and add the additional text before or after it. For example, “* (Product A)” will result in an axis title like “Axis Title (Product A).” If you want to completely replace the default title, delete the asterisk before typing the new text.

- **Axis Labels**

- **Axis Labels** options, when selected, displays the numerical labels for the x-axis and/or the y-axis in the plot.
- If available for the plot type, click the **Custom Labels** button next to the corresponding option to open the Custom Axis Labels window, which allows you to add user-defined numerical labels to the x-axis or y-axis of the plot. Note that values outside the plot’s display range are accepted but will not be shown. This option is available starting in 9.0.10.

Click the **Set Font** button next to the corresponding option to open the Font window, which allows you to set the font type, style, size, color and orientation of the text.

- **Numbers in Axis Labels**

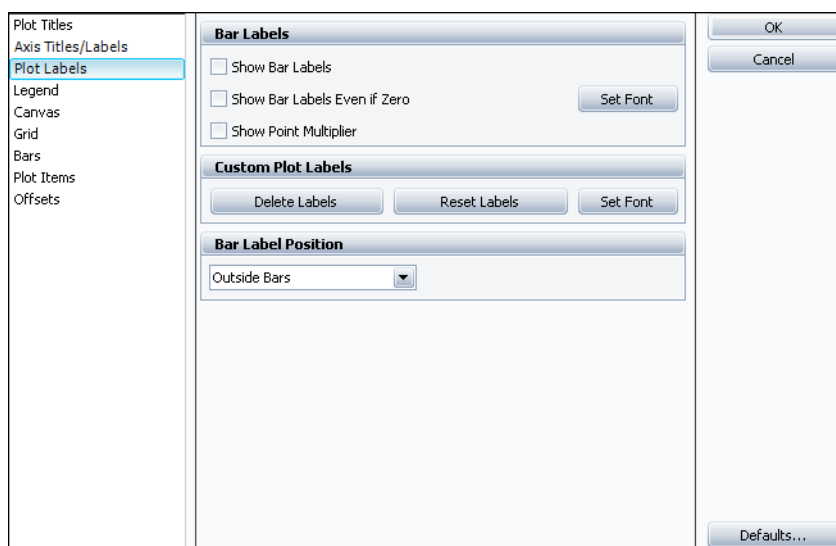
Use the options in this area to configure the mathematical precision (number of decimal places) and scientific tolerance of the values shown on the axes.

The scientific tolerance sets the point at which the numbers will be converted to normalized scientific notation. For example, setting the scientific tolerance to 3 means that all numbers with a value of 1,000 or more will be converted to normalized scientific notation (e.g., 1.0E +3).

Note: When you are working with a bar chart, the **Numbers in Axis Labels** area will contain settings for only the axis representing the dependent variable. This is affected by the orientation of your bar chart; if you are using vertical bars, this area will contain settings for the y-axis, and if you are using horizontal bars, it will contain settings for the x-axis. It is important to be aware that the settings for one axis will not transfer to the other axis when you change the bar orientation. You will need to return to this page and re-enter the settings.

26.3 Plot Labels Page

The Plot Labels page allows you to customize the labels for items (e.g., bars, slices, points) shown in the plot as well as for custom labels used in the plot.



The options on this page will vary depending on the plot style you are working with. The image above shows the options for a bar chart. All available options are presented below.

- **Bar Labels** (available only for bar charts)
 - To display the y-axis value of each bar with the bar, select the **Show Bar Labels** check box. (You can set the bar style using the **Bar Orientation** field on the Bars page of the Plot Setup. *See Section 26.7 on page 466.*)
 - **Show Bar Labels Even if Zero** if selected, bars with a y-axis value of 0 will be shown with a label of “0.” The number of decimal places in the label will conform to the y-axis math precision value specified on the Axis Titles/Labels page.
- **Point Labels** (available only for line plots)
 - To display the coordinates for each point at the lower right of the point, select the **Show Point Coordinates** check box. If this option is not selected, you can still display the coordinates for each point in a pop-up box by pointing to the point.
 - To display the point label in the same color as the border of the point itself, select the **Use Point Border Color** check box.
 - If there are overlapping points, select the **Show Point Multiplier** check box to display the number of points to the right of the point.

- **Slice Labels** (available only for pie charts)
 - To label the slices of the pie chart according to the components they represent, select the **Show Slice Labels** check box.
 - To label the slices of the pie chart with the percentage of the whole that they represent, select the **Show Slice Size** check box.
- **Custom Plot Labels** allows you to control the appearance of custom plot labels. You can add custom labels to your plot by pressing **CTRL** and clicking the plot. *See page 457 in Chapter 25.*
 - **Delete Labels** deletes all custom labels on the plot.
 - **Reset Labels** immediately resets all custom labels on the plot to use the settings specified via the **Set Font** button. This allows you to apply the settings to existing custom labels rather than just new labels created after changing the settings.
- **Bar Label Position** (available only for bar charts) allows you to specify whether you want the bar labels located within the bars or outside of the bars.

For all labels, you can click the **Set Font** button in the section to open the Font window, which allows you to set the font type, style, size and color for labels of that type.

26.4 Legend Page

The Legend page allows you to customize the display of the legend on the current plot.

The options on this page will vary depending on the plot style you are working with. All available options are presented below.

- To display the legend on the plot, select the **Show Legend** check box.
 - To include on the legend a color definition for each point/line/bar/slice shown in the plot, select the **Show Plot Items** check box.
 - To include lines above and below the legend and the user information, select the **Show Legend Border** check box. Use the options to the right to modify the appearance of the border. To change the color of the border, click the **Color** box to the left of the **Thickness** box. Adjust the thickness of the border by entering a positive integer in the input box. Change the style of the line (e.g., solid, dashed, etc.) by clicking the **Line Style** box to the right of the **Color** box.

- To display the text of the legend in the same color as the lines, points, bars and/or slices on the plot, select the **Use Item Color** check box. If not selected, the text will be red.
- **Show Analysis Information** if selected, the legend will display information about the analysis shown on the plot, including the data source and/or the settings used in the calculation, if applicable.
- To display the plot description (including the plot type) on the plot, select the **Show Plot Description** check box.
- To show the user display name, company and the date and time the plot was generated on the plot, select the **Show User Information** check box. (You set the display name and company using the User Login and Contact Information Window. *See page 51 in Chapter 2.*)
- The legend area allows you to specify the amount of space used for the legend.
 - **Fixed Legend Width** if selected, the legend will remain the same size regardless of the information it contains. You can set the percentage of the canvas width that the legend will occupy.
 - **Maximum Legend Width** if selected, the legend will automatically recalculate its width based on the information it contains. You can set the maximum percentage of the canvas area that the legend will occupy.

Click the **Set Font** button next to the corresponding option to open the Font window, which allows you to set the font type, style, size and color of the text.

26.5 Canvas Page

The Canvas page allows you to customize the color, style and thickness of the plot borders and title lines, along with the appearance of the rest of the plot sheet.

- **Plot Canvas and Area**
 - **Canvas Back Color** allows you to choose the color for the area outside the plot (i.e., the area containing the titles, labels, legend, etc.).
 - **Canvas Border** allows you to determine if the border around the plot field will be displayed and, if so, to set the color.
 - **Plot Area Back Color** allows you to choose the color for the plot background.

- **Plot Area Border Lines** allows you to hide or show each of the specified lines, as well as to choose a color, a thickness and a style for each. The borders referred to in this area are the borders of the plot area itself (i.e., the bottom border is the x-axis, etc.).
 - To show or hide a line, select or clear the associated check box.
 - To change the color of any of the lines, click the **Color** field. The drop-down list that appears allows you to choose from custom colors, web-safe colors or the colors used in the current Windows system settings. You can add colors to the Custom page by right-clicking one of the color boxes in the bottom two rows.
 - You can adjust the thickness of a line by entering a positive integer in the input box. A value of 1 will draw the thinnest possible line and other values such as 2, 3, etc. will draw thicker lines. Note that the size of the thinnest possible line is dependent upon your screen resolution.
 - In addition, you can change the style of each line by clicking the **Line Style** box to the right of the **Thickness** box. A list providing line style options (e.g., solid, dashed, etc.) will appear. Choose the line style you want and it will appear in the **Line Style** box.
- To highlight each object (i.e., point, line, bar or slice) on the plot as you point to it, select the **Highlight Selected Plot Item** check box. When an object is active, you can click it to open the Plot Setup window and edit the properties specific to that object. The remaining options in this area are available only if this option is selected.
 - **Fill Color** allows you to specify a foreground color to be used on the highlighted active object.
 - **Back Color** allows you to specify a background color to be used on the highlighted active object. This color is not used if the selected fill style does not use a background color (i.e., solid or transparent fill style).
 - **Fill Style** allows you to select a style of hatching to be used on the highlighted active object.

26.6 Grid Page

The Grid page allows you to customize the color, style and thickness of the grid lines and to set the number of axis divisions used. This page is not available when you are working with a pie chart.

The screenshot shows the 'Grid' page of the Plot Setup window. On the left, a sidebar lists various plot elements, with 'Grid' highlighted. The main panel is titled 'Axis Division Lines' and contains four rows of settings for X and Y major and minor divisions. Each row has a checked checkbox, a color selection box (red for major, green for minor), a thickness input box (all set to 1), and a line style dropdown. Below this is a section titled 'Number of Axis Divisions' with two input boxes: 'Number of Y-Major Divisions' set to 5 and 'Number of Y-Minor Divisions' set to 5. On the right side of the window are 'OK', 'Cancel', and 'Defaults...' buttons.

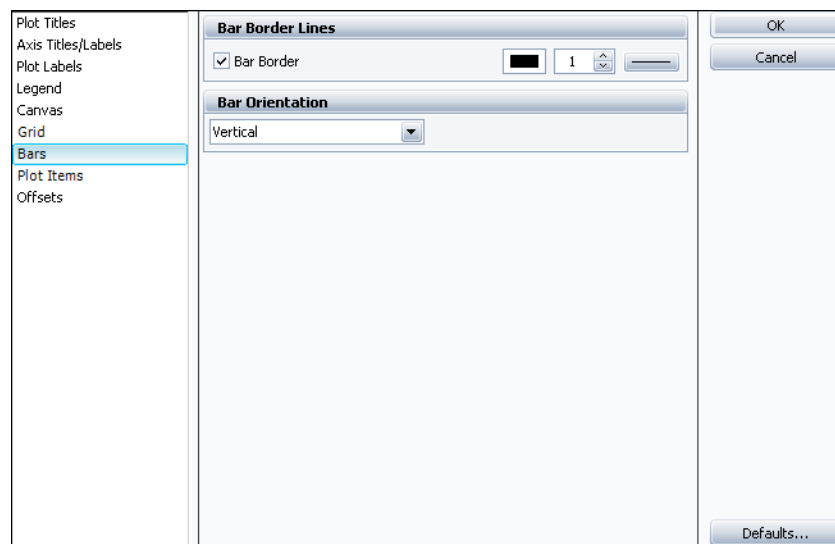
The options on this page will vary depending on the plot style you are working with. All available options are presented below.

- **Axis Division Lines** allows you to hide or show each of the axis division lines, as well as to choose a color, a thickness and a style for each.
 - To show or hide a line, select or clear the associated check box.
 - To change the color of any of the grid lines, click the **Color** box. The drop-down that appears allows you to choose from custom colors, web-safe colors or the colors used in the current Windows system settings. You can add colors to the Custom page by right-clicking one of the color boxes in the bottom two rows.
 - You can adjust the thickness of a grid line by entering a positive integer in the input box. A value of 1 will draw the thinnest possible line and other values such as 2, 3, etc. will draw thicker lines. Note that the size of the thinnest possible line is dependent upon your screen resolution.
 - In addition, you can change the style of each line by clicking the **Line Style** box to the right of the thickness box. A list providing line style options (e.g., solid, dashed, etc.) will appear. Choose the line style you want and it will appear in the **Line Style** box.
- **Number of Axis Divisions** allows you to set the number of major and minor divisions for each axis.

Note: When you are working with a bar chart, the Grid page will contain settings for only the axis representing the dependent variable. This is affected by the orientation of your bar chart; if you are using vertical bars, this area will contain settings for the y-axis, and if you are using horizontal bars, it will contain settings for the x-axis. It is important to be aware that the settings for one axis will not transfer to the other axis when you change the bar orientation. You will need to return to this page and re-enter the settings.

26.7 Bars Page

The Bars page allows you to customize the appearance of the bars in the plot. This page is available only when you are working with a bar chart.



- **Bar Border Lines** allows you to hide or show the border line for the bars, as well as to select a color, a thickness and a style for the border.
- **Bar Orientation** allows you to select how you want the plot laid out. You can choose to use vertical bars or horizontal bars.

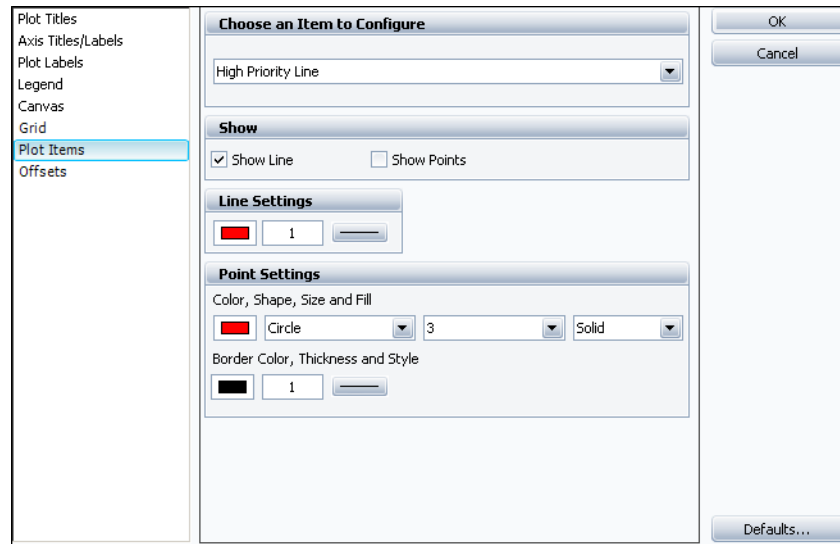
26.8 Slices Page

The Slices page allows you to customize the appearance of the slices in the plot. This page is available only when you are working with a pie chart.

- **Pie Settings**
 - **Rank** if selected, you can specify the ranking of the slices that you want to view. For example, entering **5** will cause only the five largest slices to be shown in the plot.
 - **Threshold** if selected, you can specify a minimum size (in percentage of the whole) for the slices that you want to view. For example, entering **0.1** will cause only slices accounting for ten percent or more of the whole to be shown in the plot.
 - **Show Remaining Slices as Other** if selected, all remaining slices that do not meet the rank or threshold criterion specified will be shown in the plot as “other.” This option is available only if you have specified a rank, a threshold or both.
 - **Other Slice Color** allows you to choose the color used to represent “other” slices. This option is available only if you have selected the **Show Remaining Slices as Other** option.
- **Slice Border Lines** allows you to hide or show the border line for the slices, as well as to select a color, a thickness and a style for the border.
- **Chart Type** allows you to select how you want the plot laid out. You can choose to use an area chart (blocks), cake chart (layers) or pie chart (wedges).
- **Numbers in Slice Labels** allows you to set the number of decimal places to be displayed in slice labels.

26.9 Plot Items Page

The Plot Items page allows you to specify details of the appearance of the points, lines, bars and/or slices on the plot.



The options available on this page will vary depending on the plot style that you are currently working with. The image above shows the options for a line plot.

The following options are available for all plot styles:

- **Choose an Item to Configure** allows you to choose which plot element the settings on this page apply to.
- **Show** allows you to select whether or not the plot element you currently chose to configure will be shown on the plot. Depending on the plot style that you are currently working with, you may select to show the bars, slice, line and/or points. This option is not available for all plots.

For bar charts and pie charts, the following option applies.

- **Area Fill Color and Style** allows you to specify the appearance of the bar or slice representing the selected item. To change the color of the bar or slice, click the Color box. You can select a fill style from the drop-down list.

For line plots, the following options apply:

- **Line Settings** allows you to specify the appearance of the line representing the selected item. To change the color of the line, click the **Color** box. Adjust the thickness of the line by entering a positive integer in the input box. Change the style of each line such as solid, dashed, etc., by clicking the **Line Style** box.
- **Point Settings**
 - **Color, Shape, Size and Fill** allows you to specify the appearance of the point body. To change the color of the point, click the Color box. You can select a point shape from the drop-down list, select the size of the point (with 1 being the smallest point) and select a fill style from the drop-down list.
 - **Border Color, Thickness and Style** allows you to modify the appearance of the border of the points. To change the color of the border, click the Color box. Adjust the thickness of the border by entering a positive integer in the input box. Change the style of each line such as solid, dashed, etc., by clicking the **Line Style** box.

