RGA 11 User’s Guide

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Chapter 1: Getting Started

ReliaSoft’s RGA is a powerful software tool that allows you to apply reliability growth models to analyze data from both developmental testing and fielded repairable systems. In the development stage, the software allows you to quantify the reliability growth achieved with each successive design prototype and also provides advanced methods for reliability growth projections, planning and management. For systems operating in the field, RGA allows you to calculate optimum overhaul times and other results without the detailed data sets that normally would be required for repairable system analysis.

The application is also part of the Synthesis Platform, which provides intelligent integration between reliability program activities and tools, while simultaneously facilitating effective information sharing and cooperation between engineering teams of any size. For information about features that are shared by all (or most) of the Synthesis desktop applications, see the Repositories and Projects, Desktop Application Interfaces and Synthesis Platform Tools chapters.

To get started learning about RGA, see New in Version 11: RGA or use the Contents to navigate to a specific topic.

New in Version 11: RGA

Here’s a quick overview of the main new and improved features in RGA Version 11.

Discrete Growth Planning Folio

RGA’s new discrete growth planning folio allows you to create a single- or multi-phase reliability growth testing plan for discrete data (i.e., data from one-shot devices with only two possible outcomes from the test: success or failure).

The folio allows you to make estimates about whether you will be able to achieve your reliability goal with a given management strategy or to determine what strategy will be necessary to meet the goal.

Improved Performance for Spreadsheets

Version 11 brings an updated look to spreadsheets, and improved speed performance when opening, calculating and plotting data folios.
More Flexibility in Project Manager
Version 11 brings enhancements to the Project Manager and Project Explorer to make it even easier to browse or search for a particular project or analysis folio.

**Project Filter**
The project filter now gives the option to select specific projects (instead of only filtering by specific criteria such as "Project Owner"). If you’re working in an enterprise repository with many projects, this makes it easier for you to quickly access the specific projects of interest to you.

**Minimize Visual Clutter**
We've added a new option in the Application Setup to hide empty or unused folders in the Project Explorer.

**Improved Folder Organization**
In Weibull++/ALTA and RGA, the folders in the Project Explorer are now arranged by analysis type, making it easier to find and keep related analyses all in the same folder.

More Target Markers in Plots
When applicable, plots in RGA allow you to display a target marker on the plot to highlight a value of interest such as the MTBF, failure intensity (FI), reliability or unreliability. In Version 11, you can now display up to 5 target markers.

Major Enhancements for the Synthesis Enterprise Portal (SEP)
If your organization chooses to implement a web-based Synthesis Enterprise Portal (SEP) for an enterprise database, the entire team – including managers and colleagues who don't have Synthesis desktop applications installed – will be able to access key analysis and project management details from any web-enabled device.

In Version 11, the SEP has a fresh new look with responsive design for better performance on mobile devices and more control for quickly accessing the information that’s of interest to you. The website provides at-a-glance summaries of the project plans, actions, messages, metrics, dashboards and reports that you need to stay on top of, and makes it easy to drill down for more detail. It also allows users throughout your organization to view the FMEAs and published reports created in ReliaSoft’s Xfmea/RCM++/RBI without having the desktop application installed.
Technical Support

ReliaSoft reliability software products are renowned for their ease of use and unparalleled after sale support. For users with an active maintenance agreement, we provide technical support for software-related issues via a network of regional offices and partners/distributors throughout the world.

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, e-mail or mail. To find the office that serves your region, choose File > Help > Contact Global Support Center or visit http://www.reliasoft.com/contact.htm.

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. 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.
- Your product license key.
  - To determine the license for the application on your computer, you can choose File > Application Setup and click any of the main headings in 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 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 Reliability 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/.

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Reliability Consulting
If your organization does not have sufficient time, expertise or objectivity in-house to accomplish specific reliability goals, turning to ReliaSoft 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, Reliability 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 global resources, expertise and contacts.

- Our team-based approach to consulting, combined with ReliaSoft 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.

Install and License
In addition to the information below, ReliaSoft provides an automated tool that determines whether your computer and Internet connection meet the requirements for running and activating Synthesis. It will also determine whether you could install the 64-bit version of Synthesis, if desired. [Download Requirements and Compatibility Test Tool...]

Operating Systems
32- and 64-bit versions are supported, except where noted. [See our 32-bit vs. 64-bit FAQ...]

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• Microsoft Windows Server 2008 with Service Pack 2, Windows Server 2008 R2 (64-bit version), or newer. (Requires a license that specifically allows server installations/deployments.)

**Note:** Upgrading your operating system after Synthesis has already been installed can cause issues with the activation. To prevent this, it is recommended to uninstall Synthesis prior to upgrading your operating system and then reinstall it after the upgrade. For other options, and for information about how to handle the "activated license is corrupt" message that may appear if you upgrade your operating system with live activations, please refer to [http://www.reliasoft.com/support/rs20025.htm](http://www.reliasoft.com/support/rs20025.htm).

**Minimum Hardware Requirements**

• Intel Pentium® processor; 1.5 GHz or faster processor

• 2 GB of RAM for the 32-bit version of Windows; 8 GB of RAM for the 64-bit version.

• Display: 1024 x 768 or higher resolution at 96 dpi, with 24-bit color and 64 MB of dedicated VRAM.

• 1 GB of free disk space for install; minimum of 500 MB swap space.

• Internet connection is required to use the License Manager and the internet-enabled features in the software interface.

**Additional Software**

• 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.

**Enterprise Database Platforms**

32- and 64-bit versions are supported.

• SQL Server® 2008 or newer

• SQL Server Express Edition 2008 or newer

• Oracle® 10g or newer

• Oracle Express 11g or newer

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-enabled 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
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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 document at [http://www.reliasoft.com/synthesis/sql_express.htm](http://www.reliasoft.com/synthesis/sql_express.htm) provides some information that may help you to get started.

### Synthesis Installation and Licensing

There are two alternative ways that Synthesis desktop applications may be licensed on your computer. The installation process depends on the type of licensing.

- **Locally Hosted Licensing**
  - You received a license file (*.lic) and/or a license settings file (*.prnrl)
  - Allows your organization to manage license seats or, for token-based licenses, CRS units in-house without the requirement to connect with ReliaSoft’s external license server

- **ReliaSoft-Hosted Licensing**
  - You received only a license key (a 32-digit alphanumeric code)
  - Requires you to connect with ReliaSoft’s secure external license server to activate/deactivate licenses and to control access for multi-user (floating) license seats

One or both methods can be used on the same computer. For example, if you have your own single-user license for BlockSim and will share your department’s new multi-user (floating) license for Weibull++/ALTA, you will receive a license key for BlockSim and a license settings file for Weibull++/ALTA.

If you will use both types of licensing on the same computer, use the install instructions for locally hosted licenses. When you launch any of the applications that aren’t included in your license settings file, the ReliaSoft License Manager will allow you to perform the activation of your ReliaSoft-hosted license(s) using a product license key.

Your license information, along with the name and contact information that you provide during the activation process or upon first launching an application, can be viewed by clicking any of the main headings in the Application Setup or by going to the Contact Information tab of the License Manager (File > Help > License Manager).

The contact information used elsewhere in the software (such as in plots, report output, e-mail alerts, etc.) is stored in the database and managed via the User Login and Contact Information.
window (My Portal > Users > My Profile). If you need to change your contact information, you must apply the same change(s) to each database that you work with.

Requirements for All Synthesis Installations

- Before running the installation program, make sure your computer meets the system requirements for Synthesis.
- 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.

Installing Using Locally Hosted Licensing

If you received a license file (*.lic) or license settings file (*.prnrsl), you will be using locally hosted licensing. This allows you to manage available license seats or CRS units in-house without the requirement to connect to ReliaSoft’s external license server.

**IMPORTANT:** The first step is for a license administrator to configure your organization’s license server and provide each individual user with a) the path to the license server/host (e.g., 6220@servername) and a license settings file (*.prnrsl) that specifies which ReliaSoft products on your computer will use locally hosted licensing. For detailed instructions, see [http://www.synthesisplatform.net/licensing_locally_hosted.htm](http://www.synthesisplatform.net/licensing_locally_hosted.htm).

Perform the following steps for each client installation. If you have previously connected the client computer to the appropriate license server, you can start at step 4.

1. Open the Synthesis ePack and decompress the *.zip archive in the Locally Hosted Licensing Utility folder
2. Install the HBM Prenscia Licensing Administration utility by double-clicking licinst.exe and following the prompts. The utility will start as soon as installation is complete.
3. On the Client tab of the Licensing Administration utility, click Set Client License Path and enter the path to the license server (e.g., 6220@servername).
4. Install the Synthesis desktop applications by double-clicking the installation program from the ePack (e.g., Synthesis11_1.exe) and following the prompts.
5. Open the Import/Export License Settings utility by choosing ReliaSoft > Synthesis 11 > Additional Tools > Synthesis 11 License Settings Import-Export in the Windows Start menu. Follow the on-screen instructions to import the license settings file.

The first time you launch an application, you may be asked to provide your name and basic contact information. This is required to be eligible for technical support.
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Note: Applications using locally hosted licensing must have an active connection to the license server unless you have borrowed a license. If you see a message that indicates that a license could not be obtained, this could be for a variety of reasons (e.g., you are not connected to the license server, the license server is down or there are no seats or CRS units available for the license). In addition, if you lose connection to the license server while you are using an application, you will see a message warning you to save your work before the application closes.

Installing and Activating Using ReliaSoft-Hosted Licensing

If you are requesting a demo or have already received a license key (a 32-digit alphanumeric code), you will be using ReliaSoft-hosted licensing. With this type of licensing, you must be able to connect with ReliaSoft’s secure external license server to register and activate or deactivate the application(s). This external server also controls access for multi-user (floating) licenses.

If your computer has an active Internet connection and your firewall allows the software to access the secure ReliaSoft License Server at https://Validate.ReliaSoft.org, only a few simple steps are required for activation:

1. Install the Synthesis desktop applications by double-clicking the installation program from the ePack (e.g., Synthesis11_1.exe) and following the prompts.

2. 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 request a free demo license.

3. 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. This must be your company e-mail address — not gmail, hotmail, etc.

   - **Name and Contact Info:** 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.

   - **Demo License:** If you need a demo license, most requests will be addressed immediately during normal business hours; for some locations, please allow up to 2 business days.

4. On the next page, enter the product license key provided by ReliaSoft. **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.
• **Confirmation Codes:** If your license type requires a confirmation code, 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.

5. When you see the “Your product has been activated” message, click **Finish** to start using the software.

If the computer does not have an active Internet connection, or if you encounter issues with the firewall, there are other ways to complete the activation. Please visit [http://www.synthesisplatform.net/licensing.htm](http://www.synthesisplatform.net/licensing.htm) for details. And, of course, you can always contact ReliaSoft for assistance ([http://www.reliasoft.com/contact.htm](http://www.reliasoft.com/contact.htm)).

### Uninstalling Synthesis

If you wish to stop using all of the Synthesis desktop applications on this computer, you can perform the following steps to uninstall Synthesis:

**Tip:** If you are using ReliaSoft-hosted licensing (i.e., if you received a license key and activated specific application(s) on your computer), you also have the option to deactivate one or more applications without performing a complete uninstall. For instructions, see [http://www.synthesisplatform.net/license_deactivation.htm](http://www.synthesisplatform.net/license_deactivation.htm).

1. Make sure you do not have any Synthesis applications currently open.

2. For locally hosted licenses, if you are uninstalling permanently (i.e., if you are not doing this as part of an uninstall/reinstall), open the Import/Export License Settings utility by choosing **ReliaSoft > Synthesis 11 > Additional Tools > Synthesis 11 License Settings Import-Export** in the Windows Start menu. Follow the on-screen instructions to delete the license settings file.

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 11** and follow the prompts.

5. If you have installed the HBM Prenscia Licensing Administration tool, you can follow similar steps to uninstall it.
Chapter 1: Getting Started

License Manager
The License Manager allows you to view and manage license-related details for the Synthesis desktop applications that are currently activated on your computer. You can use this interface to:

- View and, for ReliaSoft-hosted licenses, edit the contact information that is on file with ReliaSoft or change the password associated with your ReliaSoft ID. [Learn more…]
- For ReliaSoft-hosted licenses, deactivate the current application (if you don't plan to continue to use it on this computer or for this user). [Learn more…]
- For ReliaSoft-hosted floating licenses, check out or check in a license. [Learn more…]

To open the License Manager, click the License Manager link in the Help Center or choose Help > Updates & Licensing > License Manager.

You may 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.)

Contact Information and Password
The Contact Information page displays the name, phone number and other details that are on file with ReliaSoft. For locally hosted licenses, this information is read-only and can only be edited by uninstalling and reinstalling the software. For ReliaSoft-hosted licenses:

- 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
For ReliaSoft-hosted licenses, 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.

![Product Activation Screen]

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.

### Borrowing Licenses

For certain license types, your computer must be able to connect to a license server to determine whether shared license seats (or, for token-based licenses, the required number of CRS units) are available when you attempt to launch a Synthesis application.

If you need to use the application(s) when your computer is not connected to the license server, you can either "borrow" or "check out" the licenses (depending on the license type). This reduces the number of seats (or CRS units) available to other users until the licenses are returned. (For ReliaSoft-hosted licenses, you can also use this feature to make sure a license seat will be available when you need it.)

### Borrowing Locally Hosted Licenses

If you have a locally hosted license, you can use the ReliaSoft License Borrowing utility to borrow licenses for selected product(s) for a specified duration.

**IMPORTANT:** If at least one ReliaSoft product with a locally hosted license is borrowed, you will only be able to use the product(s) that are borrowed and only when the computer is not connected to the license server. All desired products must be borrowed or returned at the same time.

If any of the Synthesis applications on your computer use a ReliaSoft-hosted license (i.e., a license key rather than a license settings file), they will be unaffected by locally hosted license borrowing. For those products, see [Checking Out ReliaSoft-Hosted Licenses](#) below.
Borrow License(s)
Before attempting to borrow licenses, first make sure that your computer is connected to the license server and shut down all Synthesis desktop applications.

1. To open the ReliaSoft License Borrowing utility, navigate to the **ReliaSoft > Synthesis 11 > Additional Tools** folder in the Windows Start menu and click **ReliaSoft License Borrowing 11**.

2. The window shows all of the Synthesis desktop applications on your computer that use locally hosted licensing. Specify the borrow duration and select which product(s) you want to borrow. (Remember that all desired products must be borrowed or returned at the same time.)

3. Click **Borrow Selected Licenses**.

4. Close the window.

You will only be able to use the product(s) that are borrowed, and only when the computer is not connected to the license server. If you need to change which products are borrowed, you can reconnect to the license server and repeat the same steps again (this will restart the borrow duration for all selected products). If you need to be able to use the applications while connected to the server, you can return the licenses as described below.

Return License(s)
Before attempting to return licenses, shut down all Synthesis desktop applications and reconnect your computer to the license server.

1. Open the ReliaSoft License Borrowing utility.

2. Click **Return All Licenses**.

3. Close the window.

**Note:** You can borrow licenses only while your license is valid (e.g., if the annual expiration date of your locally hosted license is 2 days from now, you cannot borrow a license for a duration of 3 days). In addition, you cannot borrow licenses during the 24 hours prior to annual license expiration.

Checking Out ReliaSoft-Hosted Licenses
If you have a ReliaSoft-hosted floating license, you can use ReliaSoft's **License Manager** to reserve a license.

1. Open the Synthesis application.
2. Open the License Manager by clicking the License Manager link in the Help Center or choosing Help > Updates & Licensing > License Manager.

3. In the current product area on the Products page, click Check Out or Check In.
Chapter 2: Repositories and Projects

With integration into the Synthesis Platform, ReliaSoft’s desktop applications 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 (except with the Synthesis file type *.rsr11), and become familiar with the features that facilitate simultaneous access by multiple users.

This chapter discusses some of the basic requirements for using Synthesis repositories and projects. For information about other features, see Synthesis Platform Tools.

Synthesis Repositories

Database Types
Synthesis desktop applications offer three 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** (*.rsr11) 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.

- **Synthesis files** (*.rsf11) are similar to standard repositories except that they can only be used by one person at a time, and changes are not saved until you choose File > Save or Save As. This type of database is therefore best for individual users who are working alone in a single Synthesis desktop application and prefer to be able to close a file without saving changes.

- **Enterprise repositories** 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 2008 or later and Oracle 10g or later (including the free Express editions of all of these). They can be accessed via an enterprise repository connection file with the extension *.rserp.

**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 [Enterprise Repositories](#). If you plan to work alone and don’t want changes to be saved automatically, see [Synthesis Files](#).)

**Creating a New Standard Repository**
To create a new standard database, choose **File > New > Standard Repository**.

In the **Repository name** field, specify the filename for the new *.rsr11 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 **Apply login security** check box if you want the new database to be **login secure**. You can then select the **Open security window upon creation** check box if you want to add user accounts as part of the database creation process. 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 *.rsr11 file.
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 Managing User Accounts).

- **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.

### Synthesis Files

Synthesis files (*.rsf11) are similar to standard repositories except that they can only be used by one person at a time, and changes are not saved until you choose File > Save or Save As. This type of database is therefore best for individual users who are working alone in a single Synthesis desktop application and prefer to be able to close a file without saving changes. If your workflow demands simultaneous access by multiple users, we recommend that you use either a standard database or enterprise database.

Note that if you have the same Synthesis file open simultaneously in two different Synthesis applications on the same computer (this situation is not common), saving changes in any of the open applications will save all changes up to that point.

### Creating a New Synthesis File

To create a new Synthesis file, choose File > New > Synthesis File.

In the Repository name field, specify the filename for the new *.rsf11 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 Synthesis file:

- Select the Apply login security check box if you want the new database to be login secure. Note that:
  - If you do not apply login security, any database user will be able to access and edit your Synthesis file, so long as the file is saved in a location that the user has read/write access to (e.g., a shared network folder).
If you apply login security, only you will have access to the file; however, you can grant other database users the permissions to view/edit your file, if desired. Select the **Open security window upon creation** check box if you want to add user accounts to the file as part of the database creation process. (For complete instructions on implementing security settings, see Security Options.)

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

**Opening an Existing Synthesis File**
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 *.rsf11* file.

If you are unable to open a Synthesis file, you may be encountering one of the following issues:

- **File is in use.** Synthesis files can only be used by one person at a time; therefore, it is automatically locked to the first user who has it open. You will not be able to open nor view the contents of the file until the other user closes the file.

- If the Synthesis file has **login security** enabled, you may also encounter 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 Managing User Accounts).
  - **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.

**Enterprise Repositories**

Unlike standard repositories or Synthesis files, 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 2008 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](http://synthesis.reliasoft.com/sql_server.htm). For resources on Oracle, see [http://synthesis.reliasoft.com/oracle.htm](http://synthesis.reliasoft.com/oracle.htm).

The following topics will be of interest to database administrators:

- Creating a New Enterprise Repository
- SQL Server Logins or Impersonation
- Upgrading an Enterprise Repository (from Version 8, 9 or 10)
- Synthesis Admin Tool

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

- Creating an Enterprise Repository Connection File (*.rserp)
- Monitoring Connection Speed

**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 > New Enterprise Repository.
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 **Connecting to an Existing Enterprise Repository**.)

### Connecting to an Existing Enterprise Repository

If your organization has already [created an enterprise database](http://rga.reliasoft.com) 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 > 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 2008 or later, or Oracle 10 or later).

- 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 a Microsoft Active Directory® group that has a login. (See [SQL Server Logins or Using Windows Impersonation](#).)

- 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.

### 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.

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 [Managing User Accounts](#)).

- **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.

- **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 SQL Server Logins or Using Windows Impersonation.)

Note: If you get an "error occurred when reading the connection file" message, the connection file may be corrupted or is using old encryption. You can create a new connection file by choosing File > New > Enterprise Repository Connection File.

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). This document provides an overview 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. (For details and instructions on performing these tasks in SQL Server, see http://www.reliasoft.com/synthesis/sql_server.htm.)

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.

If you are using the first approach, 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 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 Enterprise Repository Connection File.
2. Under Repository Connection Settings, select Microsoft SQL Server (2008 or later) 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:

2. Click Open to connect with the repository.
Chapter 2: Repositories and Projects

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.

**Enterprise Repository Connection Speed**

If the Synthesis desktop 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 on the lower right side of the window.

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)

**Upgrading an Enterprise Repository from a Previous Version**

If you have an existing enterprise database that was created with any of the Version 8, Version 9 or Version 10 Synthesis applications, you can transfer or convert all of the existing data into a new database that is compatible with the latest version.

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). In addition, you must be a member of the Admin group in the database to perform the task.

**Tip:** If you need to be able to upgrade an enterprise database without using a Synthesis desktop application (i.e., without taking up one of the available license seats), you can access this same feature from the Synthesis Admin tool.

### Upgrading from Version 9 or 10

It is strongly recommended that you create a backup of the Version 9/10 enterprise repository. The upgrade process converts the database itself to the latest version. *This change cannot be undone.*

To upgrade the database, choose **File > Manage Repository > Upgrade Version 9/10 Repository**.

In the window, specify the Version 9/10 enterprise database that you wish to upgrade. Click **OK** to start the process.

### Upgrading from Version 8

You do not need to create a backup before upgrading a Version 8 enterprise repository. The upgrade process does not involve a direct conversion of data, but rather copies over all existing data into a new database. This complete switch to a new database is required in order to support the exclusive features in the latest version.

To upgrade the database, open any Version 11 Synthesis application and choose **File > Manage Repository > Upgrade Version 8 Repository**.

Use the left side of the window to specify the Version 8 enterprise database that you wish to upgrade. Use the right side of the window to define the new Version 11 enterprise database that the existing data will be copied into. Click **OK** to start the upgrade.

### Synthesis Admin Tool

The Synthesis Platform includes an admin tool that allows a database administrator to set up and manage enterprise databases without requiring a software user license or an activated Synthesis desktop application.
Chapter 2: Repositories and Projects

To use the Synthesis Admin tool, your organization must have already established a database server with Oracle or Microsoft SQL Server, and you must have the permissions necessary to create databases on the server.

To access the tool, open the Windows Start menu and choose ReliaSoft > Synthesis 11 > Additional Tools > Synthesis 11 Admin from the programs list. Alternatively, you can open the Windows Start menu and type Synthesis 11 Admin in the search bar.

The following features from the Synthesis desktop applications are available in the admin tool.

- Creating a new enterprise repository
- Upgrading a Version 10, Version 9 or Version 8 enterprise repository
- Manage Synthesis user accounts:
  - Adding and editing user accounts
  - Importing users from Active Directory
  - Creating alternative credentials
  - Editing user login and contact info
  - Managing security groups
- Configuring the XFRACAS or Synthesis Enterprise Portal (SEP) applications on a web server. For details, please consult the implementation guides for those web applications.

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.), a Project Planner, 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.
Creating and Managing Projects

This topic describes how to create and manage the projects that are accessible to you via the project list (View > Project Manager > Show Project Manager). This depends on your permissions in the database and any security that has been defined at the project level.

There are three types of projects: private, public or reference. In addition, a project may be locked or checked out at any given time. Each type of project is displayed under the appropriate heading in the project list:

Tip: The Manage Projects window (Project > Management > Manage Projects) allows you to perform administrative tasks for multiple projects all at once, and to manage the private projects of other users. (See Manage Projects Window.)

Creating a New Project

When you create a new project, you must specify whether it will be public, private or reference. Select or right-click the appropriate heading in the project list and (i.e., Private, Public or Reference), and then choose Project > Management > Create Project.

The selected project type will be displayed at the bottom of the Project Properties window. If desired, you can change the selection before clicking OK to create the project.
Tip: If you later need to change the project type, select the project and choose Project > Security > [Make Private, Make Public, or Make Reference]. 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.

Note: You cannot delete a reference project if any of its resources are in use, including by projects in the recycle bin.

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 MPC’s Project Properties (below). For all other Synthesis desktop applications, this may include:

- **General Tab**
- **Security Tab** (available only for public/reference projects in secure databases)
- **Configurable Settings Tab** (only in Xfmea/RCM++/RBI)

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

**Project Owner:** The user who has been identified as the project owner. In a secure database, the ability to edit the project properties is restricted to the project owner and to users with the relevant "manage all projects" permissions.

**Last Update:** The time and date the project was last changed/updated, and the user who made the change. This considers any change to any of the analysis data in the project (not just the project properties).

**General Tab**
The General tab contains the following options:

- **Name** is the identifier for the project that will appear in the current project explorer and in 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. This label may appear in the footer of some reports generated in Xfmea/RCM++/RBI or MPC.

- **Project Category** allows you to assign a project category that can be used to filter the projects displayed in the project list and in many other windows throughout the software.

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++/RBI documentation.)

- **Select Profile from Library** displays a list of all profiles that have been defined in the active library. 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. (In a secure
database, the ability to add and edit a profile is available only for users with the
"Manage profiles and templates in Xfmea/RCM++/RBI" permission.)

Security Tab
The Security tab is available only when you are working with a public or reference project in a
secure database. For a full discussion on how to use these settings, see Planning Your Security
Approach.

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.

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.

In the Enable Legacy Analyses section, you can choose whether to allow users to create and
use DVP&R or DRBFM analyses in the project. These settings are not part of the profile and may
be different for each project. (See Design Verification Plans (DVP&Rs) and Design Reviews
Based on Failure Mode (DRBFMs) in the Xfmea/RCM++/RBI documentation.)
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 the Name, Description, Remarks and Project Category. In addition, you will be able to define the following:

- **Short Description** appears in the header of the Standard report template. It is not applicable for Dassault or Sukhoi reports.

- **Proprietary Label** appears in the footer of the Standard report template. It is not applicable for Dassault or Sukhoi reports.

- **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 guideline 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.

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.

Changing the Project Owner
To change the owner, select the project in the project list and choose Project > Security > Change Owner.
Chapter 2: Repositories and Projects

In a secure database, this is available only for users with the applicable "manage all projects" permissions.

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:

  ![Project Owner Filter 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.

  ![Project Properties 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.

  ![Manage Projects Window]

http://rga.reliasoft.com
Public, Private and Reference Projects

In Synthesis repositories, there are three types of projects you can create:

- A **public** project may be accessible to any user who has access to the database, depending on the security settings that have been implemented.

- A **private** project can be viewed and edited only by the project owner. The project list shows only your own private projects, while the Manage Projects window provides the ability to manage all users’ private projects (including delete, lock/unlock or changing the project type).

- A **reference** project is like any regular public project, except that you can share its resources and FMEAs with other projects in the database. This gives you a pool of resources that can be used throughout the database by specified users (based on the security settings for the reference project), while allowing you to maintain fully functional analyses within the reference project itself. (For more information, see Local, Global and Reference Resources, and Linked FMEAs in the Xfmea/RCM++/RBI documentation.)

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

![Project List Example](image)

**Note:** In MPC, the Reference heading will appear only if reference projects already exist in the database (created by another Synthesis desktop application). You cannot create a new reference project or convert an existing project into a reference project in MPC.
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**Setting the Initial Project Type**
When you create a new project, you must specify whether it will be public, private or reference. Select or right-click the appropriate heading in the project list and (i.e., Private, Public or Reference), and then choose **Project > Management > Create Project**.

The selected project type will be displayed at the bottom of the **Project Properties window**. If desired, you can change the selection before clicking **OK** to create the project.

![Project Properties window](http://rga.reliasoft.com)

**Changing the Project Type**
To change the project type for one project, select it in the project list and choose **Project > Security** and then one of the following options:

- Make Private
- Make Public
- Make Reference

To change the project type for multiple projects simultaneously, use the **Manage Projects window** instead.

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

In a secure database, locking and unlocking a project are available only if the user a) is the **project owner**, b) has the "Lock or check out project" **permission** for the project or c) has the applicable "manage all projects" **permissions**.

**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/reference status edited.

**Unlocking a Project**

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

**Tip**: The **Manage Projects window** allows you to select multiple projects and lock or unlock them all at once.

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**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** (*.rsr11) 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.

**IMPORTANT**: If the project uses resources or FMEAs from a reference project (e.g., linked FMEAs, models, URDs) the links won't be maintained when you check out the project. Any linked resources/FMEAs will be replaced with local copies of the resources/FMEAs and stored directly within the project. See also **Local, Global and Reference Resources**.

**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).
Chapter 2: Repositories and Projects

To change this location, open the Backup/Check Out Options page of the Application Setup window and browse for a new default path under Check In/Out. 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
To check out a project, select it in the project list then choose Project > Management > Check In/Out > Check Out.

In a secure database, this is available only if the user a) is the project owner, b) has the "Lock or check out project" permission for the project or c) has the applicable "manage all projects" permissions.

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. (See Restore Points.)

Undo Check Out
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.

In a secure database, this is available only if the user a) is the user who checked out the project, b) is the project owner or c) has the applicable “manage all projects” permissions.
Manage Projects Window
The Manage Project window displays a list of all the projects that currently exist for the database and allows you to perform administrative tasks for multiple projects all at once. If you have created custom project filters, you can apply those same filters in this window.

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

In a secure database, this is available only to users with the applicable "manage all projects" permissions. Only the type of project that you have permissions for will be displayed. Projects that are under the Locked, Checked Out and Recycle Bin headings will be visible only if you have permissions for all three project types.

Tasks You Can Perform
Some of the tasks you can perform in this window include:

- See a list of private projects created by other users (and perform any administrative tasks that may be needed for those projects).
- Change multiple public projects to private all at once, and vice versa.
- Change the owner 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.
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**Edit Project Properties** allows you to view and edit the properties of the selected project(s).

**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 or restore point.

**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/reference status edited. To unlock project(s), choose **Unlock Project**. (See Locked and Unlocked Projects.)

**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 Public, Private and Reference Projects.)

**Change Owner** assigns a different database user to be the owner for the selected project(s). (See Project Owner.)

**Project Security** is available only for public and reference 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 Planning Your Security Approach.)

**Check Out**

**Undo Check Out** discards all changes made to a checked out project and restores it to the state it was in at the time it was checked out. (See Check In and Check Out Projects.)

**Excel**

**Send to Excel** exports the data currently displayed in the Manage Projects window to an Excel spreadsheet.
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, clear the check box. Remember that once you empty or delete a particular project from the recycle bin, there will be no way to get it back unless you have previously created a backup or restore point.

Restoring and Deleting Projects from the Recycle Bin
In a secure database, the ability to restore and delete projects from the recycle bin is available only if the user a) is the project owner, b) has the "Delete project" permission, or c) has the applicable "manage all projects" permissions).

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.
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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 heading in the project list and choose Project > Management > Recycle Bin > Empty Recycle Bin.

**Security**

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 or Synthesis file, 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/reference 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/reference 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.

*Tip*: If you need to be able to manage an enterprise database without using a Synthesis desktop application (i.e., without taking up one of the available license seats), you can access the same security features from the Synthesis Admin tool.

**Applying Login Security**

All enterprise databases use login security. For standard databases or Synthesis files, there are two ways to apply login security if desired:

- Upon creating a new standard database or Synthesis file (File > New), you can make it login secure by selecting the Apply login security check box.
For an existing standard database, you can apply login security at any time by choosing File > Manage Repository > Users and Security 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 or Synthesis file, you will automatically be a member of the Admin security group, which has full permissions throughout the database. You can then use the Users and Security window to add/edit/delete other user accounts and assign them to appropriate security groups.

**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.

### 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 the public/reference project security settings.

This topic 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/reference projects**
- **Different permissions for different public/reference projects**

**Tip:** In addition to these considerations, it is also important to note the following: a) Users with the applicable "manage all projects" permissions (in any of the security groups that they belong to) will always have full project-level permissions for all public or reference 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.).

Same Permissions for All Public/Reference Projects
If you want each user to have the same set of permissions for all public/reference 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. **User Accounts and Security Groups**: Assign each user account to an appropriate security group. 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.

Select or clear the Allow access to projects with repository-level security check box. If some of the projects in the database will continue to use repository-level security, this allows you to specify whether each user will be able to access those projects.

- If the option is selected (default), the user will be able to access any public/reference project that is set to use repository-level security, with the combined permissions from any of the assigned security groups.
- If the option is cleared, the user will only be able to access a project if it is specifically assigned to a security group that he/she belongs to, or if the user account is specifically assigned to the project.
2. **Project Security**: Accept the default option on the **Security** tab of the Project Properties for all public and reference projects (Project > Security > Project Security). Note that if a user belongs to more than one security group (and the **Allow access to projects with repository-level security** check box is selected for his/her user account), that user will have the combined permissions of those groups in any project that is set to repository-level security.
Different Permissions for Different Public/Reference Projects

If you want the same user to have different permissions for different public/reference 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), follow these steps:

1. **Security Groups**: Create a security group for each distinct type of access that users might need in any particular public/reference project. Here’s a simple example:
2. **User Accounts**: 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."

If some of the projects in the database will continue to use repository-level security, the **Allow access to projects with repository-level security** check box gives you the option to decide whether each user will be able to access those projects.

- If the option is selected (default), the user will be able to access any public/reference project that is set to use repository-level security, with the combined permissions from any of the assigned security groups.
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- If the option is cleared, the user will only be able to access a project if it is specifically assigned to a security group that he/she belongs to, or if the user account is specifically assigned to the project.

3. **Project Security**: Assign the appropriate security group(s) and/or specific user(s) for every public/reference 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).
User Accounts

Every person who will access a Synthesis repository, be assigned to some role in an assigned action, and/or receive alerts via e-mail or SMS message 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 alerts 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 > Users and Security**.
Chapter 2: Repositories and Projects

This topic describes how to use the Users and Security window to create, edit or delete/deactivate user accounts. The same window can also be used to enable login security for a standard database or Synthesis file, and to manage security groups (permissions) for a secure database.

**Built-in Find/Filter, Configuration and Grouping Tools**
The Users tab of the Users and Security window offers the same filter, column configuration and grouping tools that are built in to other Synthesis utilities that use a similar grid (e.g., the *Synthesis Explorer, Actions Explorer*, etc.). For details about how to use each feature, see:

- Finding and Filtering Records
- Configuring Columns
- Grouping Panel

**Creating and Editing User Accounts**
The Users tab of the Users and 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 Importing Users from Active Directory.)

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 Creating Alternative Credentials.)

- In order to access the database, the user account must be assigned to at least one security group. (If you simply wish to send e-mail alerts 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 SQL Server Logins or Using Windows Impersonation.)

**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**.
If an account has already been logged in at least once (the Last Login column shows this information), attempting to delete the account will deactivate it instead. A deactivated account will not have access to the database.

You can manually deactivate an account by clearing the check box in the Active column for the account. To reactivate the account and give the user access to the database again, select the check box in the Active column.

User Login and Contact Information
The User Login and Contact Information window contains the contact information, alerts preferences and action resource details for an individual Synthesis user. In a secure database, it also includes access settings (security groups and alternative credentials).

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

To view or edit any user account in the database, choose File > Manage Repository > Users and Security, then double-click any row in the Users table. (In a secure database, this is available only for users with the "Manage users and logins permission."
Chapter 2: Repositories and Projects

All of the user account options are described below. Some of these settings cannot be modified when you are editing your own profile.

**User Info Tab**
- **Domain** and **Username** contain the credentials used by Windows authentication to identify the user and give him/her access to the database.
- **Contact Details.** Each user can update his/her own contact details, if desired. Note that the Display Name will appear in all projects, analyses and plots you create or modify in the database. Click the **Active Directory** button to update the contact details based on information stored in Active Directory.
- **User Image.** Each user can save a profile photo, which will appear in locations such as the **User Page** of My Portal. Saved images are resized to 100 x 100 pixels.
- **Security Groups** control the user's access to the database. (See [Managing Security Groups](#).)
- **Allow access to projects with repository-level security**
  - If the option is selected (default), the user will be able to access any public/reference project that is set to use repository-level security, with the combined permissions from any of the assigned security groups.
  - If the option is cleared, the user will only be able to access a project if it is specifically assigned to a security group that he/she belongs to, or if the user account is specifically assigned to the project.

For more information, see [Planning Your Security Approach](#).

- **Update security groups upon login (if associated with Active Directory)**
  - If the option is selected (default), the user's security groups will be assigned automatically based on his/her security group in Active Directory. (See [Associating Security Groups with Active Directory](#).)
  - If the option is cleared, the user can be manually assigned to any of the available security groups.
  - **Active.** Clear or select the check box to deactivate or activate the account. A deactivated account will not have access to the database.

**Alerts/Actions Tab**
- **Receive automated alerts.** Each user can choose to receive alerts via e-mail, SMS text message or Synthesis portal messages. (See [Watches and Alerts](#) and [What is Your SMS Address?](#)) Note that alerts via e-mail and SMS text are available only if a valid SMTP
server has been defined for the database and the user account has an e-mail address/SMS contact defined.

- **When assigned to actions.** When a user account is assigned to an action (either as the Person Responsible or as part of the Team resource), the **Cost Category** and **Hours per Day** are used to calculate resource utilization and costs. (See Costs and Man Hours.)

**Alternative Credentials Tab**
The Alternative Credentials tab is available only for secure databases. Select the check box to allow the user to bypass Windows authentication and connect to the database using an alternative username and password. (See Creating Alternative Credentials.)

**Importing Users from Active Directory**
If your organization uses Microsoft Active Directory, this topic explains how to import username and contact information from the directory to create new user accounts in the Synthesis repository. (If you also wish to use Active Directory to manage the membership in Synthesis security groups, see Associating Security Groups with Active Directory.)

To import users from Active Directory, choose **File > Manage Repository > Users and Security**, click the **Active Directory** button, and then follow these steps:

1. Enter or select the domain name in the **Domains** field. If your organization’s directory is large, you may also choose to limit the search to specific groups by clicking **Load Groups** and then choosing an option from the drop-down list. You can also use the **Filter By** field to further limit the search. When you have specified the desired filters, click **Load Users** to update the table.

2. In the table of user accounts that match the filter criteria, select the check box for each user you want to create a Synthesis account for. (The names of users who already have an account in the current database will appear grayed out.)
3. 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 [Managing Security Groups](#).)

4. 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 [SQL Server Logins or Using Windows Impersonation](#).)

5. 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.

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### 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 or Synthesis file 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 up 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:

1. Open the Users and Security window (File > Manage Repository > Users and Security). On the Users tab, select the account name from the list and click **Edit**.

2. In the User Login and Contact Information window, click the **Alternative Credentials** tab and then select the check box to enable alternative credentials.
3. 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 CaseSensitive.

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 Clear Alternative Credentials link on the Other Synthesis Settings page of the Application Setup.

User Groups
The User Groups window (formerly called “Notification Groups”) allows you to create and manage groups of users that can be assigned throughout the current database for:

- Recipients for portal messages
- Monitors for assigned actions
- Team members in the Project Planning Resources

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

In a secure database, this is available only for users with the “Manage users and logins” permission.

Adding or Editing a Group
The table displays a list of the user groups that have already been defined in the current database.

To add a new group, click Add.
Chapter 2: Repositories and Projects

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

The **Available Users** list shows all of the user accounts in the current database that are not yet assigned to the group. Double-click or use the buttons to move at least one user into the **Selected Users** list.

**Deleting a Group**

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

If the user group has been assigned to any existing actions, messages or project planning teams, the group will be removed automatically and those users will no longer be assigned in the affected records. **There is no undo for delete.**

**Managing Security Groups**

In a secure database, *Synthesis 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 [Planning Your Security Approach](#), there are two basic approaches you can use:

- **Same permissions for all public/reference projects** – each user account is assigned to one security group and all public/reference projects use the default security option (repository-level security).

- **Different permissions for different public/reference projects** – each user account may be assigned to multiple security groups and each public/reference project may be accessed only by specific security groups and/or users.

**Creating, Editing or Deleting Security Groups**

You can manage the security groups by choosing **File > Manage Repository > Users and Security**. (In a secure database, this is available only to users with the "Manage users and logins" permission.)

In the Users and Security window, click the **Security** tab to see 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.
If you have selected to **Associate this security group with an Active Directory group**, the list of assigned users can be updated automatically, or you will only be able to manually import/assign users who belong to the designated Active Directory group. (See [Associating Security Groups with Active Directory](#)).

**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 private projects in the database that are accessible only to you. (Users with the "Manage all private projects" permission can still perform administrative tasks on all private projects, such as editing their properties, locking them, converting them to public projects, etc.) |

---
## Chapter 2: Repositories and Projects

<table>
<thead>
<tr>
<th><strong>Create and own public projects</strong></th>
<th>You can create and own <em>public</em> projects that other users can view and edit (depending on the project security settings).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Create and own reference projects</strong></td>
<td>You can create and own <em>reference</em> projects for sharing resources and FMEAs with other projects in the database (depending on the project security settings).</td>
</tr>
<tr>
<td><strong>Create portal messages</strong></td>
<td>You can create new messages, and edit or delete the messages you have personally created via the Messages page in My Portal.</td>
</tr>
<tr>
<td><strong>Publish to Synthesis Enterprise Portal</strong></td>
<td>You can publish your progress, results and analyses from a given project to the Synthesis Enterprise Portal (SEP), making the information accessible from any web-enabled device.</td>
</tr>
<tr>
<td><strong>Create/edit/delete SDW data collections</strong></td>
<td>You can create, edit and delete data collections in the Synthesis Data Warehouse (SDW). This includes data extraction from XFRACAS as well as custom connections, and confers the ability to create dashboard layouts for custom connections.</td>
</tr>
</tbody>
</table>

### 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*. Regardless of the project security settings, these permissions are always automatically granted to the current *project owner*.

<table>
<thead>
<tr>
<th><strong>Read</strong></th>
<th>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.).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Create/edit project items</strong></td>
<td>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, etc., as well as update the item properties.</td>
</tr>
<tr>
<td><strong>Create/edit/delete own resources</strong></td>
<td>You can create Synthesis <em>resources</em> (e.g., URDs, models, etc.) and edit or delete any existing resources you have created.</td>
</tr>
</tbody>
</table>
# Chapter 2: Repositories and Projects

<table>
<thead>
<tr>
<th>Permission</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delete project items</td>
<td>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, etc.). This permission cannot be assigned unless you also have the &quot;Create/edit project items&quot; permission.</td>
</tr>
<tr>
<td>Create/edit project plans</td>
<td>You can create and edit project plans for a given project.</td>
</tr>
<tr>
<td>Create/edit/delete local resources</td>
<td>You can create, edit and delete any local resources in the project (not just the ones that you created).</td>
</tr>
<tr>
<td>Set project security</td>
<td>You can control who can view and edit a given project. This permission allows you to configure both project security settings and item permissions.</td>
</tr>
<tr>
<td>Edit project properties</td>
<td>You can use the Project Properties window to edit the name, description, category and other settings of a given project.</td>
</tr>
<tr>
<td>Lock or check out project</td>
<td>You can:</td>
</tr>
<tr>
<td></td>
<td>- Lock and unlock a given project.</td>
</tr>
<tr>
<td></td>
<td>- Check in and check out a given project.</td>
</tr>
<tr>
<td>Create restore points</td>
<td>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).</td>
</tr>
<tr>
<td>Delete project</td>
<td>You can delete a given project.</td>
</tr>
<tr>
<td>Manage change logs in Xfmea/RCM++/RBI</td>
<td>You can enable and manage change logs within a given project. Change logs can be created for FMEAs, DVP&amp;R, Control Plan and P-Diagram analyses in Xfmea, RCM++ and RBI. See Change Logs in the Xfmea/RCM++/RBI documentation.</td>
</tr>
<tr>
<td>Approve change logs in Xfmea/RCM++/RBI</td>
<td>You can implement electronic approval tracking for change logs within a given project. See Electronic Approval Tracking in the Xfmea/RCM++/RBI documentation.</td>
</tr>
</tbody>
</table>
### 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.

<table>
<thead>
<tr>
<th>Manage users and logins</th>
<th>You can:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Use the <a href="http://rga.reliasoft.com">Users and Security window</a> to add user accounts to the database and define security groups, as well as create alternative credentials for user accounts.</td>
</tr>
<tr>
<td></td>
<td>• Use the <a href="http://rga.reliasoft.com">User Groups window</a> to add and manage distribution groups for e-mail alerts, portal messages, action alerts and projecting planning resources.</td>
</tr>
<tr>
<td></td>
<td>• Use the <a href="http://rga.reliasoft.com">Repository Logins window</a> to view and export a history of database logins.</td>
</tr>
<tr>
<td></td>
<td>• Use the <a href="http://rga.reliasoft.com">Reset &quot;In Use&quot; Flags window</a> to clear the &quot;in use&quot; status for selected database users (not just your own).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Manage project planning resources and working days</th>
<th>You can:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Use the <a href="http://rga.reliasoft.com">Project Planning Resources window</a> to manage the cost categories, teams, materials and facilities that are used for tracking resource utilization in Project Planner gates and actions.</td>
</tr>
<tr>
<td></td>
<td>• Use the <a href="http://rga.reliasoft.com">Working Days/Holidays window</a> to specify the business days that will be used for Project Planner gates and actions.</td>
</tr>
</tbody>
</table>

| Manage project/item categories | You can use the [Project/Item Categories window](http://rga.reliasoft.com) to define the project and item categories that can be used for grouping and filtering projects and items in the database. |
### Chapter 2: Repositories and Projects

<table>
<thead>
<tr>
<th>Manage other repository settings</th>
<th>You can:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Use the <a href="#">Time and Usage Units window</a> to define the time units available for use in any project within the database.</td>
</tr>
<tr>
<td></td>
<td>• Use the <a href="#">Default Name Formats window</a> to specify how default names for resources and blocks are created.</td>
</tr>
<tr>
<td></td>
<td>• Use the Task Types window in RCM++, RBI and MPC.</td>
</tr>
<tr>
<td></td>
<td>• In RCM++ and RBI, you can map the task types that are used only in RCM++/RBI to the task classes in the universal reliability definition (URD). See <a href="#">Task Types in RCM++/RBI</a> in the RCM++/RBI documentation.</td>
</tr>
<tr>
<td></td>
<td>• In MPC, you can modify the abbreviations used for MSG-3 task types. See <a href="#">Task Type Abbreviations in MPC</a> in the MPC documentation.</td>
</tr>
<tr>
<td></td>
<td>• Use the <a href="#">Repository Settings window</a> to set some default settings for existing and new databases. This includes enabling e-mail alerts for the database, activating history logs, etc.</td>
</tr>
<tr>
<td></td>
<td>• Set up <a href="#">XFRACAS connection settings</a> that allow Synthesis desktop applications to access the XFRACAS data stored in the database. This is available only for standard databases (*.rsr11).</td>
</tr>
</tbody>
</table>

| 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 SDW](#). |

| Approve actions | You can review and approve [actions](#), which are Synthesis resources that allow you to track progress made in a project. |

| Manage all portal messages | You can edit or delete any messages that are visible to you via the Messages page in [My Portal](#). This includes any messages for which you are the creator or one of the recipients. |

<p>| Manage dashboard layouts | You can create and save layouts for use in the <a href="#">Dashboard Viewer</a> in Weibull++, BlockSim and RGA. |</p>
<table>
<thead>
<tr>
<th>Manage profiles and templates in Xfmea/RCM++/RBI</th>
<th>This permission is available only in enterprise databases. You can:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Use the Profiles/Library Manager window in Xfmea/RCM++/RBI to configure the predefined settings stored in the active library of the enterprise database. See Profiles/Library Manager in the Xfmea/RCM++/RBI documentation.</td>
</tr>
<tr>
<td></td>
<td>• Use the Templates Manager window in Xfmea/RCM++/RBI to configure report templates stored in the enterprise database. See Templates Manager in the Xfmea/RCM++/RBI documentation.</td>
</tr>
<tr>
<td>Manage Lambda Predict repository settings</td>
<td>You can:</td>
</tr>
<tr>
<td></td>
<td>• Use the FIDES Settings Manager window in Lambda Predict to configure the FIDES-related settings stored in the database. This applies to the FIDES prediction standard only (see FIDES Settings Manager in the Lambda Predict documentation).</td>
</tr>
<tr>
<td></td>
<td>• Use the Custom Derating Standards Manager window in Lambda Predict to create, edit or delete user-defined derating standards stored in the database. See Creating Custom Derating Standards in the Lambda Predict documentation.</td>
</tr>
<tr>
<td></td>
<td>• 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. See MIL-217 Custom Connection Types in the Lambda Predict documentation.</td>
</tr>
</tbody>
</table>
### Chapter 2: Repositories and Projects

#### Manage MPC Settings

You can:

- Use the Manage ATA Chapters window in MPC to define the systems and subsystems that are available for use in the database. See [Managing ATA Chapters](#) in the MPC documentation.

- Use the Manage Major Zones window in MPC to define the zones and major sub-zones that are available for use in the database. See [Managing Major Zones](#) in the MPC documentation.

- Use the Configurable Options for Systems and Powerplant Analysis window in MPC to enable or disable the display of some item properties and task properties fields. See [Configurable Options for Systems and Powerplant Analysis](#) in the MPC documentation.

- Use the Configurable Options for Structural Analysis window in MPC to customize the settings for environmental deterioration (ED) and accidental damage (AD) analyses that can be performed for any structural item in MPC Plus. See [Configurable Options for Structural Analysis](#) in the MPC documentation.

- Use the Configurable Options for Zonal and L/HIRF Analysis window in MPC to customize the settings for the standard zonal, enhanced zonal and L/HIRF analyses that can be performed for any zonal item in MPC Plus. See [Configurable Options for Zonal and L/HIRF Analysis](#) in the MPC documentation.

<table>
<thead>
<tr>
<th>Manage all public projects</th>
<th>You have all the basic and advanced project-level permissions for public projects in the database. You can also change the <a href="#">project owner</a> for any public project in the database.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage all reference projects</td>
<td>You have all the basic and advanced project-level permissions for reference projects in the database. You can also change the <a href="#">project owner</a> for any reference project in the database.</td>
</tr>
<tr>
<td>Manage all private projects</td>
<td>You have all the basic and advanced project-level permissions for private projects in the database. You can also change the <a href="#">project owner</a> for any private project in the database.</td>
</tr>
</tbody>
</table>
Associating Security Groups with Active Directory

If your organization uses Microsoft Active Directory (AD), you can give an AD group a specific set of permissions in the Synthesis repository. The members of the AD group can then access the database based on the set of permissions associated with the group.

In addition, the software offers the option to automatically update the permissions of a user whenever that user is added or removed from an AD group. For example, if a user is moved from AD group A to AD group B, his/her Synthesis user account can be automatically updated with the permissions associated with AD group B. The changes will take effect the next time the user connects to the database via any of the Synthesis desktop applications. (Note that for users who will connect only via the Synthesis Enterprise Portal (SEP) website, you’ll need to update their permissions manually either via a desktop application or the Synthesis Admin tool on the web server.)

Tip: Multiple security groups can be assigned to the same user account, if appropriate. For example, a user can be assigned to the "ABC Team" group (which is associated with Active Directory) and the "Read-Only" group (which is not). (See Planning Your Security Approach.)