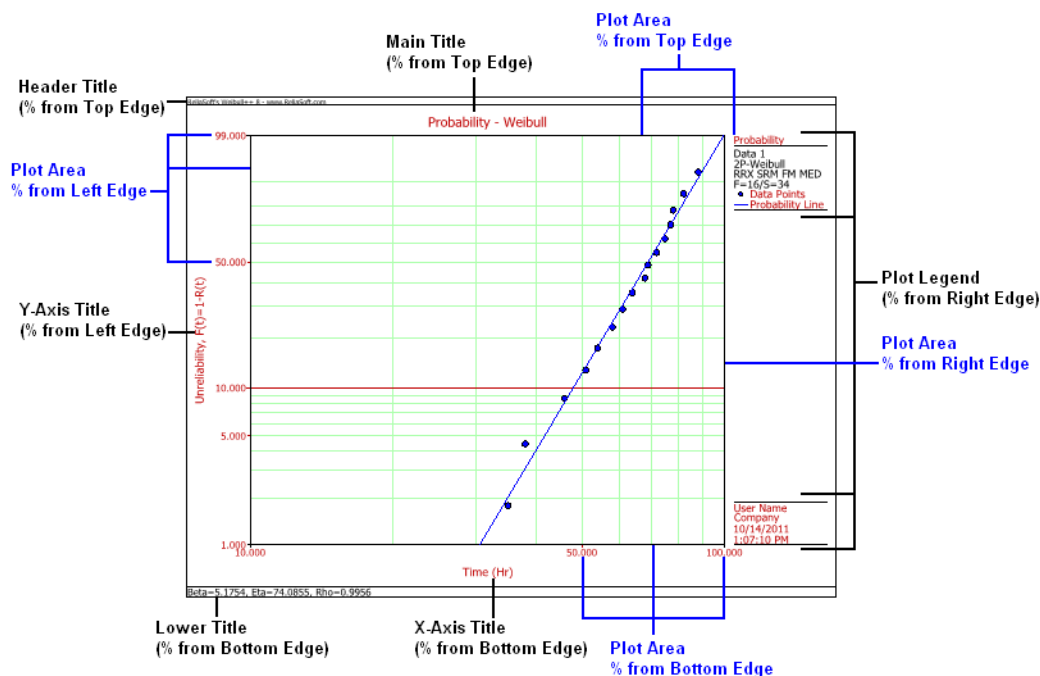
Certain point shapes are drawn using only the border color. These include minus, pike, plus and x-cross.

26.10 Offsets Page

The Offsets page allows you to specify the distance of various components from the edge of the plot area.

Automatically calculate positions from edges of plot sheet if selected, automatically calculates the offsets for maximum plot display and readability. If not selected, you can manually specify the offsets of the plot's left, right, top and bottom edges; the offset of the legend from the right edge of the plot area; and the offset of the main, x-axis, y-axis, header and footer titles. The offset values are set as a percentage of the canvas area.

For your reference, the following picture shows which plot elements are affected by each of the offset settings. (Note that the plot is generated from Weibull++, but the settings are the same for all Synthesis applications.)



26.11 Plot Defaults Window

Each time you open the Plot Setup window, the changes that you make will apply only to the current plot unless you specify otherwise. To specify settings to be used as defaults for all subsequent plots or to re-apply default settings to the current plot, click the **Defaults** button to open the Plot Defaults window.

The Plot Defaults window gives you the flexibility to set the default settings for the three main areas of a plot: the plot titles, the plot item settings and the general display areas. You can choose to separately save, load or restore the default settings of each main area or you can set the default settings for all areas at once.

The Plot Defaults window consists of nine pages:

- **All Defaults page.** This page controls the settings for all the other plot setup pages. When you click a button on this page, the effects apply to all pages. This allows you to quickly make changes without having to individually change each of the other pages.
- **Titles Text page.** This page allows you to customize default plot titles for each plot type without having to view a plot of that type. For example, you can display an RD Questions plot while changing the titles for a Control Type plot. *See Section 26.11.1 on page 471.*
- **Plot Items Display page.** This page allows you to customize the details of the default appearance of the lines, points, bars and/or slices of every plot type without having to individually change each plot. *See Section 26.11.2 on page 471.*
- **General page.** This page controls the settings for the five section pages below it. When you click a button on this page, the effects apply to the Titles Display, Labels, Legend, Canvas and Grid and Offsets pages.
- **The Titles Display, Labels, Legend, Canvas and Grid and Offsets pages** control the settings of their individual sections. When you click a button on one of these pages, the effects apply only to that specific section.

Three Defaults buttons appear on every page of the Plot Defaults window. The scope of their effects differs slightly depending on the page you are working with.

- **Save Defaults** saves settings for use as the default settings for all subsequent plots. This will overwrite the previous default settings.
- **Load Defaults** enters the saved default values for the settings. You can then click **OK** in the Plot Setup window to apply the default settings to the current plot. This is an easy way to undo changes you have made in the Plot Setup window and re-apply default settings.
- **Restore Defaults** clears the saved default settings and restores the default values that are shipped with the application.

The scope of the Defaults buttons' effects changes as follows:

- For the Titles and Plot Item Display pages, these buttons save/load/restore the settings specified on the current page.
- For the Titles Display, Labels, Legend, Canvas and Grid and Offsets pages, these buttons save/load/restore all current settings on the corresponding page(s) of the Plot Setup window (e.g., clicking **Save Defaults** on the Canvas and Grid page of the Plot Defaults window will save the settings from the Canvas, Grid, Bars and Slices pages).

Note: The settings affected by the Defaults buttons on the Titles Display, Labels, Legend, Canvas and Grid and Offsets pages include all settings relevant to the section, regardless of whether they are currently available or not. For example, if you have previously specified settings for a pie chart and are now specifying settings for a bar chart, the settings that you created for the pie chart will be saved as defaults when you click **Save Defaults** and will be applied to subsequent pie charts.

- For the All Defaults and General pages, clicking these buttons is equivalent to clicking them on all of the subordinate pages.

26.11.1 Plot Defaults: Titles Page

The Titles Text page of the Plot Defaults window allows you to customize default plot titles for each plot type.

The screenshot shows the 'Titles' page of the Plot Defaults window. The left sidebar has 'All Defaults' expanded, with 'Titles' selected. The main panel has a 'Titles' dropdown menu set to 'Standard'. Below this is a list of plot types: Occurrence/Severity Matrix - Initial, Occurrence/Severity Matrix - Initial and Revised (Sorted by Initial), Occurrence/Severity Matrix - Initial and Revised (Sorted by Revised), Occurrence/Severity Matrix - Revised, RD Questions, RD Ratings, RPN % Reduction Pareto, RPN (Pareto) - Initial (selected), and RPN (Pareto) - Revised. Below the list are three text input fields: 'Main Title' with the value 'Causes Ranked by Initial RPN', 'X-Axis Title' with the value 'Cause', and 'Y-Axis Title' with the value 'Cause RPN'. At the bottom are three buttons: 'Save Defaults', 'Load Defaults', and 'Restore Defaults'.

- **Titles** allows you to select the plot type that you are changing the default titles for.
- **Main** allows you to type the default main title for the plot.
- **X-Axis** allows you to type the default title for the x-axis for the plot.
- **Y-Axis** allows you to type the default title for the y-axis for the plot.

26.11.2 Plot Defaults: Plot Item Display Page

The Plot Items Display page of the Plot Defaults window allows you to customize details of the default appearance of the lines, points, bars and/or slices on the plot.

The screenshot shows the 'Plot Item Display' page of the Plot Defaults window. The left sidebar has 'All Defaults' expanded, with 'Plot Item Display' selected. The main panel has a 'Plot Item Type' dropdown menu set to 'Pareto Bar'. Below this is a 'Fill Style' dropdown menu set to 'Solid'. Under the 'Plot Item Color' section, there is an 'Item Order Number' dropdown menu set to '1' and a 'Color' button with a blue square. At the bottom are three buttons: 'Save Defaults', 'Load Defaults', and 'Restore Defaults'.

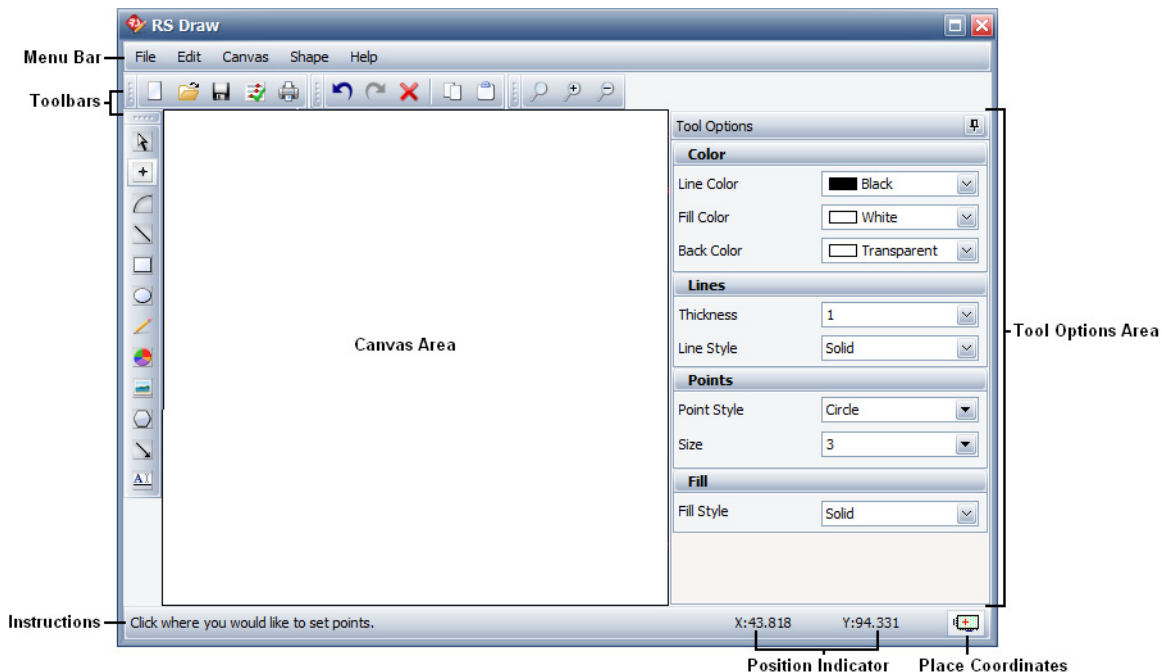
Plot Item Type allows you to select the style of plot that you want to specify default settings for. The settings you specify are retained in the background when you choose a new item in this list, so you can specify settings for each type and save all of them, if desired.

The options on this page are identical to those on the Plot Items page of the Plot Setup window for the corresponding plot style.

ReliaSoft Draw

27

 ReliaSoft Draw (RS Draw) is a full graphics metafile editor that allows you to annotate and customize your plots. With RS Draw, you can insert text, draw an object, mark a particular point or paste another picture into your plot. You can also re-arrange your objects by selecting and moving them to the position you desire. The figure below shows the RS Draw interface and its components.



27.1 Linking RS Draw

RS Draw is available by clicking the **RS Draw** icon on the Plot control panel.



The plot will be linked to RS Draw and will appear in the canvas area for editing. You will then be able to save any changes made to the plot in RS Draw to the current plot sheet by selecting **File > Apply Changes and Close** or by clicking the **Apply Changes and Close** icon on the toolbar.



27.2 RS Draw Menu Bar

The menus in the RS Draw menu bar belong exclusively to the RS Draw utility. Each menu item and its subitems are discussed next.

27.2.1 File Menu

The RS Draw File menu contains the following commands.

- **New** creates a new, blank RS Draw plot area. Only one canvas can be open in RS Draw at a time.
- **Open** opens a previously saved RSDrawCanvas (*.rdc) graphic.
- **Save** saves the current image in one of five formats: JPEG graphic (*.jpg), CompuServe Graphics Interface (*.gif), Portable Network Graphics (*.png), Windows Meta File (*.wmf) or RSDrawCanvas (*.rdc) graphic. If the graphic has never been saved, you will be prompted for a filename.
- **Apply Changes and Close** exports the current annotated graph to the current Plot Sheet.
- **Print** opens the Print window, which allows you to send the image to the printer.
- **Exit** closes RS Draw.

27.2.2 Edit Menu

The RS Draw Edit menu contains the following commands.

- **Undo** cancels the previous action. You can cancel multiple actions by choosing Undo as many times as necessary.
- **Redo** reapplies the previously canceled action. You can redo multiple actions by choosing Redo again.
- **Cut** cuts the selected object(s) and puts them on the Clipboard.
- **Copy** copies the selected object(s) to the Clipboard. Objects stored in the Clipboard can be pasted into this and other applications.
- **Copy Image** allows you to copy the plot to the Clipboard as a graphic. You must select an image type using one of the following options.
 - Select **As Bitmap** when you need a bitmap version to be used in an external application.
 - Select **As Metafile Optimized for Synthesis Spreadsheet** when you will be copying and pasting the image into Synthesis spreadsheets (e.g., analysis workbooks).
 - Select **As Metafile Optimized for External Use** when you need a metafile that will be used by an external application.
- **Paste** pastes the contents of the Clipboard onto the canvas area.
- **Delete Selected** deletes the selected object(s).
- **Select All** selects all objects in the plot area.
- **Preferences** opens the Preferences window where you can set various options about the RS Draw interface.

27.2.2.1 Preferences Window

The Preferences window allows you to set various options about the RS Draw interface. You can access it by choosing **Edit > Preferences**.

The window contains the following settings:

- **Hot Spots**
 - **Point** allows you to choose the color of the point handles that appears when a line, free-form line or polygon is selected. These handles represent the end points of the line segments that are used to draw the object, and can be moved independently of each other to reconfigure the object.
 - **Object** allows you to choose the color of the object handles that appear when an object is selected. They are used to move or resize the entire object.
- **View**
 - **Instructions** if selected, turns on the help text that displays in the Status Bar at the bottom of the RS Draw interface when you click an option on the Draw Toolbar.
- **Grid Spacing** sets the grid's width. The grid spacing is a percentage of the grid's width. For example, if you want the canvas to show 20 points, the grid spacing must be set to 0.05.

27.2.3 Canvas Menu

The RS Draw Canvas menu contains the following commands.

- **Background Color** opens the Color Palette, which allows you to choose the canvas color.
- **Show Grid** toggles the display of the dotted-line grid on and off.
- **Snap to Grid** sets the movement and placement of the selected object to be in accordance with the spacing of the grid points. In other words, each object moved or placed in the graphic will be automatically moved to align with the nearest grid lines. Note that this command is available only when the grid is displayed.
- **Zoom** opens a submenu that allows you to set the degree of magnification on the RS Draw canvas.

27.2.4 Shape Menu

The RS Draw Shape menu contains the following commands.

- **Move to Front** moves the selected object(s) to the front (i.e., displayed over the other layers).
- **Move to Back** moves the selected object(s) to the back (i.e., displayed behind the other layers).
- **Bind Group** groups the selected objects together as one. To ungroup the select objects, use the **Unbind Group** command.
- **Clone** creates a duplicate of each currently selected object and places it next to the original.
- **Align Vertically** opens a submenu that allows you to vertically align the selected object(s): Left, Center or Right. When aligning objects within the graphic, the first selected object selected is used as the reference point.
- **Align Horizontally** opens a submenu that allows you to horizontally align the selected object(s): Top, Center or Bottom. When aligning objects within the graphic, the first selected object selected is used as the reference point.
- **Rotate Right** and **Rotate Left** rotate the selected object(s) 90° in the indicated direction. To flip the selected object(s) by 180°, select **Rotate 180°**.

27.2.5 Help Menu

The RS Draw Help menu contains the following commands.

- **Contents** displays RS Draw's online help contents.
- **Visit ReliaSoft on the Web** allows you to have direct access to ReliaSoft's website at <http://www.Reliasoft.com>.

27.3 RS Draw Toolbars

Four toolbars are available on the RS Draw window. Each toolbar contains quick access icons that activate different parts of the application. Depending on the current active window or type of data, certain icons may be unavailable and will appear dimmed. You can choose which toolbars you want to appear in the interface by customizing the toolbars. *See Section 27.3.5 on page 478.* The toolbars and their icons are shown and explained next.

27.3.1 Standard Toolbar



New creates a new, blank canvas in RS Draw. Only one canvas can be open in RS Draw at a time.



Open opens a previously saved RSDrawCanvas (*.rdc) graphic.



Save saves the current graphic. If no name is currently selected, you will be prompted for a filename.



Apply Changes and Close applies the changes in the annotated graph to the current Plot Sheet and closes the RS Draw window.



Print opens the Print window, which gives you printing options and allows you to send the current graphic to the printer.

27.3.2 Edit Toolbar



Undo cancels the previous actions. You can cancel multiple actions by choosing **Undo** again.



Redo reapplies the previously canceled action. You can redo multiple actions by choosing **Redo** again.



Delete deletes the selected object(s).



Copy copies the selected object(s) to the Clipboard. Objects stored in the Clipboard can be pasted into this and other applications.



Paste pastes the contents of the Clipboard onto the canvas area.

27.3.3 Zoom Toolbar



Reset Zoom sets the degree of magnification, the zoom, to 100%.



Zoom In increases the degree of magnification.



Zoom Out decreases the degree of magnification.

27.3.4 Draw Toolbar



Select Object allows you to select an object. When an object is selected, you can move it to a new position, change its properties or delete the object. (To select multiple objects, hold down the **CTRL** key while you click the other objects you want to select.)



Point allows you to place a point on the canvas. With the tool selected, click the desired location on the canvas. The point displays at that location.



Arc allows you to draw an arc. With the tool selected, click the desired location on the canvas and drag the arc to the appropriate size.



Line allows you to draw a line. With the tool selected, click the desired start point for the line and drag to the desired length.



Rectangle allows you to draw a rectangle. With the tool selected, click the desired location on the canvas and drag the rectangle to the appropriate size.



Ellipse allows you to draw an ellipse. With the tool selected, click the desired location on the canvas and drag the ellipse to the appropriate size.



Free allows you to draw a free-form line. With the tool selected, click the desired start point for the line and draw the line. You can continue to draw until you release the mouse button.



Pie allows you to draw a pie segment. With the tool selected, click the desired location on the canvas and drag the pie segment to the appropriate size.



Image allows you to insert an image onto the canvas. You can import files of the following types: jpg, gif, png, bmp, wmf or emf. With the tool selected, click the desired location on the canvas. The Open window displays. Navigate to the appropriate folder, then choose the image and click **Open**. The image appears at the desired location.



Polygon allows you to draw a polygon. With the tool selected, click the start location on the canvas, and then click each additional end point of a line segment. As soon as you have three points an additional line is automatically drawn, closing the shape, but you can continue to add points and the polygon will be redrawn accordingly. To stop adding points, right-click the canvas area.



Arrow allows you to insert an arrow into the plot. With the tool selected, click the desired start point for the arrow line and drag to the desired length. The arrow head is automatically added at the end point of the arrow line.



Text allows you to insert a single line of text into the plot. With the tool selected, click the start point and type the text.

For all objects, you can change and set the object's properties using the Tool Options area. *See Section 27.5 on page 479.* Note that you can use the Tool Options area in two ways:

- If an existing object on the canvas is selected, changing the settings in the Tool Options area will alter that object's properties only.
- If no object on the canvas is selected, the settings in the Tool Options area will be applied to all subsequent objects created using the selected tool.

27.3.5 Customizing Bars in the RS Draw Interface

RS Draw's interface provides you with the flexibility to customize the workspace to meet your needs. You can hide or display any of the toolbars. You can also change the location and shape of any of the toolbars.

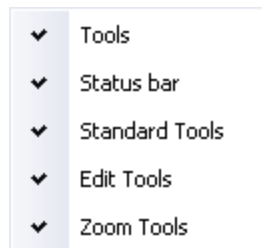
27.3.5.1 Moving Toolbars

You can move any of the toolbars by clicking the handle at the top or left side of each toolbar and dragging the bar into the position you prefer. When you move a bar, the shape may change to fit the new location.



27.3.5.2 Hiding and Showing Toolbars

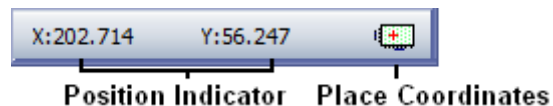
You can choose to display or hide any of RS Draw's toolbars by right-clicking inside the grey toolbar area. A Toolbar shortcut menu like the one shown next will appear.



Click a toolbar name to select or deselect it. If selected, the toolbar will appear in the RS Draw Interface. If not selected, the toolbar will not appear.

27.4 Additional Tools

Two additional tools are located on the bottom of the RS Draw window.



- **Position Indicator** indicates the exact position of the pointer within the plot area. The Position Indicator is available only if RS Draw is linked to a data set.
- **Place Coordinates** if selected, allows you to mark a point on the plot area by right-clicking at the spot you would like to mark. This option is available only if RS Draw is linked to a data set.

27.5 Object Properties — The Tool Options Area

You can set the properties of objects in RS Draw using the Tool Options area.

The Tool Options area includes the Lines Properties, the Fill Properties, the Points Properties, the Angles Properties, the Text Properties and the Color Properties. The properties that will be available will vary depending on the selected object (text, line or a shape).

The functionality of this area changes depending on what is selected on the Draw toolbar. If the Select tool is active, any changes you make are applied to the currently selected object. If any other tool is active, then any changes you make will be used as the properties of that tool the next time you use that tool to draw something.

For example, to set the default options for all rectangles, you would first click the **Rectangle** icon and, in the Tool Options area, set the property values that will be applied to all further instances of the items of that type.

To change the properties of an existing object, first click the **Select** icon, then select the object and change the desired properties in the Tool Options area. The changes are applied to the selected object immediately after you make them. To undo the change, choose **Edit > Undo**.

27.5.1 Lines Properties

The Lines properties area of the Tool Options area is available when a point, arc, line, rectangle, ellipse, free-form line, pie, polygon or arrow is the selected object. Note that when working with an object other than a line or a free-form line, these properties apply to the object's outline.

The following options are available:

- **Thickness** allows you to set the line thickness, in pixels, for the selected line. The line thickness can range from 1 to 9, with 1 being the thinnest and 9 being the thickest.
- **Line Style** allows you to choose a style for the selected line from the drop-down menu.

27.5.2 Fill Properties

The Fill properties area of the Tool Options area is available when a point, rectangle, ellipse, pie, polygon or arrow is the selected object.

The following option is available:

- **Fill Style** allows you to choose a fill style from the drop-down menu. The setting determines how the Fill and Back colors interact on the display. Note that if you choose **Transparent** then neither color displays.

27.5.3 Points Properties

The Points properties area of the Tool Options area is available when a point is the selected object.

The following options are available:

- **Point Style** allows you to set the style for the point from the drop-down menu.
- **Size** allows you to set the point size from the drop-down menu.

27.5.4 Angles Properties

The Angles properties area of the Tool Options area is available when an arc or pie is the selected object.

The following options are available:

- **Start** allows you to set the starting point for the object, where 0 is a horizontal line. The Start value determines the orientation of the object. For example, a Start value of 0 indicates that the object will start at the 3 o'clock position, while a Start value of 270 indicates that the object will start at the 12 o'clock position.
- **Sweep** allows you to set the angle of the object. The Sweep value determines how big the pie slice or arc angle is. For example, a Sweep value of 45 indicates that the object is one-eighth of a circle, while a Sweep value of 270 indicates that the object is three-quarters of a circle.

27.5.5 Text Properties

The Text properties area of the Tool Options area is available when text is the selected object.

The following options are available:

- **Font** allows you to choose the specific font.
- **Font Size** allows you to set the text point size.
- **Orientation** allows you to set the angle at which the text is displayed. For example, a value of 0 indicates that the text will start at the 3 o'clock position, while a value of 90 indicates that the text will start at the 12 o'clock position.
- **Bold** if selected, bolds the text.
- **Italics** if selected, italicizes the text.
- **Underline** if selected, underlines the text.
- **Vertical Alignment** allows you to set the text's vertical alignment relative to the insertion point. The options are: Left, Center or Right.
- **Horizontal Alignment** allows you to set the text's horizontal alignment relative to the insertion point. The options are: Top, Center or Bottom.

27.5.6 Color Properties

The Color properties area of the Tool Options area is available when a point, arc, line, rectangle, ellipse, free-form line, pie, polygon, arrow or text is the selected object.

The following options are available:

- **Line Color** opens the Color Palette, which allows you to choose a color for the selected line.
- **Fill Color** opens the Color Palette, which allows you to choose the fill color of the selected object from the drop-down menu. **Transparent** indicates that there is no fill color.

Note: If the selected object is text, the Fill Color sets the font's color. The Line Color and Back Color settings are not used with text.

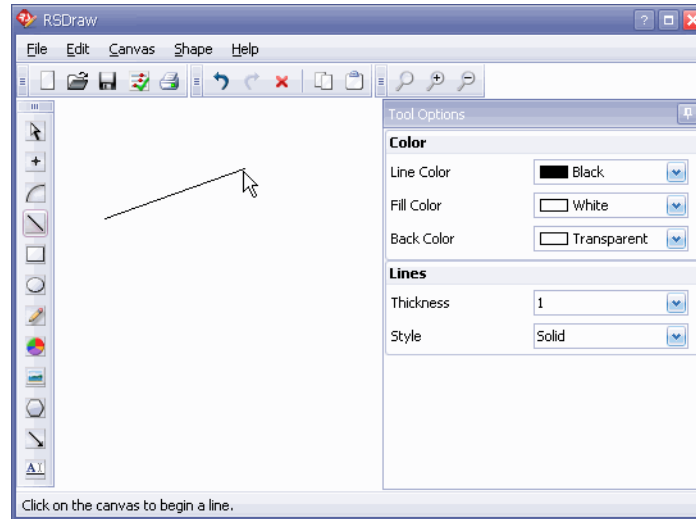
- **Back Color** opens the Color Palette, which allows you to choose the background color for the selected object from the drop-down menu. **Transparent** indicates that there is no background color.

27.6 Working with Objects: Examples

27.6.1 Drawing a Line

To draw a line on a graphic that is being edited in RS Draw, click the **Line** icon on the Draw toolbar. (The other RS Draw tools are used in a similar fashion.)

On the canvas, click the desired start point for the line and drag to the desired orientation and length. A line will appear, as shown next.



27.6.2 Editing an Object

To edit an object in RS Draw, click the **Select** icon on the Draw toolbar and then click the object. Handles appear on the object. These handles allow you to move and/or resize the object. The number and type of handles depends on the selected object. For more information about the handle types and how to set the handle colors, refer to the Preferences Window. *See Section 27.2.2.1 on page 475.*

27.6.2.1 Example: Editing a Line

When you click a line, three handles will appear on the line: one point handle at each end of the line and one object handle in the middle of the line.

Drag one of the point handles to edit the line's direction and length with respect to the other end handle. You can move the pointer around to get a feel for what you can do. When you are satisfied with the new line, release the button.

To move the line, drag the object handle to the appropriate place.

27.6.2.2 Example: Resizing a Rectangle

When you click a rectangle, five object handles will appear on the rectangle: one at each corner and one at the rectangle's center. To resize the rectangle, click one of the corner handles and move the pointer. When you are satisfied with the new size, release the button.

To move the rectangle, drag the central handle to the appropriate place.

27.7 Saving an Image

You can save an image for future use either in RS Draw or in another application.

Note: If you want to edit the image in RS Draw again, you must save the image as an RSDrawCanvas (*.rdc) graphic image. Otherwise, you will not be able to open the graphic file in RS Draw.

To save an image, do the following:

- Choose **File > Save**. The Save As window displays.
- In the **File name** field, type the image's name.
- In the **Save as type** field, choose the image type.
- Click **Save**.

There are four types of diagrams that can be used in conjunction with your FMEA analyses:

- FMEA Block Diagrams (Boundary Diagrams) - Section 28.1 (p. 483)
- Process Flow Diagrams - Section 28.2 (p. 485)
- Cause and Effect Diagrams - Section 28.3.1 (p. 486)
- Failure Relationship Diagrams - Section 28.3.2 (p. 488)

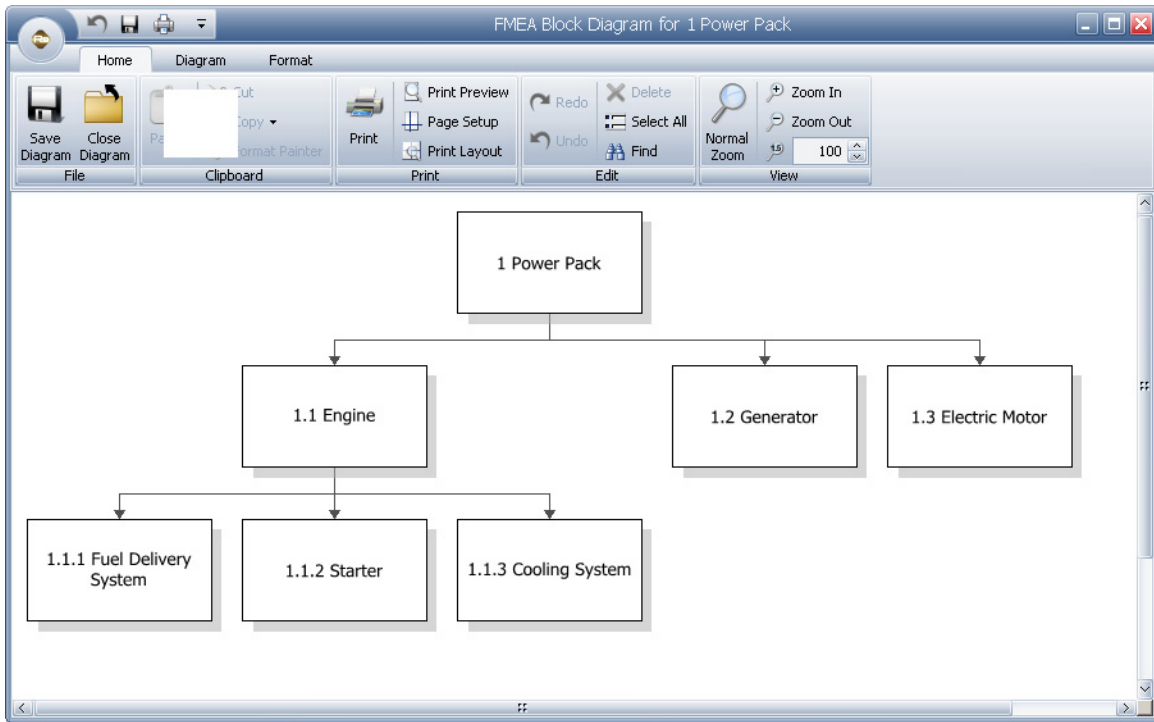
The diagram windows function in a similar manner for all diagram types. The following sections discuss:

- The commands available in the Diagram Ribbon tabs: Home, Diagram and Format - Section 28.4 (p. 489).
- How to add and connect blocks in diagrams - Section 28.5 (p. 493).
- The options available to modify the appearance of various diagram elements - Section 28.6 (p. 496).
- How to search through a diagram for specific text and/or numbers - Section 28.7 (p. 496).

28.1 FMEA Block Diagrams (Boundary Diagrams)

RBI allows you to create an FMEA Block diagram for any item in the system hierarchy. FMEA Block diagrams help to define the scope of a particular analysis project and also may provide additional information that will be useful to the analysis team when they attempt to identify potential failure modes.

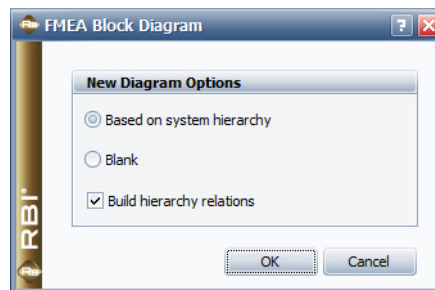
An example of an FMEA Block diagram is shown next.



To create an FMEA Block diagram, select an item in the System panel then choose **System Hierarchy > Diagrams > FMEA Block Diagram**. You can also right-click the item and choose **Diagrams > FMEA Block Diagram**.



When you are creating a new FMEA Block diagram, the FMEA Block Diagram window will appear, which gives you the option to start with a blank diagram or generate blocks based on the item's system hierarchy.



- **Based on system hierarchy** creates an FMEA Block diagram based on the selected item and its sub-items, if any, with the names of the item and its sub-items used as the blocks in the FMEA Block diagram. One block will be created per item.
 - Select the **Build hierarchy relations** option to create the diagram with the items already linked with connectors.

Tip: If a diagram has already been created, you will be prompted to either open the existing diagram, delete the previously saved diagram or create a new diagram that replaces the existing version.

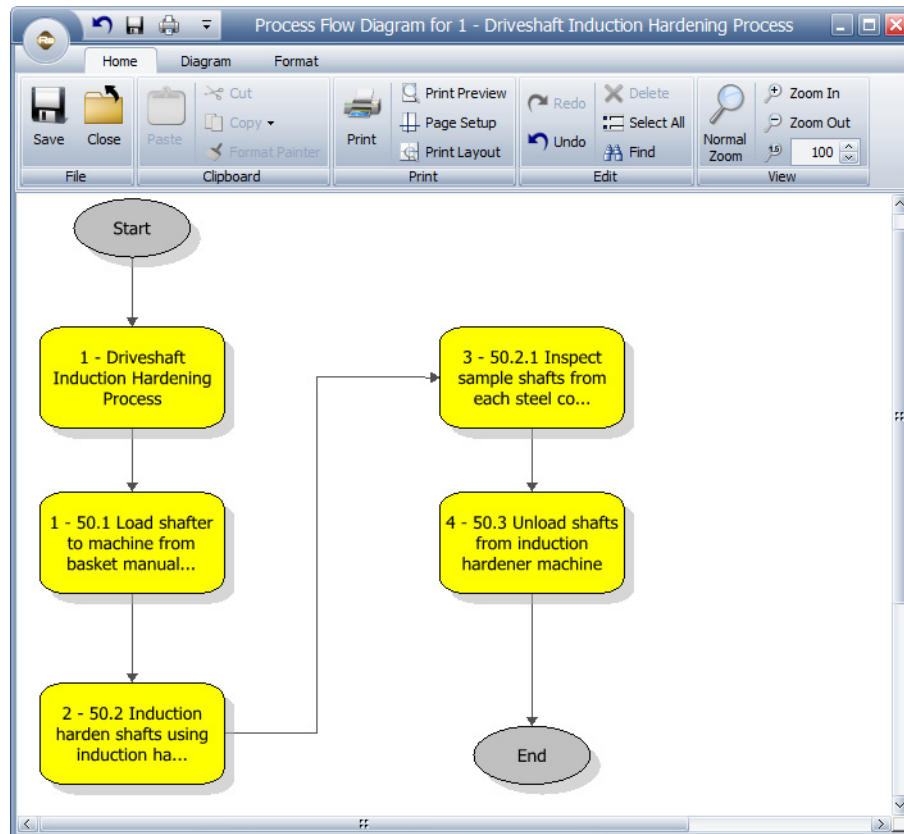
When you close the diagram, a window will appear asking if you want to save the diagram.