Assigning Permissions to an Active Directory Group

To associate a Synthesis security group with an Active Directory group, choose File > Manage Repository > Users and Security and click the Security tab. Then double-click the security group you want to edit.

In the Edit Security Group window, select the Associate this security group with Active Directory check box, and then specify the domain name and Active Directory group to use. There are two additional options, which apply only when users log in from a Synthesis desktop application:

- **Automatically update this security group's members.** If a user is added to the AD group, his/her Synthesis user account will automatically have this set of permissions the next time the user logs in to the database via any of the Synthesis desktop applications. Likewise, if the user leaves the AD group, his/her Synthesis user account will no longer have this set of permissions.

  If you do not want the changes in Active Directory to be automatically applied to a particular user, clear the Update security groups upon login check box in that user's account in the Synthesis repository.

- **Automatically create new user accounts on first login.** If a member of the AD group does not already have a Synthesis user account, it will be created automatically (and
assigned to this security group) the first time he/she tries to connect via any of the Synthesis desktop applications.

Creating/Updating Accounts Now

If you don’t want to wait for all users to log in before creating/updating their Synthesis user accounts, click the **Assign** button at the bottom of the window.

- To create new accounts, choose **Import users who are members of this Active Directory group**. This opens the Import Users from Active Directory window, but you can only choose users from the associated Active Directory group.

- To update the security groups for existing accounts, choose **Assign existing repository users who are members of this Active Directory group**. This shows a list of existing Synthesis users who also belong to the associated Active Directory group; you can select to update any or all of their accounts.
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.

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, RGA or Lambda Predict, select the item in the current project explorer and choose Project > Current Item > Item Properties. (In a secure database, this is available only if the user a) is the project owner, b) has the "Set project security" permission, or c) has the applicable "manage all projects" permissions.)

The settings are displayed on the Permissions tab of the properties window.

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 > Current Item > Item Permissions. In MPC, select an item and choose [Systems/Structures/Zones] > Security > Item Permissions. (In a secure database, this is available only if the user a) is the project owner, b) has the "Set project security" permission, or c) has the applicable "manage all projects" 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.

### Status Indicators

Synthesis desktop applications include status indicators that tell you which project items (e.g., folios, diagrams, system hierarchy items, etc.) are 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 headings, then click Customize Columns to select which columns you want to display.)

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 the Reset “In Use” Flags topic for instructions on how to reset the flags throughout the database if this problem occurs.

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

(In a secure database, this is available only for users with the "Manage users and logins" permission.)

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.
**Repository Logins**

The Repository Logins window displays a record of the date and time the users in the database logged in. To open the Repository Logins window, choose **File > Manage Repository > Repository Logins**. (In a secure database, this is available only for users with the "Manage users and logins" permission.)

The following options are available:

- Use the **Most Recent** filter to display in the table the last 10; 100; 1,000 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.

**Repository Settings**

The Repository Settings window contains settings that are shared by all users and analysis projects in the database. To access this window, choose **File > Manage Repository > Repository Settings**. (In a secure database, this is available only for users with the “Manage other repository settings” permission.)

In a standard database or Synthesis file, you can save the current settings as the default for each new standard database/Synthesis file that you create from this computer by clicking the **Set as Default** button at the bottom of the window.

---

**What’s Changed?** In prior versions, these preferences were defined in the E-mail and Other Settings window.
E-mail Settings Page

- **Enable Alerts via E-mail or SMS** configures the database to enable alerts via e-mail or SMS text message. (See [Enable Alerts via E-mail or SMS](#).)

- **Action Alerts** apply to action resources. The database can be configured to auto-subscribe a "watch" for users based on their role(s) for a particular action. You can also specify the default text that will be used at the beginning of each action alert. (See [Action Alert Preferences](#).)

Other Settings Page

- **FMEA Structure (Xfmea/RCM++/RBI)** allows you to select the default FMEA structure for new projects created in the database, which determines how the software will display the effect and cause records in the FMEAs. If you don't specify a default, users will be prompted to select the structure for each new project they create in Xfmea/RCM++/RBI. (See [Choosing the FMEA Structure](#) in the Xfmea/RCM++/RBI documentation.)

- **History Logs** allows you to turn the log on (or off) for all active projects, and stores a preference for whether the log should be activated by default for each new project. (See [History Logs](#).)

- **Actions** allows you to automatically set the person who created an action to be the person responsible for it. (See [Person Responsible and Resources](#).)

- **Enable publish to Synthesis Enterprise Portal** is available only in enterprise databases. If your organization has established a web-based Synthesis Enterprise Portal (SEP) for the current database, select this check box to enable users to publish analysis summaries, Synthesis Workbooks and other information to the portal.

- **Delete Portal Messages** deletes all portal messages for all users in the database. There is no undo for deleting portal messages.

Time and Usage Units

The Time and Usage Units window defines 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 can enter data into a Weibull++ life data folio data sheet in hours and then obtain results from the QCP in terms of years. Similarly, in RCM++, RBI or BlockSim, you can define the duration of a maintenance task in terms of hours and specify the total operating time of a system in terms of months.
**IMPORTANT:** It is important to realize that making changes to the existing units can have implications for all analyses throughout the database; therefore, it is best to set up units once, upon creation of the database.

To define time units, choose **File > Manage Repository > Time and Usage Units**. (In a secure database, this is available only to users with the "Manage other repository settings" permission.)

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). The SBU does not have to be the default unit either; 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.

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. (If you will be using the usage format of the Weibull++ warranty folio, 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.)

Use the **Delete** and **Insert** buttons below the window to manage the list of units. You can also move a unit up or down its current position by selecting it and using the **Move Up** or **Move Down** buttons.

**Note:** In Weibull++, you can specify which of the configurable repository time units are equivalent to the built-in (not configurable) "warranty time units" used in some warranty folio formats. For details, see **Manage Warranty Units** in the Weibull++/ALTA documentation.

### Default Name Formats

In all Synthesis desktop applications except MPC, the Default Name Formats window specifies the default names for new Synthesis resources, as well as new blocks in BlockSim RBDs, fault trees and phase diagrams. For example, when you create a new model, the default name will be the word "Model" plus an increment to make the name unique (e.g., "Model," "Model_1," etc.). You can configure the database to use a different default name format if desired.
To open the window, choose File > Manage Repository > Default Name Formats. (In a secure database, this is available only for users with the "Manage other repository settings" permission.)

The Resource Name column displays the basic name label for each type of resource or block. This will be represented by the \N code in the name format.

The Name Format column allows you to use any of the following elements to define the default name format for each type of resource or block:

- \N returns the label from the Resource Name column plus an increment to make the name unique (e.g., "Model," "Model_1," etc.).
- \U returns the name of the user who created the resource or block.
- \D returns the date when the resource or block was created.
- \S adds a sequential number that reflects the order in which the resource/block was added to the database.
- \T returns the Synthesis application ("tool") used to create the resource or block.
- \F returns the contents of all of the identifier fields except the category and comments fields.
- \G returns a summary of the properties of the resource or block. For example, for a node in a BlockSim diagram, \G returns the "k out of n" paths that are required.
- \I is only applicable for resources. It functions the same as \N unless there is another window, resource or analysis that it can "inherit" part of the name from. Some examples:
  - If you create a URD from BlockSim’s block properties window, the default name will be "[Block Name]_URD."
  - If you create a metric based on a model, the default name will be "[Model Name]_Metric."
  - If you push a metric from a Project Planner gate, the default name will be "[Gate Name]_[Property Name]_Metric."

**Tip:** In BlockSim diagrams, you can use an asterisk (*) to insert the default block name. For example, if you enter *System for the block name, the diagram will display the default name for the block followed by the word "System." The asterisk also allows the block name to be updated dynamically when relevant properties change.
Project Planning Resources

In all Synthesis desktop applications except MPC, project planning resources can be assigned to actions in order to track the required costs and time in the Project Planner and anywhere else that actions are used. Because project planning resources are shared throughout the database, any change made to one is automatically applied to all actions in the database that use it.

- **Cost Categories** specify direct and/or per instance costs that can be assigned to any team member, facility or material.
- **Teams** identify groups of users who will work together on any given action.
- **Facilities** specify the cost and maximum utilization for facilities (e.g., test lab) or other resources for which the cost depends on the duration of use (e.g., rented test equipment).
- **Materials** specify the cost and quantity for materials (e.g., test units) or other resources for which the cost depends on the amount used rather than the duration (e.g., purchased usage data).

To open the Project Planning Resources window, choose File > Manage Repository > Project Planning Resources. (In a secure database, only users with the “Manage project planning resources and working days” permission will be able to create and edit these resources; other users can select from the resources that have already been predefined.)

Cost Categories

Cost categories can be created from the Project Planning Resources window, or when you are creating/editing a facility, material or individual user account. Enter the Currency Symbol to use for displayed costs at the bottom of the window.

- The **Direct Cost per Hour or Unit** is the per-hour cost when assigned to a team member or facility, or the per-unit cost when assigned to a material (e.g., the cost of a single light bulb).
- The **Cost per Instance** is a one-time cost that applies every time a team, facility or material is used.
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Teams
Teams can be created from the Project Planning Resources window, or when you are defining an action. A team can include:

- Individual **Users** who have active user accounts in the database.
- **Groups** of active user accounts that have been predefined in the database.

Note that you cannot assign a cost category directly to a team. Instead, the team's cost/utilization is based on the cost category and maximum hours per day for each team member. Both of these properties are set on the **Alerts/Actions** tab of the **User Login and Contact Information window**.

Facilities
Facilities can be created from the Project Planning Resources window, or when you are defining an action.

- The **Cost Category** specifies the facility's hourly and/or per-use costs.
- The **Max Hours Per Day** is the number of hours of use if the facility is set to be 100% utilized for a given action (as specified in the action properties).

Materials
Materials can be created from the Project Planning Resources window, or when you are defining an action.

- The **Cost Category** specifies the cost per unit (e.g., the cost for each test prototype), as well as any additional fixed cost (e.g., the cost for manufacturing a sufficient number of test prototypes).
- The **Quantity** that will be used (e.g., 100 light bulbs).

Working Days/Holidays
In all Synthesis desktop applications except MPC, actions and **Project Planner gates** contain important dates like start dates and due dates. You can specify which dates will be considered working days for all actions and gates in the repository. This way, an action's cost/time estimates, as well as its duration, will be based solely on working days.

To define the working days for the repository, choose **File > Manage Repository > Working Days/Holidays**. (In a secure database, this is available only for users with the "Manage project planning resources and working days" permission.)
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In the window that appears, use the Define Work Week area on the left side to specify which days of the week will be considered regular working days (e.g., Monday-Friday).

Define Holidays
On the Define Holidays tab, you can define three different types of holidays.

- **Fixed Date - Recurring** holidays occur every year on the same calendar date (e.g., New Year’s Day is always January 1).
- **Variable Date - Recurring** holidays occur every year, but not always on the same date (e.g., Thanksgiving is always the fourth Thursday of November).
- **Fixed Date - Non-recurring** holidays occur once and do not happen again. For example, a specific Monday could become a non-working day due to weather conditions.

In the Holiday Properties window, select Move to adjacent working day if necessary to make sure the holiday will be observed when a) it occurs outside the work week, but b) there is a regular working day immediately before/after it. In this case, the holiday is observed on the nearest working day. (If there is a working day immediately before and after the holiday, it is observed on the following day.)

View Observed Holidays
The View Observed Holidays tab allows you to easily examine the names and dates of all holidays that will be observed during the work week, and can also help you make sure your working days/holidays settings are correct. Specify the years you want to view in the Displayed Range in Years area.

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. There are several ways in which you might wish to share data between XFRACAS and the analyses that you perform in Synthesis desktop applications:

- Use the Synthesis Data Warehouse in Weibull++/ALTA or RGA to extract data from XFRACAS incidents. (See Synthesis Data Warehouse.)
- Share system configuration and failure mode data between XFRACAS and Xfmea/RCM++/RBI. (See Import or Sync from XFRACAS in the Xfmea/RCM++/RBI documentation.)

When you are working with an enterprise database, the data from XFRACAS and Synthesis desktop applications can be stored in the same SQL Server or Oracle database.
When you are working with a standard database (*.rsr11) or Synthesis file (*.rsf11), you will need to establish a connection to an enterprise database that contains XFRACAS data. To do this, choose **File > Manage Repository > XFRACAS Connection**. (In a secure database, this is available only for users with the "Manage other repository settings" permission.)

In the XFRACAS Connection Settings Window, select **Connect to an enterprise repository with XFRACAS data** then choose Microsoft SQL Server or Oracle.

- For a SQL Server database, 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 is shared by multiple users. (See [SQL Server Logins or Using Windows Impersonation](http://synthesis.reliasoft.com/sql_server.htm).) If you do not use impersonation, then each user who uses the features that utilize XFRACAS must have an account in the external database that contains the XFRACAS data.

- For an Oracle database, 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.

### Managing and Restoring 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:


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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, maximum number of concurrent users is 255, etc. In addition, some specific database vulnerabilities are discussed in a 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 **Backup/Check Out Options page** of the Application Setup, the Synthesis desktop 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 (*.rsr11) 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 by 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/](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 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.

**Restore Points**

In all Synthesis desktop applications, you can create and manage *restore points* (formerly called "project baselines") 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.

**Create a Restore Point**

You can create a restore point for a 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.
In a secure database, this is available only if the user is the project owner or has the "Create restore points" permission.

**IMPORTANT:** When you create a restore point, any global, reference and FMEA 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 those 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** uses the restore point to roll back the current project to the 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** uses 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 in the Database**
To manage all the restore points that have been created in the database, choose File > Manage Repository > Restore Points. (In a secure database, this is available only for users who have all three "manage all projects" permissions.)

This opens the Restore Points window, which displays the details for each of the restore points.

- To create a new restore point, click the Create button then select the project you want to back up. 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.
Chapter 3: Desktop Application Interfaces

Most Synthesis desktop 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 database, 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, 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.

**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 currently open project(s). 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.)

My Portal provides quick access to messages, assigned actions and other information that may be of personal interest to you while working in the Synthesis Platform. 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.)

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 Show, Tile, Dock and Pin Panels.)
**Tip:** If desired, you can change the overall color scheme used in the MDIs for all Synthesis desktop applications on your computer. Use the *Skins* drop-down list on the *Synthesis Settings page* of the Application Setup to select the style you prefer.

### Status Bar

As an example, the following picture shows the status bar at the bottom of the MDI for an enterprise database:

![Status Bar Example](image)

For more information about the connection speed indicator, see [Enterprise Repository Connection Speed](#).

If working with a *Synthesis file*, the status bar also displays a reminder that you will need to save any changes before closing.

### Show, Tile, Dock and Pin Panels

In all Synthesis desktop 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 desktop 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.

![My Portal panel](image1)

![My Portal panel tiled](image2)

When the panel is not tiled, you can drag the horizontal splitter bar up to display large buttons
or down to display small icons.
Chapter 3: Desktop Application Interfaces

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.

- 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
- 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).
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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 desktop 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 and Lambda Predict, the Open Project(s) page of the Project Manager (i.e., the current project explorer) displays all the analysis folios, reports and other items in the current project(s) that apply to the software you are using.

There may be up to five nodes in the project list, indicating the sharing status of the projects: Private, Public or Reference projects, Locked projects and Checked Out projects. Additionally, the Recycle Bin is shown in the project list.

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 see only 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 project list can utilize the same project filters that are available in many other locations throughout Synthesis desktop applications. For example, with the filter shown below, the project list will show only projects belonging to Department B.
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.

To remove the filter, select **Show All** 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.

![Current Project Explorer](image)

**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 Open Project(s) page of the Project Manager allows you to manage all of the relevant *project items* (e.g., folios, diagrams, etc.) in the project(s) that are currently open.

Applications that use the current project explorer can have multiple projects open at the same time. (See **Working with Multiple Projects**.)

**Note:** Remember that each project may contain items from any Synthesis desktop application but you will see only 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 Project Items
The current project explorer can utilize the same item filters that are now available in many other locations throughout Synthesis desktop applications. (This provides more flexibility than the Filter based on creator feature in prior versions.)

For example, with the filter shown below, the current project explorer will show only items created by Joe User and updated within the current month.

To remove the filter, select Show All from the drop-down list.

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. (See Status Indicators.)

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 on 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.

Sub-Folders and Drag and Drop
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 on 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.

Working with Multiple Projects
Synthesis desktop applications that use the current project explorer (i.e., Weibull++, ALTA, BlockSim, RENO, RGA and Lambda Predict) can have multiple projects open at the same time. To enable this functionality, select the Allow multiple projects (project explorer) check box on the Synthesis Settings page of the Application Setup.

Tip: There is a separate setting that controls the ability to have multiple projects open in Xfmea/RCM++/RBI.

When you have more than one project open, the projects will be shown in the current project explorer with the most recently opened project at the top. Note that the icon shown beside each project indicates whether it is a public, private or reference project and, when applicable, whether it is locked or checked out.

<table>
<thead>
<tr>
<th></th>
<th>Unlocked, Not Checked Out</th>
<th>Locked</th>
<th>Checked Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Project</td>
<td>![Icon]</td>
<td>![Icon]</td>
<td>![Icon]</td>
</tr>
<tr>
<td>Private Project</td>
<td>![Icon]</td>
<td>![Icon]</td>
<td>![Icon]</td>
</tr>
<tr>
<td>Reference Project</td>
<td>![Icon]</td>
<td>![Icon]</td>
<td>N/A</td>
</tr>
</tbody>
</table>
In addition to the convenience of being able to view analyses from multiple projects, having multiple projects open allows you to transfer data between the projects quickly and easily. Specifically:

- For any item that can be imported/exported between projects, you can simply drag the item (analysis, multiplot, report, etc.) from the source project to the appropriate folder in the destination project. This opens the Export window, where you can just click Export to finish the export, or add more items to export before you finish the process.

- In Weibull++, ALTA and RGA, data can be copied from an analysis in one project and pasted to an analysis in another project.

- In BlockSim and RENO, blocks can be copied from a diagram in one project and pasted to a diagram in another project, according to the following rules:
  - If the block uses resources that are local to the source project, they will also be copied and added to the destination project.
  - If a resource of the same name exists in the destination project, the name of the copy will be incremented (e.g., if "Model1" already exists, the new copy might be renamed to "Model1_1").
  - If a model is associated with a data source (e.g., a model published from a Weibull++ folio), the model is copied into the destination project as a model with the association removed.
  - If the block uses resources that are global or in a reference project, they will not be duplicated. They will retain their original reference to that global/reference resource.
  - Subdiagram blocks cannot be copied and pasted across projects.

*Note:* The FMRA view is not available in BlockSim when you have multiple projects open.

**My Portal**

In all Synthesis desktop applications, *My Portal* provides quick access to messages, assigned actions and other information that may be of personal interest to you while working in the Synthesis Platform. (When you first activate the software, My Portal will be "docked" on the right side of the MDI and "unpinned." Move your mouse pointer over the tab to make the panel visible at any time. For other options, see Show, Tile, Dock and Pin Panels.)
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If your organization chooses to implement a web-based *Synthesis Enterprise Portal (SEP)* for an enterprise database, you can also access many of these same features – as well as selected metrics, reports and other details from specific analyses – from any web-enabled device.

**Portal Messages**
The Synthesis Platform’s messages feature provides a convenient way to communicate with other database users. Messages are displayed in a “timeline” format similar to social media websites like Facebook®.

These messages are displayed both in *My Portal* (in any Synthesis desktop application) and in the *Synthesis Enterprise Portal* (if it is implemented for your database).

All database users will be able to view their own messages. In a secure database, the following **permissions** are required to create, edit or delete messages:

- **Create portal messages** allows you to create new messages, and edit or delete the messages you have personally created.
- **Manage all portal messages** allows you to edit or delete any messages that are visible to you. This includes any message for which you are the creator or one of the recipients.

**Message Display Options**
The messages timeline will display all messages that were created by or addressed to you. You can sort the message threads in two ways:

- **Newest Active** considers the dates/times of both the main messages and the replies.
- **Newest Message** considers only the dates/times of the main messages.

**Create, Edit, Delete or Reply to Messages**
In Synthesis desktop applications, you can access the message commands from the My Portal tab of the ribbon, and by right-clicking inside the Messages page of the panel.
Note that the purpose of the **Refresh Messages** command is to update the display with any new messages that were recently added or changed by another database user.

**Message Recipients**
You can specify whether a message will be visible to all database users or only to specific users or groups. If you select Selected Groups/Users, you can choose from two lists: user groups that have been predefined in the database and/or individual user accounts.

![Message Recipients](image)

If a valid SMTP server has been defined for the database, you can select the **Also send this via e-mail** check box to send an e-mail copy of the message to the recipient(s). (See [Enable Alerts via E-mail or SMS](#).)

**Actions in My Portal**
Throughout the Synthesis Platform, your team can use actions to track specific assignments that need to be performed. These versatile Synthesis resources can be used multiple times in different locations, if appropriate. This may include actions in Project Plans, FMEAs or Test Plans, as well as actions that are independent of any particular analysis or plan.

This topic discusses how to view and manage actions via My Portal (in any Synthesis desktop application). If you want to view/manage all action records, see [Actions Explorer](#) or [Resource Manager](#). For information about the action properties and other general considerations that apply wherever the action may be used, see [Action Resources](#).

**Actions Displayed in My Portal**
The Actions page in **My Portal** (and in the **Synthesis Enterprise Portal**) display action records that:

- Need to be reviewed by you.
Are relevant to you in some way and are:

- **Past Due** – the completion date has passed.
- **Due Next 7 Days** – the completion date occurs within the next 7 days.
- **Past Start Date** – the start date has passed.
- **Start Today** – the start date is today.
- **Start Tomorrow** – the start date is tomorrow.
- **Start Next 7 Days** – the start date occurs within the next 7 days.
- **In Progress** – the actual start date has been entered and the action is not yet "Past Due" or "Due Next 7 Days."

If the action is not used in the Project Planner, this will be based on the planned start/completion dates. But if the action is used in a plan, it’s based on the expected dates (which can shift automatically if there are recorded delays in prior gates/actions).

Also note that if an action fits under more than one heading, it will display under the more urgent one. For example, if the action is both due in the next 7 days and past the planned start date, it will show under "Due Next 7 Days."

**Create, Edit or Delete Actions from My Portal**

In Synthesis desktop applications, you can access the portal actions commands from the My Portal tab of the ribbon, and by right-clicking inside the Actions page of the panel.

**Tip:** If an action doesn’t fit the My Portal display criteria for your computer/username (see details below), the new record won’t be displayed in your portal after you create or edit it. In such cases, you can use the Actions Explorer or Resource Manager to access the record.
Add to Outlook Calendar
The Add to Outlook Calendar command will be enabled if Microsoft Outlook is installed on your computer.

It launches Outlook’s interface for creating a new calendar event and automatically populates the subject and date. You can modify the details as needed 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.

Refresh Actions
The Refresh Actions command updates the display with any new actions that were recently added or changed by another database user.

Action Display Settings
To specify your personal preferences for displaying actions in My Portal (stored per computer/username), right-click inside the panel and choose Action Display Settings.

If you select the Display ‘Show Actions’ labels in portal check box, the panel will also include headings that indicate how the action is relevant to you:

- **I am responsible for**
  - You are assigned in the Person Responsible field.

- **I am a team member in**
  - You belong to the team assigned in the Team field.

- **I need to review/approve**
  - You are assigned in the Reviewer field.

- **I am monitoring**
  - You are assigned in the Action Monitors window, or you have personally subscribed to “watch” the action.

- **Other actions I created**
  - You are listed in the Created By field and none of the other roles apply.
Finally, you can choose to Sort by Start Date or Sort by Due Date within each node of the display.

**Action Explorer**

The **Actions Explorer** command opens a flexibility utility that allows you to explore all of the action resources that are stored in the current database. You can use it to filter, sort, add, edit or delete actions. (See [Actions Explorer](http://rga.reliasoft.com).)

Note that when you return to the Actions page in My Portal, you will need to use the Refresh Actions command to view any changes.

**Repository Users List**

The repository users list shows all active user accounts in the database, and identifies which of those users are currently connected to the database with any of the Synthesis applications.

This list is displayed both in My Portal (in any Synthesis desktop application) and in the Synthesis Enterprise Portal (if it is implemented for your database).

In Synthesis desktop applications, you can access the users list commands from the My Portal tab of the ribbon, and by right-clicking inside the Users page of the panel. Similar commands are available in the web-based Synthesis Enterprise Portal, if applicable.
My Profile opens the User Login and Contact Information window, which allows you to edit the contact information associated with your user account.

Refresh Users updates the list to reflect any recent changes in user activity.

**Project Plan Summary in My Portal**

In all Synthesis desktop applications except MPC, the Project Plan Summary page in My Portal provides a summary of the plan for the current project, if applicable.

The summary in My Portal always reflects the entire plan for the current project, based on the actual date/time from your computer. If you want to see the summary for a particular gate or action, or to estimate what the statuses would be for a different date, you must use the Project Planner window.

- Choose **Project > Management > Project Planner**.

- Click the link in the project name bar at the top of the summary in My Portal.
How to Read the Summary
The plan summary in My Portal provides the following information at-a-glance. (For details, see Project Plan Summary Panel.)

By default, this shows the current date, which is used to determine the status (e.g., "Missed Start Date"), resource usage to date, etc. Use Refresh to obtain the latest information from the Project Planner.

The top bar displays name of the project that the summary applies to. Click the link to open the project in the Project Planner.

The next two rows show the expected dates and any actual dates, and the last row shows the status.

This is the percentage of the total duration of dependent actions/gates that is complete. For example, if Action 1 (duration = 3 days) is complete and Action 2 (duration = 1 day) is incomplete, the progress is 75%.

For resource usage, the black bars show the planned man hours and costs. The colored bars show either the expected usage to date (estimated based on the number of days in progress), or the actual usage if complete. (See Costs and Man Hours.)

- Yellow = In progress and usage to date is still within plan
- Orange = In progress and usage to date has exceeded plan
- Green = Complete and actual usage was within plan
- Red = Complete and actual usage exceeded plan
Displays only if actions have been assigned to the project or gate (either directly or via dependent gates).

- **Not Started** = Actions that have not started and can complete on time
- **In Progress** = Actions that are in progress and can complete on time
- **Completed** = Completed actions that have been approved, or don't require approval
- **Past Due** = Actions that have not completed and can no longer complete on time

### Folios

#### Data Sheets

The data sheets in Weibull++/ALTA and RGA folios share some common components and features. The following picture shows the basic components of a data sheet using one particular format as an example.
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- **Caption** shows the name of the folio and the name of the sheet that is currently displayed.

- **Name Box** shows the location of the currently selected cell by listing the column letter and row number that intersect at the cell's location.

- **Data Entry Bar** shows the contents of the selected cell, which may be text, a numerical value or a formula. For text or numerical values, you can enter/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. Each data sheet contains up to 65,536 rows. The application's speed of execution is inversely proportional to the number of data rows in the current data set.

- **Column Headings** indicate the titles of the columns. To rename a heading, right-click it and choose **Rename Column**. When applicable, you can save the column titles and use them as the default headings for all new data sheets of the current type. (See **Default Column Headings**.)

- **Sheet Tabs** represent the different sheets within the folio. To rename a sheet, double-click the tab. The number of folios that can be opened at once depends on the amount of memory of your system (up to a maximum of 256 for some folio types).

**Default Column Headings**
In life data (Weibull++), life-stress (ALTA) and growth data (RGA) folios, creating a new data sheet automatically applies default column headings that are generally appropriate for the
analysis. If there are certain types of data that you frequently use (e.g., miles-to-failure, cycles-to-failure, etc.), you can customize the column headings to always use your preferred column titles.

To modify the defaults for a particular data type, first rename the column headings in an existing data sheet. Right-click the heading and choose Rename Column on the shortcut menu. Then save the new titles as the defaults. In Weibull++, choose Life Data > Format and View > Set Headers as Default. (In ALTA, the command is in the Life-Stress Data tab; in RGA, it's in the Growth tab.)

These preferences are saved for the current computer/username, and will be applied the next time you create a new data sheet for that particular data type.

To apply the new default headings to an existing analysis, open the data sheet and choose [Life Data/Life-Stress Data/Growth Data] > Format and View > Apply Default Headers.

If you ever need to restore the default column headings back to the shipped settings, choose File > Application Setup, then click Reset Application Settings or Reset All Settings on the Reset Settings page.

Resizing Columns
Column widths are set to span evenly by default. If you want to resize and have the changes saved with the folio, right-click a column heading and choose Column Width Style > Default.

To resize a column, drag the edge of the heading to the desired position, or right-click it and choose Column Width.

Entering Formulas in the Data Sheet
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++ life data folio, or in the Classification column in an RGA growth data folio). For example, in a Weibull++ life data 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.
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 be 24+24 = 48.

**Change Units**

In 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.

The units are displayed in the heading 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 Weibull++ life data, ALTA life-stress data and RGA growth data 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.

**General Spreadsheets**

General Spreadsheets can be inserted into a Weibull++ life data folio, ALTA life-stress data folio or RGA growth data folio. They provide the same spreadsheet capabilities that are available in the spreadsheet module in *Synthesis Workbooks*, but 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 on the ribbon tab for the particular type of data folio. For example, to insert a general spreadsheet into a Weibull++ life data folio, you can choose Life Data > Folio Sheets > Insert General Spreadsheet.

**Inserting Data Source Functions**

To build and insert functions that utilize a referenced analysis (data source), click a cell in the general spreadsheet and choose Sheet > Sheet Actions > Function Wizard.
The following picture shows the most complex configuration as an example:

For the function arguments:

- Brackets [ ] indicate that the input is optional.
- You can use cell references as inputs. For example, instead of entering 1000 for the Age input, you could specify to use whatever time is currently entered into cell A10, using either the relative reference (A10) or the absolute reference ($A$10). (See Cell References.)
- You can also use variable names as inputs. (See Defined Names.)

For the data source:

- Click the Select button and then select which data sheet in the folio to use as the data source.
- Any time you make changes to the data source, the general spreadsheet will need to be recalculated to reflect the most current results. Choose Sheet > Format and View > More Settings > Recalculate Formulas. The general spreadsheet may return "N/C" if the data source needs to be recalculated.
Inserting Math Functions
To add math, date, logic and other functions, click a cell in the general spreadsheet and choose Sheet > Sheet Actions > Insert Function.

Select a function from the drop-down list and click OK. You can enter inputs for the function arguments by either selecting the cells in the sheet or typing them directly into the appropriate field.

Referencing a Data Source
Some functions (e.g., AMEAN, D_COUNT, etc.) require you to reference a particular data source.

To reference a data source, use the following syntax, with the quotes and exclamation marks (!). You can only reference sheets in the same folio.

"Application!Folio!DataSheet"

In the following example, the data source is a data sheet called "Data1" in the Weibull++ folio called "Folio1".

Control Panels
Many of the analysis folios, diagram sheets and other interfaces in Synthesis desktop applications utilize a control panel that allows you to make required inputs, initiate the desired analysis or simulation and view/access applicable results. This topic describes some features that are common to most control panels. (For Xfmea, RCM++, RBI, MPC and Lambda Predict, see System Panel and Analysis panel instead.)
Switching Between Pages
Many control panels and navigation panels contain multiple pages that vary depending on the type of analysis. You can switch between pages by clicking either the large buttons or the small icons at the bottom of the panel.

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.

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.

When the control panel is hidden, only the title bar and page icons will be visible on the right side of the window (as shown next using a Weibull++ folio as an example). When you click the bar, the active page will be displayed temporarily. When you click anywhere outside of the control panel page, it will be automatically hidden again.
Identifiers Page
The Identifiers page of the control panel allows you to enter identifying details (e.g., category, name, part number, etc.) that will be associated with the analysis and any models or SEP summaries that are published from the analysis. This will help you to find, filter and group analyses and resources throughout the repository.

In folios that can have multiple data sheets, the Folio Identifiers are edited via the Item Properties window, and the Data Sheet Identifiers can be entered directly in the control panel. Use an asterisk (*) if you want the data sheet’s identifiers to be the same as the folio’s (see Synthesis Identifiers).

Publishing Page
The Publishing page allows you to view and manage information from the current analysis that is shared throughout the Synthesis Platform.

- **Model/Fitted Model** – publishes a model based on the current analysis. See Publishing Models.
• **SEP Summary** – publishes a summary of the current analysis to the Synthesis Enterprise portal website. This is visible only if the enterprise database is configured for SEP and you have the "Publish to Synthesis Enterprise Portal" permission. See [Publishing to SEP](#).

• **Metrics** – shows all of the metric resources that are associated with the current analysis. See [Showing Metrics in Folios/Diagrams](#).

### Notifications Page
When applicable, the Notifications page provides information on the **Current Status** of the analysis, along with any warnings or errors. 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. The **Latest Notifications** area displays any warnings and errors generated during analysis.

![Notifications Page](#)

### Utilized Resources Page
In BlockSim only, the Utilized Resources 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 **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 unless some block in the diagram belongs to them.

This list is not updated automatically; if you have made changes to the diagram, click the **Refresh** icon to update the list.
Double-click a resource in the list to open its properties window for viewing or editing. Click the Resource Manager icon to view/manage all of the resources available in the project.

**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 topic 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.
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**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 heading 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.

Printing

Synthesis desktop applications use different windows (Print, Page Setup and Print Preview) for different types of features.

- Printing Plots and Diagrams
- Printing Data Sheets and Synthesis Workbooks

When a report is generated in Microsoft Word or Microsoft Excel (Xfmea, RCM++, RBI, MPC and Lambda Predict), you will need to use the utilities built in to those applications.

Printing a plot from within RS Draw uses the commands specific to it.

Plots and Diagrams

To print a plot in Xfmea, RCM++, RBI or Lambda Predict, click the Print icon on the plot control panel. To print a diagram in Xfmea, RCM++ or RBI, or a diagram or plot in Weibull++, ALTA, BlockSim, RENO or RGA, choose Home > Print > Print.

Specify the properties, then print the plot or diagram.

When printing a plot, you can open the Print Preview window to preview the plot before sending it to the printer. Closing the Print Preview window will return you to the plot, not the Print window.

Printing Diagrams in BlockSim
When printing a diagram in BlockSim, you must first choose whether to print only the Current diagram (and possibly its subdiagrams on separate pages) or Choose Multiple diagrams from the current project to print.
Considerations for Printing Plots

- In Xfmea/RCM++/RBI and Lambda Predict, when printing Pareto (bar) charts or matrix charts, set the orientation of the printed page to landscape for best results. 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 use the Plot Setup window to remove the details or the legend/user information from the plot.

Print Preview - Plots and Diagrams

To preview how a plot or diagram will look on the printed page before printing it, click Preview in the Print window; click the Print Preview icon on the plot control panel or choose Home > Print > Print Preview.

Use the toolbar icons to set how many pages to display. You can open the Page Setup window to specify the printing options.

Print Layout

For diagrams in Weibull++, ALTA, BlockSim, RENO, Xfmea, RCM++ and RBI, the Print Layout option allows you to view how a diagram will appear on the printed page. The page orientation (i.e., portrait or landscape) depends on the orientation selected in the Page Setup window. To display the page boundary lines, choose Home > Print > Print Layout.

Everything within the boundary lines will appear on the printed page. Use this to make any necessary adjustments before printing the diagram.

To exit the print layout mode, choose Home > Print > Print Layout.

Page Setup - Plots and Diagrams

The Page Setup window allows you to make selections for how the page(s) will be printed. You can open it from the Print Preview window. For diagrams and plots in Weibull++, ALTA, BlockSim, RENO and RGA, or a diagram in Xfmea, RCM++ or RBI, you can also choose Home > Print > Page Setup.
**Page Tab**
Use the Page tab to set the layout, scaling and other options.

**Margins Tab**
Use the Margins tab to set the margins.

Use the **Units** drop-down list to specify the units in which the margins will be printed. The options are **System's default** (which uses the units used by your computer), **Inches** or **Centimeters**.

**Header/Footer Tab**
Use the Header/Footer tab to set the header and footer formats.

Use the toolbar on the tab to quickly insert common format codes into the selected section of the header or footer.

**Header/Footer Format Codes - Plots and Diagrams**
Use these format codes for printing the headers and footers in plots and diagrams.

By default, text will be centered in the headers/footers unless otherwise specified. Please note that the alignment codes (i.e., &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 sheet name will be right aligned. Unless otherwise stated, all format codes can be used by all items.

<table>
<thead>
<tr>
<th>Format Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;L</td>
<td>Left aligns the item.</td>
</tr>
<tr>
<td>&amp;C</td>
<td>Center aligns the item.</td>
</tr>
<tr>
<td>&amp;R</td>
<td>Right aligns the item.</td>
</tr>
<tr>
<td>&amp;A</td>
<td>Prints the sheet name.</td>
</tr>
<tr>
<td></td>
<td>(For plots in Xfmea, RCM++, RBI and Lambda Predict, nothing is printed.)</td>
</tr>
<tr>
<td>&amp;D</td>
<td>Prints the current date.</td>
</tr>
<tr>
<td>&amp;T</td>
<td>Prints the current time.</td>
</tr>
<tr>
<td>&amp;P</td>
<td>Prints the page number.</td>
</tr>
</tbody>
</table>
Chapter 3: Desktop Application Interfaces

<table>
<thead>
<tr>
<th>&amp;P+number (e.g., &amp;P+2)</th>
<th>Prints the page number plus the specified number.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;P-number (e.g., &amp;P-2)</td>
<td>Prints the page number minus the specified number.</td>
</tr>
<tr>
<td>&amp;&amp;</td>
<td>Prints an ampersand.</td>
</tr>
<tr>
<td>&amp;N</td>
<td>Prints the total number of pages.</td>
</tr>
<tr>
<td>&amp;ZA</td>
<td>Prints the name of the application (e.g., Weibull++).</td>
</tr>
<tr>
<td>&amp;ZC</td>
<td>Prints the company name.</td>
</tr>
<tr>
<td>&amp;ZU</td>
<td>Prints the user name.</td>
</tr>
<tr>
<td>&amp;ZP</td>
<td>Prints the project name.</td>
</tr>
<tr>
<td>&amp;ZI</td>
<td>Prints the name of the item. (For plots in Xfmea, RCM++, RBI and Lambda Predict, nothing is printed.)</td>
</tr>
<tr>
<td>&amp;ZL</td>
<td>Print the path to the current repository.</td>
</tr>
</tbody>
</table>

Data Sheets and Synthesis Workbooks

To print a data sheet in Weibull++, ALTA or RGA, choose Home > Print > Print. To print a Synthesis Workbook in Weibull++, ALTA, BlockSim, RENO or RGA, choose Print > Print in the Preview window.

Specify the properties, then print the data sheet or Synthesis Workbook.

Print Preview - Data Sheets and Synthesis Workbooks

To preview how a data sheet will look on the printed page before printing it, choose Home > Print > Print Preview. For Synthesis Workbooks, choose View > Print > Print Preview.
You can open the Page Setup window to specify the printing options.

**Page Setup - Data Sheets and Synthesis Workbooks**
The Page Setup window allows you to make selections for how the page(s) will be printed. For data sheets, you can open it either from the Print Preview window or by choosing Home > Print > Page Setup. For Synthesis Workbooks, choose View > Print > Page Setup.

**Spreadsheet Module**

**Page Tab**
Use the Page tab to set the orientation, scaling and other printer options.

**Margins Tab**
Use the Margins tab to set the margins.

**Header/Footer Tab**
Use the Header/Footer tab to set the header and footer formats.

Click Custom Header/Footer to open the Header/Footer window and define the format - use the specific format codes for data sheets and Synthesis Workbooks. If you choose to use different values for the first page and/or for odd and even pages, the window includes separate tabs where you define the individual formats.

**Sheet Tab**
Use the Sheet tab to specify how the pages will print and in what order they will print.

If desired, use the Print area field to limit the printed material to either a selected cell range or to a defined name.

**Word Processing Module**

**Margins Tab**
Use the Margins tab to set the margins.

**Paper Tab**
Use the Paper tab to set the paper size.
Chapter 3: Desktop Application Interfaces

Layout Tab

Use the Layout tab to see the header and footer options.

Header/Footer Format Codes - Data Sheets and Synthesis Workbooks

Use these format codes for printing the headers and footers in data sheets and Synthesis Workbooks.

<table>
<thead>
<tr>
<th>Format Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;[Page]</td>
<td>Prints the page number.</td>
</tr>
<tr>
<td>&amp;[Pages]</td>
<td>Prints the number of pages.</td>
</tr>
<tr>
<td>&amp;[Date]</td>
<td>Prints the date.</td>
</tr>
<tr>
<td>&amp;[Time]</td>
<td>Prints the time.</td>
</tr>
<tr>
<td>&amp;[Path]&amp;[File]</td>
<td>Prints the file path.</td>
</tr>
<tr>
<td>&amp;[File]</td>
<td>Prints the file name.</td>
</tr>
<tr>
<td>&amp;[Tab]</td>
<td>Prints the sheet name.</td>
</tr>
<tr>
<td>&amp;[Picture]</td>
<td>Prints a selected picture.</td>
</tr>
</tbody>
</table>

Click the **Format Picture** icon on the Header/Footer window to set the image size and other properties.
Chapter 4: RGA Ribbons

In Synthesis desktop applications, the ribbon replaces the toolbars and menus used in older software. The ribbon is divided into tabs that relate to a task or activity, such as managing the projects in a database or performing a specific type of analysis. Depending on the current activity, some commands may appear dimmed or will not appear at all.

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.

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.

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:
Chapter 4: RGA Ribbons

- **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.

**Backstage View (File Tab)**

The **Backstage view** (File tab) is the first view you will see when you start a Synthesis desktop application. This topic provides a summary of the commands available in the **Tab Pane** on the left side. For information about the right side, see [ReliaSoft Online Pane](http://rga.reliasoft.com).

- **Save** (available only when a Synthesis file is currently open) saves all recent changes to the Synthesis file (*.rsf11). This command is not applicable in a standard or enterprise database, because the changes are saved automatically as you work.

- **Save As** (available only when a standard database or Synthesis file is currently open) saves a copy of the standard database or Synthesis file to another pathname/filename and/or file type. You can save the file as a new standard database (*.rsr11), Synthesis file (*.rsf11) or compressed standard database (*.rsgz11).

- **Pack and E-mail** (available only when a standard database or Synthesis file is currently open) sends a compressed version of the standard database or Synthesis file via e-mail.

- **Open Repository** opens an existing standard database (*.rsr11), enterprise database (*.rserp), Synthesis file (*.rsf11) or a compressed standard database (*.rsgz11).

- **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 (*.rsr11, *.rserp and *.rsf11) 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 **Synthesis Settings page** of the Application Setup. 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 (*.rsr11), Synthesis file (*.rsf11) or connection file for access to an enterprise database (*.rserp).

Launch Application provides quick launch icons for other Synthesis desktop 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 be opened automatically in the new application.

Manage Repository provides a variety of tools and configurable settings for the repository. The settings are shared by all users and all analysis projects in a database.

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.

Application Setup allows you to set your personal 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.

Exit closes the current database (if any) and shuts down the application.

Manage Repository
The Manage Repository section of the Backstage View contains the following commands. The available commands depend on the current application and the database type.

Users

Users and Security controls which users can access the repository and their permissions.

User Groups create and manage groups of users that can be assigned to actions, messages, etc. throughout the current database.

Repository Logins displays a list of users who have connected to the repository and allows you to export this information to Excel.

Reset "In Use" Flags allows you to reset the flags that indicate the "in use" status of projects or items within a project.
Chapter 4: RGA Ribbons

Lambda Predict Repository Settings
Available only in Lambda Predict:

- **FIDES Settings Manager** defines the settings related to the FIDES prediction standard such as process audits, pi factors, categories, etc. (See FIDES Settings Manager in the Lambda Predict documentation.)

- **Custom Derating Standards Manager** allows you to add, edit, delete or import/export custom derating standards. (See Creating Custom Derating Standards in the Lambda Predict documentation.)

- **MIL-217 Custom Connections** defines custom connection types for use with the MIL-HDBK-217F prediction standard. (See MIL-217 Custom Connection Types in the Lambda Predict documentation.)

Xfmea/RCM++/RBI Libraries
Available only in Xfmea, RCM++ and RBI:

- **Profiles/Library Manager** configures 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 Profiles/Library Manager in the Xfmea/RCM++/RBI documentation.)

- **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 Templates Manager in the Xfmea/RCM++/RBI documentation.)

Settings and Predefined Options

- **Repository Settings** allows you to enable alerts via e-mail or SMS, activate history logs, and other settings.

- **Time and Usage Units** defines 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.

- **Project/Item Categories** defines the categories that can be used to filter and group data throughout the database.

- **Default Name Formats** (not applicable for MPC) specifies the default names for new Synthesis resources, as well as new blocks in BlockSim RBDs, fault trees and phase diagrams.
Project Planning Resources (not applicable for MPC) defines the cost categories, teams, materials and facilities that are used for tracking costs, man hours and resource utilization in actions and Project Planner gates.

Working Days/Holidays (not applicable for MPC) specifies the business days when project planning resources can be utilized.

Dashboard Layout Manager (not applicable for MPC) shows all of the predefined dashboard layouts that will be available for any Synthesis user to view for a particular data set.

Task Types (applicable only in RCM++, RBI and MPC) maps the task types used in RCM++ and RBI (e.g., Restoration, Failure Finding, etc.) to the corresponding task classes in the universal reliability definition (e.g., Preventive, Inspection, etc.) so that simulation and cost calculation results are accurate. (See Task Types in RCM++/RBI in the Xfmea/RCM++/RBI documentation.) In MPC, it allows you to modify the abbreviations used for the MSG-3 task types. (See Task Type Abbreviations in MPC in the MPC documentation.)

XFRACAS Connection is available only for standard databases (*.rsr11) or Synthesis files (*.rsf11) in Weibull++/ALTA, RGA, and Xfmea/RCM++/RBI. It allows you to define connection settings for an enterprise repository.

Database Tools

New Enterprise Repository 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.

Upgrade Version 9/10 Repository converts an existing Version 9 or Version 10 enterprise database to a Version 11 enterprise database. This cannot be undone. It is recommended that you create a backup of the Version 9/10 database before performing the upgrade.

Upgrade Version 8 Repository copies all of the existing data from a Version 8 enterprise database to a new Version 11 enterprise database.

Restore Points manages all of the project backups that are stored in the current database.
Chapter 4: RGA Ribbons

**Compact and Repair** is available only in a standard database (*.rsr11) or Synthesis file (*.rsf11). It helps to reduce the size of the database and protect against data loss and corruption. (See **Backups and Database Maintenance**.)

**Import from Version 5** is available only in Xfmea, RCM++ and RBI. It allows you to import data from a Version 5 Xfmea/RCM++ database. This command is available only when you are connected to an enterprise database and have the "Manage users and logins" permission and the applicable "manage all projects" permissions.

ReliaSoft Online Pane
On the **Backstage view**, the area on the right side 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 Platform** page displays tips and announcements related to the entire Synthesis Platform.

Note that an active Internet connection is required to see this information.

This pane can be hidden by clearing the **Display ReliaSoft Online pane** check box on the **Synthesis Settings page** of the Application Setup.

Help Center (File > Help) and Help Tab
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 's Help tab.

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](http://www.weibull.com), which is devoted entirely to the topic of reliability engineering, reliability theory and reliability data analysis and modeling.
- **ReliaWiki.org** opens the [ReliaWiki website](http://www.reliawiki.org), which is both a resource portal and a wiki for professionals in reliability engineering and related fields.
- **Reliability Discussion Forum** opens the [Reliability Discussion Forum website](http://www.reliabilitydiscussionforum.com), 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.
- **ReliaSoft.tv** opens the [ReliaSoft TV website](http://www.reliasoftware.com).

### Examples

- **Open Examples Folder** provides access to a set of example projects that are designed to help you explore various software features.

### 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 USA Office** provides the contact information you will need to obtain technical support.
- **Contact Global Support Center** helps you find your localized 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/or your contact information on file with ReliaSoft.
Chapter 4: RGA Ribbons

- **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.

**Home Tab**

The Home tab contains the following commands:

**Clipboard**

- **Paste** pastes the contents of the Clipboard to the current folio or spreadsheet. Choose **Paste Values** to paste the values only, **Paste Formats** to paste the formats only, **Paste Formulas** to paste the formulas only, or **Paste All**.

- **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 to the Clipboard. Data stored on the Clipboard can be pasted into this and other applications. If you are copying a plot, the way the plot is copied will depend on your selection in the **Copy Plot Graphic** setting in the **Application Setup window**.

- **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.

**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 text.

- **Clear**
  - **Clear All** deletes the contents and format of the selected cell(s), but does not delete the actual cell(s).
• **Clear Values** deletes only the contents of the selected cell(s). The format will be retained.

• **Clear Formats** deletes only the format of the selected cell(s). The contents will be retained.

[Select All] selects all of the cells in the currently active sheet.

[Find] allows you to quickly find text/values in the active data sheet and, if desired, replace the original with new text/values. You can specify the order in which to search (either **By Rows** or **By Columns**), and whether to look in equations (**Formulas**) or within the results of equations (**Values**).

Select the **Match Case** check box to limit the results to text that have the same case. Select the **Find Entire Cells Only** check box to limit the results to text/numbers that are identical to the search term.

To replace every instance of a text string, click **Replace** and in the **Replace With** field, type the text that will replace the original (if you don't type anything, the tool will delete the original). Click **Find Next** to search for the text. When a match is found, you can either click **Replace** to replace the original with the new text, or click **Find Next** to leave the original as-is and find the next occurrence. To replace all instances without review, click **Replace All**.

[Spelling] activates the **Spell Check utility**, which allows you to check the spelling within the current sheet.

**Print**

**Print** sends the current data sheet or spreadsheet to the printer.

**Page Setup** allows you to specify printing options.

**Print Preview** allows you to view how the current data sheet or spreadsheet will appear on the printed page.

**Tools**

**Quick Statistical Reference** opens the **Quick Statistical Reference utility**, which allows you to calculate common statistical values such as median ranks, chi-squared values and student's t values. It also includes a polynomial interpolation/extrapolation function, which allows you to obtain new data points from a set of known data points that you provide.
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.

Synthesis

**Synthesis Data Warehouse** allows you to access data from ReliaSoft’s XFRACAS or other external data sources for reliability growth analysis. (See Synthesis Data Warehouse (SDW).)

**Synthesis Explorer** allows you to explore all of the different analyses that are stored in the current database. You can filter, group and sort the analyses in a flexible grid, and also present the information in a wide variety of dashboard charts. (See Synthesis Explorer.)

**Actions Explorer** allows you to explore all of the action resources that are stored in the current database. You can filter and sort by date, status, person responsible, relevancy to you, etc. (See Actions Explorer.)

My Portal Tab


Messages

**Create Message** opens the Message window, which allows you to compose and send messages within the database.

**Edit Message** opens the Message window, which allows you to view and edit all of the properties of the message.

**Reply to Message** opens Message Reply window, which allows you to respond to a message sent to you.

**Delete Message** deletes the current message.

Actions

**Create Action** opens the Action window and adds an action to the project.
**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.