28.2 Process Flow Diagrams

RBI allows you to create a process flow diagram for any item in the system hierarchy. Process flow diagrams are high level charts that help you to visualize the steps that a product goes through in a manufacturing or assembly process.

Tip: If you want to use the process flow diagram as a starting point for preparing process FMEAs (PFMEAs) or control plans, then the PFD worksheet may be a more appropriate tool. The PFD worksheet integrates the chart into a worksheet that records more detailed information about each step in the process and it allows you to synchronize the relevant information with the PFMEA or control plan analysis. See *Chapter 19*.

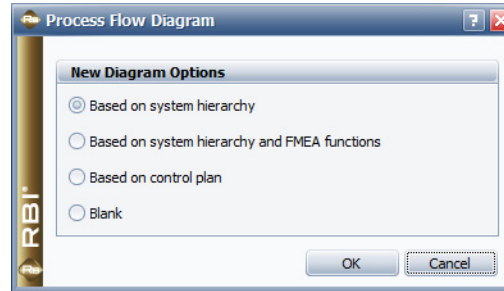
An example of a process flow diagram is shown next.



To create a process flow diagram, select an item in the System panel then choose **System Hierarchy > Diagrams > Process Flow Diagram**. You can also right-click the item and choose **Diagrams > Process Flow Diagram**.



When you are creating a new process flow diagram, the Create Process Flow Diagram window will appear, which gives you the option to start with a blank diagram or generate blocks based on the item's FMEA or control plan.



- **Based on system hierarchy** creates a process flow diagram based on the item that is currently selected in the System panel. If the item has any sub-items, those sub-items will also be added to the diagram.
- **Based on system hierarchy and FMEA functions** creates a process flow diagram based on the FMEAs of the item that is currently selected in the System panel. Each function in the existing FMEA will be transferred to a block in the process flow diagram. If the item has any sub-items, those sub-items and the FMEA functions of those sub-items if any, will also be added to the diagram.
- **Based on control plan** creates a process flow diagram based on the existing control plan associated with the item that is currently selected in the System panel. Each Process Name/Operation Description in the existing control plan will be transferred to a block in the process flow diagram.

Tip: If a diagram has already been created, you will be prompted to either open the existing diagram, delete the previously saved diagram or create a new diagram that replaces the existing version.

When you close the diagram, a window will appear asking if you want to save the diagram.

28.3 Cause, Effect and Failure Relationship Diagrams

RBI provides a cause and effect diagram and a failure relationship diagram to help you to visualize the relationship among the events described in your analysis.

The two types of diagrams are presented in more detail below.

28.3.1 Cause and Effect Diagrams

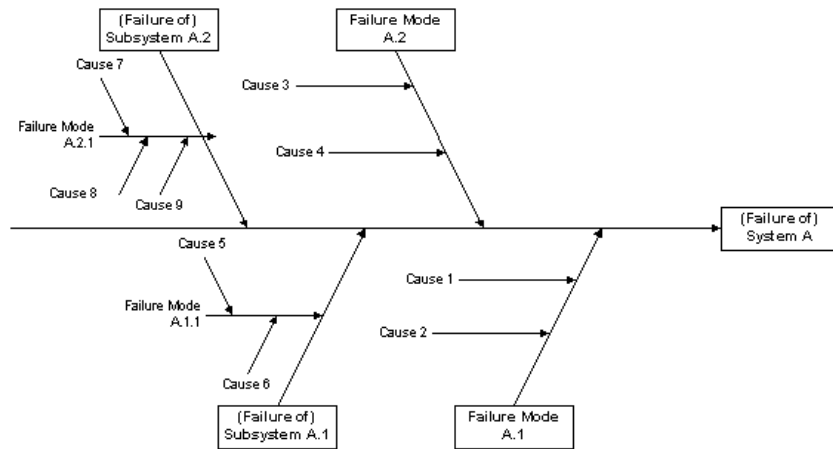
RBI allows you to automatically create a cause and effect diagram based on the current analysis. The cause and effect diagram (also known as a fishbone or Ishikawa diagram) is available for items and effects and it presents all of the events that lead up to the selected effect or item failure.

To generate a cause and effect diagram for an item, select the item and choose **System Hierarchy > Diagrams > Cause and Effect Diagram**. To generate a cause and effect diagram for an effect, select the effect and choose **FMEA > FMEA Records > Effects > Cause and Effect Diagram**.

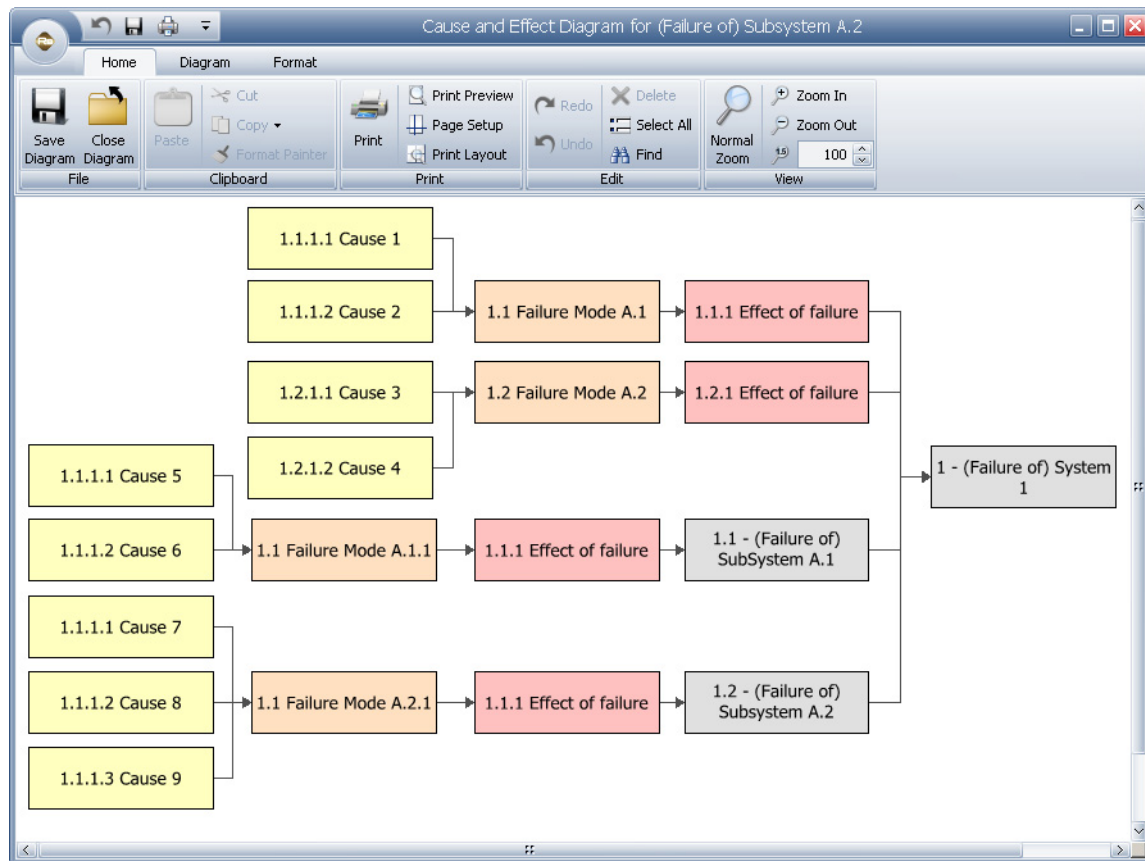


If you have not previously created and saved the diagram, it automatically displays. If there is an existing diagram, you will be prompted to either open the previously saved diagram, delete the previously saved diagram or replace it with a new one. When you close the diagram, a window will appear asking if you want to save the diagram.

Although the cause and effect diagram does not have the traditional look of the Ishikawa or fishbone diagram, it can be read the same way. An example of an Ishikawa diagram and the same diagram as it appears in the cause and effect diagram is shown next.



Ishikawa Diagram

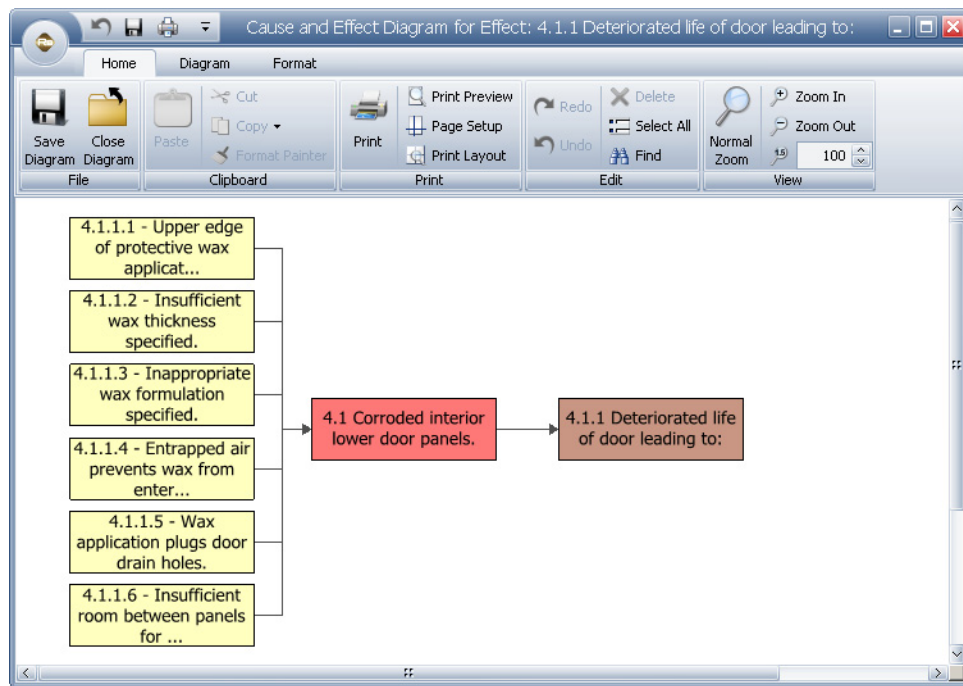


Cause and Effect Diagram for an Item Record

In the cause and effect diagram, the item or effect record you selected will appear on the far right side of the diagram. In the picture shown above, the “Failure of System A” is the item being analyzed. The events that lead to the selected event are presented to the left, the events that lead to those events are presented to the left of that, and so on until you get the basic causes that have been defined in the project.

If an item record is selected in the project, the last block(s) in the cause and effect diagram implies the failure of that item (i.e., in the above image, Cause 1, Cause 2, Cause 3 and Cause 4 are the causes of the failure). If the item has sub-items, there will be additional blocks that represent the failures of those items (assuming a reliability-wise series configuration in which the failures of any item results in the failure of the system). As shown above, the failures and causes that have been defined for these items are also included in the diagram.

If you create a cause and effect diagram for an effect record, the diagram will consist simply of the failures that lead to that effect and the causes that lead to those failures. A cause and effect diagram for an effect record is shown in the following figure.



Cause and Effect Diagram for an Effect

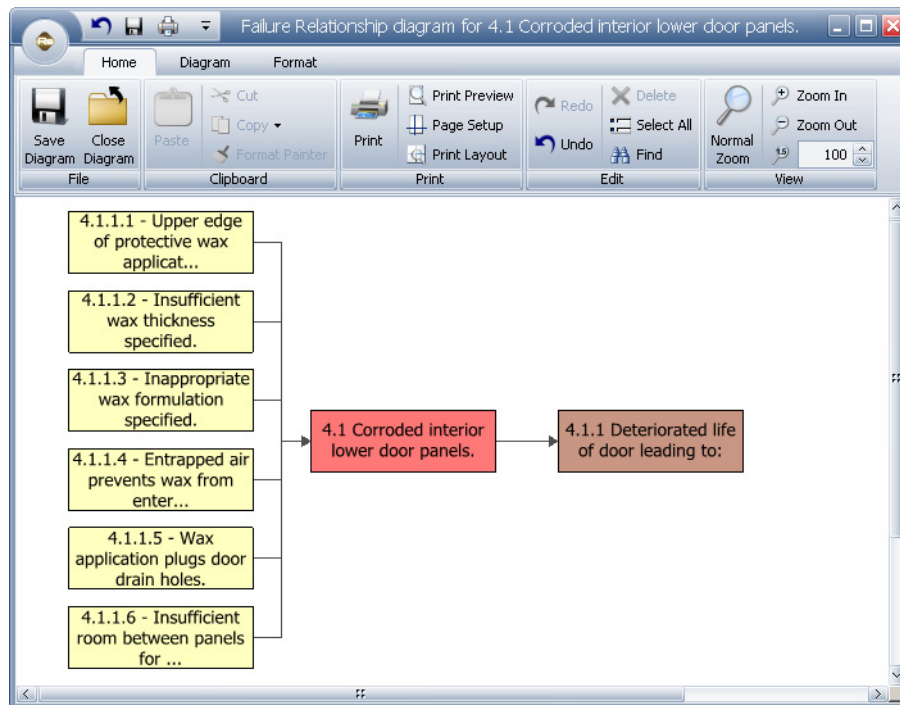
28.3.2 Failure Relationship Diagrams

RBI allows you to automatically create a failure relationship diagram based on the current analysis. The failure relationship diagram is available for failures and it presents all of the causes and effects that have been defined for the selected failure.

To generate a failure relationship diagram, select the failure record that you want to create the diagram for in the Analysis panel and choose **FMEA > FMEA Records > Failures > Relationship Diagram**.

If you have not previously created and saved the diagram, it automatically displays. If there is an existing diagram, you will be prompted to either open the previously saved diagram, delete the previously saved diagram or replace it with a new one. When you close the diagram, a window will appear asking if you want to save the diagram.

An example of a failure relationship diagram is shown next.



This example shows the failure record (block 4.1) in the middle of the diagram with all of the causes that have been defined for the failure on the left (blocks 4.1.1.1. through 4.1.1.6) and all of the effects on the right (block 4.1.1.). The arrows in the diagram demonstrate the flow with the causes leading to the failures and the failures leading to the effects.

28.4 Diagram Ribbon

The Diagram Ribbon is used with process flow diagrams, FMEA Block diagrams, cause and effect diagrams and failure relationship diagrams.

The following is a list of all the tabs on the Diagram Ribbon:

- The **Home tab** contains commands related to copying, pasting, formatting blocks and saving and opening diagrams.
- The **Diagram tab** contains commands related to adding and selecting blocks.
- The **Format tab** contains commands related to formatting blocks and setting the diagram properties.

28.4.1 Home Tab

The Home tab contains commands related to copying, pasting, formatting blocks and saving and opening diagrams.

File



Save Diagram saves the diagram



Close Diagram closes the Diagram window.

Clipboard

Paste



Pastes the contents of the Clipboard onto the diagram.



Cut cuts the selected block to the Clipboard. Data stored in the Clipboard can be pasted into this and other applications.



Copy copies the selected graphic element to the Clipboard. You can then paste this element into another location within the diagram.

- **Copy Diagram Graphic** copies the current diagram to the Clipboard. The diagram can then be pasted as an enhanced metafile (*.emf) graphic into other documents as an enhanced metafile (*.emf) graphic.
- **Copy Selected Graphic** copies the current block to the Clipboard. The block can then be pasted into other documents as an *.emf graphic.



Format Painter allows you to copy the format properties of text in a sheet and apply it to other text. To use the Format Painter, select the text with the format properties that are to be copied and then choose Format Painter. Next, click the text to which the format properties are to be applied.

Print



Print sends the current diagram to the printer.



Print Preview opens the Print Preview window, which allows you to view how the current diagram will appear on the printed page. *See page 502 in Chapter 29.*



Page Setup opens the Page Setup window, which allows you to specify printing options. *See page 497 in Chapter 29.*



Print Layout displays the page boundary lines on the diagram. Everything within the boundary lines will appear on the printed page and this view allows you to make any necessary adjustments to the final look of the diagram before sending it to the printer.

Edit



Redo reapplies the previously canceled action. You can redo multiple actions by choosing Redo again.



Undo cancels the last editing change you made.



Delete deletes the selected blocks.



Select All selects all of the blocks in the diagram.



Find opens the Find window, which allows you to search through the diagram for text and/or numbers. *See Section 28.7 on page 496.*

View

Normal Zoom



Sets the degree of magnification back to 100%.



Zoom In increases the degree of magnification.



Zoom Out decreases the degree of magnification.



Zoom% allows you to specify the degree of magnification.

28.4.2 Diagram Tab

The Diagram tab contains commands related to adding and selecting blocks.

Blocks



Add Block adds a new block to the diagram. *See Section 28.5.1 on page 493.*



Add Annotation adds a new annotation to the diagram. You can edit the text that appears in the annotation by double-clicking it to open the Edit User-Defined Label window. *See Section 28.5.1 on page 493.*



Auto Arrange automatically arranges the blocks in the diagram so that all blocks are evenly spaced and aligned.

Settings



Connect Blocks allows you to create connectors between blocks in the current diagram. When this command is selected, click the source block, hold down the left mouse button and drag a line from the source block to the destination block. When the crosshairs are located above the destination block, release the mouse button to create a connector. To stop adding connectors and return to the normal mode, right-click the diagram or clear the **Connect Blocks** command (i.e., by choosing the command again).



Lock Diagram locks the current diagram. When the diagram is locked, you cannot make changes to it. Select **Lock Diagram** again to unlock the diagram.

Properties



Rename Block opens the Rename Block window, which allows you to customize the block's name. *See Section 28.5.3 on page 494.*



Line Bend alters the bend style of the selected connectors. The commands are: Default, Straight Line, Angle, Right Angle and Custom.

The following commands are available only if the style is Custom: **Remove Bend Point** and **Remove All Bend Points**.

Selection



Cascade Select selects all the blocks that are connected from the selected block. This allows you to easily select all blocks that are connected to a block.



Trace Path traces the path of the selected block. Click another block or the diagram to remove the traced path. The color of the traced path is the same as the color for a selected connector and can be set in the Diagram Style window.



Diagram Actions allows you to perform various actions on the diagram.

- **Refresh Diagram** updates the diagram to show any changes.
- **Diagram Style** opens the Diagram Style window, which allows you to customize the appearance of the current diagram and set the default properties for connectors and new blocks that are added to the diagram.
- **Export Graphic** saves the diagram as a graphic in one of the following formats: *.wmf, *.png, *.gif or *.jpg. You will be able to use the exported graphic in any application, provided that the application supports the file format.

28.4.3 Format Tab

The Format tab contains commands related to formatting blocks and setting the diagram properties.

Format



Select Font opens the font window which allows you to set the font properties for the selected blocks.



Font Color opens the Color Palette, which allows you to set the font color for the selected text.



Fill Color opens the Color Palette, which allows you to set the fill color for the selected text.

Styles



Diagram Style opens the Diagram Style window, which allows you to customize the appearance of the current diagram and set the default properties for connectors and new blocks that are added to the diagram.



Block Style opens the Block Style window, which allows you to customize the appearance of the selected block or annotation.



Connector Style opens the Connector Style window where you can customize the appearance of the selected connectors.

Alignment and Spacing



Align Blocks allows you to specify how you want the selected blocks to be aligned.

- **Align Tops** aligns the selected blocks to the top of the first selected block.
- **Align Middles** aligns the selected blocks to the vertical center of the first selected block.
- **Align Bottoms** aligns the selected blocks to the bottom of the first selected block.
- **Align Lefts** aligns the selected blocks to the left of the first selected block.
- **Align Centers** aligns the selected blocks to the horizontal center of the first selected block.

- **Align Rights** aligns the selected blocks to the right of the first selected block.
- **Align to Grid** aligns the selected blocks to the grid.



Make Spacing Equal allows you to specify how you want the blocks to be equally spaced.

- **Horizontal** equally spaces the selected blocks according to the horizontal spacing of the first two selected blocks.
- **Vertical** equally spaces the selected blocks according to the vertical spacing of the first two selected blocks.
- **Both** equally spaces the selected blocks according to the horizontal and vertical spacing of the first two selected blocks.



Make Same Size allows you to specify how you want the blocks to be resized.

- **Width** resizes the selected blocks to be the same width as the first selected block.
- **Height** resizes the selected blocks to be the same height as the first selected block.
- **Both** resizes the selected blocks to be the same width and height as the first selected block.



Bring to Front moves the currently selected blocks in front of other objects on the diagram.



Send to Back moves the currently selected blocks behind other objects on the diagram.

28.5 Working with Diagrams

This section discusses the most common techniques that you will use to build or modify a diagram, including:

- Adding blocks and annotations - Section 28.5.1 (p. 493)
- Copying and pasting blocks - Section 28.5.2 (p. 494)
- Renaming blocks - Section 28.5.3 (p. 494)
- Connecting blocks - Section 28.5.4 (p. 494)
- Using the format painter tool - Section 28.5.5 (p. 495)

For information about how to set the appearance of various diagram elements, see Section 28.6 on page 496.

28.5.1 Adding Blocks and Annotations

To add a standard block to a diagram, choose **Diagram > Blocks > Add Block**.



To add an annotation to a diagram, choose **Diagram > Blocks > Add Annotation**.



By default, the text “New Annotation” will appear in the annotation. You can change this text by double-clicking the annotation to open the Edit User-Defined Label window.

28.5.2 Copying and Pasting Blocks

You also can cut or copy existing blocks (in the current diagram or in any other diagram of the same type) and paste them into the diagram using the **Cut**, **Copy** and **Paste** commands on the Home tab of the Ribbon. Blocks created in this manner will possess the same style and properties as the original block.

To select an individual block, click it. There are several ways to select multiple blocks:

- Hold down the **CTRL** key and click the blocks.
- Click in the diagram and drag the selection area to include the blocks you want to select.
- Choose **Home > Edit > Select All** to select all blocks in the current diagram.
- Click a block and then choose **Diagram > Selection > Cascade Select** to select all blocks that are connected to that block, either before it or after it.

28.5.3 Renaming Blocks

The Rename Block window allows you to change the description of a block in the diagram. To access this window, select a block and then choose **Diagram > Properties > Rename Block**.



Enter the description in the input area, then click **OK**.

28.5.4 Connecting Blocks

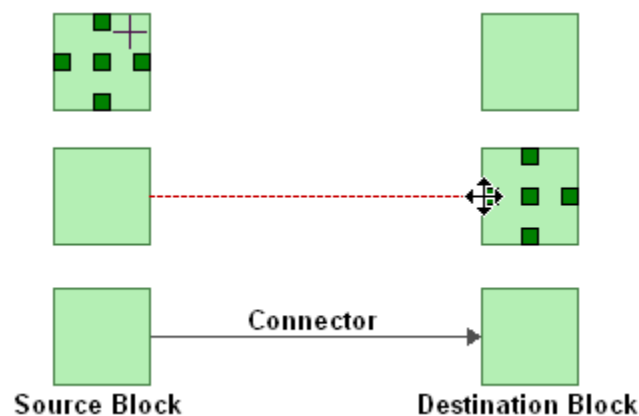
To create a connector between blocks, you can:

- Choose **Diagram > Settings > Connect Blocks**.



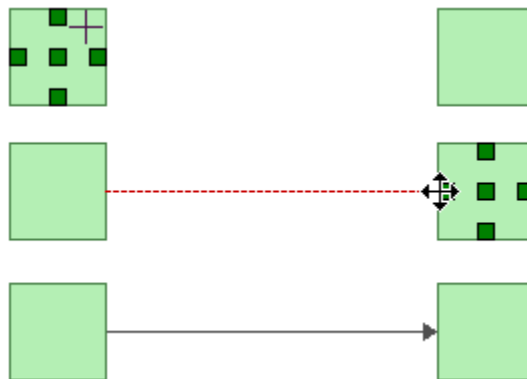
- Hold down the **ALT** key while selecting the source block and then drag a line to the destination block.

In both methods, the pointer will change to display small crosshairs. Click the source block, hold down the left mouse button and drag a line from the source block to the destination block. When the crosshairs are located above the destination block, release the mouse button to create a connector.



The location where the connector attaches to each block is determined by your selection in the **Automatic Connection Preference** field on the Connector Handles and Indicators page of the Diagram Style window. If the field is set to **Left-Right**, the connector will attach to the sides of the blocks; if it is set to **Top-Bottom**, the connector will attach to the top and bottom of the blocks. If **No Preference** is chosen, the connector will attach to the closest edges.

If you have selected **Custom** in the **Bend Style** field on the Connector page of the Diagram Style window, then when you are connecting blocks, five boxes will appear on each block that you point to. These boxes are connection points. You can click a connection point to use it as the location where the connector connects to the block. This allows you to draw connectors to and from any side of a block. The center connection point places the line using the default routing scheme, as defined in the **Automatic Connection Preference** field on the Connector Handles and Indicators page of the Diagram Style window.



Note that once you have added a connector that uses the Custom bend style, you can click the connector and drag the selected point to create a bend in the line. These custom bends can be removed by clicking the connector and choosing **Diagram > Properties > Line Bend > Remove All Bend Points** or, to remove a single bend point, by clicking the bend point and choosing **Diagram > Properties > Line Bend > Remove Bend Point**.

To stop adding connectors and return the pointer to its normal mode, release the **ALT** key or right-click the diagram or clear the **Connect Blocks** option by choosing the command again.

Tip: If you do not right-click the diagram or clear the **Connect Blocks** option to return the pointer to its normal mode, you will not be able to perform certain activities in RBI, such as moving or deleting blocks. If you are experiencing difficulties with the software, make sure that the pointer is in its normal mode.

28.5.5 Using the Format Painter Tool

You can use the Format Painter tool to copy the block properties from one block and apply them to another block in the current diagram. To use, select the block with the properties that are to be copied and then choose **Home > Clipboard > Format Painter**.



The mouse pointer will turn into a pointing hand. Next, click the block to which the properties are to be applied. The properties of the source block will be applied to the destination block.

28.6 Diagram Appearance

For diagrams in a Synthesis application, there are several ways to customize the appearance to fit your particular preferences and needs. Depending on the application, this may include:

- An RBD, fault tree or flowchart in BlockSim/RENO.
- An integrated RBD in Weibull++/ALTA.
- A functional block diagram (*see Section 28.1 on page 483*), process flow diagram (*see Section 28.2 on page 485*) or cause and effect diagram (*see Section 28.3 on page 486*) in Xfmea/RCM++/RBI.

For any of these situations, you have the ability to:

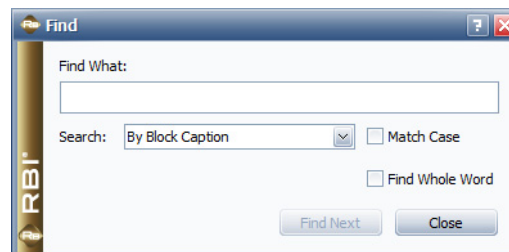
- Use the **Diagram Style** window to customize the properties of the diagram and to specify default settings for the blocks and connectors within the diagram. These default settings are used for all new blocks added to the diagram; in addition, if you change the block and/or connector settings in the Diagram Style window, the changes will be applied to all blocks and/or connectors that are using the diagram defaults (i.e., all blocks and/or connectors that do not have customized settings).
- Save the Diagram Style settings as **reusable diagram skins**.
- Use the **Block Style** window to customize properties for one or more selected blocks.
- Use the **Connector Style** window to customize properties for one or more selected connectors.

The commands for these features are located on the diagram's **Format** tab.

See the Diagram Appearance Help file for information about changing the diagram appearance.

28.7 Diagram Find Window

The Find window allows you to search through the current diagram for text and/or numbers. To open the Find window, choose **Home > Edit > Find**.



- Use the **Find What** field to type the text and/or number you want to find in the current diagram.
- Use the **Search** field to find the text and/or number by block caption.
 - **By Block Caption** searches for the block(s) with the text and/or number in the block caption.
- Select **Match Case** to find only the text in the current sheet with the same case. For example, the search term “teXt” will not find “Text” because the case does not match.
- Select **Find Whole Word** if you want to find only the text where the entire word matches the text and/or number you specified in the Find What field. If your search term makes up only part of a word, that word will not be found.

Click **Find Next** to find the next matching text and/or number. When the text and/or numbers are found, the cursor will go to that particular block.

Printing Plots and Diagrams

29

The following sections describe the various printing options that are available in RBI, including:

- Page Setup - Section 29.1 (p. 497).
- Print Preview - Section 29.2 (p. 502).

You can print plots directly from the Plot Viewer by clicking the **Print** icon on the Plot Viewer control panel. You can print diagrams by choosing **Home > Print > Print**.



Before printing a plot, you can set the printing properties in the Page Setup window by clicking the **Print Preview** icon on the Plot Viewer Control Panel to open the Print Preview window and then clicking the **Page Setup** icon to open the Page Setup window. (For diagrams you can choose **Home > Print > Print Setup**.) The Page Setup window allows you to set the margin properties and the orientation of the printed page and to change the printer options.

When printing pareto (bar) charts or Occurrence/Severity Matrix charts, it is recommended that you set the orientation of the printed page to landscape. When the orientation is set to portrait, the chart may appear stretched.

When printing pie charts with the orientation set to portrait, the pie details, legend and user information may be cut off on the printed page because the chart is too wide to fit the page. If this occurs, change the orientation to landscape or remove the details and/or the legend/user information from the plot via the Plot Setup window.

You can also print plots from RS Draw. Please note that any details that are not fully displayed on the plot in the Plot Viewer will not appear in RS Draw. If this occurs, remove the pie details and/or the legend/user information from the plot via the Plot Setup window.

29.1 Page Setup

Page Setup allows you to make selections for how the page(s) will be printed. From the Print Preview window, you can open the Page Setup window by clicking **Page Setup**. For diagrams, you can open the Page Setup window by choosing **Home > Print > Page Setup**.



The Page Setup window is made up of three tabs. The appearance of this window will vary depending on where you opened the window from (e.g., from a plot or from a diagram.). Each of the tabs in the Page Setup window and its components are presented next.

The **Properties** button is always available. It opens the Windows Page Setup window, which allows you to set printing properties for the selected printer.

29.1.1 Page Tab

The Page tab of the Page Setup window allows you to set the layout, scaling and options of the page for the printed plot or diagram.



The following option is available for plots and diagrams:

- **Orientation** displays how the sheet will be printed on the page. (The orientation can also be specified in the Windows Page Setup window, accessed by clicking **Properties**.)

For plots the following option applies:

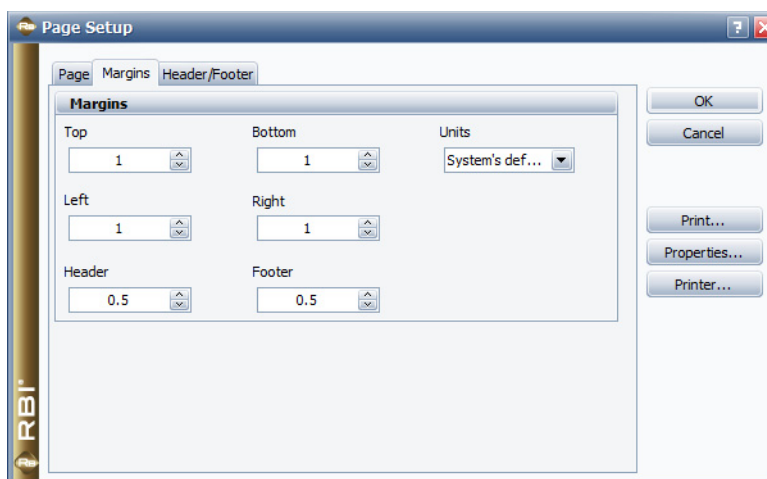
- **Options**
 - **Keep Aspect Ratio** allows you to keep the ratio of the plot height to width when the plot is printed. If your printed plot goes off the page, checking this option can help.

For diagrams the following options apply:

- **Scaling**
 - **No Fit (100%)** prints the item at its actual size.
 - **Fit to __ page(s) wide by __ tall** allows you to specify the number of pages you want the diagram printed on.
- **Options** allows you to specify the details of the printing process.
 - **Stick Pages** prints the pages without margins.
 - **Print Empty Pages** prints any blank pages in the item. If not selected, blank pages will not be printed.

29.1.2 Margins Tab

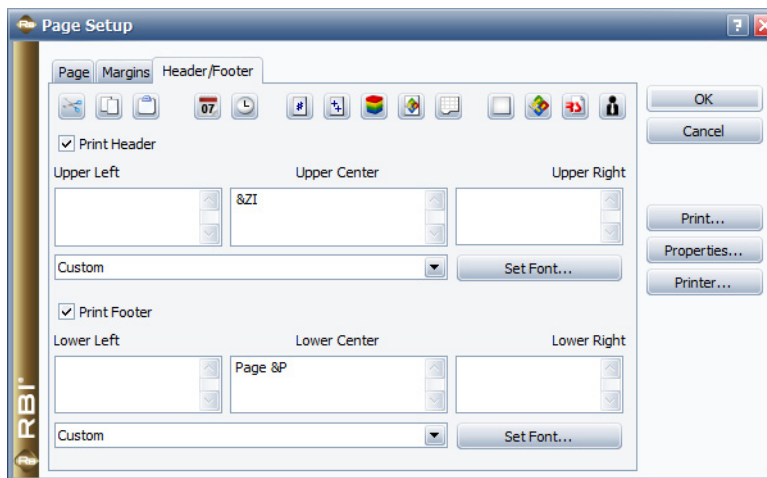
The Margins tab of the Page Setup window allows you to set the margins for the printed page. You can specify the top, bottom, left and right margins, as well as the margins for the header and footer.