### Project Tab

Unless otherwise indicated, these commands apply to the project that is currently selected in the project list. 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.

**Note:** For secure databases, access to the commands on this tab may be restricted based on the permissions assigned to the user account.

### 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.

**Edit Project Properties** allows you to view and edit the properties of the selected project.
**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.

**Transfer Project** is available only in Xfmea/RCM++/RBI. It allows you to create a new project with data transferred from the selected project. (See Transfer Projects in the Xfmea/RCM++/RBI documentation.)

**Task Numbering** is available only in MPC. It allows you to specify whether or not you want to reuse task numbers within the project. (See Task Numbering in MPC in the MPC documentation.)

**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.

**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 Import, Export and Data Conversion.)

**Configurable Settings** is available only in Xfmea/RCM++/RBI. It allows you to view/modify the configurable settings for the current project. (See Configurable Settings in the Xfmea/RCM++/RBI documentation.)

**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.

**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.

**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 or restore point.

**History Log** is available only if you are the project owner or have the applicable "manage all projects" permissions. 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.

**Project Planner** opens the Project Planner, which provides full project planning and management capabilities for the current project. This command is not available in MPC.

**E-mail Project**

**Pack and E-mail** compresses a copy of the selected project to a *.rsgz11 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**

**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.

**Change Owner** allows you to assign a different database user to be the owner for the selected project.

**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 **Locked and Unlocked Projects**.)

**Make Private** moves the selected public project into the Private heading of the project list. (See **Public, Private and Reference Projects**.)

**Make Public** moves the selected private or reference project into the Public heading of the project list.
Chapter 4: RGA Ribbons

- **Make Reference** moves the selected public project into the Reference heading of the project list. This command is not available in MPC.

### Current Item

The following commands are available when you select a specific item (a diagram, report, multiplot, etc.) in the current project explorer. This group is not available in Xfmea/RCM++/RBI or in MPC.

- **Edit** brings the selected item to the front of the windows and activates it as the current control. If an attachment is selected, the command opens the attachment in the appropriate application, if that application is installed on your computer.

- **Rename** allows you to rename the selected item.

- **Duplicate** creates a copy of the selected item within the project. The duplicate will have the same name as the original with an increment number added to the end (e.g., RBD1_1, RBD1_2, etc.). In BlockSim, you can choose to **Duplicate With Resources**, which also creates duplicate resources in the Resource Manager window.

- **Delete** deletes the selected item. **There is no undo for delete.**

- **Item Properties** is available only for project explorer items (e.g., folios, diagrams, plots, etc.). It opens the Item Properties window, which allows you to view and edit the item's **Synthesis identifiers**, **item settings** (if applicable) and **item permissions** (in secure databases).

- **Locator Link** is a link file (similar to a Windows shortcut) that provides quick access to the specific analysis. In an enterprise database, you can choose to **Save** or **E-mail** the file. In a standard database or Synthesis file, the only option is to save the file. In Xfmea/RCM++/RBI, these commands are available in the System Hierarchy tab. In MPC, they are in the Systems, Structures or Zones tab.

### Synthesis

- **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. This command is not available in MPC.

- **Batch Properties Editor** opens the Batch Properties Editor, which allows you to perform batch editing of most types of local resources in the current project. In BlockSim,
it also allows you to edit the blocks used in the diagrams. This command is not available in MPC.

Attachments is available only in Xfmea/RCM++/RBI and MPC. It adds linked or attached files to the selected project. In other Synthesis desktop applications, attachments commands are available in the current project explorer, and in the Insert tab of the ribbon.

Data Management
The following commands are available only in BlockSim.

- Mirror Group Manager opens the Mirror Group Manager window which allows you to add, view and edit groups of mirrored blocks within the project that is currently open/visible. (See Mirroring (Using Blocks in Multiple Locations) in the BlockSim documentation.)

- Maintenance Group Manager opens the Maintenance Group Manager window, which allows you to add, view and edit the maintenance task groups available to the project that is currently open/visible. (See Maintenance Groups.)

Reports

- MRBR is available only in MPC. It allows you to generate a maintenance review board report in Microsoft Word. (See Maintenance Review Board Reports in the MPC documentation.)

Insert Tab
The Insert tab contains the following commands:

Wizard

- Project Item Wizard opens the Project Item Wizard, which provides information about all the analyses that you could add to the project and guides you through any steps required to configure the analysis that you have selected.

Growth Data

- Growth Data adds a growth data folio for growth data analysis.
Test and Planning

Continuous Growth Planning adds a continuous growth planning folio to the project.

Discrete Growth Planning adds a discrete growth planning folio to the project.

Test Design opens the Repairable Systems Test Design folio that can assist you in designing a demonstration test.

Mission Profile

Mission Profile adds a mission profile folio to the project.

Simulation

Repairable Systems Monte Carlo opens RGA's Monte Carlo utility, which uses simulation to generate a single data set containing values that are distributed according to the Crow-AMSAA (NHPP) model with specified beta and lambda parameters.

Repairable Systems SimuMatic opens the SimuMatic Setup window, which allows you to generate several sets of data at once (via the Repairable Systems Monte Carlo utility) and automatically perform a large number of reliability analyses on them.

Reports and Plots

Synthesis Workbook adds a Synthesis Workbook to the project. A Synthesis Workbook is a custom reporting tool that contains both spreadsheet and word processing modules.

Overlay Plot adds an overlay plot to the project that allows you to display in a single plot results from multiple data sheets. This provides an easy visual method to compare analyses. For example, you may wish to show the growth plots of two product designs in the same plot.

Side-By-Side Plot adds a side-by-side plot to the project allowing you to display different plots of a single data set all in a single window for easy comparison.

Multi-Phase Plot adds a new Multi-Phase Plot to the project. This allows you to plot data from multiple test phases together, along with data from a growth planning folio, if desired.
Attachments

Attachment adds linked or attached files to the project.

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.

Tile Project Manager tiles the project list and current project explorer so they are both displayed simultaneously in the Project Manager panel. This command is not available in Xfmea, RCM++, RBI or MPC.

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.

Tile My Portal tiles the Messages, Actions and Users 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
The commands in this group are available only in Xfmea, RCM++, RBI, MPC and Lambda Predict.

- **Change Orientation** toggles between the two possible orientations for the System panel and the Analysis/Properties panel. These panels can be side-by-side or one on top of the other.

- **Hide System [Panel/Hierarchy]** hides the System panel in the Project window. When you want to show the panel again, choose View > Workspace Layout > Split Panels.

- **Hide [Analysis Panel/Properties]** hides the Analysis/Properties 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/Properties panel.

- **Properties View**. These commands are available only in Lambda Predict.

  - **Tree View** organizes the properties depending on whether they are physical properties (e.g., part quality level, case type, etc.) or application properties (e.g., ambient temperature, applied voltage, etc.). Depending on the prediction standard and component you are working with, the properties may also be organized according to failure mechanisms or type of data.

  - **Pi Factor View** organizes the item properties based on the pi factors that they contribute to so you can see how the values affect the failure rate calculations. The relevant pi factors will vary depending on the item's failure rate model. (See the Tree View and Pi Factor View topic in the Lambda Predict documentation.)

Expand/Collapse
The commands in this group apply to the hierarchical view that currently has focus. Depending on the application, this can be the project list, the current project explorer, the System panel, the Properties panel (Lambda Predict only) or the Analysis panel if it is using a hierarchical view.

- **Expand Tree** expands the entire tree in the hierarchical view.

- **Collapse Tree** collapses the entire tree in the hierarchical view.

- **Expand Node** expands the selected branch in the hierarchical view.
Collapse Node collapses the selected branch in the hierarchical view.

Collapse to Level collapses the hierarchical view to the level of the item that is currently selected. 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.

Cascade cascades all open project windows inside the MDI.

Tile Horizontally horizontally tiles all open project windows inside the MDI.

Tile Vertically vertically tiles all open project windows inside the MDI.

The Windows drop-down 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 ribbon.

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).
Chapter 4: RGA Ribbons

**FMRA**
The commands in this group are available only in BlockSim. (See [Failure Modes and Reliability Analysis (FMRA)](http://rga.reliasoft.com) in the BlockSim documentation.)

- **Show FMRA** opens the FMRA view, which displays the FMRA (failures modes and reliability analysis) hierarchy that is associated with the project.

- **Disassociate FMRA** deletes all of the diagrams and blocks associated with the current FMRA hierarchy and closes the FMRA view.

**Show**
The commands in this group are available only in Xfmea, RCM++, and RBI.

- **Show FMRA** enables/disables the FMRA tab in the System panel.

- **Show Test Plan** opens the Test Plan tab in the analysis panel, which displays a list of actions that describe specific tests that need to be performed. (See the Test Plans topic in the Xfmea/RCM++/RBI documentation.)

**Active Tabs**

**Growth Data Tab**
The Growth Data tab is visible when you view a growth data folio data sheet.

**Analysis**

- **Calculate** estimates the parameters of the selected model and analysis method, based on the current data set and the specified analysis settings.

- **Plot** creates a new sheet in the folio that provides a choice of applicable plot types.

- **Quick Calculation Pad** opens the [Quick Calculation Pad](http://rga.reliasoft.com), which allows you to calculate results, such as the cumulative MTBF and the expected number of failures, based on the analyzed data sheet.

- **Statistical Tests Report** performs [statistical tests](http://rga.reliasoft.com) on the active data set and displays the results in the Results Panel. These tests may include the Chi-Squared, Cramér-von Mises, Laplace Trend and Common Beta Hypothesis tests, depending on the data type.
**Event Report** opens an Event Report for the current analysis in the Results Window. The Event Report gives information on individual failure modes. Event Reports are available for all multi-phase data types and for the Multiple Systems with Event Codes data type.

**Crow Extended**

**Effectiveness Factors** is available only if the data sheet contains Projections columns. It opens the Effectiveness Factors window, which allows you to define the effectiveness factors for each BD mode to estimate the fractional decrease in failure intensity.

**Convert Modes** opens the Convert Modes window, which allows you to convert any classification and mode in the data set to another classification and mode.

**Mode Processing** opens the Mode Processing window where you can extract the first failure time for each unique BC mode and/or unique BD mode in a data set.

**Test for Fix Effectiveness** opens the Test for Fix Effectiveness utility, which allows you to assess whether or not corrective actions have been effective across phases. This command is available for all multi-phase data types, for the Multiple Systems with Event Codes data type and for any data set analyzed using Change of Slope calculations.

**Advanced Systems**

The following commands are visible when you view the data sheet in Advanced Systems View.

**Edit Systems**

- **Copy System** copies the selected system in the Advanced Systems View Explorer.
- **Paste System** pastes the copied system as a new system in the Advanced Systems View Explorer. The copied system will be named as "Copy of (name of copied system) [increment]." Thus, if you create a single copy of a system named "System A," the copy will be named "Copy of System A 1."
- **Add System** adds a system to the Advanced Systems View Explorer.
- **Delete System** deletes the selected system from the Advanced Systems View Explorer.
- **Check All** selects all systems in the Advanced Systems View Explorer for inclusion in the analysis.
- **Uncheck All** clears the check boxes for all systems in the Advanced Systems View Explorer so that none are selected for inclusion in the analysis.
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- **Expand All** expands the hierarchy in the Advanced Systems View Explorer to show the start and end times for each system.

- **Collapse All** collapses the hierarchy in the Advanced Systems View Explorer to hide the start and end times for each system.

- **Move Up** moves the selected system up one place in the Advanced Systems View Explorer.

- **Move Down** moves the selected system down one place in the Advanced Systems View Explorer.

- **Rename** allows you to change the name of the selected system in the Advanced Systems View Explorer. When selected, edit the name in the text box that appears and press **ENTER**.

**System Results**

- **Current System** displays the calculated results for the currently selected system.

- **All Systems** displays the calculated results for all systems.

**Options**

**Alter Parameters** opens the [Alter Parameters window](http://rga.reliasoft.com), which allows you to alter the values of the corresponding calculated parameters. No recalculation is performed. This command is available for any data set calculated using any model except the Crow Extended and Crow Extended - Continuous Evaluation. Furthermore, for data sets calculated with the Crow-AMSAA (NHPP) model, this functionality is not available for Change of Slope calculations.

**Auto Group Data** opens the [Auto Group Data window](http://rga.reliasoft.com), which allows you to specify intervals to group the data in the current data sheet. This command is available only for the Failure Times, Multi-Phase Failure Times and Fleet data types.

**Interval GOF** opens the [Interval Goodness-of-Fit Test window](http://rga.reliasoft.com), which allows you to evaluate the model’s fit to the combined equivalent system (for developmental data) or superposition system (for fielded systems data) and, if necessary, omit individual systems from the combined analysis. This command is available for the following data types: Multiple Systems - Concurrent Operating Times, Multiple Systems with Dates, Multiple Systems with Event Codes, Repairable Systems and Fleet.

**Batch Auto Run** opens the [Batch Auto Run window](http://rga.reliasoft.com), which allows you to quickly extract data subset(s) from an existing data set. This command is available only for the Multiple Systems - Concurrent Operating Times, Multiple Systems with Dates, Multiple Systems with Event Codes, Repairable Systems and Fleet.
Systems with Event Codes, Repairable Systems, Fleet, Multi-Phase Failure Times, Multi-Phase Mixed Data and Multi-Phase Grouped Failure Times data types.

**Link Mission Profile** allows you to select a Mission Profile in the project that you want to group the data sheet by. The data in the data sheet will be transferred to a new data sheet in the folio and grouped according to the specified Mission Profile. This command is available only for the Failure Times data type.

### Folio Sheets

- **Insert Data Sheet** inserts a new blank data sheet into the currently active folio and opens the RGA Folio Data Sheet Setup window, which allows you to select what types of data to include in the new data sheet.

- **Insert Additional Plot Sheet** inserts an overlay plot in the currently active folio. This allows you to display in a single plot results from multiple data sheets within the folio. This provides an easy visual method to compare analyses. For example, you may wish to show the reliability plots of two product designs in the same plot.

- **Insert General Spreadsheet** inserts a new blank general spreadsheet into the currently active folio.

- **Delete Sheet** deletes the current sheet within the folio.

- **Move or Copy Sheet** allows you to move or copy any of the sheets within the currently active folio. Select the sheet that you wish to move and then click (move to end) to move the selected sheet to the end of all the sheets in the folio. Select Create a Copy to create a copy of the selected sheet.

- **Select Sheet** allows you to select which sheet in the current folio you want to be active.

### Format & View

- **Insert Columns** allows you to insert additional columns into a growth data folio data sheet. The types of columns available for insertion vary depending on the data type.

- **Delete Columns** allows you to delete columns from a growth data folio data sheet. The types of columns that can be deleted vary depending on the data type.

- **Set Headers as Default** saves the current column headings as the defaults for new data sheets of the same type. To reset the default headings, click Reset Application Settings in the Application Setup.
**Chapter 4: RGA Ribbons**

**Apply Default Headers** applies the currently saved defaults to the column headings of the active data sheet.

**Switch to Normal View/Switch to Advanced Systems View** toggles between systems views for data types with multiple systems. The Advanced Systems View displays the data one system at a time and provides a navigation panel to select which system you wish to view. This view allows you to view the calculated results for each system individually and for the "equivalent" system (for reliability growth analyses) or the "superposition" system (for fielded systems analyses). In addition, this view gives you the ability to remove individual systems from consideration in a particular analysis. The Normal View displays the data for multiple systems all together in the same data sheet.

**Transfer Data**

**Transfer to New Data Type** opens the Transfer to New Data Type window, which allows you to select a data type into which you would like to transfer the data. This command is available only for the Multiple Systems - Concurrent Operating Times, Multiple Systems with Dates, Multiple Systems with Event Codes, Repairable Systems and Fleet data types.

**Transfer to Weibull++** opens the Transfer to Weibull++ window, which allows you to create a new Weibull++ data set or transfer the current RGA data set to a life data folio in Weibull++. Weibull++ is ReliaSoft’s life data analysis software and this command is available only if the software is installed on your computer. Please note that you can activate Weibull++ only after the parameters have been calculated.

**Synthesis**

**Publish Model** allows you to use the results of the growth analysis as a resource object and make it available for unlimited use elsewhere within the project, in any Synthesis application that has a need for that type of object.

**Publish SEP Summary** publishes a summary of the current analysis to the Synthesis Enterprise portal website. This is visible only if the enterprise database is configured for SEP and you have the “Publish to Synthesis Enterprise Portal” permission (see Publishing to SEP).

**Test and Planning Tab**

The Test and Planning tab is visible when you view a growth planning folio.
Analysis

- **Calculate** calculates the inputs and generates the growth planning results.

- **Plot** creates a new sheet in the folio that provides a choice of applicable plot types that show the results that are expected if you implement the plan.

- **Quick Calculation Pad** opens the **Quick Calculation Pad**, which allows you to calculate a variety of results that are expected if you implement the plan.

- **Show Results** allows you to see a summary of the inputs and results in the Results window.

Mission Profile Tab

The Mission Profile tab is visible when you view a *mission profile* data sheet.

Mission Profile

- **Insert Profile Sheet** adds a new profile sheet to the current mission profile.

- **Delete Profile Sheet** deletes the current profile sheet from the mission profile.

- **Validate Mission Profiles** sorts each profile sheet by the Cumulative Time column and checks that all necessary data have been entered.

- **Plot Mission Profiles** creates a *Mission Profile plot* for all profile sheets in the current folio.

- **Transfer Convergence Points to Profile Sheets** adds all convergence points entered on the convergence points sheet to each profile sheet in the mission profile.

Plot Tab

The Plot tab is visible when you are working with a *plot sheet*.

Plot

- **Redraw Plot** updates the plot to reflect the changes that have been made.
Chapter 4: RGA Ribbons

Quick Calculation Pad opens the Quick Calculation Pad, which allows you to calculate results, such as the cumulative MTBF and the expected number of failures, based on the analyzed data sheet.

Actions

Copy Plot Graphic copies the plot to the Clipboard as a graphic. If you will be pasting copied plots into any one of the spreadsheets built in to Synthesis applications (e.g., Synthesis Workbooks or General Spreadsheets), choose Metafile Optimized for Synthesis Spreadsheet. If you will be pasting them into external applications, choose Bitmap or Metafile Optimized for External Use.

Plot Setup opens the Plot Setup window, which offers several options for customizing a plot, such as editing axis titles, line styles, grid lines, etc.

RS Draw launches ReliaSoft Draw, which is a graphics editor that offers advanced options for annotating, inserting images, drawing images on a plot, and more.

Export Plot Graphic opens the Save As window, which allows you to save the current plot graphic as a *.wmf, *.png, *.gif, or *.jpg file.

Show/Hide Items opens the Show/Hide Plot Items window, which provides options for displaying or hiding from view certain plot items such as data points, lines, probability scales, etc.

Confidence Bounds

Show Confidence Bounds opens the Confidence Bounds Setup window, which allows you to define the properties of the confidence bounds lines to be displayed on the plot.

Hide Confidence Bounds removes the line(s) depicting the confidence bounds from the current plot.

Options

Copy Plot Data is available only for the Cumulative Number of BD Modes, MTBF BD Unseen and Discovery Rate plot types and only for plots within the growth data folio. It copies the data upon which the plot is based to the Clipboard. The data can then be pasted into other applications as needed.

Plot Modes applies to Individual Mode MTBF/FI/Reliability plots. See Plot Modes window.
Plot Systems applies to System Operation plots for multiple systems. See Select Systems to Plot window.

Plot Beta Bounds applies to Beta Bounds plots. See Beta Bounds window.

SimuMatic Tab
The SimuMatic tab is visible when you view the SimuMatic results folio.

SimuMatic
Repairable Systems SimuMatic opens the SimuMatic Setup window, which allows you to change your simulation settings and replace your current simulated data sets with new ones.

Plot creates a new sheet in the folio that generates a probability plot of all the data sets.

Sheet Tab
The Sheet tab is visible when you view data sheets and general spreadsheets.

Format and View
Format Cells opens the Format Cells window, which provides several ways to change the way data are displayed in a cell or range of cells:

- **Number tab** - sets the numbering format of a cell. Anything you type in the cell will be automatically formatted based on your selection. For example, if you select the number format and specify 3 decimal places, typing the value 1.2 in the cell will automatically display it as 1.200.

- **Alignment tab** - sets the horizontal, vertical alignment and indentation text in a cell. Includes text control options such as wrap text, shrink to fit, merge cells, as well as text direction.

- **Font tab** - sets the font, style, color, size and effects of the selected text.

- **Border tab** - applies borders around the selected cell(s) and controls the line style, thickness and color of the border lines.

- **Fill tab** - sets the background color of the selected cell(s). You can also apply a pattern style and choose a pattern color.
Chapter 4: RGA Ribbons

- **Recalculate Formulas** forces a recalculation of all formulas in the spreadsheet.

- **Defined Names** applies only to general spreadsheets. It allows you to create and manage variable names that can be referenced in any function. You can define a name for any spreadsheet cell or data sheet or function. Names can help make formulas in the spreadsheet easier to understand and maintain.

**Sheet Actions**
The following commands apply only to general spreadsheets.

- **Function Wizard** opens the Function Wizard, which helps you to build functions that return results from mathematical values (e.g., sine, pi or averages).

- **Chart Wizard** allows you to create new plots and charts based on the current spreadsheet. To use, select a range of cells for which you would like to create a chart, then click Chart Wizard and select the area where you want to place the chart.

- **AutoSum** allows you to compute the sum of the values in a range of selected cells. If a cell range is not selected, the command computes the sum of the values in the cells directly above the current cursor location.

- **Sort** allows you to reorder the selected data either in ascending or descending order. Note that you may need to be careful when sorting certain types of data in order to prevent errors in analysis.
  
  - If your analysis takes into account the order position of a data point (1st, 2nd, 3rd, etc. position), sorting may result in an inaccurate analysis.
  
  - If the range of cells that you wish to sort contains blank cells, the blank cells may be put in the first position (ascending order) or the last position (descending order).
  
  - If the values in two or more columns are related, sorting only one column may result in errors. In that situation, use the Custom Sort command.

**Rows/Columns**

- **Delete** deletes the selected cells and moves the remaining cells based on the specified direction. Note that when the cells are deleted, the information inside the cells is also deleted.
Insert inserts new cells at the current cursor location and moves the existing cells based on the specified direction. If a range of cells is selected in the sheet, then the same number of cells will be inserted.

Transfer Data
- Send to Excel exports all sheets to an Excel file.
- Send to Word exports the current sheet to a Word file.

Test Design Tab
The Test Design tab is visible when view a Test Design folio.

RDT
- Calculate calculates the required test time or number of systems for a reliability demonstration test, based on the specified inputs.
- Show RDT Table creates an RDT table and plot that allow you compare different test scenarios.
Chapter 5: RGA Growth Data Folio

The RGA growth data folio is the most commonly used folio in the application. Depending on the data type selected, the folio can be used for several different types of analysis. This chapter describes general information about growth data folios that apply to most analyses.

For more focused information about performing a particular type of analysis, you can go directly to the topic of interest, which provides information about the applicable data types and models, analysis assumptions, available results, application examples, etc.

- **Traditional Reliability Growth Analysis**: This type of analysis is used for data from in-house reliability growth testing that was conducted during the developmental stages for a product. The analysis assumes that all fixes (i.e., permanent design improvements) are applied immediately after failure and before testing resumes, and that a reliability growth model can be fitted to the data in order to track how the reliability changes over time. The metrics of interest may include the reliability, MTBF, failure intensity, expected number of failures for a given time, and the amount of testing that will be required to demonstrate a specified reliability. Depending on the data type, the following statistical models can be used in the analysis: Crow-AMSAA (NHPP), Standard Gompertz, Modified Gompertz, Lloyd-Lipow, Duane or Logistic.

- **Reliability Growth Projections, Planning and Management**: This type of analysis focuses on how the reliability growth management strategy (i.e., which modes are fixed and when) affects the reliability growth potential of the product. Instead of assuming that all fixes are applied immediately after failure and before the observational period resumes, you can use classifications to account for different fix strategies employed for different failure modes.
  - The [Crow Extended model](#) is designed for a single test phase, and it classifies failure modes as A = no fix, BC = fixed at some time during the test or BD = fix delayed until after the end of the test.
  - The [Crow Extended – Continuous Evaluation](#) model can be used for single or multiple test phases, and it classifies failure modes as A = no fix, BC = fixed immediately before testing resumes or BD = fixed at some point after testing resumes (i.e., later in the same test phase, between test phases, in a subsequent test phase or after all test phases).
  - The *growth planning folio and multi-phase plot* can be used to develop an effective reliability growth test plan, and visualize the test results across multiple phases.
Chapter 5: RGA Growth Data Folio

- **Repairable Systems Analysis**: This type of analysis is used for data from repairable systems operating in the field under typical customer usage conditions. Such data might be obtained from a warranty system, repair depot, operational testing, etc. You can use the power law or Crow-AMSAA (NHPP) models for repairable system analysis based on the assumption of minimal repair (i.e., the system is “as bad as old” after each repair) to calculate metrics such as the expected number of failures, rate of wearout or the optimum time to replace or overhaul a system to minimize life cycle costs.

### Creating a Growth Data Folio

To add a growth data folio to a project, choose **Insert > Growth Data** or right-click the **Growth Data** folder in the current project explorer and choose **Add Growth Data**.

A setup window will prompt you to select a data type to use with the folio. The data type you select determines the data entry columns that appear in the data sheet and the type of analysis you can perform (see [Data Types](#)). Click **Next** to go to the next step to configure your data sheet; otherwise, click **OK** to immediately create the folio.

**Data Sheet Configuration Options**

The configuration options that are available in the setup window will depend on your chosen data type:

- **The Units** drop-down list is available for all data types except the discrete and Multi-Phase Mixed data types. Use this list to select the time units appropriate for your data. Time units may be measured in mileage, distance, weight, etc. The appropriate columns in the data sheet will be automatically configured for the time units you select. If you later wish to change the time units of an existing data sheet, click the **Change Units** icon on the Main page of the control panel of the data sheet.

  This opens the **Change Units window**, which gives you several options for converting the time units of the existing data. 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.

- **The Use advanced systems view** check box is available for fielded/developmental multiple systems data types. (See [Normal and Advanced Systems View](#).)

- **The Number of systems** field is available for fielded/developmental multiple systems data types. If you are working with the Multiple Systems - Known Operating Times data type, this field allows you to specify the number of "Time System" columns that will
appear in the new data sheet. For all other multiple systems data types, this field allows you to specify the number of systems that will appear in the navigation panel of the Advanced Systems View (see Normal and Advanced Systems View).

- The **Number of comment columns** field is available for all data types. Use this field to specify the number of "Comments" columns that will appear in the new data sheet. The information in those columns will not affect the calculations in the folio.

**Data Types**

There are many different ways that data for analysis in RGA may be collected. The type of data you collect determines which types of analyses you can perform and which statistical models you can use. This chapter describes all of the different types of data supported by RGA. For more focused information about performing a particular type of analysis, you can go directly to the topic of interest. (See Traditional Reliability Growth Analysis; Reliability Growth Projections, Planning and Management (Crow Extended Model); or Repairable Systems Analysis.)

There are two general types of data that can be analyzed with the RGA software: developmental and fielded data. **Developmental data** are obtained from reliability growth testing conducted in-house, during the stages of development for a particular product. **Fielded data**, on the other hand, are obtained from repairable systems operating in the field under typical customer usage conditions. To provide a reference of all your options, the following table shows the three different (but related) types of analysis you can perform in RGA, the statistical models that are available for each, and the data types that can be used.
Times-to-Failure Data

The times-to-failure data types are used for analyzing failure times recorded from in-house reliability growth testing. Different data sheets are available depending on how the testing was conducted and what information is available:

- If you will be analyzing failure times from a single system (or the combined times from multiple systems), there is a choice of two data sheets depending on whether you will enter exact failure times or grouped (interval) data:
  - **Failure Times**
  - **Grouped Failure Times**

- If you will be analyzing failure times from multiple identical systems (where the data from each system is identified by the specific System ID), there is a choice of four data sheets depending on how the operating times of the systems are determined. (See [Times-to-Failure Data from Multiple Systems](http://rga.reliasoft.com) for more information about these data sheets.)
  - Multiple Systems - Known Operating Times
  - Multiple Systems - Concurrent Operating Times
- Multiple Systems with Dates
- Multiple Systems with Event Codes

If you will assume that all fixes are applied immediately after failure and before testing resumes (traditional reliability growth analysis), then you can use the Crow-AMSAA (NHPP) or Duane models. If you want to account for different fix strategies used for different failure modes (growth projections analysis), choose the Crow Extended model.

When you select the Crow Extended model, the Classification and Mode columns will be inserted into the data sheet. You can also manually insert or remove these columns by choosing Growth Data > Format & View > [Insert Columns/Delete Columns] > Projections. The Crow Extended model and mode classifications are discussed in Failure Mode Classifications.

By default, all data sheets include a Comments column for logging any pertinent information about each row of data. You can add a second comments column or delete the columns by choosing Growth Data > Format & View > [Insert Columns/Delete Columns] > Comments. The information in these columns does not affect the calculations in the folio.

See also Minimum Data Requirements for Times-to-Failure Data.

**Failure Times**

The Failure Times data type is used for situations where the exact failure times have been recorded. This data type can be used to analyze the data from a single system or for the combined times from multiple systems. For example, if three identical systems are tested and one fails at 10 hours, the recorded failure time is 30 hours.

The failure times are recorded in the Time to Event column in the data sheet. The times can be cumulative (where each row shows the total amount of test time when the failure occurred) or non-cumulative (where each row shows the incremental test time from when the last failure occurred). (See Cumulative vs. Non-Cumulative Data.)

The following example shows a data set in which the times are cumulative. The first failure (row 1) occurred at 10 hours. The second failure (row 2) occurred 5 hours later at 15 hours of total test time. The rest of the data can be read in a similar manner.

<table>
<thead>
<tr>
<th>D-T</th>
<th>Time to Event (Hr)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

Failure Times Data Sheet for Traditional Reliability Growth Analysis (Cumulative)
Chapter 5: RGA Growth Data Folio

The next example shows the same data set, but where the times are non-cumulative.

<table>
<thead>
<tr>
<th>D-T</th>
<th>Time to Event (Hr)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Failure Times Data Sheet for Traditional Reliability Growth Analysis (Non-Cumulative)

When you use the Crow-AMSAA (NHPP) or Duane model, the assumption is that fixes are applied when failures are found; therefore, each row in the data sheet will represent a different design configuration. Alternatively, when you use the Crow Extended model, you assume that different fix strategies are used for different failure modes (i.e., A = no fix, BC = fixed during test or BD = delayed fix). You will be required to identify and classify the failure mode responsible for each failure, as well as specify the effectiveness factor for each delayed fix (see Failure Mode Classifications).

**Tip:** If your data set failed the goodness-of-fit test, you can smooth out the analysis by organizing the data into groups and transferring them into a Grouped Failure Times data sheet. To do this, choose Growth Data > Options > Group Data. For more information on how to use the tool, see Group Data.

**Grouped Failure Times**

The Grouped Failure Times data type is used for cases where the failures occurred within specified time intervals, but the exact times are not known (i.e., interval data). This data type can be used to analyze the data from a single system or for the combined times from multiple systems (e.g., if three identical systems are tested and one fails between 10 and 20 hours, the recorded interval is 30 to 60 hours).

This data sheet can also be used for situations when the exact failure times are available, but it is useful to group the data into intervals for analysis purposes. For example, you could use this data sheet to smooth out the analysis of a Failure Times data set that failed the goodness-of-fit test. (See Group Data.)

The **Interval End Time** column is for recording the times that an interval ended. The times are cumulative (where each row shows the total amount of test time accumulated by the end of each interval). The **Failures in Interval** column is for recording the number of failures that occurred in each interval. The failure numbers are non-cumulative (where each row shows the number of failures that occurred in that interval only). (See Cumulative vs. Non-Cumulative Data.)
When you use the Crow-AMSAA (NHPP) or Duane model, the assumption is that fixes are applied at the end of each interval; therefore, each row in the data sheet will represent a different design configuration. The following example shows a data set where five identical systems are inspected every week. The systems accumulate a total of 250 hours of test time each week. In the first week (row 1), the total number of system failures that occurred in that week is 3. In the second week (row 2), the total number of system failures that occurred in that week is 8. The rest of the data sheet can be read in a similar manner.

<table>
<thead>
<tr>
<th>D-TG</th>
<th>Failures in Interval</th>
<th>Interval End Time (Hr)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>1250</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>1500</td>
<td></td>
</tr>
</tbody>
</table>

Grouped Failure Times Data Sheet for Traditional Reliability Growth Analysis

When you use the Crow Extended model, you assume that different fix strategies are used for different failure modes (i.e., A = no fix, BC = fixed during test or BD = delayed fix). You will be required to identify and classify the failure mode responsible for each failure, as well as specify the effectiveness factor for each delayed fix, if any (see Failure Mode Classifications).

For example, the following data set shows that in the first week (rows 1 to 2), the total number of system failures that occurred in that week is 3. Two of these failures are identified as BC100 (row 1) and one failure is identified as BD1 (row 2). In the second week (rows 3 to 8), the total number of system failures that occurred in that week is 8, and the failures are identified as BD1, BC150, BC4, BC60 (with 3 occurrences), BD23, BC3 and A75.

<table>
<thead>
<tr>
<th>D-TG</th>
<th>Failures in Interval</th>
<th>Interval End Time (Hr)</th>
<th>Classification</th>
<th>Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>250</td>
<td>BC</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>250</td>
<td>BD</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>500</td>
<td>BC</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>500</td>
<td>BC</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>500</td>
<td>BC</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>500</td>
<td>BD</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>500</td>
<td>BC</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>500</td>
<td>A</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

Grouped Failure Times Data Sheet with the Crow Extended Model.

**Times-to-Failure Data from Multiple Systems**

The multiple systems data types are for analyzing failure times from multiple identical systems (where the data set from each system is identified by the specific System ID). In multiple
systems analysis, RGA combines the operating hours of the systems to create a single *equivalent system*, which allows you to evaluate all the failures and fixes that occurred during testing. The parameters of the equivalent system, along with the results of the *goodness-of-fit tests* for that system, are calculated automatically when you analyze the data sheet. Any plots generated for the data set and analyses via the Quick Calculation Pad will be also based on the equivalent system.

There is a choice of four data sheets depending on how the operating times of the systems are determined:

- **Multiple Systems - Known Operating Times**
- **Multiple Systems - Concurrent Operating Times**
- **Multiple Systems with Dates**
- **Multiple Systems with Event Codes**

In all these data sheets, the operating time of the failed system is recorded for each failure. The following table summarizes how these data sheets obtain or estimate the operating times of the other non-failed systems.

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Operating Times of Non-Failed Systems</th>
<th>All systems must operate at same rate?</th>
<th>All systems must start the test at the same time?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known Operating Times</td>
<td>User provides the exact operating times for both failed system and all other non-failed systems.</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Concurrent Operating Times</td>
<td>RGA uses the failure time of the failed system as the operating times of the non-failed systems.</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Multiple Systems with Dates</td>
<td>RGA uses calendar dates to estimate the operating times of non-failed systems based on their average daily usage rate for the relevant time period.</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Multiple Systems with Event Codes</td>
<td>Same as &quot;Concurrent Operating Times.&quot;</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
If you will assume that when failures are found the same set of fixes is applied to all of the systems at the same time (traditional reliability growth analysis), then you can use the **Crow-AMSAA (NHPP)** or **Duane** models. Once the fix has been implemented for all systems, the test is resumed; therefore, each row in the data sheet will represent a different design configuration.

If you want to account for different fix strategies used for different failure modes (growth projections analysis), choose the **Crow Extended** model. You will be required to identify and classify the failure mode responsible for each failure (i.e., A = no fix, BC = fixed during test or BD = delayed fix), as well as specify the effectiveness factor for each delayed fix.

When you select the Crow Extended model, the **Classification** and **Mode** columns will be inserted into the data sheet. You can also manually insert or remove these columns by choosing **Growth Data > Format & View > [Insert Columns/Delete Columns] > Projections**. The Crow Extended model and mode classifications are discussed in **Failure Mode Classifications**.

By default, all data sheets include a **Comments** column for logging any pertinent information about each row of data. You can add a second comments column or delete the columns by choosing **Growth Data > Format & View > [Insert Columns/Delete Columns] > Comments**. The information in these columns does not affect the calculations in the folio.

See also **Minimum Data Requirements for Times-to-Failure Data**.

**Multiple Systems - Known Operating Times**

The Known Operating Times data type is used for situations when multiple identical systems are tested and the exact operating times for all systems are known. When a failure occurs in any of the systems, the exact operating times for all systems (both failed and non-failed) are recorded. The analysis assumes that the fixes are applied to all of the systems at the same time so they continue to have the same configuration.

The **Time System [x]** columns are for recording the failure times/operating times of the units. The times can be cumulative (where each row shows the total amount of time when the failure occurred) or non-cumulative (where each row shows the incremental time from when the last failure occurred). (See **Cumulative vs. Non-Cumulative Data**.) By default, the data sheet is configured for two systems. To insert or remove additional columns, choose **Growth Data > Format & View > [Insert Columns/Delete Columns] > System/Unit**.

The **Failed System ID** column is for recording the ID number of the system that failed. It must be represented by a positive integer.

The following data sheet shows an example in which the times are cumulative. The first failure occurred for System 1 (indicated by a 1 in the first column for row 1). At that point, the operating times for both systems were recorded — 7 hours for System 1 and 10 hours for System 2 — and the same fix was applied on both systems. The next failure occurred for System 2 (indicated by a 2 in the first column for row 2). Once again, the operating times for both...
systems were recorded — 15 hours for System 1 (8 since the last event) and 17 hours for System 2 (7 since the last event). The rest of the data can be interpreted in a similar manner.

<table>
<thead>
<tr>
<th>D-TM</th>
<th>Failed System ID</th>
<th>Time System 1 (Hr)</th>
<th>Time System 2 (Hr)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>15</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>20</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>25</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>29</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>39</td>
<td>45</td>
<td></td>
</tr>
</tbody>
</table>

Multiple Systems - Known Operating Times Data Sheet for Traditional Reliability Growth Analysis (Cumulative)

The next example shows the same data set, but the times are non-cumulative.

<table>
<thead>
<tr>
<th>D-TM</th>
<th>Failed System ID</th>
<th>Time System 1 (Hr)</th>
<th>Time System 2 (Hr)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>10</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

Multiple Systems - Concurrent Operating Times

The Concurrent Operating Times data type is used for situations when multiple identical systems are tested but a system’s exact operating time can be known only when it fails. The analysis assumes that the systems all began with the same configuration, they operate concurrently, they accumulate usage at the same rate and they receive fixes at the same time. Therefore, when a failure occurs in any of the systems, the exact operating time for the failed system is recorded and this time is also used as the operating times for the other non-failed systems.
With this data type, you can enter the data in the Normal View or Advanced Systems View. The following example shows the Normal View. The System ID column is for recording the ID of the system that the data point relates to. The Event column specifies whether the row represents the start time (S), failure time (F) or end time (E) of the system. The Time to Event column is for recording the total cumulative test time when the specified event occurred.

<table>
<thead>
<tr>
<th>D-MS</th>
<th>System ID</th>
<th>Event</th>
<th>Time to Event (Hr)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>System A</td>
<td>S</td>
<td>0</td>
<td>Start</td>
</tr>
<tr>
<td>2</td>
<td>System A</td>
<td>F</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>System A</td>
<td>F</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>System A</td>
<td>F</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>System A</td>
<td>E</td>
<td>100</td>
<td>End</td>
</tr>
<tr>
<td>6</td>
<td>System B</td>
<td>S</td>
<td>0</td>
<td>Start</td>
</tr>
<tr>
<td>7</td>
<td>System B</td>
<td>F</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>System B</td>
<td>F</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>System B</td>
<td>F</td>
<td>213</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>System B</td>
<td>E</td>
<td>299</td>
<td>End</td>
</tr>
</tbody>
</table>

The following plot shows the failure times of both systems in the example, along with the timeline for their equivalent system. When the first failure occurred at 21 hours (System A), the total operating time for the test (represented by the equivalent system) is 42 hours because there are two systems running concurrently. In other words, the analysis multiplies the failure time of the failed system by the total number of systems in the test to obtain the equivalent operating time. Similarly, the first failure of System B (at 83 hours) is shown in the equivalent system as occurring at 166 hours.
Multiple Systems with Dates

Like the Concurrent Operating Times data type, the Multiple Systems with Dates data type is used for situations when multiple identical systems are tested but a system’s exact operating time can be known only when it fails. However, this data type can be used when the systems did not all begin with the same configuration and/or they are not operated concurrently (although it still assumes that the fixes are applied to all of the systems at the same time).

When a failure occurs in any of the systems, the exact operating time for the failed system is recorded and the software estimates the operating times for the other non-failed systems using the exact calendar dates recorded for all events. Specifically, the software uses the dates to calculate the average daily usage rate of each non-failed system over the relevant time period.
The data sheet is the same as the Concurrent Operating Times data sheet but with a Date column for recording the calendar date of the events. You can enter the data in the Normal View or Advanced Systems View. The following example shows a data set in the Normal View.

<table>
<thead>
<tr>
<th>D-MS</th>
<th>System ID</th>
<th>Event</th>
<th>Time to Event (Hr)</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>System A</td>
<td>S</td>
<td>0</td>
<td>1/1/2013</td>
<td>Start</td>
</tr>
<tr>
<td>2</td>
<td>System A</td>
<td>F</td>
<td>43</td>
<td>1/6/2013</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>System A</td>
<td>F</td>
<td>66</td>
<td>1/18/2013</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>System A</td>
<td>F</td>
<td>115</td>
<td>1/31/2013</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>System A</td>
<td>E</td>
<td>159</td>
<td>2/3/2013</td>
<td>End</td>
</tr>
<tr>
<td>6</td>
<td>System B</td>
<td>S</td>
<td>0</td>
<td>1/5/2013</td>
<td>Start</td>
</tr>
<tr>
<td>7</td>
<td>System B</td>
<td>F</td>
<td>83</td>
<td>1/10/2013</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>System B</td>
<td>F</td>
<td>169</td>
<td>1/15/2013</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>System B</td>
<td>F</td>
<td>213</td>
<td>2/1/2013</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>System B</td>
<td>E</td>
<td>299</td>
<td>2/3/2013</td>
<td>End</td>
</tr>
</tbody>
</table>

Multiple Systems with Dates Data Sheet (Normal View) for Traditional Reliability Growth Analysis

The following plot shows the failure times of both systems in the example, along with the timeline for their equivalent system. For example, the plot shows that when System A failed on 1/18/2013, it had accumulated 66 hours of operating time, but we don’t know the exact operating time for System B at that point.

We do know that when System B failed on 1/15/2013 it had accumulated 169 hours of test time and then when it failed again on 2/1/2013, it had accumulated 213 hours. The total accumulated test time of System B between these two periods is 213-169=44 hours.

If we divide this result by the number of days (17), we obtain the average daily usage rate of System B during that period (2.588235 hours/day).

This can then be used to estimate the number of hours System B accumulated in the 2 days between the first failure of System B on 1/15/2013 and the first failure of System A on 1/18/2013 (2 x 2.5882 = 5.176470 hours).

Therefore, the analysis assumes that the operating time of System B was 174.176470 hours when System A failed on 1/18/2013.
For the equivalent system, the estimated operating time on 1/18/2013 is the summation of the observed operating time for System A and the estimated operating time for System B, which is 240.176470 hours.

Multiple Systems with Event Codes
The Multiple Systems with Event Codes data type is similar to the Concurrent Operating Times data type except that it always requires you to identify and classify the failure mode responsible for each failure (see Failure Mode Classifications). It also allows you to use codes to identify other types of events besides failures (e.g., the time when a fix was implemented for a particular failure mode, performance or quality issues that can be included or excluded from the analysis, etc.). This data type can be used when fixes are not implemented simultaneously for all systems. The Crow Extended model is used for the analysis.

With this data type, you can enter the data in the Normal View or Advanced Systems View. The following example shows the Normal View. The Classification and Mode columns are for identifying and classifying the failure mode responsible for each failure. The Event column
specifies the type of event the data point represents. See Event Codes for Crow Extended for information on all five possible event types. In the following data sheet, S = start time, F = failure time, I = the time when the fix for a particular failure mode was implemented, P = performance failure, Q = quality failure and E = end time.

<table>
<thead>
<tr>
<th>EC-MS</th>
<th>System ID</th>
<th>Event</th>
<th>Time to Event (Hr)</th>
<th>Classification</th>
<th>Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>System 1</td>
<td>S</td>
<td>0</td>
<td></td>
<td></td>
<td>Start</td>
</tr>
<tr>
<td>2</td>
<td>System 1</td>
<td>F</td>
<td>281</td>
<td>BC</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>System 1</td>
<td>I</td>
<td>300</td>
<td>BC</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>System 1</td>
<td>I</td>
<td>375</td>
<td>BC</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>System 1</td>
<td>P</td>
<td>675</td>
<td>BD</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>System 1</td>
<td>F</td>
<td>750</td>
<td>BC</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>System 1</td>
<td>I</td>
<td>1020</td>
<td>BC</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>System 1</td>
<td>E</td>
<td>1059</td>
<td></td>
<td></td>
<td>End</td>
</tr>
<tr>
<td>9</td>
<td>System 2</td>
<td>S</td>
<td>0</td>
<td></td>
<td></td>
<td>Start</td>
</tr>
<tr>
<td>10</td>
<td>System 2</td>
<td>F</td>
<td>122</td>
<td>BD</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>System 2</td>
<td>F</td>
<td>240</td>
<td>BC</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>System 2</td>
<td>F</td>
<td>325</td>
<td>BC</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>System 2</td>
<td>F</td>
<td>399</td>
<td>BC</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>System 2</td>
<td>I</td>
<td>430</td>
<td>BC</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>System 2</td>
<td>Q</td>
<td>550</td>
<td>BD</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>System 2</td>
<td>F</td>
<td>860</td>
<td>BD</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>System 2</td>
<td>E</td>
<td>860</td>
<td></td>
<td></td>
<td>End</td>
</tr>
</tbody>
</table>

Multiple Systems with Event Codes Data Sheet (Normal View) for Reliability Growth Projections Analysis

In this case, the process of combining the data set for the equivalent system is the same as described above for the Concurrent Operating Times data sheet, but with the addition of taking into account the time of implemented fixes across different systems. The implemented fix time is obtained by computing for the total time that the system spent in the same design configuration for a particular mode before the implemented fix took place. For these plots, the different types of events are shown in different colors: failure (red circle), implemented fix (yellow triangle), performance failure (blue circle) and quality failure (green diamond).
The ReliaWiki resource portal provides an example that demonstrates how the software builds the equivalent system for this data type at [http://www.reliawiki.org/index.php/Equivalent_System_Example](http://www.reliawiki.org/index.php/Equivalent_System_Example).

**Discrete Data**

Discrete data are obtained from one-shot devices with only two possible outcomes from the test: success or failure. An example is a missile that gets fired once and it either succeeds or fails. This type of data is also referred to as success/failure or attribute data. Different data sheets are available depending on how the testing was conducted and what information is available. This also determines what kind of analysis can be performed.

With the first three discrete data types, you can use the Crow-AMSAA (NHPP), Standard Gompertz, Modified Gompertz, Lloyd-Lipow, Duane or Logistic models to track how the reliability of the system changes over time ([traditional reliability growth analysis](http://rga.reliasoft.com)):  

- **Sequential**
• **Sequential with Mode**

• **Grouped per Configuration**

The fourth discrete data type can be used for either traditional reliability growth analysis or projections (growth projections analysis):

• **Mixed Data**

For the Mixed data type, if you will assume that all fixes are applied immediately after failure and before testing resumes (traditional reliability growth analysis), you can use the Crow-AMSAA (NHPP) model. If you want to account for different fix strategies used for different failure modes (growth projections analysis), choose the Crow Extended model.

When you select the Crow Extended model, the Classification and Mode columns will be inserted into the data sheet. You can also manually insert or remove these columns by choosing Growth Data > Format & View > [Insert Columns/Delete Columns] > Projections. The Crow Extended model and mode classifications are discussed in Failure Mode Classifications.

By default, all data sheets include a Comments column for logging any pertinent information about each row of data. You can add a second comments column or delete the columns by choosing Growth Data > Format & View > [Insert Columns/Delete Columns] > Comments. The information in these columns does not affect the calculations in the folio.

See also Minimum Data Requirements Discrete Data.

**Sequential**

The Sequential data type is used for one-shot devices where a single trial is performed for each system configuration and improvements are made before the next trial. Only the outcome (success/failure) is recorded for each trial.

The device is inspected after each trial, and then fixes are applied before the next trial begins; therefore, each row number in the data sheet represents a particular design configuration. In the following example, the device succeeded (S) for the first configuration (row 1), but failed (F) for the second configuration (row 2). The rest of the data can be read in a similar manner.

<table>
<thead>
<tr>
<th>D-DS</th>
<th>Success/Failure</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>
Sequential with Mode

The Sequential with Mode data type is used for one-shot devices where a single trial is performed for each system configuration and improvements are made before the next trial occurs. In addition to the outcome (success/failure) for each trial, the specific failure modes are also recorded.

The data sheet is the same as the Sequential data sheet, but with the addition of a **Failure Mode** column for recording the mode responsible for each failure. This allows you to track the possible recurrence of a failure mode after the fixes have been applied. If the mode does not appear again in the later trials, then the probability of failure is reduced. This is known as **failure discounting**. If you do not enter any failure modes, then no failures are discounted in the analysis (and the results will be the same as in the Sequential data type if you use the same growth model). The following figure shows an example of the data sheet.

<table>
<thead>
<tr>
<th>D-DFM</th>
<th>Success/Failure</th>
<th>Failure Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>mode a</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>mode b</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>mode c</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>mode a</td>
<td></td>
</tr>
</tbody>
</table>

Grouped per Configuration

The Grouped per Configuration data type is used for one-shot devices where multiple trials are performed for each design configuration (e.g., testing 5 missiles of the same design equals 5 trials). Improvements are made after all the devices within the group have been tested. Therefore, each row in the data sheet represents a particular design configuration. For each stage of testing, both the number of trials and the number of failures are recorded (e.g., 3 failures out of 10 trials for configuration A, 2 failures out of 10 trials for configuration B, etc.).

The **Number of Trials** column is for recording the number of devices that were tested for each design configuration. The **Number of Failures** column is for recording the number of failed units in the specified configuration. The values in these columns can be cumulative (where each row shows the total number of trials and failures since the beginning of the test) or non-cumulative (where each row shows the incremental number of trials and failures from the last configuration). (See [Cumulative vs. Non-Cumulative Data](#).)
The following example shows a data set where the values are cumulative. In the first configuration (row 1), there were 5 failures out of 10 trials. In the second configuration (row 2), there were 3 more failures (for a total of 8) out of 8 more trials (for a total of 18). The rest of the data can be read in a similar manner.

<table>
<thead>
<tr>
<th>D-DC</th>
<th>Number of Trials</th>
<th>Number of Failures</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>36</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>46</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>56</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

Grouped per Configuration Data Sheet (Cumulative)

The next example shows the same data set, but the values are non-cumulative.

<table>
<thead>
<tr>
<th>D-DC</th>
<th>Number of Trials</th>
<th>Number of Failures</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Grouped per Configuration Data Sheet (Non-Cumulative)

**Mixed Data**

The Mixed data type is used for one-shot devices where some test stages (i.e., design configurations) may have only one trial while other stages may have multiple trials. For each stage of testing, both the number of trials and the number of failures are recorded (e.g., 1 failure out of 1 trial for configuration A, 2 failures out of 5 trials for configuration B, etc.). This data type may be used in cases when you have a different number of samples available from each design configuration. For example, you might test one device initially then later start testing more samples of each design.

The **Failures in Interval** column is for recording the number of failures in a stage. The **Cumulative Trials** column is for recording the total number of trials that were performed since the beginning of the test.

When you use the Crow-AMSAA (NHPP) model for this data type, the assumption is that fixes are applied at the end of each interval; therefore, each row in the data sheet will represent a different design configuration, where each configuration can have any number of trials. For example, the following data set shows that in the first stage (row 1), 4 units were tested and 3 failed. In the second stage (row 2), 1 more unit was tested (for a total of 5) and it did not fail. In
the third stage (row 3), 4 more units were tested (for a total of 9) and all 4 failed. The rest of the data can be read in a similar manner.

<table>
<thead>
<tr>
<th>D-MX</th>
<th>Failures in Interval</th>
<th>Cumulative Trials</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

When you use the Crow Extended model, you assume that some of the fixes may be delayed until the end of the test and that some of the failure modes may not be fixed (i.e., A = no fix or BD = delayed fix). This is useful for situations when you need to perform the test in stages due to logistic reasons (e.g., cannot launch 10 missiles at the same time), or the purpose of the test is only to uncover failure modes. You will be required to identify and classify the failure mode responsible for each failure, and specify the effectiveness factor for each delayed fix, if any (see Failure Mode Classifications).

For example, the following data set shows that in the first stage (rows 1 to 3), 4 units were tested and 3 failed. The failures are identified as BD125 (row 1), A10 (row 2) and BC230 (row 3). In the second stage (row 4), 1 more unit was tested (for a total of 5) and it did not fail. The rest of the data can be read in a similar manner.

<table>
<thead>
<tr>
<th>D-MX</th>
<th>Failures in Interval</th>
<th>Cumulative Trials</th>
<th>Classification</th>
<th>Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>4</td>
<td>BD</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>4</td>
<td>A</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>4</td>
<td>BC</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>9</td>
<td>BC</td>
<td>320</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>9</td>
<td>BC</td>
<td>140</td>
<td></td>
</tr>
</tbody>
</table>

Tip: If you will assume that some fixes are implemented at the end of an interval while some are implemented at the end of the observed test time, then the Multi-Phase Mixed data type may be more appropriate.

Multi-Phase Data
Multi-phase data types are designed for practical testing situations where failures can be corrected at the time of failure, delayed until a later time during the current phase, fixed during
another phase or fixed at the end of a phase. This data type implements the Crow Extended - Continuous Evaluation model.

When used in conjunction with the growth planning folio, these data sheets allow you to compare the reliability performance of the system at each phase against the goals that were developed in the reliability growth plan.

Different data sheets are available depending on how the testing was conducted and what information is available:

- Multi-Phase Failure Times
- Multi-Phase Grouped Failure Times
- Multi-Phase Mixed Data

By default, all data sheets include a Comments column for logging any pertinent information about each row of data. You can add a second comments column or delete the columns by choosing Growth Data > Format & View > [Insert Columns/Delete Columns] > Comments. The information in these columns does not affect the calculations in the folio.

See also Minimum Data Requirements for Multi-Phase Data.

**Multi-Phase Failure Times**
The Multi-Phase Failure Times data type is used for multi-phase data analysis with the Crow Extended - Continuous Evaluation model when the exact time is recorded for each event. It is the same as the Failure Times data type, but with the addition of the Event, Classification and Mode columns for recording the information required to use the continuous evaluation model.

The following example shows the failure times of a single system, entered cumulatively. The Event column specifies the type of event the data point represents. See Event Codes for Multi-Phase Data for information on all seven possible event types. In the following data sheet, F = failure time, AP = analysis point (i.e., a designated time at which calculations will be performed and results obtained), and I = the time when the fix for a particular failure mode was implemented. The Classification and Mode columns are for identifying and classifying the failure mode that is responsible for the failure (for F, P or Q events) or the mode that received a fix (for I events).

<table>
<thead>
<tr>
<th>MP-T</th>
<th>Event</th>
<th>Time to Event (Hr)</th>
<th>Classification</th>
<th>Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>110</td>
<td>BC</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>224</td>
<td>BD</td>
<td>5004</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>333</td>
<td>BD</td>
<td>5002</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>AP</td>
<td>555</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>645</td>
<td>BC</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I</td>
<td>700</td>
<td>BD</td>
<td>5002</td>
<td></td>
</tr>
</tbody>
</table>
Multi-Phase Grouped Failure Times

The Multi-Phase Grouped Failure Times data type is used for multi-phase data analysis with the Crow Extended - Continuous Evaluation model when the time of each event falls somewhere within a specified interval. It is the same as the Grouped Failure Times data type, but with the addition of the Event, Classification and Mode columns for recording the information required to use the continuous evaluation model.

The following example shows the total test time at the end of each interval and the number of failures that occurred in each interval. The Event column specifies the type of event the data point represents. See Event Codes for Multi-Phase Data for information on all seven possible event types. In the following data sheet, F = failure time, Q = quality-related issue and P = performance-related issue. The Classification and Mode columns are for identifying and classifying the failure mode that is responsible for the failure (for F, P or Q events) or the mode that received a fix (for I events).

<table>
<thead>
<tr>
<th>MP-TG</th>
<th>Event</th>
<th>Failures in Interval</th>
<th>Interval End Time</th>
<th>Classification</th>
<th>Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>1</td>
<td>1000</td>
<td>BD</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Q</td>
<td>3</td>
<td>1000</td>
<td>A</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>6</td>
<td>1000</td>
<td>BD</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>2</td>
<td>1000</td>
<td>BC</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>1</td>
<td>1000</td>
<td>BD</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>P</td>
<td>2</td>
<td>1000</td>
<td>BC</td>
<td>125</td>
<td></td>
</tr>
</tbody>
</table>

Multi-Phase Mixed Data

The Multi-Phase Mixed data type is used for multi-phase data analysis with the Crow Extended - Continuous Evaluation model for one-shot devices, and where some test stages (i.e., design configurations) may have only one trial and other stages may have multiple trials. For each stage of testing, both the number of trials and the number of failures are recorded (e.g., 1 failure out of 1 trial for configuration A, 2 failures out of 5 trials for configuration B, etc.). This data sheet is the same as Discrete Mixed data type, but with the addition of the Event, Classification and Mode columns for recording the information required to use the continuous evaluation model.
The following example shows the number of trials and failures in each test interval. The **Event** column specifies the type of event the data point represents. See [Event Codes for Multi-Phase Data](#) for information on all seven possible event types. In the following data sheet, F = failure time and PH = end of phase. The **Classification** and **Mode** columns are for identifying and classifying the failure mode that is responsible for the failure (for F, P or Q events) or the mode that received a fix (for I events).

<table>
<thead>
<tr>
<th>MP-MX</th>
<th>Event</th>
<th>Failures in Interval</th>
<th>Cumulative Trials</th>
<th>Classification</th>
<th>Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>1</td>
<td>4</td>
<td>BD</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>1</td>
<td>4</td>
<td>BD</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>1</td>
<td>4</td>
<td>A</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>0</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>1</td>
<td>6</td>
<td>BD</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>PH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reliability Data**

The Reliability data type is used for modeling the relationship between time and reliability. You can use the Standard Gompertz, Modified Gompertz, Lloyd-Lipow or Logistic models to track how the reliability changes over time.

The **Reliability** column is for recording the reliability values. The reliability can be computed by dividing the number of systems still operating by the total number of systems, or by performing life data analysis (e.g., Weibull analysis) or other related methods. The **Time/Stage** column is for recording the cumulative test "time" when the reliability was computed. This can be measured in terms of test stages, design configurations, development time, and the like.

In this data sheet, reliability values are entered as decimals; however, you can configure the data sheet to accept percent values. You can change the setting by selecting or clearing the **Use percents (not decimals) for reliability** check box on the [Calculation page](#) of the Application Setup.
In the following example, the "Numerical" label on the control panel indicates that the reliability values are decimal values.

The next example shows the "Percentage" label on the control panel and the same data set as above, but entered as percent values.

By default, all data sheets include a Comments column for logging any pertinent information about each row of data. You can add a second comments column or delete the columns by
choosing Growth Data > Format & View > [Insert Columns/Delete Columns] > Comments. The information in these columns does not affect the calculations in the folio.

See also Minimum Data Requirements for Reliability Data.

Fielded Data
The fielded data types are used for analyzing data from repairable systems operating in the field under typical customer usage conditions. Such data might be obtained from a warranty system, repair depot, operational testing, etc.

Although fielded systems analysis applies some of the same statistical models that are used to analyze data from developmental testing, it should be noted that there is a difference in the underlying analysis assumptions. For developmental testing data, the analysis assumes that permanent fixes are being applied to improve the inherent reliability of the design; whereas for fielded system data the analysis assumes that systems may fail and be repaired many times, and that each system will always be "as bad as old" after a repair (i.e., the concept of minimal repair). The fielded systems analysis assumes that permanent design improvements, if any, are delayed until a later time.

**Tip:** If you assume that each repair partially renews the system (i.e., "better than old but worse than new") or restores the system to "as good as new," then the General Renewal Process (GRP) may be a more appropriate model. This model is available in Weibull++, ReliaSoft’s life data analysis software.

There is a choice of two data sheets for analyzing data from fielded systems. In general:

- Use the Repairable data type for analyzing the individual failure times for multiple repairable systems operating in the field. The analysis models the number of individual system failures vs. system time.

- Use the Fleet data type for analyzing the failure times for multiple repairable systems from a fleet (rather than individual system) perspective. The analysis groups the data and models the number of fleet failures vs. fleet time.

These data sheets can be used for two kinds of analysis. In general:

- If you wish to perform repairable systems analysis based on the assumption of minimal repair (i.e., the system is "as bad as old" after each repair), use the Power Law model in a Repairable data sheet. If the power law model does not provide a good fit, you can transfer the data to a Fleet data sheet and use the Crow-AMSAA (NHPP) instead.
If you wish to estimate the jump in reliability that can be expected from rolling out the same set of permanent design fixes to all systems in the field, use the **Crow Extended** model.

- In a **Repairable** data sheet, the Crow Extended analysis method is intended to be used specifically for "Operational Testing" situations when there is careful control of the test conditions and the failure intensity observed in the field is constant (i.e., beta = 1). Only two of the three failure mode classifications are applicable for such scenarios (A = no fix or BD = delayed fix).

- In a **Fleet** data sheet, the Crow Extended analysis method does not require the assumption that the failure intensity observed in the field is constant (i.e., beta does not have to equal 1). All three of the failure mode classifications are available (A = no fix, BC = fixed during test and BD = delayed fix).

**Note:** RGA displays a warning in the growth data folio when the beta = 1 hypothesis is invalid (i.e., when the 90% two-sided confidence bounds on beta do not include 1). You can choose whether to display this warning by using the **Hypothesis of Beta = 1 is Invalid** option on the **Calculations** page of the Application Setup.

When you select the Crow Extended model, the Classification and Mode columns will be inserted into the data sheet. (See **Failure Mode Classifications**.) When this model is applied to a Repairable data sheet, the analysis assumes that all permanent design fixes are delayed until a later time and therefore only two of the three failure mode classifications are available: A = no fix and BD = delayed fix.

By default, all data sheets include a **Comments** column for logging any pertinent information about each row of data. You can add a second comments column or delete the columns by choosing **Growth Data > Format & View > [Insert Columns/Delete Columns] > Comments**. The information in these columns does not affect the calculations in the folio.

(See **Minimum Data Requirements for Fielded Data**.)
Repairable Systems

The Repairable data type is used for analyzing the individual failure times for multiple repairable systems operating in the field. It models the number of individual system failures vs. the system time.

You can enter the data in the Normal View or Advanced Systems View. The following example shows the Normal View. The System ID column is for recording the ID of the system. The Event column specifies whether the row represents the start time (S), failure time (F) or end time (E) of the system. The Time to Event column is for recording the total operating time when the specified event occurred.

<table>
<thead>
<tr>
<th>F-RS</th>
<th>System ID</th>
<th>Event</th>
<th>Time to Event</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>System A</td>
<td>S</td>
<td>0</td>
<td>Start</td>
</tr>
<tr>
<td>2</td>
<td>System A</td>
<td>F</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>System A</td>
<td>F</td>
<td>55.6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>System A</td>
<td>F</td>
<td>72.7</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>System A</td>
<td>E</td>
<td>111.9</td>
<td>End</td>
</tr>
<tr>
<td>6</td>
<td>System B</td>
<td>S</td>
<td>0</td>
<td>Start</td>
</tr>
<tr>
<td>7</td>
<td>System B</td>
<td>F</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>System B</td>
<td>F</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>System B</td>
<td>F</td>
<td>46.8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>System B</td>
<td>E</td>
<td>65.9</td>
<td>End</td>
</tr>
</tbody>
</table>

In repairable systems analysis, RGA places the failure times of the systems on a single timeline to create a superposition system, which shows the order in which all the failures in the data set occurred. For example, the following plot shows the failure times of both systems in the example, along with the timeline for their superposition system. The timeline shows that the first failure occurred at 1.2 hours (System A) and that the second failure occurred at 10 hours (System B). The termination time in the superposition system is equal to the age of the oldest system.
The parameters of the superposition system, along with the results of the goodness-of-fit tests for that system, are calculated automatically when you analyze the data sheet. Any plots and QCP results will be also based on the superposition system.

**Fleet**

The Fleet data type is used for analyzing the failure times for multiple repairable systems from a fleet (rather than individual system) perspective. It groups the data and models the number of fleet failures vs. the total operating times of all systems in the fleet.

Data entry in the Fleet data sheet is the same as described above for the Repairable Systems data sheet. However, in fleet data analysis, the failure times of each system are stacked into a cumulative timeline. This allows RGA to model the failures in the population over the cumulative fleet operating time. The termination time in the cumulative timeline is equal to the sum of the ages of all the systems in the analysis. For example, the following plot shows that System A operated for a total of 1,268 hours. The first failure of System B (at 682 hours) is added to System A's end time to obtain a failure time of 1,950 hours for the cumulative timeline.
As the example demonstrates, the data sets of all the systems are stacked one after another based on the order in which the systems were entered into the data sheet; if we had entered the data set of System B first, then the first failure time of System A would have been added to the end time of System B. The ReliaWiki resource portal has more information about how the order of the systems may affect the fleet analysis at http://www.reliawiki.org/index.php/Fleet_Data_Analysis.

**Tip:** For any given observation period, the Fleet data sheet requires a complete record of the failure times of all the systems in the fleet. If your data set is limited to a record of the total amount of operating time for the fleet per observation interval (where the intervals may be measured in weeks, months, etc.) and the total number of system failures in those intervals, then you can use the Grouped Failure Times data type instead.
Cumulative vs. Non-Cumulative Data

In RGA, some data sheets may be configured to have the data input as cumulative or non-cumulative. The following data sheets have this option:

- Times-to-failure data:
  - Failure Times
  - Multiple Systems - Known Operating Times
- Discrete data:
  - Grouped per Configuration
- Multi-phase data:
  - Failure Times

If the data sheet is configured for *cumulative* data entry, each failure time represents the total amount of operating time until the failure. If the data sheet is configured for *non-cumulative* data entry, each failure time represents the incremental amount of operating time since the last failure.

For example, suppose a system fails at 10 hours and then fails again 10 hours later (at 20 hours of test total time) and then fails again 10 hours later (at 30 hours of total test time). If the data sheet is configured for non-cumulative data entry, the times are 10, 10 and 10, as shown next.

<table>
<thead>
<tr>
<th>Time to Event</th>
<th>Cumulative Failure Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time to Event</th>
<th>Non-Cumulative Failure Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
When applicable, this option also applies to the data entry for number of trials and number of failures. For example, in the following data sheets (Discrete Data: Grouped per Configuration), the left picture shows the cumulative data entry and the right picture shows the non-cumulative.

<table>
<thead>
<tr>
<th>D-DC</th>
<th>Number of Units</th>
<th>Number of Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>36</td>
<td>13</td>
</tr>
<tr>
<td>5</td>
<td>46</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>56</td>
<td>16</td>
</tr>
</tbody>
</table>

Cumulative

<table>
<thead>
<tr>
<th>D-DC</th>
<th>Number of Units</th>
<th>Number of Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

Non-Cumulative

You can specify whether the values are cumulative or non-cumulative by clicking the blue text on the Main page of the control panel, or by selecting the Data input is cumulative check box on the Analysis page of the control panel. As an example, the following pictures show these two options for the Failure Times data type.
You can configure RGA to always use a particular format each time you create any of the data sheets mentioned above. You can change this setting by selecting or clearing the **Data input is cumulative** check box on the **Calculation page** of the Application Setup.

## Normal View and Advanced Systems View

When you are analyzing data from multiple systems, RGA combines the data into a single representative system that allows you to evaluate all the failures that occurred during the observation period.

- In the following times-to-failure data types, the data sets are combined to form an **equivalent system**:
  - Multiple Systems - Concurrent Operating Times
  - Multiple Systems with Dates
  - Multiple Systems with Event Codes
- In the Repairable Systems data type, the failure times are placed on a single timeline to form a **superposition system**.
- In the Fleet data type, the failure times are stacked into a **cumulative timeline**.

For more information about how the software combines the data for analysis, click one of the links above. This topic focuses on the two different ways that you can view and enter data for all of these data types, regardless of how the analysis is performed.

The **Normal View** displays the data for multiple systems all together in the same data sheet, while the **Advanced Systems View** displays the data one system at a time and provides a navigation panel to select which system you wish to view. Any changes that you make to the data while in one view will be reflected if you switch to the other view; however, only the Advanced System View allows you to select specific systems to be excluded from the analysis (e.g., you may choose to exclude a specific system if that data set is not representative of the entire population).

To switch between the two views, choose **Growth Data > Format & View > Switch Systems View** or click the icon on the Main page of the control panel.

Regardless of which view you choose, the System Operation plot shows the failure times of the systems that were included in the analysis, as well as the timeline for the representative system.
Normal View
In the Normal View, the **System ID** column is for recording the identifier of the system (e.g., System A, SN#1234, etc.). All events entered for this system must have the same ID. The **Event** column specifies whether the row represents the start time (S), failure time (F) or end time (E) of the system. The **Time to Event** column is for recording the time of the event.

When you calculate the data sheet, the analysis results of the representative system (i.e., the equivalent system, superposition system or cumulative timeline) are displayed in the **Results** area of the control panel, as shown next. If you wish to see the results for an individual system, you must switch to the Advanced Systems View.

Advanced Systems View
In the Advanced Systems View, the left side of the data sheet shows all the systems that have been defined along with their start times (marked with green bullets) and end times (marked with red bullets). The check box to the left of each system name allows you to select whether to
include that system in the representative system for analysis (i.e., the equivalent system, superposition system or cumulative timeline). By default, all systems are selected to be included in the analysis; however, you can clear the check box to remove the system from the combined analysis. You can also edit a system name by right-clicking it and choosing Rename on the shortcut menu.

The following example shows the Advanced Systems View with the data for System A visible. In the Time to Event column, the start time of the system is entered in row 1, while the end time is entered in row 2 (these rows are reserved for this information). The failure times are entered into the subsequent rows, starting with row 3.

When you calculate the data sheet, the analysis results for the representative system (i.e., the equivalent system, superposition system or cumulative timeline) are shown in the Results area of the control panel. In addition, the analysis results for the individual system that is currently selected will be displayed in an Individual System Results, as shown next.
Transfer to New Data Type

In some cases, you can transfer your data from one type of data sheet to another. This option is available only for fielded data and some of the multiple systems data types (Concurrent Operating Times, with Dates and with Event Codes).

To transfer your data, choose **Growth Data > Transfer Data > Transfer to New Data Type** or click the icon on the Main page of the control panel.
You can choose to transfer data between any of the specified data types. A new data sheet with the transferred data will be added to the current folio. In other words, the original data sheet remains unchanged and a new data sheet is created in the same folio.

In addition, the following data sheets give you the option to transfer the data to an equivalent system, which is a single system that represents the combined operating time of all the systems in the data set. Note that this option is available only when the parameters of the data set have been calculated.

- For the Concurrent Operating Times and Multiple Systems with Dates data types, the equivalent system will be transferred into a Failure Times data sheet, which allows you to perform gap analysis or link the data set to a mission profile, if desired.
- For the Multiple Systems with Event Codes data type, the equivalent system will be transferred into a Multi-Phase Failure Times data sheet, which allows you to use the Crow Extended - Continuous Evaluation model to analyze the data set.

**Transfer Data to Weibull++**

If you have the Synthesis version of ReliaSoft's life data analysis software, Weibull++, installed on your computer, you can transfer data from RGA to a Weibull++ life data folio. This option is available for time-to-failure data (except Multiple Systems – Known Operating Times), multi-phase data (except Mixed Data) and fielded data.

The current versions of RGA and Weibull++ are integrated via the Synthesis Platform. This means that when you transfer your RGA data, the same database will be automatically opened in the Weibull++ application. The RGA data will then be stored in a new Weibull++ life data folio that is in the same project as your RGA data.

To transfer your RGA data, first calculate the parameters of the data set, and then choose Growth Data > Transfer Data > Transfer to Weibull++ or click the icon on the Main page of the control panel.
The Transfer to Weibull++ window appears, as shown next. The options that are available will depend on the type of RGA data sheet and model you are using.

- **What to Transfer?** specifies how your RGA data will be handled in Weibull++.
  - **First failure for each system** transfers only the first failure time of each system in the RGA data sheet. Choose this option if you wish to use the Weibull++ life data folio to fit a life distribution to the first times to failure and calculate the reliability (i.e., probability of operating without failure for a period of time) of the system.
  - **Time between failures in individual systems** transfers all the failure times of each system in the RGA data sheet. Although it is generally not recommended to fit a life distribution to repairable systems data, you might choose this option if you wish to use the Weibull++ life data folio to fit a distribution to the data set for simulation in BlockSim, ReliaSoft's system reliability and maintainability analysis software.

If the failure times in RGA are **cumulative**, then the process converts the times into their equivalent non-cumulative failure times (because data entry in the Weibull++ life data folio is always non-cumulative). If the data in the RGA data sheet are already non-cumulative, then no conversion will occur and the failure times that are transferred to Weibull++ will appear as they do in RGA.
• **Time between failure IDs across systems** transfers all the failure times in the RGA data sheet based on the unique failure modes in each system (you will need to select one of the options in the Apply Failure ID area to serve as the identifier for the failure modes). Choose this option if you wish to use the Weibull++ life data folio to fit a distribution to each failure mode (assuming that the systems are the lowest repairable units).

If a failure mode did not occur in a particular system, then it will be treated as a suspension for that system. Similar to the previous option, if the failure times are cumulative, the process converts the data into their equivalent non-cumulative failure times; if the data are already non-cumulative, then no data conversion will occur.

• **Apply Failure ID?** specifies how each data point in the Weibull++ data sheet will be grouped into subsets:
  
  • The **None** option does not group the data points in the Weibull++ data sheet.
  
  • The **Use the "Mode" column** option is available only when using the Crow Extended or Crow Extended - Continuous Evaluation models. It transfers the combined information from the Classification and Mode columns in the RGA data sheet to the Subset ID column in Weibull++. For example, for an RGA data point that has the classification "BD" for mode "100," that data point will be categorized as part of subset "BD100" in Weibull++.
  
  • The **Use the "Comment" column** option uses any text/values that were entered in the Comments column of the RGA data sheet to group the data points in Weibull++.

**A Note About Suspension Times in the Transferred Data**

When you select to apply a failure ID, all subsets are assumed to end at the same time. For example, if you have two systems where the observation period for System 1 ended at 100 hours and for System 2 at 150 hours, then the transferred data for System 1 will automatically include a suspension time that covers the difference between the end times of the two systems.

Note that if the data were cumulative, then the suspension time would be the difference between the last failure time for System 1 and the last failure time for System 2 (e.g., 150 - 100 = 50 hours), but if the RGA data were non-cumulative, then the suspension time would be the difference between the last failure time for system 1 and the total test duration (e.g., if the observation period ended at 250 hours, then the suspension time would be 250 - 100 = 150 hours).
Examples
The following examples show pictures of how data from a cumulative Failure Times data sheet in RGA may be transferred to a Weibull++ life data folio. Here is the original RGA data.

<table>
<thead>
<tr>
<th>D-T</th>
<th>Time to Event (Hr)</th>
<th>Classification</th>
<th>Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>BC</td>
<td>1</td>
<td>Mode 1</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>BC</td>
<td>2</td>
<td>Mode 2</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>BC</td>
<td>3</td>
<td>Mode 3</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>BD</td>
<td>4</td>
<td>Mode 3</td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>BD</td>
<td>5</td>
<td>Mode 3</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>BD</td>
<td>6</td>
<td>Mode 3</td>
</tr>
</tbody>
</table>

RGA Failure Times data sheet (cumulative)

Example 1: Here is the data set transferred to Weibull++ using the "Time between failures in individual systems" option with no failure ID applied. The cumulative times have been converted to non-cumulative. All failure times are transferred, but the failure mode is not identified.

<table>
<thead>
<tr>
<th></th>
<th>State F or S</th>
<th>Time to F or S (Hr)</th>
<th>Subset ID 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>45</td>
<td></td>
</tr>
</tbody>
</table>
Example 2: Here is the data set transferred to Weibull++ using the "Time between failures in individual systems" option and the "Use the Mode column" option. The cumulative times have been converted to non-cumulative. The failure times are grouped into subsets based on the combined information from the Classification and Mode columns in the RGA data sheet. The suspension data are added automatically to ensure that all the subsets have the same termination time.

<table>
<thead>
<tr>
<th>Subset ID</th>
<th>State F or S</th>
<th>Time to F or S (Hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC1</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>BC1</td>
<td>S</td>
<td>99</td>
</tr>
<tr>
<td>BC2</td>
<td>F</td>
<td>4</td>
</tr>
<tr>
<td>BC2</td>
<td>S</td>
<td>96</td>
</tr>
<tr>
<td>BC3</td>
<td>F</td>
<td>13</td>
</tr>
<tr>
<td>BC3</td>
<td>S</td>
<td>87</td>
</tr>
<tr>
<td>BD4</td>
<td>F</td>
<td>18</td>
</tr>
<tr>
<td>BD4</td>
<td>S</td>
<td>82</td>
</tr>
<tr>
<td>BD5</td>
<td>F</td>
<td>55</td>
</tr>
<tr>
<td>BD5</td>
<td>S</td>
<td>45</td>
</tr>
<tr>
<td>BD6</td>
<td>F</td>
<td>100</td>
</tr>
</tbody>
</table>

Example 3: Here is the data set transferred to Weibull++ using the "Time between failures in individual systems" option and the "Use the Comment column" option. The results are the same as example 2, except that the failure IDs came from the Comments column in the RGA data sheet.

<table>
<thead>
<tr>
<th>Subset ID</th>
<th>State F or S</th>
<th>Time to F or S (Hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode 1</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>Mode 1</td>
<td>S</td>
<td>99</td>
</tr>
<tr>
<td>Mode 2</td>
<td>F</td>
<td>4</td>
</tr>
<tr>
<td>Mode 2</td>
<td>S</td>
<td>96</td>
</tr>
<tr>
<td>Mode 3</td>
<td>F</td>
<td>13</td>
</tr>
<tr>
<td>Mode 3</td>
<td>F</td>
<td>5</td>
</tr>
<tr>
<td>Mode 3</td>
<td>F</td>
<td>37</td>
</tr>
<tr>
<td>Mode 3</td>
<td>F</td>
<td>45</td>
</tr>
</tbody>
</table>

Growth Data Folio Control Panel

The growth data folio control panel allows you to configure the analysis settings for the data sheet and view/access the results. This topic provides general information that applies to most analyses. For more focused information about performing a particular type of analysis, you can go directly to the topic of interest. (See Traditional Reliability Growth Analysis, Growth Projections, Planning and Management (Crow Extended Model) or Repairable Systems Analysis.)
Control Panel Main Page

- The **Model** area allows you to choose a statistical model to use in analyzing the data set. The list of models available will depend on the data type. See the Data Types topic for a complete list.

![Model Selection](image)

- The **Calculation Options** area allows you to choose the Change of Slope analysis method for situations where there has been a significant change in the failure intensity of the system. (See Change of Slope Analysis.)

![Calculation Options](image)

- The available analysis settings may vary depending on the data type. The following picture shows an example of the settings that are available for the Failure Times data type. In this example, the settings show the type of data (Developmental – Failure Times), parameter estimation method (MLE), confidence bounds method (Crow), whether a gap interval has been defined in the analysis (No Gap) and whether the failure times are entered as cumulative or non-cumulative (Cumulative).

![Analysis Settings](image)

If a setting is displayed in blue text, you can click the label to switch between the available options. These settings are also available on the Analysis page of the control panel. See Control Panel Analysis Page for a description of all available settings.

- The **Termination Time** field is available when you use the Crow-AMSAA (NHPP) or Crow Extended models with any of the following times-to-failure data types:
  - Failure Times
  - Grouped Failure Times
  - Multiple Systems - Known Operating Times
This setting allows you to specify the time when the observation period ended, if applicable. Click the (...) button to open the Termination Time window, as shown next. Select the **Time Terminated** option to enter the actual observation time, or select the **Failure Terminated** option to indicate that the observation period ended with the last failure time recorded in the data sheet.

- The **Results** area displays the calculated parameters and other results. The information shown in this area depends on the current data type and model, as well as your selections on the **Growth Data Folios page** and **Calculations page** of the Application Setup. If you are analyzing data from multiple systems, this area may show two sets of results (see **Normal and Advanced Systems View**).

As an example, the following picture shows the analysis results for one particular data set and model. Click the **Detailed Summary** icon to open the **Results window**, which shows the results in a worksheet that you can copy or print.
Folio Tools

The folio tools are arranged on the left side of the Main page. Depending on the data type or model used in the analysis, the growth data folio control panel may contain some or all of the following tools:

- **Calculate** estimates the parameters based on the selected model and analysis settings. Once the parameters have been calculated, the Results area will show the current results. This command is also available by choosing Growth Data > Analysis > Calculate.

- **Plot** creates a new sheet in the folio that provides a choice of applicable plot types. This includes plots such as MTBF vs. time, cumulative number of failures, failure intensity vs. time, etc. This command is also available by choosing Growth Data > Analysis > Plot.

- **QCP** opens the Quick Calculation Pad, which allows you to obtain calculated results based on the analyzed data sheet, such as the cumulative MTBF and the expected number of failures. This command is also available by choosing Growth Data > Analysis > QCP.

- **Effectiveness Factors** is available only when you use the Crow Extended or Crow Extended - Continuous Evaluation models. It opens the Effectiveness Factors window, which allows you to define the effectiveness factors for each BD mode to estimate the fractional decrease in failure intensity that can be expected after the delayed fix is applied. This command is also available by choosing Growth Data > Crow Extended > Effectiveness Factors.

- **Alter Parameters** opens a tool that allows you to alter the values of the calculated parameters, assuming that the likelihood function and Fisher Matrix (evaluated at the original parameter estimates) remain the same. In plots, the position of the data points remain the same, but the solution line and all subsequent analyses made via the QCP and other tools are based on the modified parameter values. Therefore, the analysis may be appropriate only within the context of your specific scenario. This command is also available by choosing Growth Data > Options > Alter Parameters.

- **Switch System View** is available only for fielded data and some of the multiple systems data types (Concurrent Operating Times, with Dates and with Event Codes). It allows you to switch between the two complementary views that are available for some multiple systems data types (see Normal and Advanced Systems View). This command is also available by choosing Growth Data > Format & View > Switch Systems View.
\texttt{Change Units} is available for all data types except discrete data. It opens the \texttt{Change Units window}, which allows you to change the time units of an existing data sheet.

\texttt{Auto Group Data} is available for data types where the exact failure times have been recorded (i.e., Failure Times and Multi-Phase Failure Times) and for the Fleet data type. It opens the \texttt{Auto Group Data window}, which allows you to specify the intervals that will be used to group the data. This command is also available by choosing \texttt{Growth Data > Options > Group Data}.

\texttt{Mission Profile Analysis} is available only for the Failure Times data sheet. It applies to cases where testing involves multiple test profiles. This command allows you to select a mission profile in the project that you want to use to analyze the data set. The data in the current data sheet will be transferred to a new data sheet in the same folio, and then grouped according to the "convergence points" in the specified mission profile. (See \texttt{Mission Profiles}.)

\texttt{Mode Processing} is available for data sets analyzed with the Crow Extended or Crow Extended - Continuous Evaluation models. This utility allows you to extract the first failure time for each unique BC mode and/or unique BD mode in a data set. This allows you to automatically copy the failure times for a particular failure mode classification into a new data sheet for separate analysis.

\texttt{Event Report} is available for all multi-phase data types and for the Multiple Systems with Event Codes data type. It opens a report about the failure modes in the current analysis, such as the classification of the modes, their first times to failure and effectiveness factors. This command is also available by choosing \texttt{Growth Data > Analysis > Event Report}. (See \texttt{Event Reports}.)

\texttt{Batch Auto Run} is available only for multi-phase data, fielded data and some of the multiple systems data types (Concurrent Operating Times, with Dates and with Event Codes). It opens the \texttt{Batch Auto Run window}, which allows you to quickly extract data from an existing data sheet based on the system ID, phase or analysis point. This command is also available by choosing \texttt{Growth Data > Options > Batch Auto Run}.

\texttt{Transfer to New Data Type} is available only for fielded data and some of the multiple systems data types (Concurrent Operating Times, with Dates and with Event Codes). It opens the \texttt{Transfer to New Data Type window}, which allows you to select the data type into which you would like to transfer the data. This command is also available by choosing \texttt{Growth Data > Transfer Life Data > Transfer to New Data Type}. 
Transfer to Weibull++ is available for time-to-failure data (except Multiple Systems – Known Operating Times), multi-phase data (except Mixed Data) and fielded data. It opens the Transfer to Weibull++ window, which allows you to transfer the current RGA data set to a new life data folio data sheet in Weibull++ (ReliaSoft’s life data analysis software). This command is also available by choosing Growth Data > Transfer Life Data > Transfer to Weibull++.

Growth Data Folio Analysis Settings

The Analysis page of the growth data folio control panel may contain some or all of the following options (and some of these settings can also be changed on the Main page of the control panel):

- The Analysis Type area allows you to choose the method for estimating the parameters of your chosen model.
  - The Least Squares method is available for the Lloyd-Lipow, Standard Gompertz, Modified Gompertz, Duane and Logistic models.

- The Confidence Interval Method area allows you to choose a method for calculating the confidence bounds. The methods that are available depend on the data type and model.
  - Fisher Matrix and Crow confidence bounds are available for the Crow-AMSAA (NHPP), Crow Extended, Crow Extended - Continuous Evaluation and Power Law models. There are two exceptions:
    - If you use the Crow-AMSAA model with the Discrete Grouped per Configuration data type, then Least Squares is the only available confidence bounds method.
    - Fisher Matrix is the only available confidence bounds method for the Lloyd-Lipow model.
  - The Least Squares method is available for the Standard Gompertz, Modified Gompertz, Duane and Logistic models.
The **Gap Interval** setting is available only when you use the Failure Times data type with the Crow-AMSAA (NHPP) model. When a gap is defined in the data set, the application assumes that reliable information for that time period is unknown and ignores any entries that have been made for the specified time interval. (See [Gap Analysis](http://rga.reliasoft.com).)

The **Data input is cumulative** check box allows you to specify whether the data will be entered cumulatively (where each row shows the total amount of operating time when the failure occurred) or non-cumulatively (where each row shows the incremental operating time from when the last failure occurred). When applicable, this setting also applies to the data entry for number of trials and number of failures in discrete data sheets. (See [Cumulative vs. Non-Cumulative Data](http://rga.reliasoft.com).) This check box is available for the following data sheets:

- Times-to-failure data:
  - Failure Times
  - Multiple Systems - Known Operating Times
- Discrete data:
  - Grouped per Configuration
- Multi-phase data:
  - Failure Times

The **Failure Discounting** setting is available only for the Discrete Sequential with Mode data type. It allows you to specify the confidence level that will be used to define the fractional decrease in failure value. (See [Failure Discounting](http://rga.reliasoft.com).)
• The Event Code Options area is available only for the Multiple Systems with Event Codes data type and all multi-phase data types. It allows you to select whether or not to include Q (quality failure) and/or P (performance failure) events in the reliability growth projections analysis.

![Event Code Options](image)

• The Statistical Tests area is available only for the Crow-AMSAA (NHPP) or Crow Extended models. It allows you to specify the significance level used in the statistical tests. (See Statistical Tests.)

**Quick Calculation Pad (QCP)**

The Quick Calculation Pad (QCP) provides a convenient way of calculating a variety of useful metrics. To access the tool, click the QCP icon on the Main page of the control panel.

This topic provides a general description of the QCP and how to use it in most analyses. For more focused information about the types of calculations that can be performed for a particular type of analysis/model, you can go directly to the topic of interest:

- Traditional reliability growth analysis (Crow-AMSAA, Duane and discrete models)
- Crow Extended model.
- Crow Extended - Continuous Evaluation model.
- Repairable systems analysis (Crow-AMSAA and Power Law models).

**How to Use the QCP**

To use the QCP, do the following:

1. Choose a metric in the Calculate area. The metrics available depend on the data type and, in the case of the Crow Extended model, which fix strategies were implemented (i.e., BC = fixed during test or BD = delayed fix).

2. If applicable, use the Units drop-down list to specify the units for any time values that are entered as inputs and/or displayed as results. The units in the QCP can be different from the units that were used for the data sheet. For example, you could enter the failure times in hours but then calculate the cumulative number of failures for 1 month.
of operation — the application will convert the times automatically based on the conversion factors specified for the database.

3. If applicable, use the **Bounds** drop-down list to specify what type of confidence bounds to calculate. The following graphics illustrate the types. The ReliaWiki resource portal provides more information on the background theory of confidence bounds at: [http://www.reliawiki.org/index.php/Confidence_Bounds](http://www.reliawiki.org/index.php/Confidence_Bounds).

![Confidence Bounds Graphics](image)

If you select **Both One-Sided**, the QCP will calculate both the lower one-sided bound and the upper one-sided bound.

4. Make any required inputs in the **Input** area.

5. Click **Calculate**. The calculated value(s) will always be displayed in the results area at the top of the window.

**Other Options**
- Click the **Report** button at the bottom of the window to display a summary of the current calculation input/output in the Results window.
- Use the **Options** drop-down list to configure other settings, including:
  - **Precision** sets the number of decimal places displayed in the results.
  - **Scientific Notation** sets the point at which numbers will be converted to normalized scientific notation. For example, setting this 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).
  - **Set Display Font** allows you to change the font style and size that is used to display the calculated value(s).
  - Select **Captions** if you want additional information to be displayed in the results area along with the values (a green light in the button indicates that this option is selected). For example, if you have selected to calculate the cumulative MTBF for a given time with 2-sided confidence bounds at the 90% confidence level, the...
first picture shows the display with captions and the second picture shows without.

- Select **Show Calculation Log** if you want to display a log on the right side of the window that records some or all of the calculations performed during this QCP session (a green light in the button indicates that this option is selected).
  - If **Auto Print Results** is selected under **Options**, all results will be automatically printed to the log each time you perform a calculation.
  - Otherwise, you can choose which results to add to the log by using the **Print** button at the bottom of the log display.

Under the log display, you can also click **Feed** to "advance the tape" or **Clear** to delete all data from the current log. If you click inside the log, you can copy some or all of the text to the Clipboard.

- Select **Non-Modal QCP** to lock the QCP in a top window position so it can remain open while you have access to all folios data sheets (a green light in the button indicates that this option is selected). The calculations performed in the QCP will be based on the currently active data sheet. If this option is not selected, you will need to close the QCP to access any data sheet. This setting can also be changed by using the **While QCP is open, have access to all folios** option on the **Other** page of the Application Setup.
Publishing Models from Analysis Results

Once a data sheet has been analyzed, you can publish the results as a model. To publish a model based on the analysis results, click the Publish to Model icon on the Publishing page of the control panel.

The type of model that will be published depends on the data type and growth model that you are working with:

- For discrete data types (Multi-Phase Mixed data sheet and Discrete data sheets), the results are in terms of the demonstrated reliability, so the published model will be a fixed reliability value.
- For all other developmental data, the results are based on the reliability growth process; therefore, the published model will be a 1-parameter exponential distribution with a mean time equal to the demonstrated MTBF.
- For fielded data analyzed with the Power Law model, the published model will be a 2-parameter Weibull distribution, where the beta parameter indicates whether the system is exhibiting wearout, infant mortality or a constant failure rate (beta = 1). If the data are analyzed with the Crow Extended model, the published model will be a 1-parameter exponential distribution with a mean time equal to the instantaneous MTBF at the termination time.

All other tools for working with the published model, such as displaying its properties and tracing its usage, are on the Publishing page of the growth data folio's control panel.

Statistical Tests

When you use the Crow-AMSAA (NHPP) or Crow Extended models, RGA automatically performs statistical tests on the calculated data set. The results of the tests help you to evaluate how well the model fits the data. Only the test that applies to the data type and model you are using will appear in the results. The results are displayed on the growth data folio control panel, and can also be displayed in a report by choosing Growth Data > Analysis > Statistical Tests Report.

The following tests evaluate the hypothesis that the failure times follow a non-homogeneous Poisson process (NHPP). The ReliaWiki resource portal provides more information about these tests at http://www.reliawiki.org/index.php/Crow-AMSAA_(NHPP).

- The Chi-squared goodness-of-fit test is applied to grouped failure times.
• The **Cramér-von Mises (CVM)** goodness-of-fit test is applied to non-grouped failure times where there are no gaps in the data.

The following tests apply to **multiple systems analysis** only. The ReliaWiki resource portal has more information about these tests at [http://www.reliawiki.org/index.php/Hypothesis_Tests](http://www.reliawiki.org/index.php/Hypothesis_Tests).

• The **Common Beta Hypothesis (CBH)** test indicates whether all the systems in the data set have similar beta values so you can evaluate whether the systems should be combined into a single representative system (i.e., the equivalent system, superposition system or cumulative timeline).

• The **Laplace Trend** test evaluates the hypothesis that a trend does not exist in the data. It can determine whether the system reliability is improving, deteriorating or staying the same. When the Crow Extended model is used without BC failures modes, it is assumed that there is no trend (i.e., the system is neither improving nor deteriorating).

**Tip:** You can set the default significance level for the statistical tests by entering a value in the Growth Data Folios page of the Application Setup, or by changing the value on-the-fly from the Analysis page of the growth data folio control panel.

The following tools are also available in RGA, but are not automatically performed when you calculate the data set:

• The **Interval Goodness-of-Fit Test tool** helps you to determine which intervals should be used to group the data so that the goodness-of-fit test passes. This option is available only for fielded data and some of the multiple systems data types (Concurrent Operating Times, with Dates and with Event Codes).

• The **Test for Fix Effectiveness tool** helps you to assess whether or not applied fixes have been effective across test phases. It is available only for the multi-phase data types.

### Interval Goodness-of-Fit Test

The Interval Goodness-of-Fit Test window helps you to group failure times into intervals so that the chi-squared goodness-of-fit test will pass when you analyze the grouped data. You specify the intervals that you are considering and the tool automatically determines the actual number of failures that were observed at the specified intervals and the number of expected failures based on the Crow AMSAA (NHPP) model. It then compares the observed vs. expected number of failures in order to evaluate how well the Crow-AMSAA (NHPP) model will fit the data when grouped into the proposed intervals.

If the model fits the data, the result will indicate that the data set passed the test; but if there is a large difference between the observed and expected number of failures, the test may fail. In
In this case, the model may not be representative of the data and you will need to adjust the specified intervals such that the test passes.


This tool is available only for fielded data and some of the multiple systems data types (Concurrent Operating Times, with Dates and with Event Codes).

To use the tool, first calculate the parameters of the data set, and then choose Growth Data > Options > Interval GOF.

\[ \chi^2 \]

The following picture shows an example of how to use the utility. The End Time column displays the interval end times that you want to consider. The Observed Failures column displays the observed failures at the specified interval end time. The Expected Failures column shows the number of failures that would be expected for that interval based on the Crow-AMSAA (NHPP) model. Note that the termination time of the test is automatically entered for you (in this example, the termination time is 2,909 hours).
• To add an interval to be considered, enter a value in the **Interval end time** field and click **Add**.

• To change an interval, select the row, enter a new value in the **Interval end time** field and click **Update**.

• To remove an interval, select the row and click **Delete**. Alternatively, you can remove all the intervals that were entered by clicking **Reset**.

Once you have specified all of the intervals that you want to consider for grouping the data, click **Calculate** to perform the test. The **Result** field displays whether the test passed or failed.

You can click **Report** to open a summary of the analysis in the **Results window**. If you want to proceed with the grouped data analysis, you can copy the "End Time" and "Observed Failures" values into a new **Grouped Failure Times data sheet**.

**Batch Auto Run**

The Batch Auto Run utility allows you to extract subsets from an existing data set.

For fielded data or with some of the multiple systems data types (Concurrent Operating Times, with Dates and with Event Codes), you can use Batch Auto Run to extract all the data that relates to a particular system ID.

For multi-phase data, you can use Batch Auto Run to extract all the events (i.e., failures, time of implemented fixes, etc.) that occurred within a particular phase or analysis point.

To use Batch Auto Run, choose **Growth Data > Options > Batch Auto Run** or click the icon on the Main page of the control panel.
You will be presented with a list of all the available subsets in your data sheet, similar to the examples shown next.

Double-click an available subset to include it in the batch auto run process or drag the subset to the Selected column. You can also click the Select All Available button to automatically include all subsets in the process.

If you are extracting data based on the system ID, you can choose to extract the selected subsets into individual data sheets by clicking the Processing Preferences tab and selecting the Place each system in an individual sheet check box. Otherwise, clear the option if you prefer to have the selected subsets appear all together in one data sheet.

**Tip:** If you wish to extract the first times-to-failure of all unique BC modes or unique BD modes in a data set, use the Mode Processing window.

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**Alter Parameters**

The Alter Parameters feature is available for any data set calculated using any model except the Crow Extended and Crow Extended - Continuous Evaluation. Furthermore, for data sets calculated with the Crow-AMSAA (NHPP) model, this functionality is not available for Change of Slope calculations.

This feature enables you to experiment with possible alternative scenarios by allowing you to alter the values of the calculated parameters, assuming that the likelihood function and the Fisher Matrix (evaluated at the original parameter estimates) remain the same. In plots, the position of the data points remain the same but the solution line and all subsequent analyses made via the Quick Calculation Pad and other tools are based on the modified parameter.
values. Therefore, the analysis may be appropriate only within the context of your specific "what-if" analysis.

To use this feature, choose Growth Data > Options > Alter Parameters or click the icon on the Main page of the control panel.

The Alter Parameters window appears. Type the new value for the parameter(s) you wish to change. The new value of the parameters will appear in the Results area of the growth data folio control panel with the label "User Modified Results" displaying in the analysis settings area, as shown in the following example.

![Screenshot of RGA Growth Data Folio](image)

Calculations with No Data Entered

RGA gives you the flexibility to generate plots and calculate metrics for reliability growth models without entering the data that the model is based upon. To do this, create an RGA growth data folio data sheet, and without entering any data, choose a distribution and then click the Calculate icon on the Main page of the control panel.
With no data specified, this opens an input window that allows you to enter the parameters for the selected model. After you enter the parameters and click **OK**, the parameters of the specified model will be displayed in the Analysis Summary area of the control panel. Any plots or QCP results you produce from this data sheet will be based on this model.

![Parameter Input](image)

### Create Random Data

The Create Random Data tool allows you to create randomly generated data for an analysis.

To use the tool, select the range of cells for which you would like to fill with random data, then right-click any of the selected cells and choose **Random Data** on the shortcut menu. This launches the Create Random Data window, which provides the following options:

- **Columns to Fill** and **Rows to Fill** areas, select which columns/rows in the data sheet to populate with random data. If you had selected a range of cells before accessing the tool, the fields will be populated automatically.

- **Generated Data** area, choose the method for generating the random data:
  - **Random data** allows you to specify a range of numerical values from which the tool will randomly select data points. The range is specified using a **starting point** and a **variability** value (in decimals) that describe how far the values can vary from the starting point. For example, if you specified a starting point of **100** and a percent variability of **0.2**, the data points would be randomly selected from a set of values that ranges from 80 to 120.

  If you clear the check boxes, the tool will use a randomly selected starting point and/or variability for each column of data.
• **Random values in a range** allows you to specify a minimum and maximum range of numerical values from which the tool will randomly select data points.

• **Random points from a set of values** allows you to manually define a set of values from which the randomly selected data points will be chosen. These can be quantitative or qualitative values, each separated by a comma (with or without a space). For example, if you are randomly entering values for a column that only accepts the values "F" and "S," you would enter `F, S` in this field.

When you select one of the first two options in the **Generated Data** area, the **Decimal places** field will be enabled, which allows you to specify the number of decimal places that will be used for each randomly generated data point.

**Auto Group Data**

The Auto Group Data tool allows you to organize data into groups. This option is available for data types where the exact failure times have been recorded (i.e., Failure Times and Multi-Phase Failure Times) and for the Fleet data type.

**Times-to-Failure and Multi-Phase Data**

For the Failure Times and Multi-Phase Failure Times data types, you might use the Auto Group Data tool to smooth out the analysis of a data set that failed the goodness-of-fit test. Grouping the data can also be used to organize the failure times into specified intervals that show the trend in the data rather than the individual failures.

To group data, choose **Growth Data > Options > Auto Group Data** or click the icon on the Main page of the control panel.

A new data sheet using the corresponding grouped data type (i.e., either Grouped Failure Times or Multi-Phase Grouped Failure Times) will be added to the same folio and populated with the grouped data.

**Fleet Data**

For the Fleet data type, the Auto Group Data tool appears automatically when you calculate the data sheet. In this case, the analysis stacks the failure times of each system in the data set into a **cumulative timeline**, and then converts it to grouped data based on the intervals that you specify. The parameters of the Crow-AMSAA (NHPP) or Crow Extended models are then calculated from the grouped data.
Grouping the Data
The following picture shows the Auto Group Data window. You can choose to specify intervals that are all the same width (constant) or intervals of different widths (user-defined). In both cases, the final interval is defined by the test termination time. The intervals must be representative of the data. The appropriate intervals will depend upon your knowledge and assumptions about the systems under test.