- **Units** allows you to specify the units in which the margins will be printed.
 - **System's defaults** uses the units used by your computer as the measurement unit by which the margins will be printed. *See page 13 in Chapter 1.*
 - **Inches** uses inches as the measurement unit by which the margins will be printed.
 - **Centimeters** uses centimeters as the measurement unit by which the margins will be printed.

29.1.3 Header/Footer Tab

The Header/Footer tab of the Page Setup window allows you to edit the header and footer for the printed page.



The Header and Footer sections of this window have similar customization options, as explained next.

- **Print Header** prints the header information.
- **Print Footer** prints the footer information.
- The **Header/Footer Preview Display Boxes** displays the header/footer format codes and their alignment on the page (left, center or right). *See Section 29.1.4 on page 501.*

- **Header/Footer Format** allows you to select a predefined header/footer format from the drop-down lists. With the exception of the **Custom** option, the available header/footer format options are different for headers and footers.
 - **Custom** allows you to create a custom header/footer format.
- **Set Font** opens the Select Font window, which allows you to specify the font properties to be used in the header or footer.

The toolbar on the Header/Footer page allows you to edit the text and insert fields into a section of the header or footer and contains the following tools:



Cut cuts the selected text to the Clipboard. Data stored in the Clipboard can be pasted into this and other applications.



Copy copies the selected text to the Clipboard. Data stored in the Clipboard can be pasted into this and other applications.



Paste pastes the contents of the Clipboard into the current control.



Date inserts the date.



Time inserts the time.



Page Number inserts the page number.



Number of Pages inserts the total number of pages.



Repository inserts the path to the current repository.



Project inserts the project name.



Sheet Name: For diagrams, prints the diagram name. For plots, nothing will be inserted.



Item Name: This option is not currently used by the software. Nothing will be inserted.



Application Name inserts the program name (i.e., RBI).



Company Name inserts the company name specified in the User Login and Contact Information window.



User Name inserts the user name specified in the User Login and Contact Information window.

29.1.4 Header/Footer Format Codes

The format codes that can be used for printing headers and footers are presented next.

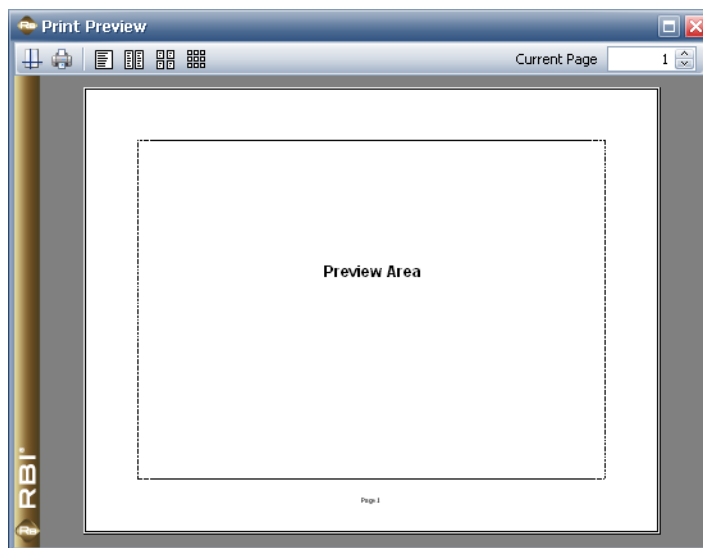
Format Code	Description
&L	Left aligns the item.
&C	Center aligns the item.
&R	Right aligns the item.
&A	For diagrams, this prints the diagram name. For plots, nothing will be inserted.
&D	Prints the current date.
&T	Prints the current time.
&P	Prints the page number.
&P+number (e.g., &P+2)	Prints the page number plus the specified number.
&P-number (e.g., &P-2)	Prints the page number minus the specified number.
&&	Prints an ampersand.
&N	Prints the total number of pages.
&ZA	Prints the name of the application (i.e., RBI).
&ZC	Prints the company name.
&ZU	Prints the user name.
&ZP	Prints the project name.
&ZI	For diagrams, this prints the item name. For plots, nothing will be inserted.
&ZL	Prints the path to the current repository.

Note: To insert a line break, press **CTRL+ENTER**.

By default, text will be centered in the headers/footers unless otherwise specified. Please note that the alignment codes (e.g., &L, &C, &R) restart each format code section. For example, in the format code &L&P &R&ZI, the page number will be left aligned and the item name will be right aligned.

29.2 Print Preview

Print preview is available for all plots and diagrams. For plots, you can open the Print Preview window by clicking the **Print Preview** icon on the Plot Viewer control panel.



For diagrams, you can choose **Home > Print > Page Preview**.



The toolbar in the Print Preview window contains quick access icons that activate different commands. It also allows you to enter the number of the page that you want to appear in the **Preview** area in the Page input box. For example, if you enter **2**, then the second page of the plot will appear in the **Preview** area. The toolbar also contains the following tools:



Page Setup opens the Page Setup window. *See Section 29.1 on page 497.*



Print sends the plot and associated plot summary information to the printer.



Single Page Layout displays one page in the Preview area.



Double Page Layout displays two pages in the Preview area.



Four Page Layout displays four pages in the Preview area.



Nine Page Layout displays nine pages in the Preview area.

Depending on your screen resolution and screen size, the print preview may be missing some lines. However, the lines will appear on the printout. The print preview will display the correct positioning and location of the data on the preview. The page orientation of the print preview depends upon the orientation selected on the first page of the Page Setup window (i.e., portrait or landscape).

Setup Windows

30

All Synthesis applications provide two setup windows that allow you to customize workspace preferences to fit the way you work:

- The **Synthesis Setup** helps you customize the preferences that apply to every Synthesis application on your computer. These preferences can be changed in any application at any time.
- The **Application Setup** helps you customize the preferences that are specific to the Synthesis application that you are currently using.

For both windows, the preferences are stored on your computer and will be the same for any Synthesis repository that you open. Although some settings may affect display preferences and analysis defaults, they do not affect data that have already been saved in a database. In other words, different users can have different preferences and work on the same project in a database without impacting each other's workspace preferences.

Note: Any configurable settings that must be the same for all users cooperating on the same project will be stored and managed directly in the database, as discussed in Chapter 2 on page 60 and other relevant sections.

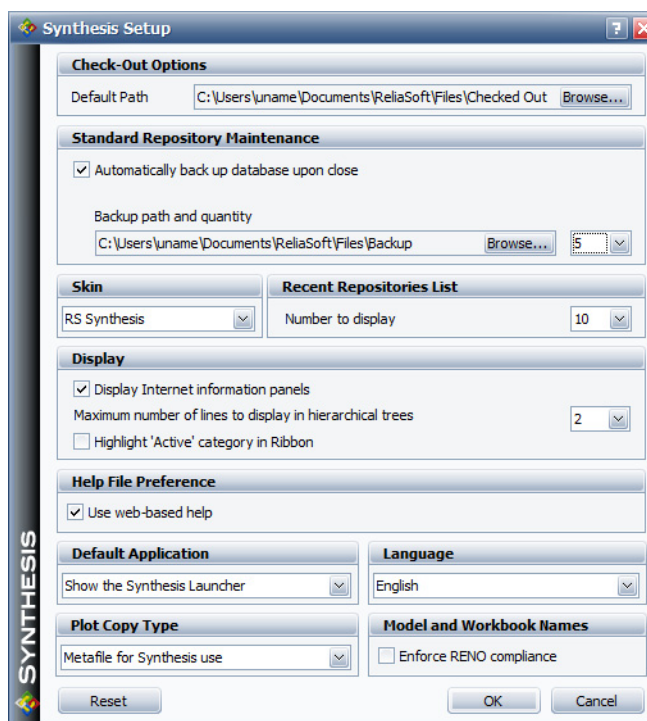
30.1 Synthesis Setup

The Synthesis Setup window contains settings that apply to every Synthesis application on your computer (and can be changed from within any Synthesis application).

To open the Synthesis Setup window, choose **File > Synthesis Setup**.



The Synthesis Setup window is shown next.



The following settings are available:

- **Check-Out Options**

- **Default Path** allows you to specify the default location for projects that you check out from a database.

- **Standard Repository Maintenance**

The following settings are applicable for standard database files (*.rsr9) only. See Chapter 2 on page 67 for more tips on keeping both standard and enterprise databases running smoothly.

- **Automatically back up database upon close** will automatically save a backup of the standard database when you close the application. The backup file will be saved as a repository (*.rsr9) file in the location specified. You can also do this manually at any time by choosing **File > Save As**.
- **Backup path and quantity** allows you to specify the location for saving backup databases and the number of backups that can be saved. Note that only one backup will be saved per day (e.g., if you open and close the same database three times in one day, only the final closing of the database will be saved in the backup folder). The backup file name will be the name of the database file with the date appended to it in year-month-day format (e.g., RSRRepository1_2011-08-15.rsr9). The **Number to display** drop-down list indicates how many days of backups can be automatically saved (up to 10).
- Use the **Skin** drop-down list to change the color scheme of the software interface. Selecting a scheme allows you to preview the changes in the Synthesis Setup window, but the selection will not be applied to the rest of the interface windows until you click **OK**. This setting applies to all Synthesis applications on your computer; the change takes effect the next time you launch each application.

Note: The skins managed here control the overall appearance of the interface. Some Synthesis applications also offer diagram skins, which control the default appearance of new diagrams. See page 496 in Chapter 28.

- In the **Recent Repositories List** area, use the **Number to display** drop-down list to set the maximum number of recently saved database files to be displayed in the **Recent Repositories** list in the Backstage view.

- **Display**

- If you would like to hide the ReliaSoft Online pane in the Backstage view and the Reliability Web Notes page in My Portal (e.g., because you do not have an Internet connection or you simply want to save the space allocated to these features), clear the **Display Internet information panels** check box.
- **Maximum number of lines to display in hierarchical trees** allows you to set the maximum number of lines to display the names and descriptions in any of the hierarchical tree interfaces within any Synthesis application on this computer (such as the system hierarchies in Xfmea, RCM++, RBI, Lambda Predict and MPC).
- Select the **Highlight ‘Active’ category in Ribbon** check box to apply the highlight color to the label that shows which tabs in the Ribbon are currently active.

- **Help File Preference**

- Select the **Use web-based help** check box to always access the web-based version of the help files. Clearing the check box provides access to the local version of the help files.
- Use the **Default Application** drop-down list to select which Synthesis application will open when you double-click a database file (*.rsr9) or enterprise connection file (*.rserp). If you want to be prompted to choose which Synthesis application to open each time you double-click a file, select **Show the Synthesis Launcher**.
- Use the **Language** drop-down list to select which language the Synthesis applications will use for the software interface. Note that this option will not be visible/applicable for applications that are currently available only in English. For a list of the applications and their supported languages, see <http://www.ReliaSoft.com/languages/index.htm>.
- Use the **Plot Copy Type** drop-down list to select which method to use by default when copying a plot to the Clipboard as an image. If you will be pasting copied plots into Synthesis spreadsheets (e.g., analysis workbooks), choose **Metafile for Synthesis Use**. If you will be pasting them into external applications, choose **Bitmap** or **Metafile for External Use**. This default setting is used when you copy a plot using **Home > Copy** or **CTRL+C**.
 - In Weibull++, ALTA, BlockSim, RENO, RGA and DOE++, if you want to choose the graphic type on the spot, you can do so by choosing **Plot > Copy Plot Graphic**, and then selecting the type.
 - In Xfmea, RCM++, Lambda Predict and RBI, you can choose the graphic type on the spot by right-clicking the plot and choosing the **Copy Plot Graphic** command on the shortcut menu.
- In the **Model and Workbook Names** area, you can select the **Enforce RENO compliance** check box to disallow spaces and special characters in names of models and analysis workbooks. This will ensure that all models and analysis workbooks can be used in RENO equations.

To reset all the options in the Synthesis Setup back to their default settings, click the **Reset** button at the bottom of the window. The change will apply to all Synthesis applications on this computer.

30.2 Application Setup

The Application Setup window contains the settings that apply specifically to RBI.

Note that the region and language settings on your particular computer will have some impact on the way information (e.g., dates and times) is displayed in the application.

To open the Application Setup window, choose **File > Application Setup**.

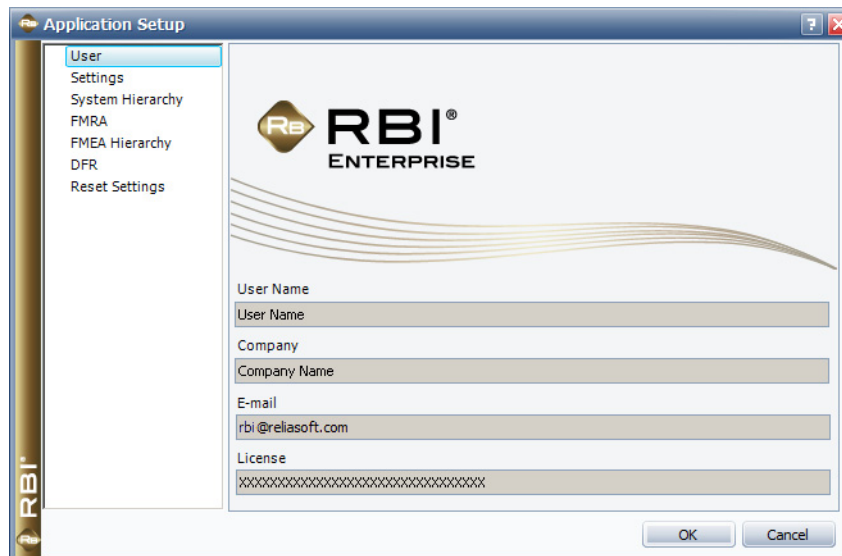


The following pages are available for RBI:

- User - Section 30.2.1 (p. 506)
- Settings - Section 30.2.2 (p. 507)
- System Hierarchy - Section 30.2.3 (p. 508)
- FMRA - Section 30.2.4 (p. 509)
- FMEA Hierarchy - Section 30.2.5 (p. 510)
- DFR - Section 30.2.6 (p. 511)
- Reset Settings - Section 30.2.7 (p. 512)

30.2.1 User Page

In all Synthesis applications, the User page of the Application Setup displays the product registration information for the current registered user of the software. This information, which includes the user's name, company and e-mail address as well as the product license key, is based on the information that you provided to ReliaSoft when you registered and activated the application. If you want to change this information, you can do so via the Contact Information tab of the License Manager (**File > Help > License Manager**). *See page 134 in Chapter 4.*



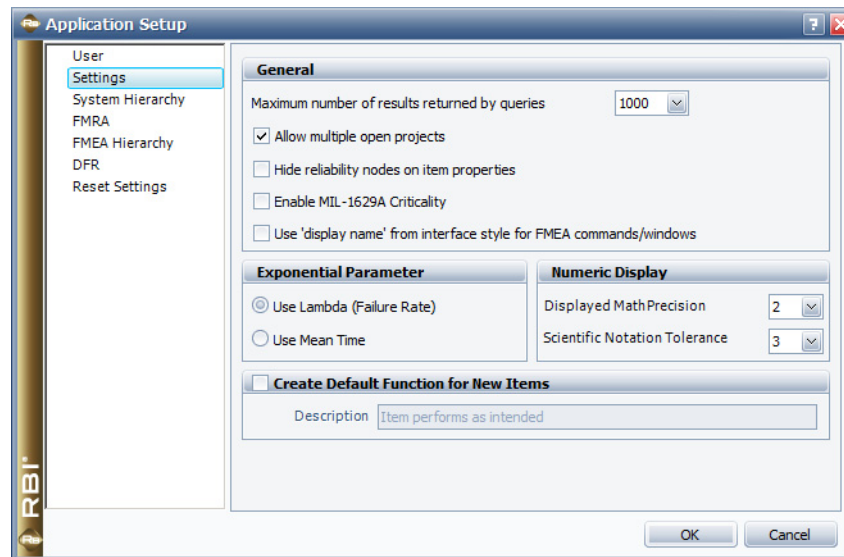
Note that the e-mail address shown here is your ReliaSoft ID. This address, along with the user name and company information associated with it, is used solely for the purpose of activating/deactivating the application on this computer. It is unrelated to personal information that is used elsewhere in the software, specifically:

- In plots and in some report output
- For notification e-mails, if enabled for the database

The contact information used in these locations is based on your user account in the current database, and is managed via the User Login and Contact Information window (**My Portal > Users > My Profile**). *See page 51 in Chapter 2.* This means that any changes you make to this information will apply only to the current database. You will need to make the changes, if they are applicable, for each database that you work with.