- Select **Constant** if you want to specify the same width for all intervals. For example, suppose the failure times are 10, 20 and 30 hours, and the test terminates at 40 hours. If you group the data by a constant width of 20 hours, the grouping will show two failures between 0 to 20 hours and one failure between 20 to 40 hours.

- Select **User Defined** if you want to use intervals of different widths in order to group the data by some qualitative characteristic or other meaningful interpretation of the data. Use the spreadsheet below the option to specify the end time of each interval. The values in the spreadsheet must increase in each subsequent row, but the intervals do not have to be of equal length. For the same example discussed above (failure times at 10, 20 and 30 hours and the test terminates at 40 hours), if you specify the intervals as 5 and 10, the grouping will show no failures between 0 to 5 hours, one failure between 5 to 10 hours and two failures between 10 to 40 hours.
Select Systems to Plot

When you are analyzing data from multiple systems, RGA combines the data into a single representative system that allows you to evaluate all the failures that occurred during the observation period. You can view the resulting timeline via the System Operation plot, which also shows the failure times of each available system in the data sheet.

In the Systems Operation plot, you can select to display or hide a system on the plot by choosing **Plot > Options > Plot Systems** or by right-clicking the plot and choosing the option on the shortcut menu.

The Select System to Plot window shows all the systems that were analyzed, including the end time, total operating time and number of recorded failures in each system. To add or remove a system on the plot, select or clear the corresponding check box. Click the column heading above the check boxes to select or clear all check boxes.

To change the order in which the systems appear in the plot, click any of the column headings to sort the values. For example, clicking the **Failures** column heading will sort the systems from the lowest to the highest number of failures. Clicking the heading again reverses the sort order. Clicking one more time returns the order to its original state (i.e., sorted by system).

To show or hide the timeline of the representative system, select or clear the **Plot System Timeline** check box.
Chapter 5: RGA Growth Data Folio

To export all the data shown in the window to an Excel file, click the **Send to Excel** button.
Chapter 6: Traditional Reliability Growth Analysis

Depending on the data type and the model selected, the RGA growth data folio can be used to perform several different types of analysis. The Growth Data Folios topic provides general information that is applicable for any type of analysis (e.g., choosing a data type, specifying the time units, using the control panel, etc.). This topic provides more focused information about using the RGA growth data folio specifically for traditional reliability growth analysis.

This type of analysis is performed with data from in-house reliability growth testing that was conducted during the developmental stages for a product. The analysis assumes that all fixes (i.e., permanent design improvements) are applied immediately after failure and before testing resumes, and that a reliability growth model can be fitted to the data in order to track how the reliability changes over time. The metrics of interest may include the reliability, MTBF, failure intensity, expected number of failures for a given time or the amount of testing that will be required to demonstrate a specified reliability.

Data Types and Models for Traditional RGA

The following information provides a summary of the data types and models that are applicable for traditional reliability growth analysis (i.e., the analysis of developmental testing data with the assumption that fixes are applied immediately after a failure and before testing resumes).

**Data Types**

You can perform traditional reliability growth analysis with any of the following data types:

- All times-to-failure data types (except for Multiple Systems with Event Codes, which is intended only for growth projections analysis)
- All discrete data types
- Reliability data
Reliability Growth Models

RGA includes six reliability growth models that can be used to track how the reliability changes over time during developmental testing. The models available will depend on the data type. The following list provides links to the ReliaWiki resource portal that discusses in detail the assumptions behind each model.

Analysis Results for Traditional RGA

When you calculate a data set, the analysis results will be displayed in the Results area on the control panel. The following pictures show some examples of analysis results.

The available results will vary depending on the data type and model you are working with. The results may include the following:

- The estimated parameters of the model are always displayed. For example, this will be a, b and c for Standard Gompertz; A and Alpha for Duane; Beta and Lambda for Crow-AMSAA; etc.
- The estimated **Growth Rate**. A larger growth rate means faster MTBF growth.
Chapter 6: Traditional Reliability Growth Analysis

- The instantaneous MTBF and failure intensity at the end of the observation period. An option on the Calculations page of the Application Setup window determines whether you prefer to call these values "demonstrated" (DMTBF and DFI) or "achieved" (AMTBF and AFI) for all new folios. For existing folios, you can change the option in the Settings tab of the Item Properties window (Project > Current Item > Item Properties).

- The demonstrated reliability (DRel) and demonstrated failure probability (DFP), which is 1 - DRel.

- Whether the test was Failure Terminated or has a specified Termination Time for the calculations. (See Termination Time window.)

- Whether the data set passed or failed the applicable goodness-of-fit tests that are performed automatically when you calculate the parameters (applies to the Crow-AMSAA model only). Only the test(s) that apply to the data type you are using will appear in the results. (See Statistical Tests.)

- For data sheets that support the Advanced Systems View, the following information will also be displayed.
  - The number of systems that were included in the analysis (e.g., 4/6 means four out of six systems were analyzed). You can omit a system from the analysis by clearing its check box on the Systems panel while the data sheet is in Advanced Systems View.
  - The control panel will show two sets of results: the larger table at the top shows the results for the equivalent system (which represents the combined operating hours of the systems), and the smaller table at the bottom show the results for the individual system that is currently selected in the data sheet. The specific system name is shown in the heading of this table.

Note: If the result of the analysis is associated with a published model, then the model's name will appear as a link at the bottom of the Results area. Click the link to view the model's properties. For details on how to publish the results as a model, see Publishing Models.

QCP Calculations and Plots for Traditional RGA
RGA includes a Quick Calculation Pad (QCP) for computing useful metrics, as well as multiple plots that allow you to visualize the results of your analyses. This topic describes the calculations and plots you can obtain from traditional reliability growth analysis (i.e., the
analysis of developmental testing data with the assumption that fixes are applied immediately after a failure and before testing resumes).

**Note:** When you analyze data from multiple systems, RGA combines the data to create a single *equivalent system*. Any plots generated for the combined data set and analyses via the Quick Calculation Pad will be based on the equivalent system. See [Times-to-Failure Data from Multiple Systems](#) for more information about how the software combines the data for analysis.

### QCP Calculations

You can open the Quick Calculation Pad (QCP) by choosing *Growth Data > Analysis > Quick Calculation Pad* or by clicking the icon on the control panel.

To perform a calculation, select the appropriate option and enter any required inputs in the **Inputs** area, then click **Calculate**. For more detailed information about all the options available in the QCP, see [Quick Calculation Pad (QCP)](#).

The types of calculations available depend on the selected data type:

**Times-to-failure data types**

- Two values can be calculated for either the **MTBF** or **Failure Intensity**:
  - The **Instantaneous** value is the MTBF/FI over a small interval \( dt \) that begins at a specified time. For example, an instantaneous MTBF of 5 hours after 100 hours of operation means that, over the next small interval \( dt \) that begins at 100 hours, the average time between failures will be 5 hours.
  - The **Cumulative** value is the MTBF/FI from time = 0 up to a specified end time. For example, a cumulative MTBF of 5 hours from 0 to 100 hours means that the average time between failures was 5 hours over the 100-hour period.
- The **Time Given** option allows you to calculate the mission duration given any of the following metrics:
  - Cumulative MTBF
  - Instantaneous MTBF
  - Cumulative failure intensity (FI)
  - Instantaneous failure intensity (FI)
• **Number of Failures** is the cumulative number of failures that are expected to occur by a specified time, based on the fitted model.

**Discrete data types**

For the Discrete-Sequential data sheet with the Crow-AMSAA (NHPP) or Duane models, the following calculations are available:

- Two values can be calculated for either the **Reliability** or **Probability of Failure**:
  - The **Cumulative** value is the reliability/prob. of failure from time = 0 up to a specified end time. For example, a reliability of 0.85 from 0 to 100 hours means that, on average, the reliability was 0.85 over the 100-hour period.
  - The **Instantaneous** value is the reliability/prob. of failure over a small interval $dt$ that begins at a specified time. For example, an instantaneous reliability of 0.85 at 100 hours duration means that, over the next small interval $dt$ that begins at 100 hours, the average reliability will be 0.85.

- The **Stage Given** option allows you to calculate at which stage a specific metric will be achieved. You can specify the following metrics:
  - Cumulative reliability
  - Cumulative probability of failure
  - Instantaneous reliability
  - Instantaneous probability of failure

• **Number of Failures** is the cumulative number of failures that are expected to occur by a specified time, based on the fitted model.

For the Discrete-Mixed data sheet with the Crow-AMSAA or Crow Extended models, the following calculations are available:

- Two values can be calculated for either the **Reliability** or **Probability of Failure**:
  - The **Average** value is the reliability/prob. of failure from time = 0 up to a specified end time.
  - The **Instantaneous** value is the reliability/prob. of failure over a small interval $dt$ that begins at a specified time.
• **Number of Failures** is the cumulative number of failures that are expected to occur by a specified time, based on the fitted model.

For all other discrete data sheets and models, the following calculations are available:

• **Reliability** is the probability of the system operating without failure for a period of time.

• **Probability of Failure** is also known as unreliability, and it is the inverse of the reliability.

• The **Stage Given** option allows you to calculate at which stage the reliability will be achieved.

**Reliability data type**

• **Reliability** is the probability of the system operating without failure for a period of time.

• **Probability of Failure** is also known as unreliability, and it is the inverse of the reliability.

• **Time Given Reliability** is the mission duration for a specified reliability value.

**Plots**

You can create plots by choosing **Growth Data > Analysis > Plot** or by clicking the icon on the control panel.

This section describes the types of plots you can create for traditional reliability growth analysis. The scaling, setup, exporting and confidence bounds settings are similar to the options available for all other RGA plot sheets. For more information on these common options, see **Plots**.

The types of plots you can create depend on the selected data type:

**Times-to-failure data types**

• **Cumulative Number of Failures** shows how the number of failures is increasing over time. It plots the failure times on the x-axis and the cumulative number of failures on the y-axis. The points represent the actual failure times in the data set and the solution line represents the expected number of failures. The vertical line represents the test termination time.

• **MTBF vs. Time** shows how the time between consecutive failures increases, decreases or remains constant over time. It plots the cumulative MTBF curve and
the corresponding instantaneous MTBF curve on the same plot. The points represent the actual failure times in the data set, while the vertical line represents the test termination time. The horizontal lines represent the instantaneous MTBF over the marked interval, which is obtained by dividing the length of the interval with the number of failures in that interval. You can specify the length of the intervals by right-clicking the plot and choosing Show/Hide Items on the shortcut menu. In the window, enter the desired interval length in the Time Interval field.

- **Failure Intensity vs. Time** shows how the rate of occurrence of failures increases, decreases or remains constant over time. It plots both the cumulative and instantaneous failure intensity curves on the same plot. The points represent the actual failure times in the data set, while the vertical line represents the failure time. The horizontal lines represent the instantaneous failure intensity over the marked interval, which is obtained by dividing the number of failures in that interval with the length of the interval. You can specify the length of the intervals by right-clicking the plot and choosing Show/Hide Items on the shortcut menu. In the window, enter the desired interval length in the Time Interval field.

- **System Operation** is available only for multiple systems analysis. It shows the failure times of each system in the data set, along with the timeline for their equivalent system that is used for calculating analysis results. See Times-to-Failure Data from Multiple Systems for more information on how the software combines the data to build the equivalent system.

**Discrete data types**

- The following plots are available when you use the Crow-AMSAA or Duane model with the Discrete-Sequential data sheet, or the Crow-AMSAA or Crow Extended model with the Discrete-Mixed data sheet:

  - **Cumulative Number of Failures** shows how the number of failures is increasing over time. It plots the failure times on the x-axis and the cumulative number of failures on the y-axis. The points represent the actual failure times in the data set and the solution line represents the expected number of failures. The vertical line represents the test termination time.

  - **Reliability vs. Time** shows how the reliability increases, decreases or remains constant over time. It plots both the cumulative and instantaneous reliability curves on the same plot.

  - **Unreliability vs. Time** shows how the probability of failure increases, decreases or remains constant over time. It plots both the cumulative and instantaneous probability of failure curves on the same plot.
For all other models and/or discrete data sheets, the following plots are available:

- **Reliability vs. Time** shows the reliability values over time, capturing trends in the system’s failure behavior.

- **Unreliability vs. Time** shows the probability of failure of the system over time.

Reliability data type

- **Reliability vs. Time** shows the reliability values over time, capturing trends in the system’s failure behavior.

- **Unreliability vs. Time** shows the probability of failure of the system over time.

**Tip:** RGA includes two additional plot utilities you can use across all types of data: the overlay plot, which allows you to compare different data sets or models; and the side-by-side plot, which allows you to display different plots of a single data set all in a single window for easy comparison.

### Example: Failure Times Data

The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.

The name of the project is "Failure Times - Duane and Crow-AMSAA," and the folio that contains the data is called "Crow-AMSAA (NHPP)."

A prototype of a system is tested at the end of one of its design stages. When a failure occurs in the system, the time of failure is recorded and then a fix is applied before testing resumes. A total of 40 failures were observed during this period. The prototype has a design specification of an MTBF = 135 hours with a 90% confidence level. The goal is to determine whether the prototype meets the specified MTBF goal.
The data from the test are recorded in a Failure Times data sheet configured for cumulative failure times, as shown next. To specify the time when the test ended, click the (...) button on the control panel to open the Termination Time window. Select **Failure Terminated** and click **OK**.

On the control panel, choose the **Crow-AMSAA (NHPP)** model, and then analyze the data by choosing **Growth Data > Analysis > Calculate** or by clicking the icon on the Main page of the control panel.
The results show a demonstrated MTBF (DMTBF) = 166.2217 hours at the end of the test, as shown next.

![Results Table]

You can use the Quick Calculation Pad (QCP) to obtain the 90% confidence bounds on the demonstrated MTBF. To access the QCP, choose **Growth Data > Analysis > Quick Calculation Pad** or click the icon on the Main page of the control panel.

In the QCP, select to calculate the instantaneous **MTBF** with **lower one-sided** confidence bounds. Select **Hour** for the time units and then make the following inputs:

- Time = 3256.3
- Confidence Level = 0.9
Click **Calculate** to obtain the results. It shows that the lower limit on the MTBF at the specified time with a 90% confidence level is 131.2122 hours. Therefore, the prototype has met the specified goal.

To create a plot of the result, close the QCP, and then choose **Growth Data > Analysis > Plot** or click the icon on the Main page of the control panel.
On the plot's control panel, click the **Plot Type** drop-down list and choose **MTBF vs. Time**. The following plot shows the cumulative MTBF and the corresponding instantaneous MTBF on a logarithmic plot. (Note that you can switch to a linear scale by clearing the **Use Logarithmic Axes** check box on the plot's control panel).

The points represent the actual failure times in the data set, while the vertical line represents the test termination time. The horizontal lines on the plot are the instantaneous intervals, which show the MTBF over a specified interval length. The MTBF over an interval is obtained by dividing the length of the interval with the number of failures in that interval. The intervals can be used to observe a general MTBF trend, whether the MTBF increases, decreases or stays the same over time.

You can specify the length of the intervals by choosing **Plot > Actions > Show/Hide Items** or by right-clicking the plot and choosing **Show/Hide Items** on the shortcut menu.
In the window, make sure that the Show Intervals check box is selected, and then specify the length of the interval in the Time Interval field, as shown next. Click OK and the plot will refresh to show the new results.

![Show/Hide Items](image)

**Example: Discrete (Success/Failure) Data**

*The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.*

*The name of the project is "Discrete Data- Sequential."

A cartridge device is required to have a reliability of 95% at the end of a reliability growth testing program. The device is designed for emergency use and its casing is destroyed when it releases its charge; therefore, the design can be tested and improved only through sequential pass/fail tests. The result of each trial (whether the device passed or failed) is recorded in a Discrete Sequential data sheet.

Choose the Logistic model, and then analyze the data set by choosing Growth Data > Analysis > Calculate or by clicking the icon on the Main page of the control panel.
The following picture shows the data set and the calculated parameters of the logistic model.

To create a plot of the results, choose Growth Data > Analysis > Plot or click the icon on the Main page of the control panel.
The following reliability vs. time plot shows how the reliability of the device changes with each new improvement in the design. The vertical line represents the stage when the test was terminated. This plot shows that the reliability after 20 trials is 75%.

You can use the Quick Calculation Pad (QCP) to predict when the reliability will reach 95%. To access the QCP, choose **Growth Data > Analysis > Quick Calculation Pad** or click the icon on the Main page of the control panel.
In the QCP, select to calculate the **Stage Given Reliability**, and then enter **0.95**. Select **Hour** for the time units and click **Calculate** to obtain the result. The result indicates that if the reliability keeps its trend, it is expected to reach 95% at the 42nd stage of testing, as shown next.

![QCP screenshot](image)

**Change of Slope Analysis**

Change of Slope analysis can be applied to situations where a major change in the system design or operational environment causes a significant change in the failure intensity of the system. In this case, a single model may not provide a good fit for the data set.

To analyze this type of data set, the Change of Slope analysis splits the data set into two segments, based on the time that the change took place, and then applies a separate Crow-AMSAA (NHPP) model to each segment. The time that the change took place can be estimated from the data or based on your own knowledge about the specific change that was applied to the system. Note that although two separate models are applied to the segments, the
information collected in the first segment are considered when creating the model for the second segment.

This analysis is available when you use the Crow-AMSAA (NHPP) model with any times-to-failure data type (except Multiple Systems with Event Codes) or with Discrete – Mixed data.

**Note:** The Change of Slope analysis requires at least three failures up to the break point and two failures after the break point (in the case of grouped data, this would be the number of intervals before and after the break point).


**Example**

*The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.*

*The name of the project is "Failure Times - Change of Slope."*
A system is put through a reliability growth testing program. A total of 58 failures are observed during the 660 hours of testing. The data are recorded in a Failure Times data sheet and analyzed with the Crow-AMSAA (NHPP) model, as shown next.

The results show that the data set failed the Cramér-von-Mises (CVM) goodness-of-fit test. This indicates that the model is not a good fit for the data. In addition, the following plot shows that there appears to be a significant change in the slope of the points at around 400 hours. As it turns out, a major design change was implemented at this point in time. Given this scenario, we can repeat the analysis using the Change of Slope methodology with the break point set to 400.
Return to the data sheet. In the Calculations Options area of the control panel, select the Change of Slope option, and then click the Calculate icon. This opens the Change of Slope - Break Point window, which allows you to specify the point at which the data set should be divided. Enter a value of 400, as shown next.
RGA automatically splits the data into two segments and fits a separate Crow-AMSAA (NHPP) model to each segment. For the first segment, the data points up to 400 hours are used to calculate its parameters. For the second segment, the data points after 400 hours plus information from the first segment are used to calculate its parameters.

The following results show the estimated parameters for Segment 2. Based on this model, the demonstrated MTBF (DMTBF) of the system at the end of the test is 38.3063 hours. (The Segment 1 model can be used to calculate the MTBF for times up to 400 hours only.) The results also show that the data set has passed the chi-squared goodness of fit test.

The following plot shows that the model provides a much better fit to the data. If you choose to display the confidence bounds on the plot, only the bounds on Segment 2 (which is the model of interest) will be plotted, as shown next.
Gap Analysis

Gap analysis is used in situations where issues such as oversight, biases, human error, technical difficulties, etc. cause some portion of the data to be erroneous or completely missing. This causes the analysis to return distorted estimates of the growth rate and actual system reliability. In this type of situation, you can use the Gap Analysis feature in RGA to analyze the data set.

Gap analysis assumes that the information within the problematic time interval is unavailable or unreliable and does not use any entries that have been made for that time period. Instead, the number of failures for that interval is assumed to be unknown, but the rest of the data follow the Crow-AMSAA model. The analysis retains the contribution of the interval to the total test time, but no assumptions are made regarding the actual number of failures over the interval.
This analysis is available when you use the Failure Times data type with the Crow-AMSAA (NHPP) model using standard calculations (gap intervals are not compatible with Change of Slope calculations). You can define one gap interval per data set. Each gap is a time range that exists within the data, and it has a defined start time and end time. There must be at least one failure before and after the specified gap interval.

The ReliaWiki resource portal provides more information about the analysis at http://www.reliawiki.org/index.php/Gap_Analysis.

**Example**

*The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.*

*The name of the project is "Failure Times - Gap Analysis."

A system is put through a reliability growth testing program. The test is terminated after 1,000 hours of testing, and a total of 86 failures were observed during that period. The data are recorded in a Failure Times data sheet and analyzed with the Crow-AMSAA (NHPP) model, as shown next.
The results show that the data set failed the Cramér-von-Mises (CVM) goodness-of-fit test. This indicates that the model is not a good fit for the data.

The following plot shows that the number of failures from 500 to 625 hours is abnormally high. A quick investigation found that new data collectors were assigned to the project at around that time and that extensive design changes involving the removal of several parts were also made within that period. It is possible that the parts that were removed were incorrectly reported as failed parts. Based on their knowledge of the system and the test program, the analysts agree that such a large number of failures were extremely unlikely. They decide to repeat the analysis using gap analysis.
Return to the data sheet. On the Analysis page of the control panel, select the **Specify a gap interval** check box and then enter **500** to **625** for the gap interval, as shown next.
Return to the Main page of the control panel and analyze the data set by choosing **Growth Data > Analysis > Calculate** or by clicking the icon on the Main page of the control panel.

This time, the analysis will ignore the failure times observed between 500 and 625 hours. The resulting plot now shows that the model provides a much better fit to the data.

### Failure Discounting

Failure discounting applies to the analysis of discrete data (also known as *success/failure* or *attribute* data), in which the data set records the success or failure of each one-shot trial (e.g., of a missile or other type of device that either succeeds or fails). In RGA, you can perform failure discounting by using the Discrete Sequential with Mode data type.

This analysis is used to track the possible recurrence of a failure mode after a fix has been applied. If the mode does not appear again in the later trials, then the probability of failure due
to that mode is reduced. The amount of reduction is related to the consecutive number of successful tests after the fix was applied. The following equation describes this relationship:

\[ f = 1 - \left(1 - CL\right)^{\frac{1}{S_n}} \]

where \( f \) is the failure value due to the mode, \( CL \) is the confidence level and \( S_n \) is the number of additional successful tests after the first success following the fix.

For example:
- In trial#1, failure mode A occurred. The failure value due to this mode is 1 (i.e., counted as one failure). A permanent fix is then applied for mode A.
- In trial#2, mode A did not recur. This marks the first success after the fix was applied. The failure value due to this mode is still counted as 1.
- In trial#3, mode A did not recur; therefore, \( S_n = 1 \), and the failure value due to mode A is reduced to 0.9, based on a 90% confidence level.
- In trial#4, mode A did not recur; therefore, \( S_n = 2 \), and the failure value due to mode A is further reduced to 0.684, based on a 90% confidence level.
- In trial#5, mode A occurs again, and because a second fix now needs to be applied, the failure value due to this mode resets back to 1.

Failure discounting has the effect of reducing the total number of failures in the analysis, which results in a higher reliability estimate. The following example illustrates this effect.

**Example**

*The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.*

*The name of the project is "Discrete Data - Sequential with Mode."

The ReliaWiki resource portal provides the mathematical calculations behind this example at [http://www.reliawiki.org/index.php/Failure_Discounting](http://www.reliawiki.org/index.php/Failure_Discounting).

A device under development undergoes a reliability growth program. A total of 22 trials are performed and the result of each trial is recorded in the Discrete Sequential with Mode data sheet. Whenever a failure occurs, a fix is applied to the device and the failure mode that caused the failure is recorded.
Chapter 6: Traditional Reliability Growth Analysis

On the Analysis page of the control panel, enter 0.9 for the confidence level in the Failure Discounting area, as shown next.

Select the Standard Gompertz model and then analyze the data set by choosing Growth Data > Analysis > Calculate or by clicking the icon on the Main page of the control panel.

The following picture shows the data set and the parameters of the model.

To compare how failure discounting affects the reliability estimates, copy the Success/Failure data and paste them into a Discrete Sequential data sheet. Analyze that data sheet using the Standard Gompertz model.
The following picture shows the copied data set and the parameters of the Standard Gompertz model, this time, without failure discounting.

To create an overlay plot that compares the results of the two analyses, choose **Insert > Reports and Plots > Overlay Plot**.
When prompted to select which data sheets to plot, select the two data sheets you have been working with. The following picture shows the resulting overlay plot (with annotations added via RS Draw to make the plot easier to interpret). It shows that the reliability estimates are higher when failure discounting is used because of its effect of reducing the total number of failures in the analysis.
Chapter 7: Crow Extended Model

Traditional reliability growth analysis is used to analyze data from tests where design fixes are incorporated during the observation period (the test-fix-test strategy). However, in actual practice, fixes may be delayed until after the end of the observation period (test-find-test), or you may implement some fixes during the observation period while delaying others (test-fix-find-test).

With the Crow Extended model, you can perform reliability growth projections, planning and analysis—which allows you to analyze test data from any or all of these strategies by providing additional information about the failure modes and the reliability growth management strategy (i.e., which modes are fixed and how effectively the design improvements reduce failure intensity). You can also use this model for data from fielded repairable systems in order to evaluate the improvement (i.e., the jump in MTBF) that could be achieved by rolling out a set of fixes for all systems operating in the field.

Data Types for Crow Extended Model
You can apply the Crow Extended model to any of the following data types.

- All times-to-failure data types
- Discrete Mixed data
- All fielded data types

When the Crow Extended model is selected in any of these data sheets, additional Classification and Mode columns will appear in the data sheet. These columns are used to classify and identify the failure mode responsible for each observed failure. To learn how to use these two columns in an analysis, see Failure Mode Classifications. For the background theory behind the Crow-Extended model, the ReliaWiki resource portal provides more information at: http://www.reliawiki.org/index.php/Crow_Extended.

Mode Classifications

To use the Crow Extended model, you must classify and identify the failure mode responsible for each observed failure. This information is entered in the Classification and Mode columns in the data sheet. These columns are inserted automatically when you choose the Crow Extended model from the Model drop-down list on the growth data folio control panel.
Tip: If the Crow Extended model is not selected but still available for the current data type, you can manually add the Classifications and Mode columns to the data sheet by choosing Growth Data > Format & View > Insert Columns > Projections. This will allow you to record projections data in case you decide to change the model to Crow Extended later. When CrowExtended is not selected, the projections data will not affect the calculations.

The Classification column records the code that describes how the failure mode is treated. The possible codes are described next.

- **A** indicates that no fix will be applied (i.e., management chooses not to address the failure mode because of technical, financial or other reasons).

- **BC** indicates that a fix was applied during the observation period. The analysis assumes that the effect of the design improvement was experienced during the observation period and will be reflected in the data.

- **BD** indicates that the fix will be delayed until after the observation period. You will be required to define the effectiveness factor for each BD mode to estimate the fractional decrease in failure intensity that is expected to occur after the fix has been implemented.

Tip: BC modes are not available for data sheets configured for fielded data or Discrete Mixed data because these data types assume that all design improvements are delayed (i.e., no reliability growth during the observation period). If you are using Discrete Mixed data (i.e., success/failure data from a series of trials on one-shot devices) and you want to account for fixes that were implemented during the test, you can use a data sheet configured for Multi-Phase Mixed data instead. In this sheet, you can enter a BD failure event and its implemented fix event (i.e., "I" event). Such a failure will, in effect, be treated as a BC mode.

The Mode column records the specific failure mode identification, which is optional for A modes but required for all BC and BD modes. This can be entered as either a name or a numerical code (e.g. "seal leak," "1," "BD1," etc.).
The next picture shows the first ten rows of a Failure Times data sheet with failure mode identification and mode classification information.

<table>
<thead>
<tr>
<th>D-T</th>
<th>Time to Event (Hr)</th>
<th>Classification</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>BD</td>
<td>seep leak</td>
</tr>
<tr>
<td>2</td>
<td>25.3</td>
<td>BD</td>
<td>valve</td>
</tr>
<tr>
<td>3</td>
<td>56.4</td>
<td>BD</td>
<td>hose</td>
</tr>
<tr>
<td>4</td>
<td>63.6</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>72.2</td>
<td>BD</td>
<td>hose</td>
</tr>
<tr>
<td>6</td>
<td>99.6</td>
<td>BD</td>
<td>operator error</td>
</tr>
<tr>
<td>7</td>
<td>100.3</td>
<td>BD</td>
<td>bearing</td>
</tr>
<tr>
<td>8</td>
<td>102.5</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>112</td>
<td>BD</td>
<td>seep leak</td>
</tr>
<tr>
<td>10</td>
<td>112.2</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

**Tip:** If you discover that a certain failure mode was classified incorrectly (e.g., if every "operator error" mode in the above data sheet should have been classified as an A classification instead of BD), or if you want to change a particular mode identifier (e.g., you want to change every instance of a particular number in the Mode column to a name), you can use the Convert Modes window to apply the update automatically.

**Convert Modes Window**

The Convert Modes window allows you to convert any failure mode classification and mode in the current data set to another classification and mode. For example, suppose a particular failure mode occurs several times during the observation period and is currently classified as BD in the data sheet. If it is later decided to ignore this mode rather than addressing it after the observation period, you could convert every instance of it in the data sheet to an A classification.

To access this window, choose Growth Data > Crow Extended > Convert Modes.

Two drop-down lists appear next to Failure Mode. Choose the failure mode classification in the first list and the failure mode identifier in the second. Then, in the Convert To drop-down list, choose the classification that you want the selected failure mode to be changed to, and if desired, enter a new identifier in the input field.

Click Convert to apply the specified changes. The Classification and Mode columns in the data sheet will be updated accordingly, and a message will appear specifying the number of changes that were made. When you are finished converting failure modes, click the Close button.
Mode Processing Window
The Mode Processing utility allows you to extract the first failure time for each unique BC mode and/or unique BD mode in a data set. This allows you to automatically copy the failure times for a particular failure mode classification into a new data sheet for separate analysis. This tool applies only to data sets analyzed with the Crow Extended or Crow Extended - Continuous Evaluation models.

To use the tool, you must first analyze the data sheet (by clicking the Calculate icon on the control panel), and then choose Growth Data > Crow Extended > Mode Processing.

In the window that appears, select the check box next to each mode classification you wish to extract. If the data set does not contain a particular mode classification, the corresponding check box will be unavailable.

For example, if you select to extract BC modes, the failure times for all BC modes will appear in a new data sheet. (If a particular failure mode (e.g., BC 100) has more than one failure time, only the first time will be extracted.) The new data sheet will have the same name as the source data sheet plus the name of the mode classification and an increment to reflect the number of data sheets that have been created for the same classification.

You can then analyze the extracted data set using traditional reliability growth analysis techniques.

**Tip:** If you wish to extract subsets of data based on either the system ID recorded in multiple systems data sheets or the phases/analysis points recorded in multi-phase data sheets, use the Batch Auto Run utility.
Effectiveness Factors for Crow Extended
If you are using the Crow Extended model and have classified some failure modes as BD modes (i.e., the modes will not be addressed until after the current observation period), you will need to specify the expected effectiveness of the delayed fixes. This information is used to estimate the fractional decrease in failure intensity that will occur after the design fixes are implemented. For example, you could indicate that 60% of a BD mode’s failure intensity will be removed from the system after the delayed fix has been implemented (i.e., 40% of the failure intensity will remain because the fix is not perfectly effective). This information is used to estimate the fractional decrease in failure intensity that will occur after corrective action is taken.

To specify the effectiveness factors for the BD modes, choose Growth Data > Crow Extended > Effectiveness Factors or click the icon on the control panel.

In the spreadsheet area of the window that appears, all BD modes are pre-populated in the BD Mode column. There are two ways to specify the effectiveness of delayed fixes for these modes.

1. You can use the Effectiveness Factor column to set a different effectiveness factor (entered as a decimal) for each unique mode.

or

2. You can set one general factor that applies to all modes by clicking the Use Fixed Effectiveness Factor button on the toolbar and entering the fixed value in the input box, as shown next. Any values entered in the Effectiveness Factor column will then be ignored.

The average of all effectiveness factors will appear in the status bar in the bottom left corner of the window. This value can be used as an input to the growth planning folio, and it can also be useful as a point of reference for estimating the effectiveness factor of a BD mode in a future analysis.

You can enter any additional information about the effectiveness factors in the Comments column. The information in this column does not affect calculations.

If you want to save a record of how the effectiveness factors are currently defined, you can click the Transfer to Folio icon. This will add to the folio a general spreadsheet that contains the effectiveness factors you've selected to use, as well as the comments you've entered.
Event Codes for Crow Extended

The Event column that appears in the Multiple Systems with Event Codes data type allows you to specify the type of event that each row in the data sheet represents, so it can be handled appropriately in the calculations. The drop-down list in the column contains the following options:

- **F - Failure** is the default event type. Any event left unspecified will be treated as a normal failure.
- **I - Implemented Fix** indicates the time when the fix for a specified BC failure mode was implemented. This type of event must be preceded by an observed instance of the BC mode in question.
- **P – Performance** and **Q - Quality** indicate failures due to performance or quality issues. You can choose whether or not to consider these events in the analysis.
- **Events marked with X - Exclude** will always be excluded from the analysis. This event code can be used to add comments or a timestamp within the data set. Note that an "X" can be placed in front of any existing event code or entered by itself. For example, "XF" indicates a failure in the data set that should be excluded from the analysis.

The Event Code Options area on the Analysis page of the control panel allows you to choose whether performance (P) and quality (Q) failures will be included in the analysis. By default, both check boxes will be selected.

Crow Extended Analysis Results

When you calculate a data sheet using the Crow Extended model, the analysis results will be displayed in the Results area on the control panel. The results that apply to all failure modes are displayed first. Use the scroll bar to see results that only apply to failure modes with a particular classification (i.e., A Modes = not fixed, BC Modes = fixed during observation period or BD Modes = fixed after observation period), as shown next.
When you use the Crow Extended model, the results may include the following:

- **Beta** and **Lambda** are the two parameters of the Crow Extended model.
  - If beta < 1, the reliability improved during the observation period. If beta > 1, the reliability deteriorated. In addition:
    - If the data set does not include BC modes, **Beta (hyp)** will indicate that the model assumes beta = 1 (i.e., the reliability neither improved nor deteriorated). If this value is shown in red, then the 90% two-sided confidence bounds on beta do not include 1, which means this assumption may not be valid.
    - When working with times-to-failure data, **Beta (Unb)** indicates that the unbiased MLE estimate of the beta parameter was calculated.
  
  Note that the preference to display Beta (hyp) and/or calculate Beta (Unb) is set on the Calculations page of the Application Setup window for all new folios or in the Settings tab of the Items Properties window for existing folios.

- If the data set includes BC failure modes, the **Growth Rate** will also be displayed, which is equal to 1 - beta. A positive value means the MTBF is improving, and larger values mean faster growth.

- The metrics used to describe the reliability at the end of the observation period will vary depending on the data type you are working with.
  - If you're working with times-to-failure or fielded data, the results will show the mean time between failures and the failure intensity at the end of the
observation period. An option on the Calculations page of the Application Setup window (for all new folios) or in the Settings tab of the Items Properties window (for existing folios) determines whether you prefer to call these values "demonstrated" (DMTBF and DFI) or "achieved" (AMTBF and AFI).

- If you're working with Discrete Mixed data, the results will show the demonstrated reliability (DRel) and demonstrated failure probability (DFP), which is 1 - DRel.

- The Statistical Tests area shows whether the data set passed or failed the applicable goodness-of-fit tests that are performed automatically when you calculate the parameters.
  - For failure times and grouped failure times, this will be the Cramer-von Mises test (CVM).
  - For mixed data, it will be the chi-squared test (Ch-Sq).
  - For data from multiple systems, this area may also show the results from the common beta hypothesis (CBH) and/or the Laplace Trend test.

See Statistical Tests for more information.

- Depending on the data type, the Other area may display the Termination Time:
  - If you are using the Failure Times, Grouped Failure Times or Multiple Systems - Known Operating Times data types, you can use the Termination Time window to specify whether this is the time of the last observed failure, or a specific time that you enter.
  - For all other data types that can be analyzed with the Crow Extended model, the termination time is the end of the observation period.

- Finally, if you are working in a data sheet that supports the Advanced Systems View, the following information will also be displayed.
  - The Other area will show the number of systems that were included in the analysis (e.g., 4/6 means four out of six systems were analyzed). You can omit a system from the analysis by clearing its check box on the Systems panel while the data sheet is in Advanced Systems View.
  - The control panel will show two sets of results: the larger table at the top shows the results for the equivalent system (which represents the combined operating hours of the systems), and the smaller table at the bottom show the results for the individual system that is currently selected in the data sheet. The specific system name is shown in the heading of this table.
**Calculations and Plots**

RGA includes a Quick Calculation Pad (QCP) for computing useful metrics, as well as multiple plots that allow you to visualize the results of your analyses. This topic describes the calculations and plots you can obtain from data sheets analyzed with the Crow Extended model.

**Note:** When you analyze data from multiple systems, RGA combines the data to create a single representative system (i.e., equivalent system, superposition system or cumulative timeline, depending on the data type). Any plots generated for the combined data set and subsequent analyses via the Quick Calculation Pad will be based on the resulting representative system. See Times-to-Failure Data from Multiple Systems and Fielded Data for more information about how the software combines the data for analysis.

**QCP Calculations**

You can open the Quick Calculation Pad (QCP) by choosing Growth Data > Analysis > Quick Calculation Pad or by clicking the icon on the control panel.

To perform a calculation, select the appropriate option and enter any required inputs in the Input area, then click Calculate. For more detailed information about all the options available in the QCP, see Quick Calculation Pad (QCP).

The Basic Calculations tab of the QCP includes the typical calculations for traditional reliability growth analysis (e.g., cumulative/instantaneous MTBF and expected number of failures). These calculations are applicable only when your data set includes BC failure modes. (See QCP Calculations and Plots for Traditional RGA.)

On the Extended Calculations tab, the available calculations will vary depending on whether you’re analyzing failure times or mixed (discrete) data. For failure times, the calculated values will be mean time between failures (MTBF) and failure intensity (FI). For mixed data, the values will be reliability and probability of failure. Most of these calculations are applicable only when your data set includes BD failure modes.

- Three values can be calculated for either the mean time between failures (MTBF), failure intensity (FI).
• The **Demonstrated/Achieved** values reflect the reliability at the end of the observation period, before any delayed fixes have been implemented.

• The **Projected** values reflect the reliability that will be achieved after the delayed fixes have been implemented.

• The **Growth Potential** values are the best values that could be achieved by applying the current reliability growth management strategy. In other words, this estimates the maximum reliability growth that you can expect if you continue to find new failure modes at the same rate and make the same types of decisions about which failure modes to fix.

• **Discovery Rate** is the rate at which new BD failure modes are being discovered (i.e., the failure intensity of unseen BD modes) at a specified time. For example, if the discovery rate at 400 hours is 0.02, then 0.02 new BD modes are being discovered every hour (equivalently, 2 new BD modes are discovered every 100 hours).

• **MTBF BD Unseen** is the mean time between failures due to unseen failure modes at a specified time (i.e., BD modes that did not appear during the observation period but are estimated from the analysis).

• **Number of Failures** is the cumulative number of failures that are expected to occur by a specified time, based on the fitted model.

  • If the data set includes BC failure modes, then this value is calculated on the assumption that the reliability changed during the observation period. The option will thus be on the Basic Calculation tab with the other typical calculations for traditional reliability growth analysis (e.g., cumulative/instantaneous MTBF).

  • Otherwise, the calculation assumes that the reliability neither deteriorated nor improved during the observation period (i.e., beta = 1).

**Plots**

You can create plots by choosing **Growth Data > Analysis > Plot** or by clicking the icon on the control panel.

This section describes the types of plots you can create for the Crow Extended model. The scaling, setup, exporting and confidence bounds settings are similar to the options available for all other RGA plot sheets. (See **Plots**.)

Once again, the available calculations will vary depending on whether you’re analyzing failure times or mixed (discrete) data. For failure times, the calculated values will be mean time
between failures (MTBF) and failure intensity (FI). For mixed data, the values will be reliability and probability of failure.

The plots described next apply to data sets that include at least some BD modes. Some of these plots apply specifically to data sets that consist entirely of A/BD modes (e.g., when you use the Crow Extended model to analyze fielded data), where the analysis assumes that there is no reliability growth during the observation.

- **Cumulative Number of Failures** shows the total number of failures versus time. Data points on the plot represent the cumulative number of failures that have been reported by a given time (e.g., the second point marks the time at which the second failure was observed). The lines that can be included will vary depending on whether there are BC modes in the data set.
  - If both BC and BD modes are included, the plot can include the Expected Failures line, which serves as an empirical goodness-of-fit test for the Crow Extended model. It is fitted using the beta that was calculated from the data points.
  - If only A/BD modes are included, the plot can include the Assumed Parameters line based on the assumption that beta = 1 (i.e., no reliability growth was experienced during the observation period) and the Estimated Parameters line based on the beta calculated from the data points. You can then compare the two lines to evaluate whether the beta = 1 assumption is valid.

- The **Value vs. Time** plots show how the value increases, decreases or remains constant over time. The points represent the actual failure times in the data set and the plot includes one line for the instantaneous value and one line for the cumulative value. These plots are available when your data set includes BC failure modes.

- **Beta Bounds** is available when only A/BD modes are included in the data set. This plot is used to assess the validity of the assumption that beta = 1. For example, if the two-sided 95% confidence bounds on beta do not include 1, then you can (with 95% confidence) reject the hypothesis that beta = 1. The following lines can be shown in the plot:
  - The Beta Hypothesis line marks beta = 1.
  - The Beta Bounds lines show the confidence bounds for beta at five different confidence levels. You can configure these lines using the Beta Bounds window.

- **System Operation** is available only for multiple systems analysis. It shows the failure times of each system in the data set, along with the timeline for their representative system (i.e., equivalent system, superposition system or cumulative timeline), which is used to evaluate all the failures and fixes that occurred during the observation period. Each type of event is color coded on the plot: failure (red circle), implemented fix (yellow triangle), performance failure (blue circle) and quality failure (green diamond).
To learn more about how the failure times are combined, see the following topics:

- For multiple systems times-to-failure data types, see [Times-to-Failure Data from Multiple Systems](http://rga.reliasoft.com).
- For fielded data types, see [Fielded Data](http://rga.reliasoft.com).
- The **Growth Potential** plots are applicable only when the data set includes BD failure modes. The plots can include these items:
  - The Demonstrated/Achieved point represents the value at the end of the test, before any delayed fixes have been implemented.
  - The Projected point represents the expected value after the delayed fixes have been implemented.
  - The Growth Potential line represents the best value that could be achieved by applying the current reliability growth management strategy (i.e., the portion of the system's failure intensity that will be addressed by design fixes).
  - If desired, you can use the [Show/Hide Plot Items window](http://rga.reliasoft.com) to show the Instantaneous line, which shows how the value changes over time during the test. The instantaneous value is calculated over a small interval \( dt \) that begins at a given time. For example, an instantaneous MTBF of 5 hours at 100 hours duration means that, over the next small interval \( dt \) that begins at 100 hours, the average MTBF will be 5 hours.
  - If desired, you can estimate the projected MTBF or failure intensity with a specified amount of further testing. This option is applicable only for developmental testing when BD failure modes are included in the data. To enable this option and specify a time greater than the termination time, click the [...] button.

- The **Final** bar charts provide the same information as the Growth Potential plots, but using bars instead of lines.
• **Cumulative Number of BD Modes** shows the total number of unique observed BD modes versus time. This plot can include these items:
  
  • Data points on the plot represent the cumulative number of BD modes that have been discovered by a given time. For example, the second point marks the time at which the second unique BD mode (e.g., BD2) was observed.
  
  • The Cumulative Number of BD Modes line is fitted to the data points and shows how the cumulative number of discovered BD modes changes with time.

• **MTBF BD Unseen** and **Discovery Rate** show the rate at which new unique BD failure modes are being discovered at any given time. For example, if the MTBF for unseen BD modes is 50 hours, then 2 more unique BD modes are expected to be observed over the next 100 hours. The discovery rate is the failure intensity of the unseen BD modes (i.e., the inverse of the MTBF). In a successful reliability growth test, the MTBF for unseen BD modes will increase over time and the discovery rate will decrease.

• The **Individual Mode** bar charts show two bars for each failure mode. Use the Plot Modes window to choose which failure modes to include in the chart.
  
  • The Before bars represents the value at the end of the test, before any delayed fixes have been implemented.
  
  • The After bars are available only for BD modes and represents the value after the delayed fixes have been implemented.

• The **Failure Mode Strategy** pie chart breaks down the overall failure intensity (FI) into six possible categories:
  
  • The Type A slice represents the FI that is due to failure modes that are ignored (i.e., no fixes will be implemented).
  
  • The Type BC - Seen slice represents the FI that is due to BC modes that were observed and for which fixes were implemented.
  
  • The Type BC - Unseen and Type BD - Unseen slices represents the FI that is due to BC and BD modes that were not observed but are estimated from the analysis. If they were observed (e.g., through future testing), fixes would be implemented.
  
  • The Type BD - Remained and Type BD - Removed slices represent the FI that is due to BD modes that were observed (i.e., they represent the FI due to seen BD modes). The Remained slice represents the portion of FI that is expected to stay in the system because the fixes are not 100% effective, while the Removed slice represents the FI that is expected to be eliminated.
• **Conditional Reliability/Unreliability** is available only when you are using the Repairable data sheet. These plots show the reliability/unreliability versus system age or mission time.

  • If you choose to hold the system age constant, the plots will show the reliability/unreliability for different mission times. For example, assuming that the system has already operated for 100 hours, the plot can show the reliability for the next 10 hours, 20 hours, 30 hours, etc.

  • If you choose to hold mission time constant, the plots will show the reliability/unreliability for different system ages. For example, assuming that the mission will be 100 hours, the plot can show the reliability for a system that has already operated for 10 hours, 20 hours, 30 hours, etc.

To specify which value will be held constant, click the [...] button on the control panel. In the window that appears, select the type of metric that will be held constant, as shown next. Then enter the constant value in the input field.

Tip: RGA includes two additional plot utilities you can use across all types of data: the overlay plot, which allows you to compare different data sets or models; and the side-by-side plot, which allows you to display different plots of a single data set all in a single window for easy comparison.
Plot Modes Window
When you’re viewing an Individual Mode MTBF/FI/Reliability plot, you can select which of the failure modes in the current data sheet will appear by choosing Plot > Options > Plot Modes or by right-clicking the plot and choosing the option from the shortcut menu.

To show/hide all of the modes, click the column headings above the check boxes.

To select all modes of a given classification (i.e., all A modes, all BC modes or all BD modes), choose the desired classification in the Select by Mode field at the bottom of the window.

To export all the data shown in the window to an Excel file, click the Send to Excel button.

Changing the Order of the Failure Modes
The order of failure modes in this window reflects the order of modes in the plot. By default, the modes are shown in the same order that they occurred during the observational period. To change the order, you can sort the modes by clicking the column heading that you wish to sort by. Click the heading again to reverse the order of the sort, and click it one more time to return the order to its original state.

- **Classification** displays the mode classifications.
- **Mode** displays the failure mode identifiers.
- **Effectiveness Factor** displays the corresponding effectiveness factor for each BD mode, if any factor was specified.
- **Time to First Failure** displays the first time at which the failure mode was observed.
- **Before MTBF** displays the mode's MTBF at the end of the observation period and before any delayed fixes are implemented.
- **After MTBF** displays the mode's MTBF after any delayed fixes are implemented. For BD modes, the "before" and "after" values will be different. For A and BC modes, they will be the same.
- **Change in MTBF** displays the difference between the "before" and "after" values for BD modes.

Beta Bounds Window
When you’re viewing the Beta Bounds plot, you can specify which confidence levels to show by choosing Plot > Options > Plot Beta Bounds or by right-clicking plot and choosing the option
from the shortcut menu. Beta Bounds is available when only A/BD modes are included in the data set analyzed with the Crow Extended model.

- In the window that appears, you can select to show up to five confidence levels.
- For each beta bound line you have selected to show, enter the confidence level as a percentage in the input field.
- You can click the color field to define the line color for the beta bound. To add a new color to the Custom tab, right-click one of the color boxes in the bottom two rows.
- The drop-down list in the lower left corner of the window allows you to select which type of confidence bounds (one-sided or two-sided) to display in the plot. For example, if you use 90% one-sided bounds, then the upper and lower one-sided 90% bounds will be used (which is the same as using two-sided 80% bounds). The following graphics illustrate the difference between one- and two-sided bounds.
Chapter 7: Crow Extended Model

Crow Extended Examples

The Crow Extended model can be used with data obtained from developmental testing or from systems operating in the field. The following topics provide examples of using the model with these different types of data:

- The **developmental testing example** uses data obtained from a single system during a developmental test. In this scenario, design fixes are applied during the test. Thus, reliability growth is expected to be observed during the test, and additional growth can be projected for fixes that will be applied after the test.

- The **operational testing example** uses data obtained from two fielded repairable systems that were tested under customer use conditions. In this scenario, any repairs performed during the test are assumed to be minimal repairs (i.e., they do not improve the system reliability). All permanent design fixes are delayed until after the test. Thus, reliability growth is not expected to be observed during the test, but the model will project the growth due to fixes that will be applied after the test.

**Example Using the Crow Extended Model for Developmental Test Data**

*The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.*

*The name of the project is "Crow Extended - Failure Times," and the folio that contains the data is called "Corrective and Delayed Fixes."

Failure times for a single system undergoing developmental testing were recorded. Some of the observed failure modes were not addressed, some were addressed during the test and some
were delayed until after the test. The test ended at 400 hours, and the goal is to estimate the following values:

- The MTBF demonstrated at the end of the test.
- The MTBF that can be expected after the BD failure modes are addressed.
- The maximum MTBF that can be achieved if all BD modes that exist in the system were discovered and fixed according to the current maintenance strategy (i.e., given the portion of the system's failure intensity that will be addressed by corrective actions).

The data from the test are recorded in a Failure Times data sheet configured for cumulative failure times and with the Crow Extended model selected, as shown next. Modes classified as "A" are not addressed. "BC" modes are addressed during the test, and "BD" modes are addressed after the test. Numerical codes were used to identify the modes in the order in which they appeared (e.g., 100 and 200 are the first and second BC modes, 1 and 2 are the first and second BD modes, etc.). To specify that the test is time terminated at 400 hours, click the (...) button on the control panel to open the Termination Time window.

Next, enter an effectiveness factor for each BD mode to specify the effectiveness of each delayed fix (e.g., a factor of 0.7 means the fix will reduce the mode's failure intensity by 70%). To do this, choose Growth Data > Crow Extended > Effectiveness Factors or click the icon on the control panel.
Enter the factors shown next. You can see that the average effectiveness factor for all the delayed fixes—displayed in the status bar—is 0.7250. Click OK to save the changes and close the window.

Click the Calculate icon on the folio's control panel to analyze the data.

**Note:** This model uses the maximum likelihood estimation (MLE) method to calculate the parameters, which is known to produce a biased value for beta. This bias is more evident when working with small sample sizes. If the folio is not configured to remove this bias, you will be prompted to change the option in the Settings tab of the Item Properties window ([Project > Current Item > Item Properties](#)). To ensure the unbiased beta is always calculated for all new folios, use the Calculations page of the Application Setup window to select the option. This example assumes that the unbiased beta is calculated.
Chapter 7: Crow Extended Model

The results for all failure modes will appear as shown next.

The beta, lambda and growth rate (1 - beta) parameters are shown in the table. In addition to these values, the table provides this information:

- The demonstrated/achieved mean time between failures (DMTBF/AMTBF) at the end of the test is 7.8471 hours.
- The demonstrated/achieved failure intensity (DFI/AFI) at the end of the test is 0.1274.
- The data is shown to have passed the Cramér-von Mises statistical test (CVM), which means we can accept the hypothesis that the failure times follow a non-homogeneous Poisson process (NHPP). This hypothesis is assumed by the Crow Extended model.

Next, to view all the desired values in a plot, click the Plot icon on the control panel.
Then choose **Growth Potential MTBF** from the **Plot Type** drop-down list. The plot appears as shown next.

The following information is shown in the plot:

- The blue Demonstrated point shows the MTBF at the end of the test (before the BD failure modes are addressed) is 7.8471 hours.
- The red Projected point shows that, after the BD failure modes are addressed, the MTBF is expected to be 11.3182 hours.
- The green Growth Potential line shows that the maximum achievable MTBF given the current management strategy is 14.9957 hours.
Example Using the Crow Extended Model for Operational Test Data

The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.

The name of the project is "Crow Extended - Operational Test Data for Two Systems," and the folio that contains the data is called "Operational Test Data."

Operational testing for two systems is performed towards the end of a new product development program. The systems are pilot builds and are subjected to representative customer use conditions during testing. When a system fails, a minimal repair is performed to bring the system back to operating condition (i.e., repairs are only enough to bring the system back to operation). Therefore, the configuration of each system during the test is assumed to not change and the reliability is assumed to neither deteriorate nor improve during the test (i.e., $\beta = 1$). In addition, for each failure time, the associated failure mode is identified and classified.

The analysts have the following goals:

- Determine the MTBF that would be attained at the end of the basic reliability tasks if all the problem failure modes were uncovered in early design and corrected in accordance with the management strategy.

- Create a plot to determine whether new BD modes are being discovered at a decreasing rate throughout the test. If so, this would indicate that the number of remaining unseen BD modes is decreasing with time.
The data from the test are recorded in a Repairable data sheet with the Crow Extended model selected. Modes classified as "A" are not addressed, and "BD" modes are addressed after the test. Numerical codes were used to identify each specific failure mode. Some of the data for System 1 (selected in the Systems panel on the left) are shown next.

Before you can analyze the data, you must enter an effectiveness factor for each BD mode to specify the effectiveness of each corrective action that will be performed after the test (e.g., a factor of 0.7 means the corrective action will reduce the mode's failure intensity by 70%). To do this, choose Growth Data > Crow Extended > Effectiveness Factors or click the icon on the control panel.

In the window that appears, select the Use Fixed Effectiveness Factors option and then enter 0.6 in the input field. Click OK to save the factors and return to the folio.

Click the Calculate icon on the folio's control panel to analyze the data.
The results for all failure modes will appear as shown next.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Results (All Modes)</th>
<th>Results (A Modes)</th>
<th>Results (BD Modes)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta (hyp)</td>
<td>1.0000</td>
<td>MTBF (Hr)</td>
<td>Beta (UnB)</td>
<td>Termination Time (Hr): 541.0000</td>
</tr>
<tr>
<td>Beta</td>
<td>0.6685</td>
<td>149.2857</td>
<td>0.7898</td>
<td>Systems: 2/2</td>
</tr>
<tr>
<td>Lambda (Hr)</td>
<td>0.0676</td>
<td>FI</td>
<td>Lambda (Hr)</td>
<td></td>
</tr>
<tr>
<td>DMTBF (Hr)</td>
<td>33.7097</td>
<td>0.0067</td>
<td>MTBF</td>
<td></td>
</tr>
<tr>
<td>DFI</td>
<td>0.0297</td>
<td></td>
<td>FI</td>
<td></td>
</tr>
</tbody>
</table>

- The **Parameters** values include estimated parameters for the fitted model and other calculations based on those parameters.
  - The beta hypothesis, **Beta (hyp)**, is the assumed beta value for the analysis. If this value is shown in red, then the beta = 1 assumption may not be valid.
  - The calculated **Beta** and **Lambda** parameters are 0.8685 and 0.0676. The calculated beta value is used to determine whether the beta = 1 assumption is valid. (If 0.8685 were significantly different from 1, then the assumption would be invalid.)
  - The demonstrated/achieved mean time between failures (**DMTBF/AMTBF**) at the end of the test is 33.7097 hours.
• The demonstrated/achieved failure intensity (DFI/AFI) at the end of the test is 0.0297.

• The **Statistical Tests** values indicate whether the data meet various assumptions underlying the analysis.
  
  • The data is shown to have passed the Cramér-von Mises test (**CVM**), which means we can accept the hypothesis that the failure times follow a non-homogeneous Poisson process (NHPP).

  • The data also passed the Common Beta Hypothesis (**CBH**) test, which means the data sets from both systems can be assumed to have the same beta value.

To calculate the maximum attainable MTBF based on the current management strategy, click the **Quick Calculation Pad** icon on the control panel.
In the window that appears, select the **MTBF** option in the **Projected** area. After you click **Calculate**, the QCP will appear as shown next.

This result means the MTBF demonstrated at the end of the test (the DMTBF of 33.7097 shown on the control panel) is expected to increase to 42.3824 hours after all the BD modes have been fixed.

The next goal is to create a plot to examine how the failure intensity due to unseen BD modes changes over time. To do this, click the **Plot** icon on the control panel.
Then choose **Discovery Rate** from the **Plot Type** drop-down list and clear the **Use Logarithmic Axes** option on the control. The plot will appear as shown next.

![Rate of Discovery Plot](image)

As unique BD modes are being discovered during the test, the unseen failure intensity decreases. This indicates that unique BD modes are being discovered at a decreasing rate, which is the desired outcome for a reliability growth test.
Chapter 8: Continuous Evaluation Model

While the Crow Extended model facilitates reliability growth projections, planning and analysis for a single test phase, the Crow Extended – Continuous Evaluation model is designed for analyzing data across up to 10 test phases.

This model provides increased flexibility to analyze data from practical testing situations in which the failure modes may be addressed a) at the time of the failure, b) later in the same test phase, c) between test phases d) during a subsequent test phase or e) after the completion of all test phases.

The continuous evaluation model is available in three Multi-Phase data types: Multi-Phase Failure Times, Multi-Phase Grouped Failure Times and Multi-Phase Mixed data.

Two related features will be discussed in the next chapter. You can use the growth planning folio to develop the plan for a multi-phase test. Then after you’ve begun to enter the test data into a multi-phase data sheet, you can use a multi-phase plot to link the plan with your test data. The plot provides a visual way to track the progress toward meeting your MTBF goal and determine whether you will need to make adjustments in the remaining test.

For an example that demonstrates how these three tools can be used together, see Example: Multi-Phase Test Planning and Analysis.

Event Codes for Multi-Phase Data

The Event column that appears with all three Multi-Phase data types allows you to specify the type of event that each row in the data sheet represents, so it can be handled appropriately in the calculations.

The drop-down list in the Event contains the following options:

- **F - Failure** is the default event type. Any event left unspecified will be treated as a normal failure.

- **I - Implemented Fix** indicates the time when the fix for a specified BD (delayed fix) failure mode was implemented. This type of event must be preceded by an observed instance of the BD mode in question.

- **P - Performance** and **Q - Quality** indicate failures due to performance or quality issues. You can choose whether or not to consider these events in the analysis.

- Events marked with **X - Exclude** will always be excluded from the analysis. This event code can be used to add comments or a timestamp within the data set. Note that an "X"
can be placed in front of any existing event code or entered by itself. For example, "XF" indicates a failure in the data set that should be excluded from the analysis.

- **AP - Analysis Point** indicates a point at which the demonstrated, projected and growth potential MTBF/FI values can be displayed on a multi-phase plot in order to track the progress up to that point.

- **PH - End of Phase** indicates the end of a test phase.

The **Event Code Options** area on the Analysis page of the control panel allows you to choose whether performance (P) and quality (Q) failures will be included in the analysis. By default, both check boxes will be selected.

### Failure Mode Classifications for Multi-Phase Data

Like the failure mode classifications for the Crow Extended model, analysis with the Crow Extended – Continuous Evaluation model will also require you to identify and classify the specific mode responsible for each failure.

For both models, the **Mode** column records the specific failure mode identification, which is optional for A modes but required for all BC and BD modes. This can be entered as either a name or a numerical code (e.g., "seal leak," "1," "BD1," etc.).

However, the classifications are applied a bit differently for the continuous evaluation model in order to support a wider array of possible management strategies. Specifically, for the Classification column in a multi-phase data sheet:

- **A** indicates that no fix will be applied. Management chooses not to address the failure mode because of technical, financial or other reasons. (This is the same as in Crow Extended.)

- **BC** indicates that the fix will be applied at the time of failure and before the testing continues. (Whereas, in Crow Extended, BC indicates that the fix is applied at any time during the test.)

- **BD** indicates that the fix will be delayed until a later time, either in the same test phase, between test phases, in a subsequent test phase or after all test phases are completed.
(Whereas, in Crow Extended, BD indicates that the fix is delayed until after the completion of the test.)

The increased flexibility for the treatment of BD failure modes means that the data set can also contain the exact times when the delayed fixes are implemented. Use the I – Implemented Fix event code to indicate the time of a delayed fix. The I event must have the exact same classification and mode as the prior failure event (F, P or Q). For example, the following picture shows a highly simplified data set where Mode 1 occurs at 100 hours but the fix is delayed. The first test phase ends at 200 hours and then the fix for Mode 1 is implemented during the second phase, at 250 hours of total test time.

<table>
<thead>
<tr>
<th>MP-T</th>
<th>Event</th>
<th>Time to Event (Hr)</th>
<th>Classification</th>
<th>Mode</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>100</td>
<td>BD</td>
<td>Mode 1</td>
<td>Delayed Fix</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>120</td>
<td>A</td>
<td>Mode 2</td>
<td>No Fix</td>
</tr>
<tr>
<td>3</td>
<td>PH</td>
<td>200</td>
<td></td>
<td>Mode 3</td>
<td>End of Phase 1</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>210</td>
<td>BD</td>
<td>Mode 3</td>
<td>Delayed Fix</td>
</tr>
<tr>
<td>5</td>
<td>I</td>
<td>250</td>
<td>BD</td>
<td>Mode 1</td>
<td>Implemented Fix</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>260</td>
<td>BC</td>
<td>Mode 4</td>
<td>Immediate Fix</td>
</tr>
</tbody>
</table>

If the fix is implemented between test phases or after all test phases are completed, you will not be able to enter a specific I event time in the data sheet. In such cases, you will use the Effectiveness Factors window to indicate when the fix was (or will be) implemented, and supply the estimated effectiveness factor to be used during data analysis. (See Effectiveness Factors for Multi-Phase Data.)

Effectiveness Factors for Multi-Phase Data

Like the effectiveness factors for the Crow Extended model, analysis with the Crow Extended – Continuous Evaluation model may also require you to specify the decrease in failure intensity for some delayed fixes. However, in the continuous evaluation model, a specified effectiveness factor is required only if the delayed fix time (I event) is not recorded in the data set. (If the fix time is provided, the model can use the data to evaluate the effectiveness of those fixes.)

To specify the required effectiveness factors, choose Growth Data > Crow Extended > Effectiveness Factors or click the icon on the control panel.
In a multi-phase data sheet, the Effectiveness Factors window will display one or both of the following sheets.

**BD Modes Sheet**

The BD Modes sheet is always displayed and it shows a list of any BD failure modes in the current data set that *do not* have a specific fix time (I event) recorded in the data set. For each failure mode in the list:

- Use the **Implemented at End of Phase #** column to specify when the delayed fix was (or will) be applied.
  - If the fix was applied after a specific test phase, select that phase from the drop-down list. For example, if the fix was applied between Phase 1 and Phase 2, select **1 – Phase 1**.
  - If the fix is not yet implemented, select **Not Implemented**.
- Specify the effectiveness factor, entered as a decimal. For example, 0.6 indicates that 60% of the failure intensity will be removed after the fix is applied but 40% will remain. There are two options:
  - If you want to assign different effectiveness factors for different failure modes, use the **Effectiveness Factor** column to specify the factor for each mode.
  - If you prefer to assume the same effectiveness factor for all failure modes shown in the list, click the **Use Fixed Effectiveness Factor** button on the toolbar. This will disable the column in the spreadsheet and you can enter a single value in the input box next to the button, as shown next.

**Implemented Fixes Sheet**

If you have selected the **Allow EF values for BD modes with implemented fixes** option on the **Calculations page** of the Application Setup, the Implemented Fixes sheet will show a list of the BD failure modes in the current data set that *do* have a specific fix time (I event) recorded. This sheet is for your information only. Any inputs you provide here will not affect the calculations.

**Analysis Results for Multi-Phase Data**

When you calculate a multi-phase data sheet with the Crow Extended – Continuous Evaluation model, the following results will be displayed on the Main page of the control panel. By default, the Results area displays the results from all **failure mode classifications** first. Use the scroll bar
to see results that only apply to failure modes with a particular classification (A, BC and BD), as shown next.

• **Beta, Lambda** and **p** are the three parameters of the Crow Extended - Continuous Evaluation model.

  • If $\beta < 1$, the reliability improved during the observation period. If $\beta > 1$, the reliability deteriorated. In addition:

    • If the data set does not include any failure modes that were fixed before the end of the last test phase (such as BC modes), **Beta (hyp)** will indicate that the model assumes $\beta = 1$ (i.e., the reliability neither improved nor deteriorated). If this value is shown in red, then the 90% two-sided confidence bounds on $\beta$ do not include 1, which means this assumption may not be valid.

  • When working with times-to-failure data, **Beta (UnB)** indicates that the unbiased MLE estimate of the beta parameter was calculated.

Note that the preference to display Beta (hyp) and/or calculate Beta (UnB) is set on the Calculations page of the Application Setup window for all new folios or in the Settings tab of the Items Properties window for existing folios.

• The **p** value is the probability that the corrective action for an observed BD failure mode will occur after the end of the last test phase. In other words, for every new BD mode that is discovered during the test, **p** is the probability that its corrective action will be delayed until after the test.
• The **Growth Rate** is equal to 1 - beta. A positive value means the MTBF is improving, and larger values mean faster growth.

• The metrics used to describe the reliability at the end of the observation period will vary depending on the data type.
  
  • For failure times and grouped failure times, the results will show the mean time between failures and the failure intensity at the end of the observation period. An option on the Calculations page of the Application Setup window (for all new folios) or in the Settings tab of the Items Properties window (for existing folios) determines whether you prefer to call these values "demonstrated" (DMTBF and DFI) or "achieved" (AMTBF and AFI).

  • For mixed data, the results will show the demonstrated reliability (DRel) and demonstrated failure probability (DFP), which is 1 - DRel.

• The **Statistical Tests** area shows whether the data set passed or failed the applicable goodness-of-fit test that is performed automatically when you calculate the parameters. For failure times and grouped failure times, this will be the Cramer-von Mises test (CVM). For mixed data, it will be the chi-squared test (Ch-Sq). (See Statistical Tests.)

• For failure times and grouped failure times data sheets, the **Termination Time** is the time of the last data point that is not excluded from the analysis. If this is the end of a phase (PH) or an analysis point (AP), the folio performs a time-terminated calculation. If this is a failure time (F, P or Q), it will be failure-terminated. This is not applicable for mixed data sheets.

*Note: If the result of the analysis is associated with a published model, then the model’s name will appear as a link at the bottom of the Results area. Click the link to view the model’s properties. For details on how to publish the results as a model, see Publishing Models.*

**QCP Calculations and Plots for Multi-Phase Data**

RGA includes a Quick Calculation Pad (QCP) for computing useful metrics, as well as multiple plots that allow you to visualize the results of your analyses. This topic describes the calculations and plots you can obtain from multi-phase data sheets analyzed with the **Crow Extended – Continuous Evaluation** model.
QCP Calculations
You can open the Quick Calculation Pad (QCP) by choosing Growth Data > Analysis > Quick Calculation Pad or by clicking the icon on the control panel.

To perform a calculation, select the appropriate option and enter any required inputs in the Input area, then click Calculate. For more detailed information about all the options available in the QCP, see Quick Calculation Pad (QCP).

The Basic Calculations tab of the QCP includes the typical calculations for traditional reliability growth analysis (e.g., cumulative/instantaneous MTBF and expected number of failures). These calculations are applicable only when your data set includes failure modes that were fixed before the end of the last test phase. (See QCP Calculations and Plots for Traditional RGA.)

On the Multi-Phase Calculations tab, the available calculations will vary depending on whether you’re analyzing failure times or mixed (discrete) data. For failure times, the calculated values will be mean time between failures (MTBF) and failure intensity (FI). For mixed data, the values will be reliability and probability of failure. Most of these calculations are applicable only when your data set includes BD failure modes. The projected and growth potential calculations apply only when the data set includes BD modes that will be fixed after the end of the last test phase (as specified in the Effectiveness Factors window).

- The Demonstrated values reflect the reliability at the end of the last test phase, before any delayed fixes are implemented.

- The Nominal values represent the best case scenario in which a fix is applied to every BD failure mode, even if the fix has not yet been implemented or planned. These calculations consider the implemented fix times (I events) and all of the effectiveness factors (even if the fix is marked "Not Implemented").

  - **Nominal Projected** are the expected values after the delayed fixes for all seen BD failure modes.
  - **Nominal Growth Potential** are the best possible values that could be achieved if all delayed fixes are implemented for all seen and unseen BD failure modes.

- The Actual values take into account which delayed fixes have actually been implemented in the current management strategy. These calculations consider the implemented fix times (I events) and the effectiveness factors for the fixes that were marked to be implemented after a specific test phase. However, any BD failure mode that is marked as "Not Implemented" in the Effectiveness Factors window is given an EF=0.

  - **Actual Projected** are the expected values after the delayed fixes that are actually implemented for seen BD failure modes.
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- **Actual Growth Potential** are the best possible values that could be attainable by applying the current management strategy for both seen and unseen BD failure modes.

- **Discovery Rate** is the rate at which new BD failure modes are being discovered (i.e., the failure intensity of unseen BD modes) at a specified time. For example, if the discovery rate at 400 hours is 0.02, then 0.02 new BD modes are being discovered every hour (equivalently, 2 new BD modes are discovered every 100 hours).

- **MTBF BD Unseen** is the mean time between failures due to unseen failure modes at a specified time (i.e., BD modes that did not appear during the observation period but are estimated from the analysis).

- **Number of Failures** is the cumulative number of failures that are expected to occur by a specified time, based on the fitted model.
  - If the data set includes some failure modes that were fixed before the end of the last test phase, then this value is calculated on the assumption that the reliability changed during the test. The option will thus be on the Basic Calculations tab with the other typical calculations for traditional reliability growth analysis (e.g., cumulative/instantaneous MTBF).
  - Otherwise, the calculation assumes that the reliability neither deteriorated nor improved during the observation period (i.e., beta = 1).

**Plots**

You can create plots by choosing **Growth Data > Analysis > Plot** or by clicking the icon on the control panel.

This section describes the types of plots you can create for the Crow Extended – Continuous Evaluation model. The scaling, setup, exporting and confidence bounds settings are similar to the options available for all other RGA plot sheets. (See **Plots**.)

Once again, the available calculations will vary depending on whether you’re analyzing failure times or mixed (discrete) data. For failure times, the calculated values will be mean time between failures (MTBF) and failure intensity (FI). For mixed data, the values will be reliability and probability of failure.

Also note that all projected and growth potential values displayed in the plots are based on the “actual” (not “nominal”) calculations.

- **Cumulative Number of Failures** shows the total number of failures versus time. Data points on the plot represent the cumulative number of failures that have been reported.
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by a given time (e.g., the second point marks the time at which the second failure was observed). The lines that can be included will vary depending on whether there the data set includes failures modes that will be fixed before the end of the last test phase.

- If some failure modes will be fixed before the end of the last test phase, the plot can include the Expected Failures line, which serves as an empirical goodness-of-fit test for the Crow Extended model. It is fitted using the beta that was calculated from the data points.

- If no failure modes will be fixed before the end of the last test phase, the plot can include the Assumed Parameters line based on the assumption that beta = 1 (i.e., no reliability growth was experienced during the observation period) and the Estimated Parameters line based on the beta calculated from the data points. You can then compare the two lines to evaluate whether the beta = 1 assumption is valid.

- The **[Value] vs. Time** plots show how the value increases, decreases or remains constant over time. The points represent the actual failure times in the data set and the plot includes one line for the instantaneous value and one line for the cumulative value. These plots are available when your data set includes failure modes that were fixed before the end of the last test phase.

- The **Growth Potential** plots are applicable only when the data set includes failure modes that will be fixed after the end of the last test phase (as specified in the Effectiveness Factors window). The plots can include these items:
  - The Demonstrated/Achieved point represents the value at the end of the test, before any delayed fixes have been implemented.
  - The Projected point represents the expected value after the delayed fixes have been implemented.
  - The Growth Potential line represents the best value that could be achieved by applying the current reliability growth management strategy (i.e., the portion of the system's failure intensity that will be addressed by design fixes).
  - If desired, you can use the Show/Hide Plot Items window to show the Instantaneous line, which shows how the value changes over time during the test. The instantaneous value is calculated over a small interval $dt$ that begins at a given time. For example, an instantaneous MTBF of 5 hours at 100 hours duration means that, over the next small interval $dt$ that begins at 100 hours, the average MTBF will be 5 hours.
  - If desired, you can estimate the projected MTBF or failure intensity with a specified amount of further testing. This option is applicable only for developmental testing when BD failure modes are included in the data.
enable this option and specify a time greater than the termination time, click the [...] button.

- The Final bar charts provide the same information as the Growth Potential plots, but using bars instead of lines.

- **Cumulative Number of BD Modes** shows the total number of unique observed BD modes versus time. This plot can include these items:
  - Data points on the plot represent the cumulative number of BD modes that have been discovered by a given time. For example, the second point marks the time at which the second unique BD mode (e.g., BD2) was observed.
  - The Cumulative Number of BD Modes line is fitted to the data points and shows how the cumulative number of discovered BD modes changes with time.

- **MTBF BD Unseen** and **Discovery Rate** show the rate at which new unique BD failure modes are being discovered at any given time. For example, if the MTBF for unseen BD modes is 50 hours, then 2 more unique BD modes are expected to be observed over the next 100 hours. The discovery rate is the failure intensity of the unseen BD modes (i.e., the inverse of the MTBF). In a successful reliability growth test, the MTBF for unseen BD modes will increase over time and the discovery rate will decrease.

- The **Individual Mode** bar charts show two bars for each failure mode. Use the Plot Modes window to choose which failure modes to include in the chart.
  - The Before bars represents the value at the end of the test, before any delayed fixes have been implemented.
  - The After bars are available only for BD modes and represents the value after the delayed fixes have been implemented.
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- The **Failure Mode Strategy** pie chart breaks down the overall failure intensity (FI) into six possible categories:
  - The Type A slice represents the FI that is due to failure modes that are ignored (i.e., no fixes will be implemented).
  - The Type BC - Seen slice represents the FI that is due to BC modes that were observed and for which fixes were implemented.
  - The Type BC - Unseen and Type BD - Unseen slices represent the FI that is due to BC and BD modes that were not observed but are estimated from the analysis. If they were observed (e.g., through future testing), fixes would be implemented.
  - The Type BD - Remained and Type BD - Removed slices represent the FI that is due to BD modes that were observed (i.e., they represent the FI due to seen BD modes). The Remained slice represents the portion of FI that is expected to stay in the system because the fixes are not 100% effective, while the Removed slice represents the FI that is expected to be eliminated.

**Tip:** RGA includes two additional plot utilities you can use across all types of data: the overlay plot, which allows you to compare different data sets or models; and the side-by-side plot, which allows you to display different plots of a single data set all in a single window for easy comparison.

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**Event Reports**

Once you have calculated the parameters for the Multiple Systems with Event Codes data type or any multi-phase data type, you can choose **Growth Data > Analysis > Event Report** to view a special report in the **Results window**. The Event Report can consist of up to five tabs, depending on the types of events defined in the data set. The tabs are described next.

**Mode Summary Tab**

The Mode Summary tab is always displayed and it provides the following information for each unique failure mode in the data sheet:

- **Mode and Classification**: The unique identifier and classification (A, BC or BD) for the failure mode.
- **First Failure**: The time of the first failure due to that mode.
- **Total Failures**: The total number of failures due to that mode.
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For the Multiple Systems with Event Codes data type, there is one additional column.

- **Effectiveness Factor**: The effectiveness factor assigned for each BD failure mode.

For multi-phase data types, there are three additional columns. These columns are applicable only for BD failure modes that do not have an implemented fix time (I event) in the data set. For these failure modes, the Effectiveness Factors window records the phase after which the fix will be applied, if any, along with the estimated effectiveness factor. Therefore, the report displays:

- **Nominal EF**: The effectiveness factor that will be used for "nominal" calculations (e.g., nominal projected MTBF, etc.). These calculations represent the best case scenario in which a fix is applied to every BD failure mode, even if the fix is marked "Not Implemented."

- **Phase Fixed**: A number indicates the phase after which the fix was applied (e.g., the number 2 indicates that the fix was applied after the end of Phase 2 but before the start of Phase 3). "Not Implemented" indicates that the fix has not been applied.

- **Actual EF**: The effectiveness factor that will be used for "actual" calculations (e.g., actual projected MTBF, etc.). These calculations take into account which delayed fixes have actually been implemented in the current management strategy. Therefore, if the fix is "Not Implemented," the actual EF will be zero.

**Implemented Fixes Tab**

The Implemented Fixes tab is present only if the Multiple Systems with Event Codes data set contains BC failure modes, or if the multi-phase data set contains BD failure modes that have an implemented fix time (I event) in the data set. For each applicable failure mode, this tab provides the following information:

- **Mode and Classification**: The unique identifier and classification (A, BC or BD) for the failure mode.

- **First Failure**: The time of the first failure due to that mode.

- **Total Failures**: The total number of failures due to that mode.

- **Before Fix Failures and After Fix Failures**: The number of failures due to the mode that occurred before and after the fix was implemented.

- **Before Fix Runtime and After Fix Runtime**: The amount of operating time before and after the fix was implemented. In a Multiple Systems with Event Codes data sheet, this is the sum of the operating times for all affected systems.

For the Multiple Systems with Event Codes data type, there is one additional column:

- **Systems With Fixes**: The number of systems for which the fix was implemented.
For multi-phase data types, if the Allow EF values for BD modes with implemented fixes option is selected on the on the Calculations page of the Application Setup, there are two additional columns:

- **Effectiveness Factor** and **Comments** display any additional information that you have entered on the Implemented Fixes tab in the Effectiveness Factors window. This information is for your information only and is not considered in the data analysis.

Quality Events and Performance Events Tabs
The Quality Events tab and the Performance Events tabs are present only if the data set contains events of these types. These tabs provide summaries for the events that have been marked with the Q and P event types.

Mode Fix List Tab
The Mode Fix List tab is present only if fixes have been implemented to Multiple Systems with Event Codes data. The tab provides a summary of all systems that have a fix recorded for each failure mode.

Test for Fix Effectiveness
The Test for Fix Effectiveness window allows you to apply Dr. Crow’s "Statistical Test for Effectiveness of Corrective Actions" test for an applicable data set. This test helps you to determine whether the fixes applied during or at the end of a phase have effectively reduced a system's failure intensity.

The utility is available for:

- Any of the multi-phase data types (as long as the parameters have been calculated and the data set contains at least two phases).
- Any data sheet that has been analyzed with the Change of Slope calculation option.

To access the window, choose Growth Data > Crow Extended > Test for Fix Effectiveness.

If you are working with a multi-phase data sheet, use the Phase 1 and Phase 2 drop-down lists to choose the two phases you want to compare. If you are working with a Change of Slope analysis, Segment 1 is the data before the specified Break Point, while Segment 2 is the data after.
Specify the **Significance Level** (a decimal between 0 and 1) and click **Test**. The utility gives two results:

- The first result compares the average failure intensities of the two phases (or segments). If the average failure intensity during the second is less than during the first (at the specified significance level), the utility displays "Passed." If not, it displays "Failed."

- The second result compares the average failure intensity during the second phase (or segment) with the instantaneous failure intensity at the end of the first. If the average failure intensity during the second is less than the instantaneous failure intensity at the end of the first (at the specified significance level), the utility displays "Passed." If not, it displays "Failed."

Click the **Report** button to see a more detailed summary of the analysis in the **Results window**. This includes the failure intensities that are calculated for both phases.
Chapter 9: Growth Planning Folio and Multi-Phase Plot

Growth Planning Folio

RGA’s growth planning folio helps you to use the Crow Extended growth planning model to plan a single- or multi-phase reliability growth test program that is designed to achieve a specific MTBF or reliability goal.

Creating a Growth Testing Plan

To create a growth planning folio, choose Insert > Test and Planning, then choose either Continuous Growth Planning (if working with times-to-failure data) or Discrete Growth Planning (if working with one-shot devices).

In the Data sheet of the folio:

1. **Do you know how the test time will be accumulated across each test phase?** Choose Yes if you want to specify the end time (and other details) for each phase of testing. Choose No if you want to create a plan for a single test phase with no specific end time.

2. **Planned test phases** is available only if you chose Yes to the question in step 1 above. Specify the number of phases and then define each phase:

   - **Phase Name** can be any alphanumeric identifier, up to 50 characters.
   
   - **Cumulative Time** is the amount of cumulative test time at the end of each phase. Because this represents cumulative test time across all test phases, the number must be higher for each subsequent phase.

   - **Average Fix Delay** is the amount of test time from when a failure mode is discovered until a fix is likely to be implemented.
As an example, the following picture shows the inputs for a multi-phase test with 5 test phases that last 1,000 hours each. In the first phase, the planners estimate that delayed fixes (for BD failure modes) will, on average, take 500 hours each. The fix time is expected to increase in later phases.

If there are a lot of test phases and/or if you have this information available in an external data file, you can click the Edit Phase Data icon to open a more flexible spreadsheet for entering/editing these details. The Import icon at the bottom of this window allows you to import data from an Excel spreadsheet (*.xls).

3. Which value would you like to calculate? Your selection determines the required inputs for the design. Note that the calculations in the continuous growth planning folio are in terms of MTBF, while the calculations in the discrete growth planning folio are in terms of reliability.

- **Initial MTBF/Reliability** is the value before the test program begins. It can be determined by some initial testing or through historical information, engineering expertise and/or reliability predictions.

- **Goal MTBF/Reliability** is the requirement that you need to achieve by the end of the test program.

- **Growth Potential Design Margin** estimates the amount by which the growth potential value (i.e., the value that would be achieved if you continued testing until all failure modes are observed and corrected according to the current maintenance strategy) exceeds the goal. This value provides a "safety factor" to ensure that the requirement is met. A higher GP design margin means there's a smaller risk that the reliability observed in the field will not meet the requirement, but it also means a more rigorous reliability growth program will be required. Typically, the GP design margin is between 1.2 and 1.5.

- **Average EF** (where EF = effectiveness factor) estimates the fractional decrease in failure intensity you expect to achieve by implementing design fixes. Typically, about 30% of the failure intensity for the failure modes that are addressed will remain in the system after implementing all of the design fixes; therefore, in
many reliability growth programs, the average effectiveness factor is 0.7. The value must be greater than 0, and less than 1.

- **Management Strategy Ratio** determines the percentage of the unique failure modes discovered during the test that will be fixed. This is an important variable in reliability growth planning because the management strategy can be changed to address a larger percentage of the discovered failure modes if the goal cannot be reached with the current strategy. Generally, the management strategy is recommended to be above 90%.

- **Discovery Beta** is the rate at which new, unique B failure modes are being discovered during testing. These are the failure modes that will be fixed. In growth planning, it is assumed that most failures will be identified early on, and that new failure modes will be discovered at a decreasing rate as the test proceeds. Therefore, this value must be greater than 0 and less than 1. This input is always required; you cannot solve for the discovery beta.

- **Average Fix Delay** is required only for single-phase plans with no specific end time (i.e., you chose No to the question in step 1 above). This value is the amount of test time from when a failure mode is discovered until a fix is likely to be implemented.

### Analysis Results

Once you have entered all of the required inputs, calculate the results by choosing **Test and Planning > Analysis > Calculate** or clicking the icon in the control panel.

The result shows the estimated value for the metric you have selected to solve and other results that may be used to evaluate the test plan. You can then use the **Plot sheet** to visualize the results expected if you implement the test plan, and the **QCP** to calculate a variety of metrics based on the test plan.

- Additional results in continuous growth planning folios:
  - **Time at which growth begins** is the estimated time when the first B failure mode (i.e., the first failure mode that will be fixed) is expected to occur. Reliability growth is expected to begin after this time.
  - **Final MTBF** is the expected MTBF at the end of the test, taking into account the average fix delay.
  - **Time to reach goal** is the test time at which the goal MTBF is expected to be reached. The **Actual** value takes into account the average fix delay, and the
Nominal value does not. If the current test plan will not meet the goal, this field displays "Goal not met."

- Additional results in discrete growth planning folios:
  - **Trial at which growth begins** is the estimated number of trials when the first B failure mode (i.e., the first failure mode that will be fixed) is expected to occur. Reliability growth is expected to begin after this time.
  - **Initial MTrBF** (where MTrBF = mean trials before failure) is the initial estimated system MTrBF.
  - **Growth Potential MTrBF** is the expected MTrBF that could be reached if you continued testing until all B failure modes are observed and fixed according to the management strategy.
  - **Final MTrBF** is the expected MTrBF at the end of the test.
  - **Num. trials to reach goal** is the number of trials at which the goal reliability is expected to be reached. The **Actual** value takes into account the average fix delay, and the **Nominal** value does not. If the current test plan will not meet the goal, this field displays "Goal not met."

Growth Planning Folio Plots
The Plot sheet in the **growth planning folio** shows a variety of plots that display the results that are expected if you implement the plan. To view the growth planning folio plots, choose **Test and Planning > Analysis > Plot** or click the icon on the control panel.

The following is a description of the different types of plots you can create for growth planning. For general information on working with plots, see **Synthesis Plot Utilities**.

**Plot Types**
The following plots show the expected value of the specified metric across all planned test phases:

- **MTBF vs. Time** (available only for the continuous growth planning folio)
- **Reliability vs. Time** (available only for the discrete growth planning folio)
- **MTrBF vs. Time** (available only for the discrete growth planning folio)
Chapter 9: Growth Planning Folio and Multi-Phase Plot

- **Failure Intensity vs. Time**

- For the plots above, you can use the check boxes in the control panel to select which of the following elements will be displayed in the plot:
  
  - **Nominal Idealized** and **Actual Idealized** lines (also called *idealized growth curves*) show the overall characteristic pattern for the reliability growth across all phases of testing. The *nominal* curve is the best case scenario, which assumes that the average fix delay is zero. The *actual* curve takes into account the average fix delay. If fixes are not incorporated instantaneously, the actual line will show slower growth compared to the nominal line.
  
  - **Planned Growth** lines display information for each phase of testing (and thus are available only when you have provided information for each phase). These horizontal lines mark the time when each phase will begin and end, while the vertical position of each line shows the expected value of the metric at the beginning of the phase. You can point to the line to see the specific values. (Note that in the continuous growth planning folio, you can show confidence bounds on the planned growth lines, but only when you have at least 3 test phases specified on the folio's Data sheet.)

  ![Graphs showing various lines and metrics](image)

  - The **Termination Line** shows the end time of the final test phase.
  
  - The **Goal** line shows the target value that you hope to achieve by the last phase of testing.

The following plots are also available:

- **Cumulative Number of B Modes** shows the cumulative number of observed unique B failure modes versus time. These are failure modes that have been discovered and will be fixed.

- **MTBF B Unseen** shows the mean time between failures due to B failure modes that have not yet appeared in testing. These are failure modes that are anticipated based on the analysis and will be fixed when/if they are discovered.
• **Discovery Rate** shows the rate at which unique B failure modes are being discovered. In other words, it is the failure intensity of the unseen B failure modes.

**Growth Planning Folio QCP**

After you have used the Data sheet in the [growth planning folio](http://rga.reliasoft.com) to create a reliability growth program test plan, you can use the Quick Calculation Pad (QCP) to calculate a variety of results that are expected if you implement the plan.

To open the QCP for growth planning folio calculations, choose **Test and Planning > Analysis > Quick Calculation Pad** or click the icon on the control panel.

To perform a calculation, click one of the buttons on the left side of the window and enter any required inputs in the **Input** area, then click **Calculate**. For more detailed information about all the options available in the QCP, see **Quick Calculation Pad (QCP)**.

**Continuous Growth Planning Folio**

- **Nominal MTBF** and **Nominal Failure Intensity** calculations reflect the best case scenario. They assume that the average fix delay is zero.

- **Actual MTBF** and **Actual Failure Intensity** take into account the average fix delay. If fixes are not incorporated instantaneously, the actual value will show slower growth compared to the nominal value.

- **Planned MTBF** and **Planned Failure Intensity** return the expected MTBF or failure intensity at the beginning of each test phase. To perform this calculation, you must select the phase from a drop-down list. Note that, unlike the other calculations, you can calculate confidence bounds on the planned growth values, but only when you have at least 3 test phases specified on the folio's Data sheet.

- **Discovery Rate** is the rate at which new BD failure modes are being discovered at the specified time.

- **MTBF B Unseen** is the mean time between failures due to B failure modes that have not yet appeared in testing but are estimated from the analysis. These are failure modes that would be fixed if they were discovered.

- **Cum. Num. B Modes** is the cumulative number of B failure modes that are expected to have been seen during testing by the specified time (i.e., failure modes that will be fixed).
Discrete Growth Planning Folio

- **Nominal Reliability**, **Nominal MTrBF** and **Nominal Failure Intensity** calculations reflect the best case scenario. They assume that the average fix delay is zero.

- **Actual Reliability**, **Actual MTrBF** and **Actual Failure Intensity** take into account the average fix delay.

- **Planned Reliability**, **Planned MTrBF** and **Planned Failure Intensity** return the expected value of the metric at the beginning of each test phase. To perform this calculation, you must select the phase from a drop-down list.

- **Discovery Rate** is the rate at which new B failure modes are being discovered at the specified time.

- **MTBF B Unseen** is the mean time between failures due to B failure modes that have not yet appeared in testing but are estimated from the analysis. These are failure modes that would be fixed if they were discovered.

- **Cum. Num. B Modes** is the cumulative number of B failure modes that are expected to have been seen during testing by the specified time (i.e., failure modes that will be fixed).

Multi-Phase Plot

The multi-phase plot displays key analysis results from data analyzed with the Crow Extended model or Crow Extended – Continuous Evaluation model so you can see how the demonstrated, projected and growth potential MTBF or failure intensity changes across multiple analysis points and/or test phases.

If desired, you can also link the plot to a growth planning folio so you can see how the actual test results compare to the plan, and determine if it’s necessary to make adjustments in subsequent test phases in order to meet your reliability growth goals.

To create a multi-phase plot, choose **Insert > Reports and Plots > Multi-Phase Plot**.
Multi-Phase Plot Wizard

When you create a new multi-phase plot or click the Multi-Phase Plot Setup button in an existing plot, the Multi-Phase Plot Wizard allows you to specify the data source(s) for the plot. The test data displayed in the plot can come from:

- One Multi-Phase data sheet that includes all of the analysis points and phase data defined together in a single data source. [See details below.]

or

- Multiple Data Sheets that each contain the data from one particular analysis point or phase. This requires you to assign a specific data sheet to each analysis point and phase you want to display in the plot. [See details below.]

After you have defined the test data source(s), the second page in the wizard also allows you to select an applicable growth planning folio, if desired. Use this option if you want to use the plot to compare the test results against what was expected based on the reliability growth program plan.

Click Finish when you’re ready to save the changes and create or return to the Multi-Phase Plot window.

Option 1: Getting the Test Data from One Multi-Phase Data Sheet

If you select Multi-Phase and proceed to the next page in the wizard, you will be prompted to select a single analyzed multi-phase data sheet that contains all of the test phases and analysis points already defined in a single data sheet.
Option 2: Getting the Test Data from Multiple Data Sheets

If you select **Multiple Data Sheets** and proceed to the next page in the wizard, you will be prompted to select the separate data sheets that contain the data for each analysis point and phase you wish to display in the plot. The data sheets must be calculated with either the Crow Extended or Crow Extended – Continuous Evaluation model, and each sheet can be used only once in the same plot.

One Sheet per Phase

If you don’t wish to include analysis points in the plot, you can simply specify the number of phases at the top of the window and then select one data sheet on the tab for each phase.

Separate Sheets for Analysis Points

If you want to include analysis points, there must be a separate data sheet that contains the data for each analysis point, in addition to the data sheets that contains all of the data for each entire test phase.

For example, in the following picture, the data from the first week of testing were recorded and analyzed in four separate data sheets (in which each sheet contains all of the data up to a specific point in time).
In other words:

- "Monday (Wk1)" contains the data from Sunday and Monday.
- "Wednesday (Wk1)" contains all of the data from Monday’s data sheet, plus the additional data collected on Tuesday and Wednesday.
- "Friday (Wk1)" contains all of the data from Wednesday’s data sheet, plus the additional data collected on Thursday and Friday.
- "Full (Wk1)" contains all of the data from Friday’s data sheet, plus the additional data collected on Saturday. This data sheet contains all of the data from phase 1.

To select the data sheets for the analysis points, click the (...) button in the Analysis Points bar. In the Select Data Sheets window that opens, select the check box for all the data sheets that contain analysis point data for the current phase.

To remove a data sheet from the Analysis points list, you can return to the Select Data Sheets window and clear the check box, or simply double-click the data sheet name in the list.

**Multi-Phase Plot Control Panel**

In the Multi-Phase Plot window’s control panel, the Plot Type drop-down list allows you to select whether the plot will display the mean time between failures (MTBF) or failure intensity, while the Units drop-down list allows you to select the time units, which are defined at the database level.

The Multi-Phase Plot Setup button opens the Multi-Phase Plot Wizard, which allows you to view or change the data source(s) that are displayed in the plot.

The Show area at the bottom of the control panel allows you to select which results and other elements will be shown in the plot.

- The options under the Phases and Analysis Points headings are based on the test data from each phase.
  - The Demonstrated values reflect the reliability before any delayed fixes are implemented.
  - The Projected values reflect the expected jump in reliability after delayed fixes are implemented.
Chapter 9: Growth Planning Folio and Multi-Phase Plot

- The Growth Potential values are the maximum system reliability that can be attained with the current system design and reliability growth management strategy (i.e., all B failure modes have been found and fixed).

- The Estimated Parameters Line is applicable only for the test phases (not analysis points). It shows MTBF or failure intensity vs. time within each individual test phase.

- The Phase Termination Line is applicable only for the test phases (not analysis points). It provides a long vertical line to more clearly mark the end of each test phase.

- The options under the Planning heading are based on the growth planning folio that’s been linked to the plot, if any.

- The Nominal Idealized and Actual Idealized lines (also called idealized growth curves) show the overall characteristic pattern for the reliability growth across all phases of testing. The nominal MTBF/FI is the best case scenario, which assumes that the average fix delay is zero. The actual MTBF/FI takes into account the average fix delay.

- The Planned Growth lines mark the time when each phase will begin and end, while the vertical position of each line shows the expected MTBF or failure intensity at the beginning of the phase.

- The Goal Value line shows the target MTBF or failure intensity that you hope to achieve by the last phase of testing.

If you want to hide/display confidence bounds, choose Plot > Confidence Bounds > [Show/Hide] Confidence Bounds.

The remaining options in the control panel are similar to other plot sheets throughout the application. Specifically:

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 window, which allows you to customize most aspects of the plot including the titles, colors, sizes, etc.

- **RS Draw** launches ReliaSoft Draw, which allows you to view the plot in greater detail, add annotations and modify selected plot elements.
Chapter 9: Growth Planning Folio and Multi-Phase Plot

Export Plot Graphic saves the plot 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.

The Options area provides:

- **Auto Refresh** automatically updates the plot to reflect any changes that have been made. If not selected, you must click the Redraw Plot icon to refresh the display.

- **Keep Aspect Ratio** maintains the ratio of the horizontal size to the vertical size of the plot graphic when you resize the plot sheet.

In the Scaling area:

- The X and Y Scaling boxes show the minimum and maximum values for the x- and y-axes. You can change these values if the check box beside the value range is not selected. If it is selected, the application will automatically choose appropriate values for the range.

Example: Multi-Phase Test Planning and Management

The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.

The name of the project is "Multi-Phase Test Planning and Management."

A manufacturer is developing a small electric vehicle for indoor use, such as airports. The goal MTBF for the vehicle is 300 operating hours. 20 developmental prototypes are going to be tested for 3,000 hours each, for a total of 60,000 hours. The first phase of testing is planned to end at 5,000 hours of cumulative test time; the second phase will end at 15,000 hours; the third phase will end at 25,000 hours; the fourth will end at 35,000 hours; the fifth will end at 45,000 hours and the sixth will end at 60,000 hours.

The analysts wish to:

- Create a test plan that will achieve the desired MTBF goal.

- Use the Crow Extended - Continuous Evaluation model to analyze the data at the end of each phase of testing.

- Use the multi-phase plot to track the actual progress against the original test plan.
Continuous Growth Planning Folio

The first step of creating an overall reliability growth program plan is to set an idealized growth curve and planned MTBF goal at each stage of the program. This will help determine the management strategy that may be needed to achieve the final MTBF goal. (The reliability growth program plan for this example is located in the growth planning folio called "Test Plan."

The inputs on the Data sheet are shown next.

<table>
<thead>
<tr>
<th>Assumed inputs for the reliability growth test plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal MTBF (Hr)</td>
</tr>
<tr>
<td>Growth Potential Design Margin</td>
</tr>
<tr>
<td>Average EP</td>
</tr>
<tr>
<td>Management Strategy Ratio</td>
</tr>
<tr>
<td>Discovery Beta</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planned test phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Phases</td>
</tr>
<tr>
<td>Phase name</td>
</tr>
<tr>
<td>Phase 1</td>
</tr>
<tr>
<td>Phase 2</td>
</tr>
<tr>
<td>Phase 3</td>
</tr>
<tr>
<td>Phase 4</td>
</tr>
<tr>
<td>Phase 5</td>
</tr>
<tr>
<td>Phase 6</td>
</tr>
</tbody>
</table>

You can see that the cumulative test time at the end of each test phase has been defined under the **Planned test phases** heading, along with the average fix delay for failure modes that are discovered in each phase. In this case, the team expects that it will be easier to implement fixes earlier in the process; therefore, the estimated fix delay increases in each phase. For example, the fix for a failure mode discovered during Phase 1 is expected to be implemented approximately 3,000 test hours later; whereas a failure mode discovered during Phase 5 might not be able to be fixed until approximately 8,000 test hours later because the design is more mature at that point.
Chapter 9: Growth Planning Folio and Multi-Phase Plot

The growth planning folio also shows the inputs for the Crow Extended growth planning model. In this case, the analysts have selected to calculate for the **Initial MTBF** that the product must have before reliability growth testing begins in order to achieve the **Goal MTBF** of 300 hours by the end of the test program, given the following growth management strategy:

- **A GP Design Margin** of 1.3, which indicates that the growth potential MTBF (i.e., the maximum achievable MTBF if you continue until all modes are observed and corrected according to the current maintenance strategy) must equal 130% of the goal MTBF. This value provides a "safety factor" to ensure that the reliability requirement is met.

- **An Average EF** of 0.7, which indicates that the team expects that the fixes applied to failure modes discovered during testing will remove about 70% of the failure intensity due to those modes.

- **A Management Strategy** of 0.95, which indicates that the team plans to fix about 95% of the failure modes that are discovered during testing (while about 5% may be classified as A modes, which are not fixed due to technical, financial or other reasons).

- **A Discovery Beta** of 0.71, which indicates that the inter-arrival times between unique failure modes discovered during testing will become larger as the test progresses.

As shown next, the results indicate that the initial MTBF must be about 131 hours when the first test phase begins. Furthermore, the plan estimates that the MTBF goal will be achieved after about 58,000 hours of test time.

<table>
<thead>
<tr>
<th>Results</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time at which growth begins (Hr)</td>
<td>72.7696</td>
</tr>
<tr>
<td>Initial MTBF (Hr)</td>
<td><strong>130.6500</strong></td>
</tr>
<tr>
<td>Final MTBF (Act) (Hr)</td>
<td>300.7271</td>
</tr>
<tr>
<td>Time to reach goal (Actual) (Hr)</td>
<td><strong>58050.9825</strong></td>
</tr>
<tr>
<td>Time to reach goal (Nominal) (Hr)</td>
<td><strong>49180.9170</strong></td>
</tr>
</tbody>
</table>

Click the **Plot** icon to see a visual representation of the results that are expected in each phase of testing. The following picture contains annotations to help you identify the following:

- **The Actual Idealized** and **Nominal Idealized** lines show the overall characteristic pattern for the reliability growth across all phases of testing.
  - The **actual** MTBF takes into account the average fix delay. If fixes are not incorporated instantaneously, the actual line will show slower growth compared to the nominal line.
  - The **nominal** MTBF is the best case scenario, which assumes that the average fix delay is zero.

- **The horizontal Planned Growth** lines mark the duration of each test phase, as well as the MTBF that is expected to be achieved by the beginning of the phase. For example,
the planned growth line for Phase 4 begins at 25,000 hours, ends at 35,000 hours and shows that the MTBF is planned to be about 280 hours by the beginning of that phase.

- The **Goal** line marks the MTBF the analysts plan to achieve.
- The **Termination** line marks the end of the last test phase at 60,000 hours of cumulative test time.
Analyze the Test Data with the Continuous Evaluation Model

When the testing began, the team used the Multi-Phase Failure Times data type in RGA to record the data. For demonstration purposes, the sample project contains separate folios with the data up to the end of each individual test phase. As an example, you can open the "Test Data - Through Phase 2" folio, which contains all of the data through the end of the second phase. The last twenty data points from this folio are shown next.