30.2.2 Settings Page

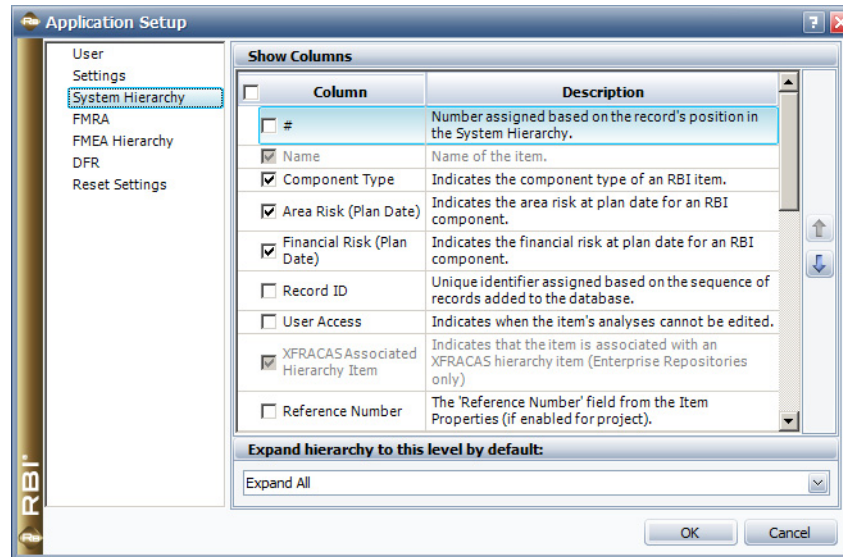
The Settings page of Xfmea/RCM++/RBI's Application Setup allows you to set some other preferences that are applicable only to Xfmea/RCM++/RBI.



- **General**
 - **Maximum number of results returned by queries** allows you to choose the maximum number of results to display when you are using the Query Utility.
 - By default, you can have multiple projects open at the same time. To allow only one open project at a time, clear the **Allow multiple open projects** check box.
 - Select the **Hide reliability nodes on item properties** check box if you wish to hide the Operation, Reliability/Availability and Reliability Policy areas on the Properties tab of the Analysis panel. These areas can be used to define the reliability and maintenance characteristics of the selected item for use in criticality analysis, RCM cost/availability calculations and/or the FMRA. Note that you can still work with the reliability policy by using the Failure Modes and Reliability analysis (FMRA).
 - Select the **Enable MIL-1629A Criticality** check box if you wish to be able to access the MIL-1629A Criticality Analysis utility. This utility provides an alternative to the standard criticality analysis that is performed directly in the FMRA. *Refer to page 379 in Chapter 16 for more details.*
 - Select the **Use 'display name' from interface style for FMEA commands/windows** check box if you wish to use the display name from the interface style (which is configurable for each project), rather than the property name (which is the same for each project) for the FMEA Ribbon commands and properties windows. (This option is available in 9.0.2 and higher.)
- **Exponential Parameter** allows you to specify whether lambda or mean time will be used to define probability models that use an exponential distribution.
- **Numeric Display**
 - **Displayed Math Precision** allows you to set the mathematical, decimal tolerance shown in the FMRA view and with the mode criticality and item criticality used with criticality analysis. Please note that the tolerance on the precision is limited by Windows to 15 digits.
 - **Scientific Notation Tolerance** sets the point at which the software will switch to scientific notation for the calculated results.
- To automatically add an FMEA and create a default function for newly created system hierarchy items, select the **Create Default Function for New Items** option and enter the default text in the **Description** field.

30.2.3 System Hierarchy Page

The System Hierarchy page of Xfmea/RCM++/RBI's Application Setup allows you to specify your personal display preferences for the system hierarchy. These settings are stored per computer/username, and different users may have different display preferences without affecting the stored data.



For more information about the specific columns that are available for this hierarchy, refer to page 210 in Chapter 7.

The table contains the same options that are also available when you right-click inside any column header in the system hierarchy and choose **Customize Columns**.

- To choose which columns to display, use the check boxes.
- To change the column order, use the arrow buttons to move the selected field up or down in the list. You can also drag/drop a field into the desired position.
- To restore the default settings for all hierarchies in the current application, you can click the **Reset Application Form Settings** or **Reset All Settings** buttons on the Reset Settings page of the Application Setup.

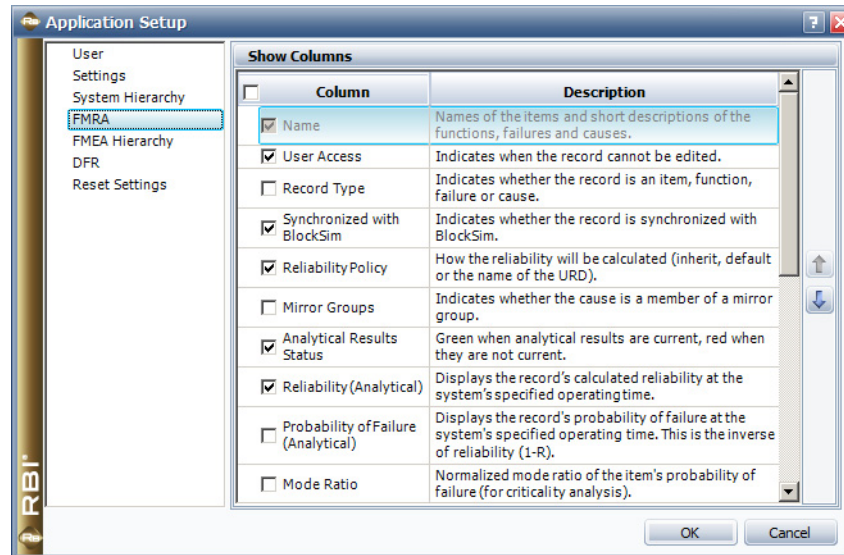
Tip: If you want to restore only the settings for one particular hierarchy without resetting any other application form settings, you can delete the specific file from C:\Documents and Settings\USERNAME\Application Data\ReliaSoft\APPLICATION\TreeLists_Settings_V9, where USERNAME is your Windows login and APPLICATION is either Xfmea9, RCM9, RBI9, MP9 or Lambda Predict9. For example, to reset only the system hierarchy in Xfmea/RCM++/RBI, delete the file called frmFMEA_treeSystem.

Other Options

The **Expand hierarchy to this level by default** drop-down list allows you to choose which level(s) in the hierarchy will be visible by default. If you prefer to see all nodes in the hierarchy expanded so all records are visible, choose **Expand All**. If you prefer to have some nodes collapsed by default when you first view a particular hierarchy, choose another option from the drop down list.

30.2.4 FMRA Page

The FMRA page of Xfmea/RCM++/RBI's Application Setup allows you to specify your personal display preferences for the FMRA page of the System panel. These settings are stored per computer/username, and different users may have different display preferences without affecting the stored data.



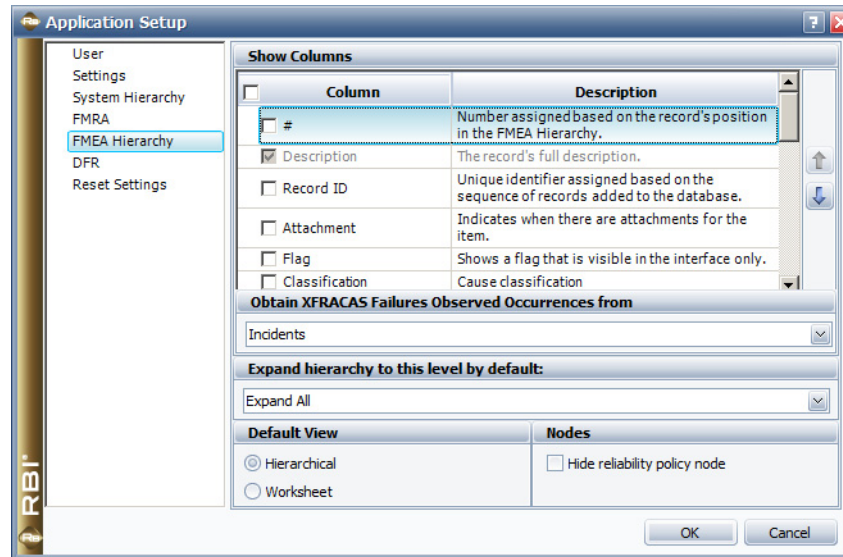
For descriptions of the available columns, refer to page 227 in Chapter 8.

The table contains the same options that are also available when you right-click inside any column header in the FMRA view and choose **Customize Columns**.

- To choose which columns to display, use the check boxes.
- To change the column order, use the arrow buttons to move the selected field up or down in the list. You can also drag/drop a field into the desired position.
- To restore the default settings for all hierarchies in the current application, you can click the **Reset Application Form Settings** or **Reset All Settings** buttons on the Reset Settings page of the Application Setup.

30.2.5 FMEA Hierarchy Page

The FMEA Hierarchy page of Xfmea/RCM++/RBI's Application Setup allows you to specify your personal display preferences for the FMEA hierarchy view. These settings are stored per computer/username, and different users may have different display preferences without affecting the stored data.



For descriptions of the available columns, refer to the page 346 in Chapter 14.

The table contains the same options that are also available when you right-click inside any column header in the FMEA hierarchy and choose **Customize Columns**.

- To choose which columns to display, use the check boxes.
- To change the column order, use the arrow buttons to move the selected field up or down in the list. You can also drag/drop a field into the desired position.
- To restore the default settings for all hierarchies in the current application, you can click the **Reset Application Form Settings** or **Reset All Settings** buttons on the Reset Settings page of the Application Setup.

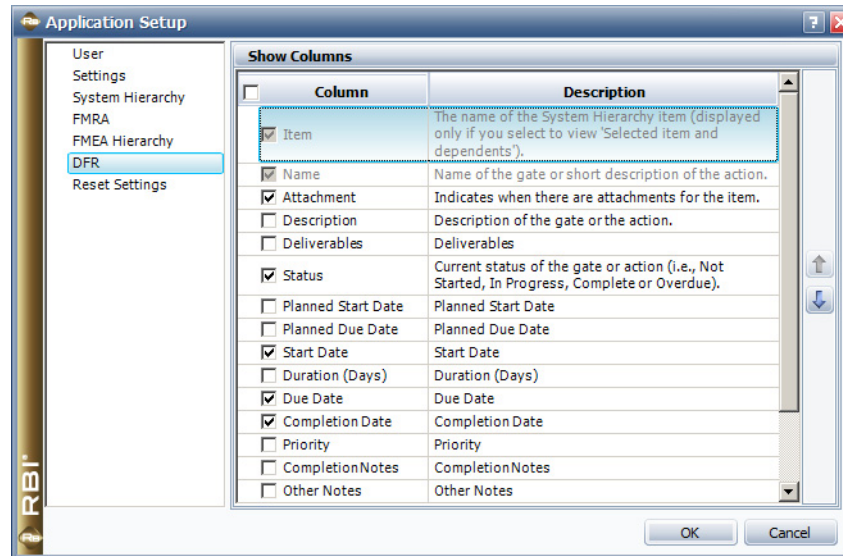
Other Options

- **Obtain XFRACAS Failures Observed Occurrences from** allows you to choose where failures imported from XFRACAS come from. In XFRACAS, failure modes can be specified for incidents, problems and/or failure analyses, depending on the settings implemented by the system administrator. Therefore, it is necessary to specify which of these locations should be considered when counting the occurrences of failure mode/cause combinations.
 - If you choose **Incidents**, the Observed Occurrences column in the FMEA hierarchy will display the number of incidents with each failure mode/cause combination.
 - If you choose **Problems**, the column will display the number of problems with each failure mode/cause combination multiplied by the number of incidents associated with each problem.
 - If you choose **Failure Analyses**, the column will display the number of failure analyses with each failure mode/cause combination.
- **Expand hierarchy to this level by default** allows you to choose whether to display all hierarchy levels or limit the default view to function, failure, effect or cause levels.

- **Default View** allows you to choose from the hierarchical or worksheet view.
- **Nodes** allow you to hide the Reliability Policy node in the FMEA Hierarchy View. This node can be used to define the reliability and maintainability characteristics of the failure causes for use in criticality analysis, RCM cost/availability calculations and/or the FMRA. *See Chapter 8.* Note that you can still work with the reliability policy by using the FMRA tab of the Ribbon.

30.2.6 DFR Page

The DFR page of Xfmea/RCM++/RBI's Application Setup allows you to specify your personal display preferences for DFR analyses. These settings are stored per computer/username, and different users may have different display preferences without affecting the stored data.



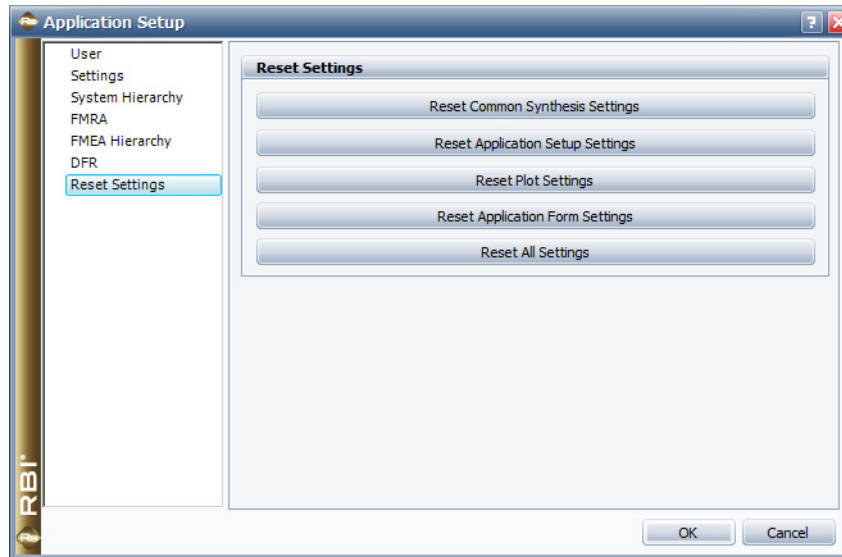
For descriptions of the available columns, refer to page 244 in Chapter 9.

The table contains the same options that are also available when you right-click inside any column header in the DFR view and choose **Customize Columns**.

- To choose which columns to display, use the check boxes.
- To change the column order, use the arrow buttons to move the selected field up or down in the list. You can also drag/drop a field into the desired position.
- To restore the default settings for all hierarchies in the current application, you can click the **Reset Application Form Settings** or **Reset All Settings** buttons on the Reset Settings page of the Application Setup.

30.2.7 Reset Settings Page

The Reset Settings page of the Application Setup is where you reset particular items to their original configuration. Some of these options apply to all Synthesis applications on this computer; others apply only to the application that you are currently using.



- **Reset Common Synthesis Settings** resets only the settings that are shared by all Synthesis applications (i.e., the settings that are managed by via the Synthesis Setup window).
- **Reset Application Setup Settings** resets only the settings that are managed via the Application Setup window for this application.
- **Reset Plot Settings** clears the saved defaults for all pages of the Plot Setup and restores the settings that are shipped with the application.
- **Reset Application Form Settings** resets only the application-specific form setting for this application, such as the size, location and last state of the interface windows.
- **Reset All Settings** resets all common Synthesis settings, application settings, plot settings, etc. This is the same as clicking all of the individual “Reset” buttons above.

Note: When selecting **Reset All Settings**, the default settings are not immediately applied to an open project. To see the changes, you must close, then reopen the project.

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- 1.3 **Location.** Means the postal address of the site where the Application shall be installed. Location shall mean a single physical location.
- 1.4 **Named User(s).** Means the individual(s) permitted to Access the Application, and it refers to specific individuals.
- 1.5 **ReliaSoft License Server.** Means the ReliaSoft server(s) that provides license activation, registered end-user management, license management and license compliance enforcement services for the Application.
- 1.6 **You.** Means the licensee or the individual acquiring the license of this Application and, in either case, the affiliates, employees, contractors and agents of said licensee or individual.

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- (ii) Number of Concurrent Access Licenses (or CALs), which is the maximum number of computers that can Access the Application at any given time.

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CANNOT be split or transferred between multiple organizations in cases of corporate acquisitions or divestitures, except as allowed in items (a) and (b) of this section (Section 4.2), and with ReliaSoft Corporation's written consent.

In the case of Standard and Concurrent Network Licenses, Named User Activations can be deactivated and replaced by new users on a **permanent** basis. In other words, replacement of users is allowed to accommodate attrition and reassignment of user responsibilities in the ordinary course of doing business. However, replacing users on a daily, weekly, monthly or even quarterly basis and frequently reactivating users that were previously replaced is an indication that the number of Named Users (for Standard Network Licenses) or Named User Activations (for Concurrent Network Licenses) obtained by You is not adequate to serve the pool of users intending to Access the Application and is therefore prohibited. Each Standard Network License seat or Concurrent Network Named User Activation can be reassigned to a different Named User no more than two times in a year.