<table>
<thead>
<tr>
<th>MP-T</th>
<th>Event</th>
<th>Time to Event (Hr)</th>
<th>Classification</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>F</td>
<td>12147</td>
<td>BC</td>
<td>104</td>
</tr>
<tr>
<td>80</td>
<td>I</td>
<td>12500</td>
<td>BD</td>
<td>5005</td>
</tr>
<tr>
<td>81</td>
<td>F</td>
<td>12564</td>
<td>BD</td>
<td>5006</td>
</tr>
<tr>
<td>82</td>
<td>F</td>
<td>12720</td>
<td>BD</td>
<td>5003</td>
</tr>
<tr>
<td>83</td>
<td>F</td>
<td>12932</td>
<td>BD</td>
<td>5001</td>
</tr>
<tr>
<td>84</td>
<td>I</td>
<td>12935</td>
<td>BD</td>
<td>5001</td>
</tr>
<tr>
<td>85</td>
<td>AP</td>
<td>13000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>F</td>
<td>13064</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>87</td>
<td>F</td>
<td>13289</td>
<td>BC</td>
<td>102</td>
</tr>
<tr>
<td>88</td>
<td>F</td>
<td>13576</td>
<td>BD</td>
<td>5017</td>
</tr>
<tr>
<td>89</td>
<td>F</td>
<td>13983</td>
<td>BD</td>
<td>5009</td>
</tr>
<tr>
<td>90</td>
<td>AP</td>
<td>14000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>91</td>
<td>F</td>
<td>14133</td>
<td>BD</td>
<td>5004</td>
</tr>
<tr>
<td>92</td>
<td>F</td>
<td>14333</td>
<td>BD</td>
<td>5007</td>
</tr>
<tr>
<td>93</td>
<td>F</td>
<td>14395</td>
<td>BD</td>
<td>5003</td>
</tr>
<tr>
<td>94</td>
<td>F</td>
<td>14633</td>
<td>BD</td>
<td>5016</td>
</tr>
<tr>
<td>95</td>
<td>F</td>
<td>14733</td>
<td>BD</td>
<td>5013</td>
</tr>
<tr>
<td>96</td>
<td>F</td>
<td>14736</td>
<td>BD</td>
<td>5006</td>
</tr>
<tr>
<td>97</td>
<td>F</td>
<td>14933</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>98</td>
<td>F</td>
<td>14998</td>
<td>BD</td>
<td>5010</td>
</tr>
<tr>
<td>99</td>
<td>PH</td>
<td>15000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As you can see, in addition to recording the time and mode classification for each failure event (F)—where A = no fix, BC = immediate fix before testing resumes and BD = delayed fix—this data type also allows the team to identify:

- **PH**: The end time of each phase, which allows for the data from multiple test phases to be entered and analyzed together in the same data sheet.

- **I**: The specific time when delayed fixes are implemented during testing. For example, on row 84 in this picture, you can see that a fix was applied at 12,935 hours for mode 5001.

- **AP**: Specific analysis points at which the team wants to calculate results in order to track the progress of the test plan.
(Although they are not shown in this picture, this data type also allows you to mark events as performance (P) or quality (Q) issues that can be excluded from the analysis if desired. You can also mark any event with an X to exclude it from the analysis.)

For the BD (delayed fix) failure modes that do not have a specific fix time (I event) recorded in the data set, the Effectiveness Factors window allows the team to specify when the fix was (or will be) implemented. To open the window, choose Growth Data > Crow Extended > Effectiveness Factors.

As you can see, the fix for mode 5017 was implemented at the end of the second phase, and it's expected to have an effectiveness factor of 0.79 (i.e., only 79% of the mode's failure intensity is expected to be removed because the fix is not perfectly effective). The remaining modes have not yet been fixed before the start of Phase 3; they may be fixed during or between later test phases.

**Multi-Phase Plot**

As the testing progressed, the team used RGA’s multi-phase plot to track the progress against the original test plan. As an example, you can open the "Through Phase 2" multi-phase plot. This plot shows that the MTBF expected after the delayed fixes are implemented after Phase 2 (194.0895 hours) is less than the MTBF planned for the beginning of Phase 3 (264.2011 hours). The team can use this information to determine whether the growth management strategy needs to be adjusted in subsequent phases.
Note: The multi-phase plots in this example are based on analyses that use the maximum likelihood estimation (MLE) method to calculate the parameters, which is known to produce a biased value for beta. In this example, all these plots are based on unbiased estimates of beta. If the folio is not configured to remove this bias, you will be prompted to change the option in the Settings tab of the Item Properties window (Project > Current Item > Item Properties). To ensure the unbiased beta is always calculated for all new folios, use the Calculations page of the Application Setup window to select the option.
Finally, if you open the "All Test Phases" multi-phase plot, you can see that the demonstrated MTBF eventually exceeded the goal, indicating a successful reliability growth plan.
Chapter 10: Repairable Systems Analysis

Some of the models in RGA can be used to analyze data from repairable systems operating in the field under typical customer usage conditions. Such data might be obtained from a warranty system, repair depot, operational testing, etc.

Specifically, you can use the power law or Crow-AMSAA (NHPP) models for repairable system analysis based on the assumption of minimal repair (i.e., the system is “as bad as old” after each repair) to calculate metrics such as the expected number of failures, rate of wearout or the optimum time to replace or overhaul a system to minimize life cycle costs.

The ReliaWiki resource portal has more information on repairable systems analysis at http://www.reliawiki.org/index.php/RGA_Models_for_Repairable_Systems_Analysis.

Tip: For even more advanced repairable systems analysis capabilities, you may wish to use ReliaSoft's BlockSim software. With BlockSim, you can use discrete event simulation to perform a wide variety of reliability, availability, maintainability and supportability (RAMS) analyses for repairable systems.

Data Types and Models for Repairable Systems Analysis

There is a choice of two data sheets for analyzing data from repairable systems. In general:

- Use the Repairable data type for analyzing the individual failure times for multiple repairable systems operating in the field. The analysis models the number of individual system failures vs. system time.

- Use the Fleet data type for analyzing the failure times for multiple repairable systems from a fleet (rather than individual system) perspective. The analysis groups the data and models the number of fleet failures vs. fleet time.

If you wish to perform repairable systems analysis based on the assumption of minimal repair (i.e., the system is "as bad as old" after each repair), use the Power Law model in a Repairable data sheet. If the power law model does not provide a good fit, you can transfer the data to a Fleet data sheet and use the Crow-AMSAA (NHPP) instead.

For information about using the Crow Extended model for fielded systems, see Crow Extended.
QCP Results and Plots for Repairable Systems Analysis

RGA includes a Quick Calculation Pad (QCP) for computing useful metrics, and multiple plots that allow you to visualize the results of your analyses. The following calculations and plots are available when you are performing repairable systems analysis with the power law or Crow-AMSAA (NHPP) model.

Note: When you analyze data from fielded systems, RGA combines the data to create a single superposition system or cumulative timeline. Any plots generated for the combined data set and subsequent analyses via the Quick Calculation Pad will be based on the resulting system/timeline. See Fielded Data for more information about how the software combines the data for analysis.

QCP Calculations

To open the Quick Calculation Pad (QCP), choose Growth Data > Analysis > Quick Calculation Pad or click the icon on the control panel.

This section describes the types of calculations you can perform in the QCP for repairable systems analysis. For general information on how to use the QCP, see Quick Calculation Pad (QCP). For information about the metrics and plots available for other types of analyses that you can perform in RGA, see QCP Calculations and Plots for Traditional RGA and QCP Calculations and Plots for Crow Extended.

When you are performing repairable systems analysis with a Repairable or Fleet data sheet, the following calculations will be available:

- Two values can be calculated for either the MTBF or Failure Intensity:
  - The Instantaneous value is the MTBF/FI over a small interval $dt$ that begins at a specified time. For example, an instantaneous MTBF of 5 hours after 100 hours of operation means that, over the next small interval $dt$ that begins at 100 hours, the average time between failures will be 5 hours.
  - The Cumulative value is the MTBF/FI from time = 0 up to a specified end time. For example, a cumulative MTBF of 5 hours from 0 to 100 hours means that the average time between failures was 5 hours over the 100-hour period.

- The Time Given option allows you to calculate the mission duration given any of the following metrics:
  - Cumulative MTBF
• Instantaneous MTBF
• Cumulative failure intensity (FI)
• Instantaneous failure intensity (FI)

• **Number of Failures** is the cumulative number of failures that are expected to occur by a specified time, based on the fitted model.

The following calculations are available only for the Repairable data sheet (which models the number of individual system failures vs. system time, rather than the number of fleet failures vs. fleet time).

• **Reliability** is the probability that a system that has already operated for a certain amount of time will successfully complete a mission of a certain duration. Enter the amount of time that the system has already operated for in the **System Age** field, and enter the duration of the mission in the **Mission Time** field. For example, if the system age = 2 years and mission time = 1 year, the QCP will calculate the reliability for one additional year of operation after the system has already operated for two years (i.e., conditional reliability). To calculate the standard (i.e., non-conditional) reliability, enter 0 for the system age.

• **Prob. of Failure** is similar to reliability, except that it is the probability that the system will *not* complete the mission. Thus, it is equal to 1 - Reliability.

• **Mission Time** is the duration of a mission that a system can complete while still maintaining a certain reliability. Enter the required reliability in the **Reliability** field, and if you will assume that the system has already operated for a certain time prior to the mission, enter the prior operating time in the **System Age** field. For example, if system age = 1 year and reliability = 0.9, then the QCP will calculate the longest mission that the system can complete while maintaining a reliability of at least 90%, under the assumption that the system that has already operated for one year.

• **Optimum Overhaul** is the best time to use between regularly scheduled renewals of the system. By overhauling the system at the right times, you can minimize the total life cycle cost. The optimum overhaul time is calculated using the average **Repair Cost** and the **Overhaul Cost**. For example, if it costs $1,000 to repair the system and $3,000 to overhaul it, the QCP can calculate the optimum time to overhaul the system (e.g., every 5 years).

**Plots**
You can create plots by choosing **Growth Data > Analysis > Plot** or by clicking the icon on the control panel.
This section describes the types of plots you can create for repairable systems analysis. The scaling, setup, exporting and confidence bounds settings are similar to the options available for all other RGA plot sheets. For more information on these common options, see Synthesis Plot Utilities.

When you are performing repairable systems analysis with a Repairable or Fleet data sheet, the following plots may be available.

- **Cumulative Number of Failures** shows the total number of failures versus time. Data points on the plot represent the cumulative number of failures that have been reported by a given time (e.g., the second point marks the time at which the second failure was observed). The Expected Failures line is fitted to the data points and serves as an empirical goodness-of-fit test for the model.

- The [Value] vs. Time plots show how the value increases, decreases or remains constant over time. The points represent the actual failure times in the data set and the plot includes one line for the instantaneous value and one line for the cumulative value.

- **System Operation** shows the failure times of each system plotted on separate lines. The last line is the timeline for the representative system (i.e., superposition system or cumulative timeline), which is used to evaluate all the failures that occurred during the observation period. To learn more about how the failure times are combined, see Fielded Data.

- **Conditional Reliability/Unreliability** is available only when you are using the Repairable data sheet. These plots show the reliability/unreliability versus system age or mission time.
  - If you choose to hold the system age constant, the plots will show the reliability/unreliability for different mission times. For example, assuming that the system has already operated for 100 hours, the plot can show the reliability for the next 10 hours, 20 hours, 30 hours, etc.
  - If you choose to hold mission time constant, the plots will show the reliability/unreliability for different system ages. For example, assuming that the mission will be 100 hours, the plot can show the reliability for a system that has already operated for 10 hours, 20 hours, 30 hours, etc.
To specify which value will be held constant, click the [...] button on the control panel. In the window that appears, select the type of metric that will be held constant, as shown next. Then enter the constant value in the input field.

- **Optimum Overhaul** plots are only available when Beta > 1 and only when you are using the Repairable data sheet. These plots show two values; economic life and useful life. Economic life is the overhaul time that minimizes cost (same as the QCP calculation). Useful life takes into account the reliability requirement for the given mission duration. Click **Overhaul Settings** on the plot control panel to change the parameters.

*Tip:* RGA includes two additional plot utilities you can use across all types of data: the overlay plot, which allows you to compare different data sets or models; and the side-by-side plot, which allows you to display different plots of a single data set all in a single window for easy comparison.
Example Using Power Law Model for Repairable Systems Analysis

The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.

The name of the project is "Repairable Systems - Race Car Analysis."

Failure times were recorded for three Formula 1 race cars operating in the field. Each car failed multiple times during the observation period. When a failure occurred, the failure time was recorded, along with the name of the failed component that was replaced. For example, the data set for the first car is shown next using the Advanced Systems View.

![Advanced Systems View](image)

According to this data set, the first car was observed during its first 2,500 kilometers of operation. The engine was replaced when the car failed after 249.8 kilometers, the front suspension was replaced after 584.2 kilometers, and so on. Similar data sets are available for two others cars.

The goals of the analysis are to analyze the combined data from all three repairable systems in order to:

- Estimate the total number of failures that you could expect for a car that competes in ten 200-kilometer races.
- Determine the probability that a car that has finished two races will complete a third without any failures.
• Determine if it would be feasible to overhaul the entire car at regular intervals in order to minimize its total life cycle cost. If it is feasible, calculate the overhaul time, assuming an average repair cost of $192,000 and an overhaul cost of $500,000.

On the control panel, choose the **Power Law** model, and then analyze the data by choosing **Growth Data > Analysis > Calculate** or by clicking the icon on the Main page.

A summary of the calculation results will then be shown on the control panel.

![Results Table](image)

You can see in the results that the data passed the Cramér-von Mises (CVM) test, which indicates that the power law model provides a good fit for the data. (If the power law model did not provide a good fit, you could transfer the data to a **Fleet** data sheet and use the Crow-AMSAA model instead. The Fleet data sheet allows you to group the data and combine them into a cumulative timeline for analysis.)

To estimate the total number of failures expected for one car over the period of ten 200-kilometer races, open the QCP by choosing **Growth Data > Analysis > Quick Calculation Pad** or by clicking the icon on the Main page of the control panel.

In the QCP, choose to calculate the **Number of Failures** with **None** for the confidence bounds. Select **km** for the time units and then enter **2000** (i.e., the equivalent of ten 200-kilometer races) in the **Time** field.
Click **Calculate** to obtain the result, as shown next. This analysis estimates about 5 failures for a car that competes in ten races.

You can also use the QCP to determine the probability that a car that has finished two 200-kilometer races will complete a third race. Choose to calculate **Reliability** and make the following inputs:

- **System Age = 400** (i.e., two races, each 200 kilometers)
- **Mission Time = 200** (i.e., a third 200-kilometer race)
According to this result, the reliability of the car for the third race is estimated to be 69.88%.

Finally, to calculate an optimum overhaul time, first make sure the beta value of the fitted power law model is greater than 1 (indicating wearout). If the system has a constant failure rate (beta = 1) or a decreasing rate (beta < 1), then it will not be cost-effective to implement an overhaul policy.
Since beta is greater than 1, you can use the QCP to solve for the optimum overhaul time. In the QCP, choose to calculate **Optimum Overhaul**, and then make the following inputs:

- Repair Cost = **192000**
- Overhaul Cost = **500000**

According to this result, the total life cycle cost of the car can be minimized by overhauling it every 1,619 kilometers.
Chapter 11: Mission Profile Folios

Mission Profiles can help you to ensure that your testing is representative of the expected conditions of actual use by checking, at defined "convergence" points, whether expected usage and actual usage are acceptably close. The ReliaWiki resource portal provides more information about operational mission profile testing at: http://www.reliawiki.org/index.php/Operational_Mission_Profile_Testing.

To add a mission profile folio to a project, choose Insert > Mission Profile or right-click the Mission Profile folder in the current project explorer and choose Add Mission Profile.

To use a mission profile folio in RGA, do the following:

- Set the convergence points
- Define the profile for each separate characteristic that will be tested
- Validate the mission profiles
- Create a plot that allows you to visually compare the actual vs. expected usage in any or all of the defined profiles

If desired, you can also link a profile with a data sheet in order to group the data.

Convergence Points Sheet

On the Convergence Points sheet, enter the times at which you want to check that the expected usage and the actual usage either meet their expected averages or fall within an accepted range (i.e., the amount that the usage can vary from the expected value, while still being acceptable. For example, if the expected number of miles traveled is 1,000 and the allowed variance is 100, then usages of 1,051 and 913 are acceptable, while usages of 1,103 and 879 are not). You must include a minimum of three convergence points in the analysis. The test times between the convergence points do not have to be the same.
Chapter 11: Mission Profile Folios

The following example shows a convergence points sheet with four times defined.

<table>
<thead>
<tr>
<th>Convergence Points</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>250</td>
</tr>
<tr>
<td>3</td>
<td>320</td>
</tr>
<tr>
<td>4</td>
<td>400</td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

All of the define convergence points must be included in all of the profile sheets that you add to the folio. To automatically add the defined convergence points to each profile sheet, choose Mission Profile > Mission Profile > Transfer Convergence Points to Profile Sheets or click the icon on the control panel.

Profile Sheet

Each profile sheet represents a different part of testing (e.g., a different task that the system performs, etc.). By default, each new mission profile folio starts with one profile sheet. You can add additional profile sheets to the folio by choosing Mission Profile > Mission Profile > Insert Profile Sheet.

At a minimum, each profile sheet must contain the times that you entered on the convergence points sheet. It may also contain any additional times at which usage is observed and recorded.

The profile sheet contains the following information:

- The **Cumulative Time** column indicates the time at which the usage is measured. The input is cumulative, which means that the times must be increasing and each row represents the total test time up to that point.

- The **Expected Usage** column is the usage value that you expect at that time (e.g., the distance that the system should have traveled, the number of hours it should have operated or the number of times it should have performed a certain action). These inputs are also cumulative, which means that the values must be increasing and each row represents the total distance, hours operated, times used, etc. up to that point in time.

- The **Actual Usage** column is the usage value recording during the testing. These inputs are also cumulative.
In the **Plus/Minus Range** field, specify the accepted variance from the expected usage values.

The following example shows part of the data in a profile sheet:

<table>
<thead>
<tr>
<th></th>
<th>Cumulative Time</th>
<th>Expected Usage</th>
<th>Actual Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>150</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>250</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>300</td>
<td>150</td>
</tr>
<tr>
<td>7</td>
<td>35</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>8</td>
<td>40</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>9</td>
<td>45</td>
<td>450</td>
<td>600</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td>11</td>
<td>55</td>
<td>550</td>
<td>800</td>
</tr>
<tr>
<td>12</td>
<td>60</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>13</td>
<td>65</td>
<td>650</td>
<td>800</td>
</tr>
<tr>
<td>14</td>
<td>70</td>
<td>700</td>
<td>800</td>
</tr>
<tr>
<td>15</td>
<td>75</td>
<td>750</td>
<td>800</td>
</tr>
<tr>
<td>16</td>
<td>80</td>
<td>800</td>
<td>900</td>
</tr>
<tr>
<td>17</td>
<td>85</td>
<td>850</td>
<td>950</td>
</tr>
<tr>
<td>18</td>
<td>90</td>
<td>900</td>
<td>1000</td>
</tr>
<tr>
<td>19</td>
<td>95</td>
<td>950</td>
<td>1000</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>21</td>
<td>105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Validating the Mission Profile**

After you have entered all of the data, you can validate the profile to make sure that all necessary data points have been entered. To do so, choose **Mission Profile > Mission Profile > Validate Mission Profiles** or click the icon on the control panel.

This feature checks that all convergence points are in all the profile sheets and sorts the data by the Cumulative Time column.

**Note:** Validation also occurs when you generate a plot of the mission profile. If all of the data points have been entered, all of the profile sheets are marked as being verified.

---

**Note:** Complete data set is not shown.
Mission Profile Plots

You can visually compare the expected usage and the actual usage in any or all of the mission profiles defined in the folio by choosing Mission Profile > Mission Profile > Plot Mission Profiles or clicking the icon on the control panel. A plot sheet will be added to the folio.

An example of a mission profile plot is shown next:

The plot sheet control panel includes the following options:

- **Redraw Plot** updates the plot to reflect any changes that have been made.

- **Plot Setup** opens the Plot Setup window, which allows you to customize most aspects of the plot including the titles, colors, sizes, etc.
RS Draw launches ReliaSoft Draw, which allows you to view the plot in greater detail, add annotations and modify selected plot elements.

Export Graphic allows you to save the current plot graphic in one of the following formats: *.jpg, *.gif, *.png or *.wmf.

- **Auto Refresh** automatically redraws the plot when something changes. If not selected, you must click the Redraw Plot icon to refresh the display.

- **Keep Aspect Ratio** maintains the ratio of the horizontal size to the vertical size of the plot graphic when you resize the plot sheet.

- **Units** allows you to choose which units you want the plot to show from the drop-down menu.

- In the **Scaling** area, the **X** and **Y Scaling** boxes show the minimum and maximum values for the x- and y-axes. You can change these values if the check box beside the value range is not selected. If it is selected, the application will automatically choose appropriate values for the range.

- **Show**
  - Select **Show Plus/Minus Range** if you want to display lines that show the allowed *accepted variance* from the expected average usage values on the plot. (Accepted variance is the amount that the usage can vary from the expected value, while still being acceptable. For example, if the expected number of miles traveled is 1,000 and the allowed variance is 100, then usages of 1,051 and 913 are acceptable, while usages of 1,103 and 879 are not.)
  - Select **Intervals** if you want to display the convergence points on the plot.
  - **Available Profiles** allows you to select which of the profile sheets in the folio will be included in the plot.

**Linking a Mission Profile to a Data Sheet**

If your actual testing follows the balanced test plan that you established in an RGA mission profile folio, then it is likely that you will get valid results from analyzing the test data directly with one of the reliability growth models in a Failure Times data sheet. However, if there is a possibility that the test data might not be appropriate for direct analysis, you can use the mission profile folio to group the data based on the specified convergence points so it is suitable for reliability growth analysis.
To use this feature, first enter the test data in a **Failure Times data sheet**, then click the **Mission Profile Analysis** icon on the growth data folio control panel.

After you select one of the mission profiles in the current project, the application will automatically transfer the data to a new **Grouped Failure Times data sheet** in the folio. The data will be grouped according to the times in the specified mission profile.

**Example: Using the Mission Profile Folio**

*The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose **File > Help**, click **Open Examples Folder**, then browse for the file in the RGA sub-folder.*

*The name of the example is "Mission Profiles," and the folio that contains the data is called "Tank Testing Profile."

A team is working on a military system that must perform three tasks:

- firing a gun
- moving under environment 1
- moving under environment 2

They use a mission profile to create a test plan that defines the expected accumulated usage values for each task, and includes the same four convergence points (100, 250, 320 and 400 hours) in each task's profile. The purpose of these convergence points is to make sure that the usage levels for all three tasks match up at those specific times (even if there is some variation from the test plan in between convergence points).

When the team performs the test, they record the actual usage values in the mission profile folio, and they record the failure times data in an RGA growth data folio.
The mission profile folio called "Tank Testing Profile" shows the actual and expected usage for all three tasks. As shown next, the plot shows all three planned mission profiles together with the actual usage during the test. For example, the straight blue line shows the planned usage for the gun firing task and the jagged black line shows the actual usage during the test. You can see that the actual usage tends to fluctuate around the plan (due to normal variations under actual test conditions), but always meet the target at each of the four convergence points. The same applies for the actual usage on the environment 1 and environment 2 tasks.

The plot can be used to track whether the test is proceeding according to plan. In addition, the mission profile folio can also assist with data analysis by automatically grouping the data based on the specified convergence points.

If there has been significant variation from the test plan in between the convergence points, this means that the usage values for the three tasks may not have been properly balanced at certain points in time, and an analysis of the exact failure times may give misleading results. For this example, the team decides to group the data at the convergence points so they can be sure that the usage of all three tasks has been synchronized according to the plan.
Chapter 11: Mission Profile Folios

The "Tank Data" growth data folio contains the failure times observed during the test. The first data sheet (called "Original Data") contains the exact failure times. To create the second sheet (called "Grouped Data"), the analyst simply opened the original data sheet and clicked the **Mission Profile Analysis** icon on the control panel.

When prompted, he selected the applicable mission profile and the application automatically grouped the data. The following picture shows the grouped data analysis, which is based on balanced usage values for the three different tasks.

![Grouped data analysis screenshot](http://rga.reliasoft.com)
The following plot shows some useful planning metrics obtained from the grouped data analysis with the Crow Extended model: the demonstrated, projected and growth potential MTBFs.
Chapter 12: Monte Carlo and SimuMatic

When using RGA, the engineer will typically fit a reliability growth model to actual data obtained from developmental testing or fielded repairable systems operating in the field. However, in some situations, it may be useful to generate simulated data sets containing values that are distributed according to a specified set of parameters. For example, simulated data could be used to:

- Design reliability growth tests.
- Obtain simulation-based confidence bounds.
- Experiment with the influences of sample sizes and data types on analysis methods.
- Evaluate the impact of allocated test time.

You can use Monte Carlo simulation in RGA to produce data sets based on various user inputs, such as data type, the beta and lambda parameters of the Crow-AMSAA (NHPP) model and sample size. The software will randomly generate input variables that follow a specified probability distribution. In the case of reliability growth and repairable system data analysis, the goal is to generate failure times for systems that are assumed to have specific characteristics. Therefore, the inter-arrival times of the failures will follow a non-homogeneous Poisson process with a Weibull failure intensity (as specified in the Crow-AMSAA model).

The following utilities are available for generating and analyzing simulated data:

- The Repairable Systems Monte Carlo utility uses simulation to generate a single data set containing values that are distributed according to the Crow-AMSAA model with specified beta and lambda parameters. The data set is then automatically placed in an RGA growth data folio, where it can be analyzed like any other data set.
- The Repairable Systems SimuMatic folio generates a large number of data sets using Monte Carlo simulation. It then automatically analyzes the group of data sets as a whole in order to explore a variety of questions. For example, you can use SimuMatic to calculate the simulation-based confidence bounds on the demonstrated MTBF.

Monte Carlo Utility

RGA's Repairable Systems Monte Carlo utility uses simulation to generate a single data set containing values that are distributed according to the Crow-AMSAA (NHPP) model with specified beta and lambda parameters.
To access the utility, choose Insert > Simulation > Repairable Systems Monte Carlo.

The setup window will appear. Follow the steps outlined below to set up the simulation:

1. On the Main tab of the window, select a data type and time units in the Data Type area. In the Parameters area, enter the beta and lambda values for the Crow-AMSAA model that will be used to generate the data set.

In the Data Sets / Points area, enter the following information:

- Specify the Number of systems for which data will be generated. This value is fixed at 1 unless you selected a multiple systems data type on the Main tab (i.e., Multiple Systems - Concurrent or Repairable Systems).
- Use the Test termination field to specify what will determine the end of the observation period for the simulated data.
  - If the period will end after a specific number of failures have been observed, choose Failure Terminated from the drop-down list and enter the number of Failures in the next field.
  - If the observation period will end at a specific time, choose Time Terminated from the drop-down list and enter a Time in the next field.
- If you selected to generate Grouped Failure Times data, click the Set Intervals link to open a window that allows you to specify the intervals that will contain the failures. You need at least three intervals to simulate this type of data.

2. On the Settings tab, specify how you want to generate the data set and where you want the data to be stored.

- Select the Use Seed check box if you would like to set a consistent starting point from which the random numbers will be generated. Using the same seed value and keeping all other settings the same will allow you to replicate your results.
- In the Math Precision area, enter the number of decimal places that will be used for each simulated data point. (This does not affect the precision used in the calculated parameters and other results.)
- Use the Generate Data in Specified Folio drop-down list to specify where to put the simulated data. If you select a folio that already exists in the project, the data will be placed into a new data sheet at the end of that folio, and any existing data sheets and plots will remain unchanged. If you choose <New Folio> the software will create a new folio to place the data into.
After the simulation is set up, click **Generate** to create a new growth data folio data sheet populated with a data set that meets your specifications.

**SimuMatic**

RGA's Repairable Systems SimuMatic tool generates multiple data sets using Monte Carlo simulation. It then analyzes each data set individually (e.g., to find the instantaneous MTBF at a specified time) and also analyzes the group of data sets as a whole (i.e., it shows the average and median parameter values for all data sets).

To access the utility, choose **Insert > Simulation > Repairable Systems SimuMatic**.

The setup window will appear. Follow the steps outlined below to generate and analyze the simulated data sets.

1. On the Main tab of the window, select a data type and time units in the **Data Type** area. In the **Parameters** area, enter the beta and lambda values for the Crow-AMSAA model that will be used to generate the data set.

    In the **Data Sets / Points** area, enter the following information:

    - Specify the **Number of Data Sets** that will be generated.
    - Specify the **Number of systems** for which data will be generated. This value is fixed at 1 unless you selected a multiple systems data type on the Main tab (i.e., **Multiple Systems - Concurrent** or **Repairable Systems**).
    - Use the **Test termination** field to specify what will determine the end of the observation period for the simulated data.
        - If the period will end after a specific number of failures have been observed, choose **Failure Terminated** from the drop-down list and enter the number of **Failures** in the next field.
        - If the observation period will end at a specific time, choose **Time Terminated** from the drop-down list and enter a **Time** in the next field.
    - If you selected to generate Grouped Failure Times data, click the **Set Intervals** link to open a window that allows you to specify the intervals that will contain the failures. You need at least three intervals to simulate this type of data.
2. On the Settings tab, specify how you want to generate the data set and where you want the data to be stored.
   • Select the **Use Seed** check box if you would like to set a consistent starting point from which the random numbers will be generated. Using the same seed value and keeping all other settings the same will allow you to replicate your results.
   • In the **Math Precision** area, enter the number of decimal places that will be used for each simulated data point. (This does not affect the precision used in the calculated parameters and other results.)

3. On the Analysis tab, enter the bounds that will be shown in the SimuMatic plots. For example, if you enter **90**, then the plots will show 90% one-sided upper and 90% one-sided lower confidence bounds.

4. On the Test Design tab, select the **Calculate Target Time** check box if you wish to a) calculate the time at which the demonstrated MTBF reaches a certain value and b) mark the lower confidence bound on this value on the instantaneous MTBF vs. time plot. For example, if you wanted to know the time for an instantaneous MTBF of 1,000 hours, then you would enter **1,000** in the **Instantaneous MTBF** field. To mark the 90% lower confidence bound on this value in the IMTBF vs. time plot, you'd enter **90** in the **Lower 1-sided Confidence Level** field.

5. On the Results tab, specify the metrics that will be calculated.
   • The first four areas are for instantaneous MTBF calculations (i.e., the MTBF over a small interval \( dt \) that begins at a specified time) and cumulative MTBF calculations (i.e., the MTBF from time = 0 up to a specified end time). Click the arrow to open a drop-down table where you can enter the user-specified values.
     • The two areas on the left (e.g., **Instantaneous MTBF Given Time**) allow you to specify up to ten different times and SimuMatic will calculate the MTBF(s).
     • The two areas on the right (e.g., **Time Given Instantaneous MTBF**) allow you to specify up to ten different MTBFs and SimuMatic will calculate the time(s).
   • In the **Metrics to Calculate** area, select the metrics you wish to calculate for each data set. You can then use the results on the Sorted sheet to estimate, for example, the one-sided 90% lower confidence bound on any of these values at the end of the test. (See **SimuMatic Example**.)

6. Click the **Generate** button to create and analyze the data. The results will be displayed in the **Repairable Systems SimuMatic folio**.
SimuMatic Folio
The Repairable Systems SimuMatic folio gives you access to the generated data sets and to the results of analyses performed automatically for those data sets.

Control Panel
- The SimuMatic Setup icon allows you to change your simulation settings and replace the current simulated data sets with new ones.

- The Plot icon generates the Plot sheet, which allows you to view five different plots based on the simulated data.

- The Model area always displays "Crow-AMSAA (NHPP)" because this is the only model RGA SimuMatic uses to generate simulated data.

- The Analysis Settings table shows what settings were used in the analysis of each data set. These settings will vary depending on the data type selected.

As an example, the following picture shows the settings that are used for the Failure Times data type. The settings show the type of data (Developmental – Failure Times), parameter estimation method (MLE), confidence bounds method (Crow), whether a gap interval has been defined in the analysis (No Gap) and whether the failure times are entered as cumulative or non-cumulative (Cumulative).

<table>
<thead>
<tr>
<th>Developmental</th>
<th>Failure Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLE</td>
<td>Crow</td>
</tr>
<tr>
<td>No Gap</td>
<td>Cumulative</td>
</tr>
</tbody>
</table>

- The Parameters area displays the Crow-AMSAA model parameters that were used to generate the data.

- In the Additional Results area:
  - The T(i) (...) button opens a report that displays each data set in its own column. (Note that this report will contain multiple sheets when there are too many data points to fit onto one sheet.)
  - The Summary (...) button opens a report that displays the settings used to generate the data. It also displays the average and median parameter values of the data sets.
Simulation Sheet
The Simulation sheet shows the parameters calculated for each data set. It also contains a separate column for each of the calculations that you specified on the Analysis and Results tabs of the setup window. The following columns may be included in the Simulation sheet, depending on the metrics you chose to calculate in the RGA SimuMatic Setup window.

- **Beta** and **Lambda** of the Crow-AMSAA model are the calculated parameters for each data set.
- The following values are calculated according to the inputs you provided on the Analysis tab of the setup window.
  - **Target DMTBF** is the time required to demonstrate the specified MTBF.
  - **DMTBF** is the demonstrated MTBF at the end of the test.
  - **DFI** is the demonstrated failure intensity at the end of the test.
  - **Growth Rate** is equal to 1 - beta. A larger growth rate means faster MTBF growth.
- The following values are calculated according to the inputs you provided on the Results tab of the setup window.
  - **IMTBF(t)** and **CMTBF(t)** are the instantaneous/cumulative MTBF at a specified time, t.
  - **T_IMTBF(m)** and **T_CMTBF(m)** are the time given a specified instantaneous/cumulative MTBF, m.

As an example, the following picture shows the results from the first ten data sets for a particular simulation. In this case, the analysts chose to display only the Crow-AMSAA model parameters (Beta and Lambda), the growth rate, the instantaneous MTBF at 15,000 hours (IMTBF(15000)) and the lower confidence bound on the time at which the demonstrated MTBF reached a specified target value (Target DMTBF).
Sorted Sheet
In the Sorted sheet, the calculated values from the Simulation sheet are sorted from least to greatest in order to show the confidence bounds. The Percentage column displays the percentage of data sets that are equal to or less than a given data set. So, for example, if you wished to obtain the 90% lower one-sided confidence bound on the instantaneous MTBF at 15,000 hours, you would look up the value of $\text{IMTBF}(15000)\ (\text{Hr})$ that corresponds to 10% (i.e., 100% - 90%), as shown next.
Alternatively, if you wished to obtain the 90% two-sided confidence bounds of IMTBF(15,000), you would look up the values that correspond to 5% (for the lower bound) and 95% (for the upper bound), as illustrated in the next figure.

![90% two-sided confidence bounds]

**Plot Sheet**
In the plot sheet, five different kinds of plots are available in the **Plot Type** drop-down list on the control panel.

- **Cumulative Number of Failures** gives an indication of how the number of failures is increasing over time. It plots the times on the x-axis and the cumulative number of failures on the y-axis. The points represent the actual failure times in the data set, and the solution line represents the expected cumulative number of failures based on the calculated model parameters. The vertical line represents the test termination time.

- The **Cumulative MTBF vs. Time** and **Instantaneous MTBF vs. Time** plots show how the time between consecutive failures increases, decreases or remains constant over time.
  - The cumulative MTBF is the MTBF from time = 0 up to a given end time. For example, a cumulative MTBF of 5 hours from 0 to 100 hours means that, on average, the time between failures was 5 hours over the 100-hour period.
  - The instantaneous MTBF is the MTBF over a small interval $dt$ that begins at a given time. For example, an instantaneous MTBF of 5 hours at 100 hours duration means that, over the next small interval $dt$ that begins at 100 hours, the average MTBF will be 5 hours.
• The **Cumulative Failure Intensity** and **Instantaneous Failure Intensity** plots show how the failure intensity changes over time.
  
  • The cumulative failure intensity is the average failure intensity from the beginning of the test (i.e., t=0) up to a given time.
  
  • The instantaneous failure intensity is the failure intensity over a small interval $dt$ that begins at a given time.

The following options on the plot sheet are unique to SimuMatic plots. They allow you to control which elements will be displayed on the plot. See [Plots](https://example.com) for information about the features that are common to all (or most) plot sheets (such as plot setup, RS Draw, aspect ratio, etc.).

• **Simulation Lines** plots the line (e.g., cumulative MTBF vs. time) for every simulated data set.
  
• **True Parameter Line** plots the line defined by the parameters of the Crow-AMSAA model. (These parameters are visible on the control panel of the Simulation sheet.)
  
• **Median Line** and **Average Line** plots the lines defined by the median and average parameters of all generated data sets.
  
• **CB on Function** and **CB on Time** plot two-sided confidence bounds on the plot. The "Function" is determined by the current plot type (e.g., cumulative MTBF is the function for the cumulative MTBF vs. time plot). The percentile of the confidence bounds is determined by what you entered for **Confidence Bounds on Plot** on the Analysis tab of the setup window.
  
• **Target** is available when you have selected the **Calculate Target Time** option on the Analysis tab of the setup window. This option marks the target time on the instantaneous MTBF/FI vs. time plots.

**SimuMatic Example**

*The data set used in this example is available in the example database installed with the software (called "RGA11_Examples.rsgz11"). To access this database file, choose File > Help, click Open Examples Folder, then browse for the file in the RGA sub-folder.*

*The name of the project is "RGA SimuMatic."

A reliability engineer is developing a reliability growth test plan for a new system. The target MTBF that she needs to demonstrate at the end of the test is 800 hours with 90% confidence. There will be 2,000 hours of test time available. Before she can perform the test, she needs to determine the number of prototypes that must be tested in order to demonstrate the target.
Chapter 12: Monte Carlo and SimuMatic

Based on historical data, the expected beta and lambda parameters for the Crow-AMSAA model are 0.55 and 0.21, respectively.

The SimuMatic folio called "Test Design - 10 Systems" contains all the simulated data and analysis results based on the assumption that 10 systems will be tested. To recreate this folio on your own, follow the steps described next.

- Choose Insert > Simulation > Repairable Systems SimuMatic to open the SimuMatic Setup window.

- On the Main tab of the setup window, select the Multiple Systems - Concurrent data type and choose Hour (Hr) for the time units. Then, in the Parameters area, enter 0.55 for beta and 0.21 for lambda.

- In the Data Sets / Points area on the Main tab, specify that you will create 200 data sets in order to simulate a time terminated test that ends at 2,000 hours. As a conservative guess, enter 10 for the Number of systems that will be tested. The area will appear as shown next.

- On the Settings tab, select the Use Seed check box and enter a seed value of 1. Then enter 4 in the Math Precision area.

- On the Analysis tab, enter 90 in the Confidence Bounds on Plot area to specify the bounds that will be available to show in all the plots. In this case, lines will be available that show the 90% one-sided lower bound and 90% one-sided upper bound.

- On the Test Design tab, select the Calculate Target Time option, then specify that you will estimate the test time required to demonstrate an instantaneous MTBF of 800 hours. To place a target point on the instantaneous MTBF vs. time plot that marks the 90% lower one-sided confidence bound on the required test time, enter 90 in the Lower 1-sided Confidence Level field.
• On the Results tab, select the Demonstrated MTBF option and clear all other options and inputs. You can use the Clear All icon to delete any values entered in the first four areas.

• Click the Generate button to create and analyze the data.

The Simulation sheet of the new SimuMatic folio displays the results for each data set in separate rows on the Simulation sheet, as shown next (where the parameters and calculated results for the first 19 data sets are visible).

The Beta and Lambda columns display the parameters that were calculated for each data set. The DMTBF (Hr) column shows the demonstrated MTBF at the end of the test, and the last column shows the test time required to demonstrate the target MTBF (an instantaneous MTBF of 800 hours, as specified on the Analysis tab of the setup window).
The Sorted sheet shows the results for each column sorted from least to greatest. On this sheet, you can see the demonstrated MTBF at the 10th percentile of the results (i.e., 90% one-sided lower bound), shown next.

This shows, with 90% confidence, that the demonstrated MTBF at the end of a 2,000-hour test will be at least 647.0804 hours.

The T(IMTBF=800 Hr) column displays the total accumulated test time required to demonstrate the MTBF goal of 800 hours. You will use the required test time to calculate the number of systems that need to be tested.

On the Sorted sheet, you can see that the 90% upper one-sided confidence bound on the required test time is 29,806 hours, as shown next.

Given that each system in the test accumulates 2,000 hours of testing, the current plan of 10 systems will lead to a total accumulated time of 20,000 hours. Therefore, approximately 10,000 hours of additional test time are required in order to accumulate 29,535 test hours and reach the target MTBF. In other words, an additional 5 systems (each tested for 2,000 hours) will be needed to accumulate enough test time.
To confirm that 5 additional systems will be enough to demonstrate the goal MTBF, return to the RGA SimuMatic Setup window and change the **Number of systems** on the Main tab to **15**. Then perform the simulation again and check the 90% one-sided lower bound on the demonstrated MTBF. The “Test Design – 15 Systems” folio contains all the simulated data and analysis results based on the assumption that 15 systems will be tested. The lower bound on the demonstrated MTBF with 15 systems is shown next.

According to this result, you know with 90% confidence that testing 15 systems for 2,000 hours will demonstrate an MTBF of at least 800.6462 hours at the end of the test. You conclude that 15 systems will be sufficient to demonstrate the goal MTBF.
Chapter 13: Test Design Folios

In a zero-failure reliability demonstration test (RDT), the engineer aims to demonstrate a specified target metric (e.g., an MTBF of at least 500 hours with 90% confidence) by testing a specified number of systems for a predetermined time. If no failures occur, then the target metric is demonstrated. This method has been adapted for scenarios where the target metric can be demonstrated even if some failures occur, so long as a specified number of allowable failures is not exceeded. For example, in a demonstration test where the number of allowable failures is 2, the target metric is demonstrated if no more than 2 failures occur during the test.

The test design folio can assist you in using the NHPP model to design a demonstration test for repairable systems by solving for either the test time required per system or the number of systems that must be tested. To create a test design folio, choose Insert > Test and Planning > Test Design.

**IMPORTANT:** The test design folio in RGA (known as the "Repairable Systems - Design of Reliability Tests" tool in prior versions of the software) is based on the non-homogeneous Poisson process (NHPP), so it is suitable only for designing tests involving repairable systems. For tests involving non-repairable items, use the RDT utility in Weibull++, which provides four test design methods that are suitable for non-repairable systems: parametric binomial, non-parametric binomial, exponential chi-squared and non-parametric Bayesian.

Follow the steps outlined next to use the utility:

- In the **Calculation Options** area on the control panel, specify the **Units** of measurement for the calculation. Note that "Assumes Beta = 1" is displayed in this area, which means that the utility assumes the failure intensity is constant during the test.

- Select the **Display systems as integers** option on the control panel if you will be solving for the number of systems to test and want to round the calculation up to the nearest whole number (e.g., any number greater than 4 would both be displayed as 5).

- In the **What metric would you like to demonstrate?** area on the RDT sheet, specify the metric that you intend to demonstrate with the test you are designing.
  - In the **Metric** drop-down list, specify whether you will demonstrate the system's MTBF or failure intensity.
  - The **Demonstrate this [metric]** field allows you specify the value of the metric you wish to demonstrate. For example, if you wish to demonstrate an MTBF of 1,000 hours, you would enter **1,000** in this field.
The With this confidence level (%) field allows you to specify, as a percentage, the confidence level at which the target metric will be demonstrated. For example, if you wish to demonstrate with 90% confidence that the MTBF is at least 1,000 hours, enter 90 in this field.

In the Solve for this value area, specify what value you are using the RDT utility to solve for. The Value drop-down list allows you to choose whether you are solving for the test time (per system) that will be required to demonstrate the target metric, or the number of systems that you'll need to test.

If you select Required test time, you'll enter the number of systems that will be tested in the next input field.

If you select Required number of systems, you'll enter the test time in the next input field.

In the last input field, enter the maximum number of failures that you will allow to occur during the test. For example, if you want to demonstrate the target metric with 2 failures or less (e.g. two systems fail once, but no other failures occur), then you would enter 2 in this field.

After you have made all of the required inputs, click the Calculate icon to solve for the specified value. To examine other possible test scenarios, you can also create a table and plot based on the inputs.

See Repairable Systems RDT Example.

RDT Table and Plot
In addition to calculating a single value (i.e., required test time per system or number of systems to test), the test design folio also allows you to create a table and plot that provide quick ways to consider many possible test plan scenarios without having to perform each calculation individually. Depending on what you select to solve for, the table will display a range of test duration values as a function of sample size and number of allowable failures, or it will display a range of required sample size values as a function of test time and number of allowable failures. The plot will graphically display the results with one line for each number of allowable failures.

Follow the steps outlined below to create the table.

- Open the test design folio and solve for required test time or number of systems.
- Click the Create RDT Table icon on the control panel.
• The Table of RDT sheet will appear. In the **Calculation Options** area, select which value you wish to have the table solve for.

• **Test time given number of systems** solves for the test time given different numbers of systems that could be tested. When you select this option, the **Number of Systems Range** area will require that you enter the smallest and largest integer that you want to consider, along with an increment to determine how many values in between will also be calculated. For example, if you specify 10 to 20 with a increment of 2, the table will show results for 10, 12, 14, etc.

• **Number of systems given test time** solves for the number of systems that must be tested given a different test times. When you select this option, the **Test Time Range** area will require that you enter a starting test time, an ending test time and an increment value by which the test time will increase.

For either option, you must enter starting, ending and increment values for the number of allowable failures in the **Number of Failures Range** area. A demonstration test will fail to demonstrate the target metric if the number of failures exceeds this number. Thus, if you are designing a zero-failure test, then the test will demonstrate the target metric only if no failures occur.

• Click **Calculate** to create the table.

An example table is shown next.

<table>
<thead>
<tr>
<th>Amount of Test Time</th>
<th># of Systems for 0 Failures</th>
<th># of Systems for 1 Failures</th>
<th># of Systems for 2 Failures</th>
<th># of Systems for 3 Failures</th>
<th># of Systems for 4 Failures</th>
<th># of Systems for 5 Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500</td>
<td>6.4378</td>
<td>11.9772</td>
<td>17.1161</td>
<td>22.0602</td>
<td>26.8399</td>
<td>31.6240</td>
</tr>
<tr>
<td>3500</td>
<td>4.5984</td>
<td>8.5552</td>
<td>12.2258</td>
<td>15.7573</td>
<td>19.2028</td>
<td>22.5886</td>
</tr>
<tr>
<td>4000</td>
<td><strong>4.0236</strong></td>
<td><strong>7.4858</strong></td>
<td><strong>10.6976</strong></td>
<td><strong>13.7876</strong></td>
<td><strong>16.8024</strong></td>
<td><strong>19.7650</strong></td>
</tr>
<tr>
<td>5000</td>
<td>3.2189</td>
<td>5.9886</td>
<td>8.5581</td>
<td>11.0301</td>
<td>13.4420</td>
<td>15.8120</td>
</tr>
<tr>
<td>5500</td>
<td>2.9263</td>
<td>5.4442</td>
<td>7.7801</td>
<td>10.0274</td>
<td>12.2200</td>
<td>14.3745</td>
</tr>
</tbody>
</table>

You can use this table (and the plot of the results shown below) to consider different test scenarios. For example, according to the fifth cell in the column called "# of Systems for 0 Failures," if you tested 5 systems (i.e., 4.0236 rounded up to the nearest whole number) for 4,000 hours each and no failures occurred, then the test would demonstrate the target metric.
To view a plot of the table results, click the **Plot** icon.

Each colored line in the plot corresponds to a specific number of failures; this depicts how the allowed number of failures influences the test time and the required sample size. To choose which lines to display in the plot, use the options in the **Select Failures** area on the control panel. In the following plot, lines for all numbers of allowable failures considered in the table (i.e., 0 to 5) are shown.
Test Design Folio Example

This topic presents an example of how to use the test design folio to calculate the number of repairable systems needed to show a specified MTBF at a specified confidence level in a zero-failure demonstration test. An RDT table and plot will also be created in order to examine a variety of different test scenarios.

At the end of a reliability growth testing program for a repairable system, a manufacturer wants to demonstrate that a new product has achieved an MTBF of 10,000 hours with 80% confidence. The available time for the demonstration test is 4,000 hours for each system under test. Assuming zero failures are allowed, determine the required number of systems to be tested in order to demonstrate the desired MTBF.

Follow the steps outlined next to solve for the required number of systems.

- Create a new test design folio by choosing Insert > Test and Planning > Test Design.

- On the control panel, specify that time values will be in hours, and select to round up the number of systems to the next whole number (e.g., any number above 4 will be displayed as 5), as shown next.

- On the input sheet, specify that you wish to demonstrate an MTBF of 10,000 hours with a confidence level of 80%, as shown next.

- Then specify that you wish to use the folio to solve for the Required number of systems that must be tested to demonstrate this value, given an available test time of 4,000 hours and with 0 failures allowed, as shown next.
Chapter 13: Test Design Folios

- After you select the **Display systems as integers** option on the control panel, click the **Calculate** icon to view the result.

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of systems</td>
</tr>
</tbody>
</table>

According to the folio, if you test 5 systems for 4,000 hours and no failures occur, then you will demonstrate an MTBF of at least 10,000 hours with 80% confidence.

- You can use the RDT table to compare the required test times given different numbers of systems and different numbers of allowable failures. To generate an RDT table using these inputs, click the **Create RDT Table** icon.

- Use the default settings on the control panel of the Table of RDT sheet. According to these settings, the table will calculate the test time required to demonstrate the target metric. The tool will consider different numbers of systems that could be tested, from 1 to 10 in increments of 1. And the number of allowable failures will range from 0 to 5, also in increments of one.

- Click the **Calculate** icon to recreate the table.
The table appears next. For example, by looking in the second column, you can investigate the test times required in a zero-failure demonstration test, given different numbers of systems being tested.

<table>
<thead>
<tr>
<th>Number of Systems</th>
<th>Test Time for 0 Failures</th>
<th>Test Time for 1 Failures</th>
<th>Test Time for 2 Failures</th>
<th>Test Time for 3 Failures</th>
<th>Test Time for 4 Failures</th>
<th>Test Time for 5 Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16094.3794</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>8047.1897</td>
<td>14971.5424</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>5364.7931</td>
<td>9981.0282</td>
<td>14263.4328</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>4023.5949</td>
<td>7485.7712</td>
<td>10697.5746</td>
<td>13787.6129</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>3218.8759</td>
<td>5988.6169</td>
<td>8558.0597</td>
<td>11030.0903</td>
<td>13441.9594</td>
<td>N/A</td>
</tr>
<tr>
<td>6</td>
<td>2682.3966</td>
<td>4990.5141</td>
<td>7131.7154</td>
<td>9191.7419</td>
<td>11201.6328</td>
<td>13176.6542</td>
</tr>
<tr>
<td>7</td>
<td>2298.1971</td>
<td>4277.5835</td>
<td>6112.8998</td>
<td>7878.6360</td>
<td>9601.3996</td>
<td>11294.2750</td>
</tr>
<tr>
<td>8</td>
<td>2011.7974</td>
<td>3742.8856</td>
<td>5348.7873</td>
<td>6893.8065</td>
<td>8401.2246</td>
<td>9882.4906</td>
</tr>
<tr>
<td>9</td>
<td>1788.2644</td>
<td>3327.0094</td>
<td>4754.4776</td>
<td>6127.8200</td>
<td>7467.7552</td>
<td>8784.4361</td>
</tr>
<tr>
<td>10</td>
<td>1609.4379</td>
<td>2994.3085</td>
<td>4279.0298</td>
<td>5515.0452</td>
<td>6720.9797</td>
<td>7905.9925</td>
</tr>
</tbody>
</table>

- To show the table’s results in a plot, click the **Plot** icon.