In cases of corporate acquisitions or divestitures: (a) Standard Network and Concurrent Network licenses remain with the organization that originally obtained the licenses, (e.g., if the organization that holds the license is acquired by another entity, the licensing rights will be transferred to the acquiring entity); (b) Unlimited Site-Wide licenses remain with the original licensing site and therefore pass on to the owner of the specific licensing site as long as the site continues to exist; (c) Unlimited Division-Wide licenses remain with the organization that originally obtained the licenses in cases where the Division is being partially divested, and are terminated when the Division is fully divested. As an example, in a partial divestiture, the portions of the Division divested will not have access to the Division-Wide license whereas the portions of the Division that remain will continue to have access to the Division-Wide license; and (d) Unlimited Corporate-Wide licenses remain with the organization that originally obtained the licenses as long as said organization divested a portion of its business or acquired other organizations, and are terminated in cases where said organization was acquired by another organization. As an example, in a partial divestiture, the portions of the corporation divested will not have access to the Corporate-Wide license whereas the portions of the corporation that remain will continue to have access to the Corporate-Wide license. As a further example, an organization with a Corporate-Wide license having acquired other entities (either in part or in whole) will continue to have the same licensing rights as before the acquisition and can therefore deploy the same licensing rights to the newly acquired entities.

This section also applies to Standard Network and Concurrent Network License Rentals.

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- 5.3 **Proprietary Notices.** All title, trademarks, copyrights and intellectual property rights in and pertaining to the Application (including but not limited to any copies thereof, software structure and organization, source code, images and new releases) are valuable property of ReliaSoft Corporation and are owned or licensed by ReliaSoft Corporation. You may not intentionally remove, alter or destroy any form of copyright and trademark notices, proprietary markings or confidential legends placed upon or contained within the Application, including but not limited to any such notices contained in physical and/or electronic media or documentation, in the Application interface boxes, or in any of the runtime resources, code or other embodiments originally contained in or dynamically or otherwise created by the Application.
- 5.4 **Use of ReliaSoft Corporation's Marks.** You may not use the name, logos, trade names or trademarks of ReliaSoft Corporation or any of its affiliates in any manner including, without limitation, in your advertising, promotional literature or any other material, whether in written, electronic, or other form distributed to any third party, except in the form provided by ReliaSoft Corporation and then solely for the purposes of identifying your use of the ReliaSoft Corporation Application.
- 5.5 **Verification.** You will provide, on ReliaSoft Corporation's reasonable written request, written verification that the Application is being used according to the terms of this Agreement. Upon thirty days prior written notice, if ReliaSoft Corporation has reasonable grounds to believe that this Agreement has been breached, ReliaSoft may audit your use of the Application provided such audit is: (a) limited to records relating solely to the Application necessary to verify compliance with the terms of this Agreement; (b) performed by a reputable independent third party auditor acceptable to You (acting reasonably); (c) the third party auditor shall comply with your standard security policies; (d) the third party

auditor shall execute your standard protective non-disclosure agreement; and (d) the cost of any requested audit will be solely borne by ReliaSoft Corporation if no breach is found as a result of the audit or will be solely borne by You if a breach is found. Such audit shall occur no more than once every twelve months and shall not unreasonably interfere with your normal business operations.

- 5.6 **Modification.** ReliaSoft Corporation reserves the right to modify or enhance the Application without obligation to notify You of such changes or to furnish them to You, unless otherwise agreed upon with a separate agreement (such as an annual maintenance agreement).
- 5.7 **Copying.** You may not, under any circumstances, copy the Application, in whole or in part, except as expressly provided under the Copyright section above.
- 5.8 **Separation of Components.** The Application is licensed as a single product. Its component parts may not be separated for use on more than one computer.
- 5.9 **Rental or Other Exploitation.** You may not publish, sub-license, re-license, assign, sell, distribute, license, transfer, rent, lease or lend the Application to any party, except transfer the Application as expressly provided under the Transfer section above. If you received any revenues from the unlawful distribution of the Application, such revenues will be forfeited to ReliaSoft Corporation.
- 5.10 **Fees.** You will pay ReliaSoft Corporation all fees or other amounts due under this Agreement, plus any and all applicable taxes, within the payment term due date specified on the respective invoice. In the event that the respective invoice is not paid on time, or at all, ReliaSoft Corporation reserves the right to terminate this Agreement and revoke the corresponding licenses issued to You within the scope of this Agreement.
- 5.11 **Termination.** Without prejudice to any other rights, ReliaSoft Corporation may terminate this Agreement if You fail to comply with the terms and conditions of this Agreement and such breach is not cured within thirty days of notice of such breach. In such event, You must destroy all copies of the Application and all of its component parts. Additionally, You may be held liable for any damage or loss of profit caused to ReliaSoft Corporation arising from unauthorized use or duplication of this Application.
- 5.12 **Supplemental Licenses.** If, after the effective date of this Agreement, You subsequently purchase additional licenses of the Application, these supplemental licenses will be included under this Agreement.
- 5.13 **Press Releases.** As part of this Agreement, You acknowledge that ReliaSoft Corporation may make reference to You as a customer of ReliaSoft Corporation in press releases, advertising and promotional materials, and You consent to any such reference. ReliaSoft Corporation will NOT disclose any further details beyond referring to You as a customer without prior written consent, not to be unreasonably withheld.
- 5.14 **Relationship.** You and ReliaSoft Corporation are independent contractors and neither is an agent, joint venture partner, partner or employee of the other, and ReliaSoft Corporation will not be obligated by any agreements or representations made by You to any person, nor with respect to any other action by You, nor will ReliaSoft Corporation be obligated for any damages to any person, whether caused by your actions, failure to act, negligence or willful conduct.
- 5.15 **Upgrades.** If the Application is an upgrade from another product, whether from ReliaSoft Corporation or another supplier, You may use or transfer the Application only in conjunction with that upgraded product, unless You destroy the upgraded product. If the Application is an upgrade of a ReliaSoft Corporation product, You may use the upgraded product only in accordance with this Agreement. If the Application is an upgrade of a component of a package of software programs that You licensed as a single product, the Application may be used and transferred only as part of that single product package and may not be separated for use on more than one computer.
- 5.16 **U.S. Government Restricted Rights.** The Application was developed at private expense. No portion of the Application was developed with government funds and the Application is a trade secret of ReliaSoft Corporation for all purposes of the Freedom of Information Act. The Application and documentation are provided with RESTRICTED RIGHTS. Use, duplication or disclosure by the Government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013 (or its successor) or subparagraphs (c)(1) and (2) of the Commercial Computer Software Restricted Rights at 48 CFR 52.227-19 (or its successor), as applicable. Manufacturer is ReliaSoft Corporation, 1450 S. Eastside Loop, Tucson, Arizona 85710, USA.
- 5.17 **Limited Warranty.** ReliaSoft Corporation warrants that: (a) the Application will perform substantially in accordance with the accompanying written materials, and on machines meeting the published minimum requirements, for a period of sixty (60) days from the date of receipt; and (b) any media on which the Application is furnished will be free from defects for a period of sixty (60) days from the date of receipt. Some states and jurisdictions do not allow limitations on duration of an implied warranty, so the above limitation may not apply to You; in such states and jurisdictions the liability of ReliaSoft Corporation shall be limited to the minimum extent permitted by law. To the extent allowed by applicable law, implied warranties on the Application and media, if any, are limited to sixty (60) days; and (c) at the time of installation, the Application will be free from any mechanism, feature or any other codes or instructions that: (i) cause the Application to remotely transmit information to ReliaSoft or any third party, except to communicate with one of ReliaSoft's servers to

facilitate specific functions of the Application (such as to communicate with the ReliaSoft License Server, access the online help files, etc.); or (ii) may be used to permit Access to, or use of, the Application or computer system on which the Application is loaded, or to which the Application is linked, by ReliaSoft or any third party.

- 5.18 Customer Remedies.** ReliaSoft Corporation's and its suppliers' or licensors' entire liability and Your exclusive remedy shall be, at ReliaSoft Corporation's option, either (a) return of the fee paid for the Application, or (b) repair or replacement of the Application or media that does not meet ReliaSoft Corporation's Limited Warranty and which is returned to ReliaSoft Corporation with a copy of your receipt or invoice. Any replacement Application or media will be warranted for the remainder of the original warranty period or thirty (30) days, whichever is longer. None of these remedies nor any product support services offered by ReliaSoft Corporation are available without a valid License Certificate issued by ReliaSoft Corporation.
- 5.19 Warranty Exclusions.** The Limited Warranty is void if the damage or defect has resulted from accident, abuse or misapplication. Any modification of the Application by any person other than ReliaSoft Corporation shall void this warranty. Any manipulation of the Application's data storage infrastructure or direct storage of data into the Application's data storage from outside the Application by any person other than ReliaSoft Corporation or ReliaSoft Corporation's authorized representative shall void this warranty. The warranties in this section extend only to You and are contingent upon proper use of the Application. The warranties will not apply to any failure caused by (a) accident, (b) unusual physical, electrical or electro-magnetic stress, (c) negligence, (d) misuse, (e) failure of electrical power, air conditioning or humidity control, (f) use of the Application with any equipment or software not reflected in ReliaSoft Corporation's specifications, (g) installation, alteration or repair of the Application by anyone other than ReliaSoft Corporation or ReliaSoft Corporation's authorized representative, or (h) or installation on equipment on which the original identification marks have been removed or altered.
- 5.20 No Other Warranties.** No oral or written information or advice given by ReliaSoft Corporation, its suppliers, dealers, distributors or agents shall create a warranty or in any way increase the scope of the Limited Warranty, and You may not rely on any such information or advice as a warranty.
- 5.21 Use of Results Provided By the Application Disclaimer.** You understand that the results provided by the Application cannot replace judgment required for important decisions. Use of the results provided is done completely at your own risk. ReliaSoft Corporation does not warrant that the functions of this Application will meet your requirements or be error free. You assume all risk of the use, quality and performance of the Application, and You are advised to use your own discretion and judgment regarding the use of the Application.
- 5.22** RELIASOFT CORPORATION, ON BEHALF OF ITSELF AND ITS LICENSORS, DISCLAIMS ALL OTHER WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WITH REGARD TO THE APPLICATION. IN NO EVENT SHALL RELIASOFT CORPORATION OR ITS SUPPLIERS OR LICENSORS BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES WHATSOEVER (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF BUSINESS INFORMATION OR ANY OTHER PECUNIARY LOSS) ARISING OUT OF THE USE OF OR INABILITY TO USE THE APPLICATION, EVEN IF RELIASOFT CORPORATION HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. USE OF THIS APPLICATION IS DONE COMPLETELY AT YOUR OWN RISK, INCLUDING THE USE OF RESULTS PROVIDED BY THIS APPLICATION. RELIASOFT CORPORATION'S LIABILITY HEREUNDER SHALL BE LIMITED TO PHYSICAL DAMAGE DIRECTLY CAUSED BY THE SOLE NEGLIGENCE OF RELIASOFT CORPORATION AND SHALL NOT EXCEED THE PRICE PAID FOR THE SOFTWARE PRODUCT. NOTWITHSTANDING ANYTHING HEREIN TO THE CONTRARY, THE FOREGOING DISCLAIMER AND LIMITATION OF LIABILITY SHALL NOT APPLY TO RELIASOFT CORPORATION'S OBLIGATIONS UNDER ANY CLAIM OF INFRINGEMENT AS DESCRIBED IN SECTION 5.28 OF THIS AGREEMENT.
- 5.23 Venue.** Venue for any proceedings arising out of or relating to this Agreement shall be in Tucson, Pima County, Arizona. The parties disclaim the application of the United Nations Convention on Contracts for the International Sale of Goods. This Agreement is governed by the laws of the State of Arizona, USA, without reference to conflict to law principles. Each party to this Agreement submits to the exclusive jurisdiction of the state and federal courts in the State of Arizona for the purpose of resolving any disputes arising under or relating to this Agreement. Each party waives any jurisdictional, venue or inconvenient forum objections to such courts.
- 5.24 Legal Expenses.** If legal action is taken by either party to enforce this Agreement, all costs and expenses (including reasonable attorney fees) incurred by the prevailing party in exercising any of its rights or remedies or in enforcing any of the terms, conditions, or provisions of this Agreement will be paid by the other party.
- 5.25 Force Majeure.** ReliaSoft Corporation will not be responsible for delays or failures in its performance due, in whole or in part, to any cause beyond its reasonable control.
- 5.26 Export Control.** Regardless of any disclosure made by You to ReliaSoft Corporation of an ultimate destination of the Application, You will not export, either directly or indirectly any Application without first obtaining all licenses required,

from the U.S. Department of Commerce or any other agency or department of the United States Government, and complying with the applicable laws. Neither the Application nor any direct product thereof may be exported, directly or indirectly, in violation of applicable export laws, or may be used for any purpose prohibited by these laws including, without limitation, nuclear, chemical or biological weapons proliferation. ReliaSoft Corporation will provide You with all reasonable information requested by You in connection to exporting the Application, including providing You with the U.S. Export Controls Classification Number (ECCN) for the Application.

- 5.27 Waiver.** The waiver by either party of any breach of this Agreement shall be in writing and shall not constitute a waiver of any other or subsequent breach. No waiver of any of the provisions of this Agreement will be deemed, or will constitute, a waiver of any other provision, whether or not similar, nor will any waiver constitute a continuing waiver. The failure by a party to enforce any provision of this Agreement will not be deemed a waiver of future enforcement of that or any other provision.
- 5.28 Indemnification.** You will indemnify and hold ReliaSoft Corporation harmless against any and all claims, damages, losses, costs or other expenses (including reasonable attorney fees) that arise directly or indirectly from your breach of this Agreement. ReliaSoft Corporation shall defend, indemnify and hold harmless, at its own expense, You and your assigns, successors, directors, officers and employees (each an "Indemnified Party") against any and all claims incurred by or made against an Indemnified Party by a third party in connection with a claim, suit or action which is based on an allegation that the Application when used by You as authorized under this Agreement, misappropriates or infringes any third party patent, copyright, trade secret or other intellectual property right (each, a "Claim") provided that ReliaSoft Corporation shall have received from the Indemnified Party: (i) notice of such Claim as soon as possible after You receive notice of the Claim; given that a failure to provide notice shall only relieve ReliaSoft Corporation of its indemnity obligation to the extent ReliaSoft Corporation was prejudiced by such failure; (ii) the exclusive right to control and direct the investigation, defense or settlement of such claim; and (iii) all reasonable necessary cooperation by You. If your use of any of the Application is, or in ReliaSoft Corporation's opinion is likely to be, enjoined due to a Claim, ReliaSoft Corporation may, at its sole discretion: (a) modify the Application so that it becomes non-infringing, provided such modifications result in software with substantially similar functionality and performance; (b) procure for You the right to continue using the Application under substantially the same terms and conditions as provided for hereunder; or (c) if (a) and (b) are commercially impracticable, terminate the Agreement and refund to You the license fee paid by You for the Application which is the subject of the Claim as reduced to reflect a three-year straight-line depreciation from the applicable license purchase date. The foregoing indemnification obligation of ReliaSoft Corporation shall not apply: (1) if the Application is modified by any party other than ReliaSoft Corporation and such modification was not authorized in writing by ReliaSoft Corporation, but solely to the extent the alleged infringement is caused by such modification; or (2) to any release of the Application other than the most current release, provided that: (I) the most current release was either made available at no cost to You and (II) You had a commercially reasonable period of time (not to exceed 60 days) after availability of the current release to implement the current release so as to avoid the infringement claim. This section (Section 5.28) sets forth ReliaSoft Corporation's sole liability and your sole and exclusive remedy with respect to any claim of infringement.
- 5.29 Equitable Relief.** You acknowledge and agree that, due to the unique nature of the Application, there can be no adequate remedy at law for any breach of your obligations under this Agreement, that any such breach may allow You or third parties to unfairly compete with ReliaSoft Corporation resulting in irreparable harm and therefore that, upon any such breach or threat thereof, ReliaSoft Corporation shall be entitled to injunctive and other appropriate equitable relief in addition to whatever remedies it may have at law.
- 5.30 Entire Agreement; Amendments.** This Agreement is the complete and exclusive statement of the agreement between the parties and supersedes all prior agreements and communications with respect to the subject matter, and there are no oral representations, understandings or agreements that are not fully expressed herein. Any terms appearing on any order or other form used by You which modify or conflict with the terms and conditions set forth herein are expressly rejected. Except for the purpose of negating implied warranties, no course of prior dealings between the parties and no usage of the trade shall be relevant to supplement or explain any term used in this Agreement. No ReliaSoft Corporation employee other than an officer of ReliaSoft Corporation (Vice President and above) shall have any actual or apparent authority to modify the terms of this Agreement in any way. All amendments shall be in writing and signed by the authorized representative of ReliaSoft Corporation.
- 5.31 Severability.** If any one or more of the provisions of this Agreement shall for any reason be held to be invalid, illegal or unenforceable in any respect, any such provision shall be severable from this Agreement, in which event this Agreement shall be construed as if such provision had never been contained herein.
- 5.32 Electronic Signatures.** ReliaSoft Corporation and You agree that this Agreement may be executed electronically and that electronic copies of this Agreement shall be binding upon the parties to the same extent as manually-executed copies.

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