Like the RDT table, the plot shows the relationship between number of systems and test time, given different numbers of allowable failures. To choose which lines to display in the plot, use the options in the **Select Failures** area on the control panel. In the following plot, lines for all numbers of allowable failures considered in the table (i.e., 0 to 5) are shown.
The Quick Statistical Reference (QSR) tool allows you to quickly and easily calculate many common statistical values (e.g., median ranks and chi-squared values) and interpolate (or extrapolate) values using the polynomial interpolation function.

To open the QSR, choose **Home > Tools > Quick Statistical Reference**.

The **Function Option page** of the QSR is for calculating statistical values. The **Interpolation page** is for interpolating (or extrapolating) values using the polynomial interpolation function.

### Calculating Statistical Values

To calculate a statistical value, select the appropriate function option on left side of the Function Option page. Then enter the required inputs and click **Calculate**. The following options are available.

**Median Ranks**

The Median Ranks option returns the probability of failure based on the sample size and order number of the failure. The probability estimates are at a 50% confidence level.

The median rank is obtained by solving the following equation for $Z$:

$$0.5 = \sum_{k=j}^{N} \binom{N}{k} Z^k (1 - Z)^{N-k}$$

where:

- $N$ is the sample size.
- $j$ is the order number.
- $Z$ is the median rank.
Other Ranks

The Other Ranks option returns the probability of failure based on the sample size and order number of the failure. The probability estimates are at a confidence level percentage point that is specified by the user.

The rank is obtained by solving the following equation for $Z$:

$$P = \sum_{k=j}^{N} \binom{N}{k} Z^k (1 - Z)^{N-k}$$

where:

- $N$ is the sample size.
- $j$ is the order number.
- $P$ is the confidence level.
- $Z$ is the rank.

Standard Nominal Values

The Standard Normal Tables option returns the probability of observing a value less than or equal to $x$ on the standard normal curve, given a value for $x$. To find the value of $x$ given the probability, use the Inverse Standard Normal Values option.

The probability is obtained by solving the following equation for $Z(x)$:

$$1 - Z(x) = \int_{x}^{\infty} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$

where $Z(x)$ is the probability of observing a value less than or equal to $x$.

Inverse Standard Normal Values

The Inverse Standard Normal Tables option returns a value for $x$ on the standard normal curve, given the probability of observing a value less than or equal to $x$. To find the probability given $x$, use the Standard Normal Tables option.
The output is obtained by solving the following equation for $x$:

$$1 - Z(x) = \int_{x}^{\infty} \frac{e^{-\frac{t^{2}}{2}}}{\sqrt{2\pi}} dt$$

where $Z(x)$ is the probability of observing a value less than or equal to $x$.

**Cumulative Poisson**

The Cumulative Poisson option returns the probability of an event occurring $n$ times during a specified interval. The required inputs are $n$ and the average rate of occurrence for the event, $\lambda$, where $\lambda > 0$.

The probability is obtained by solving for $P(n, \lambda)$ in the following equation:

$$P(n, \lambda) = e^{-\lambda} \sum_{i=0}^{n} \frac{\lambda^i}{i!}$$

where:

- $n$ is the maximum number of occurrences (and the upper limit of the summation).
- $\lambda$ is the average rate of occurrence for the event.

**Cumulative Binomial Probability**

The Cumulative Binomial Probability option returns the probability of an event occurring $k$ or more times in $N$ trials. The required inputs are $k$, $N$ and the probability (entered as a decimal number) of the event occurring per trial.

The probability is obtained by solving for $P$ in the following equation:

$$P = \sum_{i=k}^{N} \binom{N}{i} p^i (1 - p)^{N-i}$$
where:

- $P$ is the probability of the event occurring $k$ or more times in $N$ trials.
- $p$ is the probability of the event occurring per trial.
- $N$ is the minimum number of trials (and the end of the summation).
- $k$ is the minimum number of occurrences (and the starting point of the summation).

**F-Distribution Values**

The F-Distribution option returns $Q(F|n1, n2)$, the significance level at which we can reject the hypothesis that one sample has a smaller variance than another. The three inputs required are the degrees of freedom for both samples and the ratio of the observed dispersion of the first sample to that of the second. To find the ratio of the observed dispersion, use the Inverse F-Distribution Values option.

The output is obtained by solving for $Q(F|n1, n2)$ in the following equation:

$$Q(F|n1, n2) = 1 - \frac{\frac{1}{2}n1}{\frac{1}{2}n2} \frac{1}{\frac{1}{2}n1, \frac{1}{2}n2} \int_{0}^{F} (n2 + n1 t)^{-\frac{1}{2}(n1+n2)} dt$$

where:

- $n1$ is the degrees of freedom for the first sample.
- $n2$ is the degrees of freedom for the second sample.
- $F$ is the ratio of the observed dispersion of the first sample to that of the second.
- $B$ is the beta function.

**Inverse F-Distribution Values**

The Inverse F-Distribution option returns $F$, the ratio of the observed dispersion of one sample to that of another. The three inputs required are the degrees of freedom for both samples and the significance level at which we can reject the hypothesis that the first sample has a smaller variance than the second. To find the significance level at which we can reject the hypothesis, use the F-Distribution Values option.
The output is obtained by solving for $F$ in the following equation:

$$Q(F|n_1, n_2) = 1 - \frac{1}{B\left(\frac{1}{2}n_1, \frac{1}{2}n_2\right)} \int_0^F t^{(n_2-2)\left(n_2 + n_1 t\right)} \frac{1}{2}(n_1 + n_2) \ dt$$

where:

- $n_1$ is the degrees of freedom for the first sample.
- $n_2$ is the degrees of freedom for the second sample.
- $Q(F|n_1, n_2)$ is the significance level at which we can reject the hypothesis that the first sample has a smaller variance than the second.
- $B$ is the beta function.

**Chi-Squared Values**

The Chi-Squared Values option returns the chi-squared value at the $(1-d)$ percentile. The required inputs are the area to the right of the critical value and the number of degrees of freedom.

The output is obtained by solving for $x_{d,v}^2$ in the following equation:

$$P(X^2 > x_{d,v}^2) = \left[2^v \Gamma\left(\frac{v}{2}\right)\right]^{-1} \int_{x_{d,v}^2}^\infty e^{-\frac{t}{2}} \frac{v}{2}^{-1} dt$$

where:

- $d$ is the area to the right of the critical value.
- $v$ is the number of degrees of freedom.
- $X^2$ is a chi-squared random variable with $v$ degrees of freedom.

**Incomplete Beta Function**

The Incomplete Beta Function option returns the value of $l_x(a,b)$. The required inputs are the values of $x$, $a$ and $b$. 

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The output is obtained by solving for $I_x(a,b)$ in the following equation:

$$I_x(a, b) = \frac{1}{B(a, b)} \int_0^x t^{(a-1)}(1 - t)^{(b-1)} dt$$

where $0 < x < 1$.

**Gamma Function**

The Gamma Function option returns the value of $\Gamma(n)$. The only required input is $n$.

The output is obtained by solving for $\Gamma(n)$ in the following equation:

$$\Gamma(n) = \int_0^\infty t^{x-1} e^{-t} dt$$

where $n > 0$.

**Student's t Values**

The Student's t Values option returns the $t$-value of the Student's $t$-distribution, given the probability of observing a value equal or less than the $t$-value and the number of degrees of freedom.

The output is obtained by solving for $t$ in the following equation:

$$a = P(t > t_{a;\nu}) = \int_{t_{a;\nu}}^\infty f(t)dt$$

where:

- $a$ is the probability of observing a value equal to or less than $t$.
- $\nu$ is the degrees of freedom.
Interpolating a Value from a Data Set

The Interpolation page uses the polynomial interpolation function to interpolate (or extrapolate) values given a set of known data points that you provide.

The QSR attempts to fit a polynomial to the given data points. The polynomial is of the \((i - 1)\) order, where \(i\) is the number of data points. You must enter at least 2 data points, and you cannot enter more than 10.

Note that if the given data points are far from the point of interest, the resulting polynomial can oscillate between values, thus yielding erroneous results. Moreover, interpolation based on only data points, with no background information on the actual function, can also yield erroneous results. For these reasons, an approximate error value is returned with each interpolation.

Follow the steps outlined below to obtain values with the QSR:

- In the **Input** area of the Interpolation page, specify the number of data points you wish to enter in the **Number of x-y values** field. Then click the **Update** button to create a table on the left of the page where you can enter the known data points that you wish to interpolate from.

- In the table on the left side of the page, enter the x- and y-values data points that you wish to interpolate from.

- In the **Input** area, enter the x-value for which the corresponding y-value will be obtained.

- Click the **Calculate** button to obtain the corresponding y-value of the x-value you entered in the Input area. The y-value and an approximate error value are displayed in the **Output** area.
**Chapter 15: RGA Minimum Data Requirements**

**Minimum Data Requirements - Times-to-Failure Data**

The minimum data requirements for analysis of developmental times-to-failure data are presented next:

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Minimum Requirements</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure Times</td>
<td>At least 3 unique failures.</td>
<td>Crow-AMSAA, Duane</td>
</tr>
<tr>
<td>Grouped Failure Times</td>
<td>At least 3 unique failures.</td>
<td>Crow-AMSAA, Duane</td>
</tr>
<tr>
<td>Multiple Systems - Known Operating Times</td>
<td>At least 3 unique failures for overall analysis.</td>
<td>Crow-AMSAA, Duane</td>
</tr>
<tr>
<td>Multiple Systems - Concurrent Operating Times</td>
<td>At least 3 total failures for overall analysis.</td>
<td>Crow-AMSAA, Duane</td>
</tr>
<tr>
<td></td>
<td>At least 3 unique failures on an individual system to return individual system results.</td>
<td>Crow Extended: BD modes - at least 3 unique</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BD modes - at least 3 unique</td>
</tr>
</tbody>
</table>
Chapter 15: RGA Minimum Data Requirements

Multiple Systems with Dates

At least 3 total failures for overall analysis.

At least 3 unique failures on an individual system to return individual system results.

Crow-AMSAA, Duane

Crow Extended:
BD modes - at least 3 unique
BD modes - at least 3 unique

Multiple Systems with Event Codes

At least 3 total failures for overall analysis.

At least 3 unique failures on an individual system to return individual system results.

Crow Extended:
BD modes - at least 3 unique
BC modes - at least 3 unique
I events apply only to BC modes and there must be an I event for each BC mode

Minimum Data Requirements - Discrete Data

The minimum data requirements for analysis of developmental discrete data are presented next:

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Minimum Requirements</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequential</td>
<td>At least 3 reliability points (this is not equal to the number of data points or failures).</td>
<td>Crow-AMSAA, Standard Gompertz, Lloyd-Lipow, Duane, Logistic</td>
</tr>
<tr>
<td></td>
<td>At least 4 reliability points</td>
<td>Modified Gompertz</td>
</tr>
<tr>
<td>Sequential with Mode</td>
<td>At least 3 reliability points (this is not equal to the number of data points or failures).</td>
<td>Standard Gompertz, Lloyd-Lipow, Logistic</td>
</tr>
<tr>
<td></td>
<td>At least 4 reliability points</td>
<td>Modified Gompertz</td>
</tr>
<tr>
<td>Grouped per Configuration</td>
<td>At least 3 data entries (configurations).</td>
<td>Crow-AMSAA, Standard Gompertz, Lloyd-Lipow, Duane, Logistic</td>
</tr>
<tr>
<td></td>
<td>At least 4 reliability points</td>
<td>Modified Gompertz</td>
</tr>
</tbody>
</table>
### Minimum Data Requirements - Multi-Phase Data

The minimum data requirements for analysis of developmental multi-phase data are presented next:

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Minimum Requirements</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure Times</td>
<td>At least 3 unique failures.</td>
<td>Crow Extended - Continuous Evaluation: maximum of 10 phases</td>
</tr>
<tr>
<td>Grouped Failure Times</td>
<td>At least 3 unique failures.</td>
<td>Crow Extended - Continuous Evaluation: maximum of 10 phases</td>
</tr>
<tr>
<td>Mixed Data</td>
<td>At least 3 intervals with at least 1 failure in each</td>
<td>Crow Extended - Continuous Evaluation: maximum of 10 phases</td>
</tr>
<tr>
<td></td>
<td>BD modes - at least 3 unique</td>
<td></td>
</tr>
</tbody>
</table>
Minimum Data Requirements - Reliability Data

The minimum data requirements for analysis of developmental reliability data are presented next:

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Minimum Requirements</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>At least 3 unique failures.</td>
<td>Lloyd-Lipow: Initial Time/Stage &gt; 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Logistic: Initial Time/State &gt;= 0</td>
</tr>
<tr>
<td></td>
<td>At least 4 unique failures.</td>
<td>Standard Gompertz and Modified Gompertz:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Initial Time/Stage &gt;= 0</td>
</tr>
</tbody>
</table>

Minimum Data Requirements - Change of Slope Calculations

The minimum requirements for Change of Slope calculations require at least 3 failures up to the break point and at least 2 failures after the break point. Therefore, there must be at least 5 total failures or intervals (in grouped data) to conduct the analysis.

Change of Slope calculations are available only for developmental testing data using Crow-AMSAA, for the following data types:

- Failure Times
- Grouped Failure Times
- Known Operating Times
- Concurrent Operating Times
- Multiple Systems with Dates
- Mixed
### Minimum Data Requirements - Fielded Data

The minimum data requirements for analysis of fielded data are presented next:

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Minimum Requirements</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Repairable Systems</strong></td>
<td>At least 3 total failures for overall analysis.</td>
<td>Power Law</td>
</tr>
<tr>
<td></td>
<td>At least 3 unique failures on an individual system to return individual system results.</td>
<td>Crow Extended: BD modes - at least 3 unique BC modes - at least 3 unique</td>
</tr>
<tr>
<td><strong>Fleet</strong></td>
<td>At least 3 total failures for overall analysis.</td>
<td>Crow-AMSAA</td>
</tr>
<tr>
<td></td>
<td>At least 3 unique failures on an individual system to return individual system results</td>
<td>Crow Extended: BD modes - at least 3 unique BC modes - at least 3 unique</td>
</tr>
</tbody>
</table>
Chapter 16: RGA Settings

The Application Setup contains personal preferences that are stored per computer/username. These include default settings for new analyses/plots that you create from this computer, as well as personal preferences that don’t affect shared analysis data stored in the database.

In addition, note that the region and language settings will determine how dates, times, decimals, currency, etc. are displayed on your computer.

To open the Application Setup window, choose File > Application Setup.

The settings on the pages listed under Synthesis Settings are the same for all Synthesis desktop applications; the pages listed under the application name contain settings that apply only to the current applications.

Synthesis Settings

Synthesis Settings
The Synthesis Settings page of the Application Setup can be changed from within any Synthesis desktop application.

- **Interface** sets the language and the skin (color scheme) for the software interface. Selecting a skin shows you a preview of the changes in the Application Setup window. The change takes effect in the rest of the interface the next time you launch each application.
  
  Note that a language change will not affect applications that are currently available only in English. For a list of supported languages, see [http://www.reliasoft.com/languages/index.htm](http://www.reliasoft.com/languages/index.htm).

- **Open With** sets the Synthesis application to launch by default when you double-click an *.rsr11, *.rsf11 or *.rserp file from this computer. If you want to be prompted to choose an application each time, select Show the Synthesis Launcher.

- **Recent Repositories List** sets the maximum number of recently saved database files to be displayed in the "Recent Repositories" list in the Backstage view.

- **Auto Save** specifies when folios and diagrams will be saved automatically. The application always saves folios/diagrams upon calculate or close. If you want to also
save periodically while you're editing, specify an interval. This can be useful if you're working across a network in an enterprise database. (This setting does not apply to Synthesis files.)

• **Other**

  • **Allow multiple projects (project explorer)** applies to Synthesis desktop applications that use the current project explorer (i.e., Weibull++, ALTA, BlockSim, RENO, RGA, and Lambda Predict). Select the check box if you want to have multiple projects open at the same time. There is a separate setting for project windows in Xfmea/RCM++/RBI. (See [Working with Multiple Projects](http://rga.reliasoft.com).)

  • **Show project name in opened folios** applies to Synthesis desktop applications that use the current project explorer (i.e., Weibull++, ALTA, BlockSim, RENO, RGA, and Lambda Predict). It shows the project name in [brackets] on the tab or window caption. This may be useful when you have multiple projects open at the same time.

  • **Use web-based help**. Select the check box to always make F1 and other help commands open the most up-to-date help file from the Internet when possible. If you clear this check box, they open the local help file that was installed with the software.

  • **Display ReliaSoft Online pane** shows the [ReliaSoft Online pane](http://rga.reliasoft.com) in the Backstage view. If you do not have Internet connection or you simply want to reclaim the space allocated to these features, you can clear the check box to hide these panels.

  • **Highlight 'Active' category in ribbon** applies a highlight color to the label that shows which tabs are currently active.

  • **Use non-modal Resource Manager** locks the Resource Manager in a top window position so it can remain open while you have access to the project. If not selected, you must close the Resource Manager to return to the project.

  • **Warn when changing metric associations** shows a warning when you select an existing metric in a situation that will change the metric's associated model. (See [Showing Metrics in Folios/Diagrams](http://rga.reliasoft.com).)

  • **Hide unused project folders** applies to Synthesis desktop applications that use the current project explorer (i.e., Weibull++, ALTA, BlockSim, RENO, RGA, and Lambda Predict). It hides from view all folders that do not contain any project items.
• **Highlight colors** sets the colors used to color-code values in the following analyses:
  - Results in the FMRA in **BlockSim** and **Xfmea/RCM+/RBI**
  - Certain BlockSim plots
  - BlockSim **FRED reports**
  - BlockSim **allocation analysis**
  - **Spread of failure rate contributions** in a prediction folio in Lambda Predict.

**Backup/Check Out Options**
The Backup/Check Out Options page of the Application Setup can be changed from within any Synthesis desktop application.

- **Standard Repository Maintenance** applies to standard database files (*.rsr11) only. It allows you to automatically save a backup of a database in the location you specify when you close the application. The backup file will be named after the database file with the backup date appended (e.g., RSRepository1_2016-01-15.rsr11).

  You can specify how many days of backups can be automatically saved (up to 10), but 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).

  Note that you can also create backups manually at any time by choosing **File > Save As**. For more tips on keeping databases running smoothly, see **Backups and Database Maintenance: Protecting Your Data**.

- **Check In/Out** specifies the default save location for projects that you **check out** from a database.

**Other Synthesis Settings**
The Synthesis Settings > Other page of the Application Setup can be changed from within any Synthesis desktop application.

- **Model, Variable and Workbook Names** disallows spaces and special characters in the names of models (including those published from any Synthesis desktop application) and variables, and in the names of workbooks created in BlockSim/RENO. This will ensure that all models, variables and workbooks can be used in RENO equations.
• **Display Object IDs.** Select the check box to always display the unique object identifier (object ID) of each project and resource in the repository. The project IDs will be displayed in the Manage Projects window and in the Edit Project Properties window, while the resource IDs will be displayed in the Resource Manager.

• **Copy Plot Graphic** sets the default file type to use when copying a plot to the Clipboard as an image. If you will be pasting copied plots into Synthesis 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. If you want to choose the graphic on the spot, you can do so by right-clicking the plot and choosing the Copy Plot Graphic command on the shortcut menu.

• **Hierarchical Trees** sets the maximum number of lines for displaying names and descriptions in any of the hierarchical tree interfaces used in Xfmea, RCM++, RBI, Lambda Predict and MPC.

• **Alternative Credentials** applies to secure databases. It allows you to either save your alternative credentials (so your account is automatically logged in whenever you open a secure database from a different domain) or clear the credentials from this computer.

• **Diagram Skins Utility** converts diagram skins created in Synthesis Version 9 to the latest version. Click the Convert link, and in the window that opens, select the name of the skin(s) that you wish to convert. You will need to close and re-launch the application to use the converted skin(s). (See "Converting Version 9 Skins" in the BlockSim, Weibull++/ALTA or Xfmea/RCM++/RBI documentation.)

### Application-Specific Settings

#### Growth Data Folios Settings

The Growth Data Folios page of RGA’s Application Setup contains default settings that will be applied when you create a new folio in RGA. Note that some of the configurable settings that are saved with the folio can still be modified from the control panel and others can now be modified via the Item Properties window.

• **Data Sheet Options**

  • **Show Alter Data Type** enables the Alter Parameters command in all growth data folios. The command enables you to experiment with possible alternative scenarios by allowing you to alter the values of the calculated parameters.
• **Use advanced systems view** uses the Advanced Systems View by default when you create a new data sheet that offers both the Normal View and Advanced Systems View. (See Normal and Advanced Systems View.)

• **Warn when transferring data with excluded events** displays a message when you transfer a data set that has some coded events excluded from the calculations. This applies only when you transfer data from a Multiple Systems Event Code data sheet to another type of data sheet.

• **Default Number of Systems**
  - For 'Multiple Systems - Known Operating Times' data sheets specifies the number of "Time System" columns that will appear by default in the data sheet.
  - For all other fielded/developmental multiple systems data types specifies the number of systems that appear by default in the navigation panel of the Advanced Systems View. (See Normal and Advanced Systems View.)

• **Statistical Tests.** When you use the Crow-AMSAA (NHPP) or Crow Extended models, RGA automatically performs statistical tests on the calculated data set. Use the check boxes to select which test results to display in the Result area of the growth data folio control panel.
  - **Show Chi-Squared** applies to grouped failure times only. The test evaluates the hypothesis that the failure times follow a non-homogeneous Poisson process (NHPP).
  - **Show Cramér-von Mises (CVM)** applies to non-grouped failure times where there are no gaps in the data. The test evaluates the hypothesis that the failure times follow a non-homogeneous Poisson process (NHPP).
  - **Show Laplace Trend** applies to multiple systems analysis only. The test evaluates the hypothesis that a trend does not exist in the data, and displays in the analysis results whether the system reliability is improving, deteriorating or staying the same.
  - **Show Common Beta Hypothesis (CBH)** applies to multiple systems analysis only. The test evaluates whether all the systems in the data set have similar beta values (i.e., operated in a similar manner).
  - **Default Significance Level** specifies the significance level used in the statistical tests.
Chapter 16: RGA Settings

Calculations Settings
The Calculations page of RGA’s Application Setup contains default settings that will be applied to calculated results when you create a new folio in RGA. Note that any of these configurable settings that are saved in an existing folio can be modified via the Item Properties window.

- **Precision to be Displayed on Calculations** sets the math precision (number of decimal places) and the point at which the software will switch to scientific notation. For example, if the scientific notation tolerance is set to 5, then any number that is larger than $10^5$ will be displayed using scientific notation.

- **Failure Discounting** applies only to the Discrete Sequential with Mode data type. Specify the confidence level that will be used to define the fractional decrease in failure value. (See Failure Discounting.)

- **Crow/Power Law Models** applies only to calculations using the Crow-AMSAA (NHPP), Power Law, Crow Extended or Crow Extended - Continuous Evaluation models. Select whether to display the value of the power law parameter, $\Lambda$, or the Weibull parameter, $\eta$, in the analysis results.

- **Duane Model** applies only to calculations using the Duane model. Select whether to display the value of the $A$ parameter (cumulative failure intensity) or the $b$ parameter (cumulative MTBF) in the analysis results.

- **Crow Extended Model** applies only to calculations using the Crow Extended or Crow Extended - Continuous Evaluation models.
  - **Show Crow-AMSAA beta for beta = 1 hypothesis** displays the value of the beta parameter for the Crow-AMSAA (NHPP) model in addition to the hypothetical value of beta calculated for the Crow Extended or Crow Extended - Continuous Evaluation models, as shown in the following example.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Results (All Modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta (hyp)</td>
<td>1.0000</td>
</tr>
<tr>
<td>Beta</td>
<td>0.8685</td>
</tr>
<tr>
<td>Lambda (Hr)</td>
<td>0.0676</td>
</tr>
<tr>
<td>DMTBF (Hr)</td>
<td>33.7097</td>
</tr>
<tr>
<td>DFI</td>
<td>0.0297</td>
</tr>
</tbody>
</table>

- **Allow EF values for BD modes with implemented fixes** adds a second tab in the Effective Factors window when you are using the Crow Extended - Continuous Evaluation model. This allows you to record the effectiveness factors for BD modes that were fixed during testing. Note that this functionality is for your information only; it is not used in calculations.
• **Instantaneous MTBF/FI at the End of Development Testing** sets whether the instantaneous MTBF and failure intensity at the end of the test will be shown in the analysis results with the term “demonstrated” (i.e., DMTBF/DFI) or “achieved” (i.e., AMTBF/AFI).

• **User Warnings**
  - **Beta = 1 hypothesis is invalid** displays a message when the beta = 1 hypothesis fails. This warning applies only to the Crow Extended or Crow Extended - Continuous Evaluation models.
  - **Model parameters out of range** displays a message when the value of the k parameter (logistic model) or Alpha parameter (Lloyd-Lipow model) is less than or equal to zero. Negative values indicate that the analysis results may not be valid.
  - **Effectiveness factors of zero** displays a message when one or more effectiveness factors equal to zero. This warning applies only to the Crow Extended or Crow Extended - Continuous Evaluation models.

• **Other Options**
  - **Use percents (not decimals) for reliability** displays reliability values as percentages (e.g., 90) rather than decimals (e.g. 0.90). This applies to the Reliability data type only.
  - **Data input is cumulative** configures the data sheet for cumulative failure times, by default, instead of non-cumulative failure times. (See Cumulative vs. Non-Cumulative Data.)
  - **Calculate unbiased beta** removes the bias of the MLE estimate of the beta parameter, when applicable. An unbiased estimate will be labeled in the results as "Beta (UnB)" instead of "Beta." For more information, the "Unbiasing Beta for the Crow-AMSAA (NHPP) Model" article at: http://www.weibull.com/hotwire/issue141/hottopics141.htm demonstrates how the bias is corrected for Crow-AMSAA (NHPP). This is also applicable to the Crow Extended, Crow Extended - Continuous Evaluation and power law models.
Plots Settings

The Plot page of RGA's Application Setup contains default settings that will be applied when you create a new plot sheet in RGA. Note that some of the configurable settings that are saved with the plot can still be modified from the control panel, others can be modified via the Show/Hide Plot Items window (Plot > Actions > Show/Hide Plot Items), and still others via the Plot Setup.

- **Settings for Numbers in Axis Labels** sets the math precision (number of decimal places) and the point at which the software will switch to scientific notation for the X- and Y-axis labels.

- **Settings for Plot Sheets**
  - **Enable auto refresh** activates the auto refresh option.
  - **Show legends on plots** displays information about the objects shown on the plot.
  - **Show user, date and time** displays the display name, date and time on plots. The user information comes from your user account in the current database (see User Login and Contact Information window) and is displayed at the bottom right corner of the plot.
  - **Show program ID on plots** displays the software name and URL in the Header Title section of the plot (e.g., RGA - www.ReliaSoft.com).
  - **Show outline on plots** displays the canvas border on the plot.

- **Other Options**
  - **Enable interactive plot** highlights each point, line, slice or bar on the plot when you move the pointer over it. Point coordinates/values will be displayed on highlighted objects. Note that if you change this setting, you must redraw the plot to see the change.
  - **Display interval lines (when applicable)** applies only to times-to-failure data sheets. Select the check box to display the instantaneous interval lines on the MTBF vs. time plot or failure intensity vs. time plot.
Other Settings
The Other Settings page of RGA’s Application Setup contains default settings that will be applied when you create a new folio in RGA.

- **Preferences**
  - **Show the Project Item Wizard when creating new projects** displays a wizard that helps you select the first new folio to create in a project. If not selected, the new project will be blank.
  - **While QCP is open, have access to all folios** locks the QCP in a top window position (i.e., non-modal) so it can remain open while you have access to all folios. The calculations performed in the QCP will be based on the currently active data sheet. If not selected, you must close the QCP in order to return to the folios. This setting can also be changed from within the QCP by selecting or clearing the **Non-Modal QCP** option in the **Options** drop-down list.
  - **Show warning when deleting data sheets** displays a confirmation message when deleting a data sheet.

- **Other Options**
  - **Default folio font** sets the default font for data sheets in new folios.
  - **Show list of distributions on hovering** displays the distribution/model drop-down list in control panels when you move the pointer over the bar. If not selected, you must click the bar to display the list.

Reset Settings
The Reset Settings page of the Application Setup allows you to restore some or all of the settings to their original configuration. Note that it’s recommended to close all windows before resetting settings. If the change does not take effect immediately, restart the application.

- **Reset Common Synthesis Settings** resets the settings under the **Synthesis Settings** heading in the Application Setup.
- **Reset Application Settings** resets the settings under the current application’s heading in the Application Setup. It also clears any saved default column headings in life data (Weibull++), life-stress data (ALTA) and growth data (RGA) folios.
- **Reset Application Form Settings** resets the form settings for the current application (e.g., size and location of windows).
Chapter 16: RGA Settings

- **Reset Plot Settings** resets the Plot Setup settings that are applied by default when you create a new plot in the current application.

- **Reset FIDES Settings** (Lambda Predict only) resets the predefined FIDES settings (e.g., saved pi factors, process audits, etc.) that are applied by default when you create a new repository. (See FIDES Settings Manager in the Lambda Predict documentation.)

- **Reset Component Defaults** (Lambda Predict only) resets the component property values that are applied by default when you add a new component to a prediction. (See Default Component Properties in the Lambda Predict documentation.)

- **Reset All Settings** resets all the saved settings for the current application. This is the same as clicking all of the individual "Reset" buttons above.

**Project Item Settings**

Synthesis desktop applications offer a variety of configurable settings that are stored per computer/username and managed via the Application Setup.

Your personalized application setup determines the default settings for new folios, diagrams and flowcharts that you create in Weibull++, ALTA, BlockSim, RENO and RGA. The relevant settings are also saved with each individual folio/diagram and are accessible from the Item Properties window. This makes it possible to have different settings for different analyses, and also ensures that any given analysis will be the same for all database users.

To view and edit the configurable settings in the Item Properties window, select the folio, diagram or flowchart in the current project explorer and choose **Project > Current Item > Item Properties**.

The settings are displayed on the second tab of the properties window. (In a secure database, the settings can be edited only if the user is the project owner or has the "Create/edit project items" permission.)

If you modify the settings for a particular project item, the new preferences will be saved with the folio/diagram. The default preferences for new folios/diagrams in the application setup will remain unchanged.

**Region and Language Settings**

The Region and Language settings for your particular computer will have some impact on the way some information is displayed in Synthesis applications.
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, 2015 is stored in the database, User A might see it as "9/25/2015" while User B might see "25-Sep-15."

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

- 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
- Which measurement system is the default for the Page Setup window

### Viewing or Changing the Region and Language Settings for Your Computer

To view or change the region and language settings:

- In Windows 8 or Windows 10, move the pointer to 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.

As an example, the Windows 7 interface is shown here. The Windows 8 and Windows 10 versions look different but function similarly.
Other relevant settings are managed via the Customize Format window:

- In Windows 8 or Windows 10, click the **Additional settings** button.
- In Windows 7, click the **Additional settings** 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.

**Which Language is Selected by Default When You Install the Software**

The user interface for Synthesis desktop applications is available in several languages. You can change this language at any time by choosing an option from the Language drop-down list on the Synthesis Settings page of the Application Setup.
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.

**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 history provided throughout Synthesis applications (e.g., for resources, FMEA records, diagrams, in history logs, etc.).
- 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., a spreadsheet module in Synthesis Workbooks, General Spreadsheets, etc.).
- Dates and times displayed in the Weibull++ event log folio are created by the folio and are not affected by the computer's settings.

**Changing the Decimal Symbol, the List Separator and the Currency Symbol**

How decimal values are displayed depends on the value of the **Decimal symbol** field on the Numbers page of 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 a spreadsheet module in Synthesis Workbooks or 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("Weibull!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("Weibull!Folio1!Data 1",500,100,0.9)).

The currency symbol that is displayed in the software depends on the selection in the Currency symbol field on the Currency page of the Windows Customized Format window.

**Setting the Measurement System in the Page Setup**

On the Margins tab of any Synthesis desktop 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.
Chapter 17: Synthesis Platform Tools

Categories, Identifiers and Filters

Defining Categories

In all Synthesis desktop applications, you can use flexible *categories* and *identifiers* to filter and group analysis data in a way that fits your specific needs. There are two types:

- **Project Categories** can be applied to projects in all desktop applications.
- **Item Categories** can be applied to project items (e.g., folios, diagrams, system hierarchy items) and resources (e.g., models, URDs) in all desktop applications except MPC.

This topic describes how to define the categories that will be available throughout the current database. To learn how to use them to filter and group data, see [Project and Item Filters](#). (For additional options related to categories for system hierarchy items, see [Item Categories in Xfmea/RCM++/RBI](#) in the Xfmea/RCM++/RBI documentation.)

Accessing the Project/Item Categories Window

There are two ways to access the Project/Item Categories window and specify which categories will be available throughout the current database. (In a secure database, these are available only for users with the “Manage project/item categories” permission.)

To open the window from the backstage view, choose **File > Manage Repository > Project/Item Categories**.

Alternatively, you can click inside any Category drop-down list (e.g., in a properties window, filter, etc.) and click the **Edit Categories** icon.
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Adding, Renaming and Deleting Categories

- To rename 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.*
Synthesis Identifiers
In all Synthesis desktop applications, you can use flexible identifiers and categories to filter and group analysis data in a way that fits your specific needs. The Synthesis identifiers are available for project explorer items (e.g., folios, diagrams, plots, etc.) and there is one standard set of identifier fields for all relevant locations.

<table>
<thead>
<tr>
<th>Category</th>
<th>Bulb A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number</td>
<td>PN12345</td>
</tr>
<tr>
<td>Version</td>
<td>Rev 1</td>
</tr>
<tr>
<td>Supplier</td>
<td>Acme Chandelier</td>
</tr>
<tr>
<td>Application</td>
<td>Chandelier</td>
</tr>
<tr>
<td>Description</td>
<td>Light bulb</td>
</tr>
<tr>
<td>Comments</td>
<td>Based on in-house test data.</td>
</tr>
<tr>
<td>Keywords</td>
<td>Bulb, Life, Test Data</td>
</tr>
</tbody>
</table>

This topic describes how to view and edit identifiers for each type of resource or analysis, and how existing identifiers will be converted from Version 8 or 9. To learn how to use identifiers to filter and group data, see Project and Item Filters.

For Synthesis Resources
To view and edit the identifiers for most types of Synthesis resources, you can simply open the properties window and select the Identifiers node. They can also be edited via the Batch Properties Editor. Note that:

- For published models, the identifiers are obtained from the analysis (e.g., Weibull++ folio, BlockSim diagram, etc.). To make a change, you must first edit the identifiers for the analysis and then republish the model.

- Identifiers are not applicable for the following resource types: Variables, Maintenance Groups, Mirror Groups, Actions and Controls.

For Project Explorer Items
To view and edit the identifiers for folios, diagrams, plots and other analyses in Weibull++, ALTA, BlockSim, RENO or Lambda Predict, select the item in the current project explorer and choose Project > Current Item > Item Properties.
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The identifiers are always displayed on the first tab of the properties window.

When applicable, the fields are also visible on the Identifiers page of the control panel. If a folio has multiple data sheets, you can use this page to define separate identifiers for each sheet. Note that the Folio Identifiers will be used in item filters and in the Synthesis Explorer; while the Data Sheet Identifiers will be used when publishing a model.

You can use an asterisk (*) in any or all of the data sheet fields to apply the same text from the corresponding folio field. As an example, the following picture shows the identifiers for a Weibull++ life data folio that contains multiple data sheets for each design prototype of a new chandelier bulb in development. Although most of the data sheet identifiers will be the same as the folio (indicated with *), the Version and Comments fields have been modified for each data sheet. The data sheet identifiers will be used when you publish a model.

For System Hierarchy Items
To view and edit the identifiers in Xfmea, RCM++ and RBI, select an item in the system hierarchy and go to the Properties tab in the Analysis panel. The same set of identifiers will be used for all analyses associated with that item (e.g., FMEA, control plan, etc.).
The fields are grouped together under the Identifiers heading. Name, Category and Keywords will always be displayed. The remaining identifiers may be hidden or renamed based on the configurable settings for the current project. (See Configurable Settings in the Xfmea/RCM++/RBI documentation.)

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Bulb A</td>
</tr>
<tr>
<td>Category</td>
<td>Bulb A</td>
</tr>
<tr>
<td>Part Number</td>
<td>PN12345</td>
</tr>
<tr>
<td>Version</td>
<td>Prototype</td>
</tr>
<tr>
<td>Supplier</td>
<td>Acme Chandelier</td>
</tr>
<tr>
<td>Application</td>
<td>Chandelier</td>
</tr>
<tr>
<td>Description</td>
<td>A specific type of light bulb with specific characteristics.</td>
</tr>
<tr>
<td>Comments</td>
<td>FMEA performed in August 2015. John Engineer moderated.</td>
</tr>
<tr>
<td>Keywords</td>
<td>Bulb, FMEA</td>
</tr>
</tbody>
</table>

**For Diagram Blocks**

To view and edit identifiers for diagram blocks in BlockSim, open the block properties and select the Identifiers node. The fields are also visible on the Identifiers page of the control panel when the block is selected.

You can use these identifiers in BlockSim’s Find utility and in the Batch Properties Editor.
Conversion from Version 8/9
The following table shows how the "global identifiers" from previous versions will be mapped when you convert existing data in a Version 8/9 database (where “ - “ indicates no change).

Project and Item Filters
In many locations throughout all Synthesis desktop applications, you can use flexible filters to limit a list of projects, project items (e.g., folios, diagrams, system hierarchy items, etc.) or resources (e.g., models, URDs, etc.).

The drop-down list contains the filters you have saved in this database, plus any filters that another user has chosen to share with other database users.
Use the drop-down list to apply an existing filter. To stop filtering the list, select Show All (formerly called "Default filter").

**Sharing Filters with Other Users**
To share a saved filter, open the filter's properties window and select the Show to all repository users check box.

In a secure database, a shared filter can be edited or deleted only by a) the user who created the filter or b) a user with the "Manage other repository settings" permission.

**Project Filters**
Project filters can be applied to lists that contain project names such as the Project Manager and Synthesis Explorer. Now in Version 11, the filter can either be a query based on specified criteria, or a selected list of projects.

- **Based on Criteria.** You can match All Criteria (AND query) or Any Criteria (OR query):
  - Owner ([project owner](#))
  - Category ([project category](#))
  - Analysis/Feature (whether the project contains analyses associated with the specified application or feature)
  - Last Updated By
  - Last Updated Date

- **Based on Selected Projects.** Click the Add button to select the projects you want to include, or the Remove button to remove a selected project from view.

Clear the Show locked projects check box if you want to exclude locked projects from the results, even if they meet the criteria.

Projects are always grouped based on whether they are public, private or reference. For additional grouping, select the Group by category and/or Group by owner check boxes. If you select both, the results will be grouped first by project category and then by project owner. For example:
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Item Filters
Item filters can be applied to lists that contain project items and resources such as the Current
Project Explorer and Resource Manager.

Select whether the item must match All Criteria (AND query) or Any Criteria (OR query):

- Category (item category)
- Created By
- Last Updated By
- Last Updated Date
- Synthesis identifiers (Name, Part Number, Version, Application, Supplier, Description, Comments and Keywords)

Synthesis Explorer

The Synthesis Explorer is available in all Synthesis desktop applications except MPC. You can use this flexible tool to explore all of the different analyses that are stored in the current database.

To access the utility, choose Home > Synthesis > Synthesis Explorer.

To reduce the amount of time required to populate the grid, first use the project and item filters (discussed below) to limit your search, then click Load Data.
The analyses shown in the explorer may include:

- Project items in Weibull++, ALTA, BlockSim, RENO, RGA and Lambda Predict (e.g., folios, diagrams, plots, Synthesis Workbooks, etc.).
- Analyses that are associated with system hierarchy items in Xfmea, RCM++ or RBI (e.g., FMEAs, control plans, risk based inspection analyses, etc.).
- Project Plans that can be created for any project.

You can filter/sort/group the analyses based on Synthesis application, analysis type, analysis creator and many other properties. You can also present the information in a wide variety of dashboard charts.

This topic summarizes the tools you can use to find and organize data in the Synthesis Explorer’s flexible grid. For information about presenting the data graphically, see Synthesis Explorer Dashboards. For a list of the properties that can be used in either the grid or the dashboard, see Synthesis Explorer Properties.

**Save and Apply Views**

Once you have customized the Synthesis Explorer’s grid to suit a particular purpose (using the built-in find/filter, column configuration and grouping features described below), you can save the preferences as a view that can be used again whenever you need it. A view is saved in the database and available only to the user who created it.

To create a view, first configure the grid to suit your particular needs and then click **Save View**.

To quickly apply these same preferences again at any time, click **Apply View** and select one of the saved views from the list.

---

**Note**: The view does not affect filtering that has been applied from the Project Filter, Item Filter or Category Panel.

**Project and Item Filters**

The Synthesis Explorer can utilize the same project and item filters that are available in many other locations throughout Synthesis desktop applications. For example, with the custom filters shown below, the Synthesis Explorer will show only analyses performed by Department A (project filter) that were modified within the last month (item filter).
To remove either filter, select Show All from the drop-down list. To remove both filters at the same time, select Data > Clear Filters.

After you clear or change these filters, you must click Load Data again to update the grid.

**Category Panel**

The category panel provides a quick way to filter the data based only on item category. For example, you might use the panel to first view the analyses for Category A and then quickly switch to see the analyses for Category B.

To show or hide the panel, click Data > Show Category Panel.

When there are many categories, the tools at the top of the panel can help you find and select the one(s) you need.

**Built-in Find/Filter, Configuration and Grouping Tools**

The Synthesis Explorer offers the same filter, column configuration and grouping tools that are built in to other Synthesis utilities that use a similar grid (e.g., the Resource Manager). For details about how to use each feature, see:

- Finding and Filtering Records
- Configuring Columns
- Grouping Panel
Synthesis Explorer Dashboards

You can use the flexible Synthesis Dashboard utility for presenting data from the Synthesis Explorer.

As with any other Synthesis dashboard, you can use the Dashboard Viewer to select any of the layouts that have been predefined for this type of data, and you can use the Dashboard Layout Manager to create or edit layouts.

(In a secure database, the Dashboard Layout Manager is available only for users with the “Manage dashboard layouts” permission.)

Values and Arguments

When you’re creating bar charts or pie charts based on Synthesis Explorer data, note that the argument(s) determine the bars or slices shown in the chart and the value will always be the quantity of analyses that fit the specified criteria.

If you use the default Count option when specifying the value, then any of the Synthesis Explorer properties will return the same quantities. You may prefer to choose the one that gives the most appropriate chart label(s). For example, the following pie chart uses the same property (“Application Source”) for both the Value and Argument in order to display the total quantity/percentage of analyses for each Synthesis application.

Tip: Use the Design tab of the ribbon to configure the chart labels and other settings to fit your particular preferences. For example, in this chart, the Data Labels are configured to display the Argument, Value and Percent (e.g., BlockSim: 648 (23.44%).}
If there is ever a situation in which you want to show only the number of distinct values for a particular property, you can use the Count Distinct option instead. For example, the following pie chart uses User Created By (Count Distinct) for the value in order to show the number of users who created analyses with each Synthesis application.
As you can see from looking at both charts, the “Count” shows that there are 648 total BlockSim analyses; while “Count Distinct” shows that only 18 distinct users created BlockSim analyses.

Filtering the Data
Any filters that are currently applied in the Synthesis Explorer grid will not be reflected in the dashboard charts. However, you can incorporate filters directly into the dashboard layout. For example, if you want to show all of the Weibull++ analyses that were created by a particular user, you can create a filter like the one shown next. (See Using the Filter Editor.)

In addition (or instead), you can configure the layout with one or more master filters that allow individual users to change the filters on-the-fly in the Dashboard Viewer. As an example, the following picture shows a layout in which the user’s current selections in the two grids determine which analyses will be reflected in the pie chart at any given time. (See Configuring a Master Filter and Using Master Filters.)
Synthesis Explorer Properties
The following properties will be available when you are using either the grid or dashboard in the Synthesis Explorer.

Application
- **Application Source** is the primary Synthesis application (or product family) for viewing or editing the analysis. (Note that Project Planners and Simulation Worksheets are listed under Synthesis because they can be created/edited from more than one product family.)
- **Application Activated**? indicates whether the primary application is activated on your computer.

Project
- **Project Name** is the project in which the analysis is stored.
- **Project Type** indicates whether it is a public, private or reference project.

Analysis
- **Analysis Name** is the name of the folio, diagram, plot, system hierarchy item, etc.
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- **Analysis Type** and **Variant** indicate the type of analysis. This can include project items (e.g., folios, diagrams, plots, etc.) and specific analyses that are associated with a system hierarchy item in Xfmea, RCM++ or RBI (e.g., FMEAs, risk based inspection analyses, etc.). The variant is used to distinguish:
  - Analytical vs. simulation RBDs and fault trees in BlockSim.
  - Discrete vs. continuous Markov diagrams in BlockSim.
  - The specific prediction standard in Lambda Predict (e.g., MIL-217, Telcordia, etc.). If the prediction folio uses more than one standard, this will show as “Multiple.” If a standard has not yet been added to the prediction folio, the variant field will be blank.

**Categories and Synthesis Identifiers**
*Note that these properties are preceded with “SI” in the Dashboard Layout Designer, so that all Synthesis identifiers can be grouped together in the data source panel.*

- **Category** is the category assigned to the analysis.
- **Name, Part Number, Version, Supplier, Application, Description, Comments** and **Keywords** are the standard Synthesis identifiers that can be defined for the analysis. Note that Xfmea/RCM++/RBI analyses use the identifiers defined for the system hierarchy item they are associated with.

**Creation and Last Update**
- **User Created** and **Date Created** indicate the database user who originally created the analysis, and the associated date/time.
- **User Updated** and **Date Updated** indicate the database user who last modified the analysis, and the associated date/time.

**Synthesis Locator Links**
Synthesis Locator Links provide quick access to specific analyses in a Synthesis repository (similar to Windows shortcuts). You can save these link files anywhere on your computer or network, e-mail to a colleague, post on the Internet or an intranet, etc.

When you double-click (open) a Synthesis Locator Link file (*.rsrl11), it will launch the appropriate Synthesis application and go directly to a specific project item (e.g., folio, diagram, plot, system hierarchy item, etc.) or FMEA record (e.g., function, failure, etc.), as long as the following conditions are met:
- The database still resides in the same location and you have access to the server.
• You have an active user account in the database.
• The required Synthesis application is activated on your computer.

**Tip**: In the case of a standard database or Synthesis file, the locator link stores the pathname/filename that was open when the *.rsll file was created. If that was a mapped network drive (e.g., P:\Synthesis\Repository1.rsrl1), the link will only work if all other users have that drive mapped to the same letter. To make sure the link works for all users, you may need to open the database from the UNC pathname (e.g., \SharedDrive\Synthesis\Repository1.rsrl1) before creating a locator link file.

### Creating a Locator Link

In an enterprise database, you can choose to either send the file by e-mail or save it to a specified location. In a standard database or Synthesis file, the only option is to save the file because it is likely that the pathname may only work on your own PC (as discussed above).

![Enterprise database](image1.png) ![Standard database or Synthesis file](image2.png)

- For an item selected in a current project explorer (Weibull++/ALTA, BlockSim/RENO, RGA or Lambda Predict), choose **Project > Current Item > Save Locator Link**.
- For an item selected in an Xfmea/RCM++/RBI system hierarchy, choose **System Hierarchy > Current Item > Save Locator Link**.
- For an item, structure or zone selected in an MPC hierarchy, choose **[Systems/Structures/Zones] > Tools > Save Locator Link**.

**Note**: If you get a "Locator Link is not properly formatted" message, the locator link may be corrupted or is using old encryption. Create a new locator link using the methods described above.

### Posting Locator Links on a Web Page

Remember that Synthesis Locator Links are files that must be opened from a computer where Synthesis desktop applications are installed. If you post the *.rsrl1 as a standard link on an HTML web page, you will need to instruct users to download the file (instead of opening directly from the web browser).
What's Changed? In Version 10, Synthesis Locator Link files used the *.rsll extension. Note that these links are not compatible with Version 11.

Watches and Alerts

Automated alerts can be an effective tool to facilitate communication and track the status of assigned responsibilities.

Alerts can be sent via e-mail, SMS text message and/or Synthesis portal messages, depending on the Receive automated alerts preference specified for your personal user account.

- Alerts via portal message are always available in any database.
- Alerts via e-mail or SMS are only available if they are enabled for the database, and a valid SMTP server has been defined. (See Enable Alerts via E-mail or SMS.)

Alerts can now be sent for:

- Any Synthesis resource that you have personally subscribed to “watch.” (See Subscribing to a Watch.)
- Action resources, under any of the following conditions:
  - You have personally subscribed to watch the action.
  - You are the action’s creator, person responsible or assigned reviewer/approver and the database has been configured to auto-subscribe a watch for that role. (See Action Alert Preferences.)
  - You are assigned via the Action Monitors window. (See Action and Gate Monitors.)
- Project Planner gates, under either of the following conditions:
  - You have personally subscribed to watch the gate.
  - You are assigned via the Gate Monitors window.
- Change logs you have been assigned to approve in Xfmea/RCM++/RBI. (See Electronic Approval Tracking in the Xfmea/RCM++/RBI documentation.)
Enable Alerts via E-mail or SMS
To configure a database to enable alerts via e-mail and/or SMS text message, choose File > Manage Repository > Repository Settings.

In a secure database, this is available only for users with the “Manage other repository settings” permission.

What’s Changed? In prior versions, similar preferences were defined in the E-mail and Other Settings window.

1. Select the Enable Alerts via E-mail or SMS 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.)

<table>
<thead>
<tr>
<th>SMTP port</th>
<th>SMTP server</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>&lt;Insert a valid SMTP address&gt;</td>
</tr>
</tbody>
</table>

3. Enter your e-mail address (or a valid SMS text messaging address if you prefer) in the Recipient address for test message field and then click Send Test Message.

If the test message cannot be sent, an error will be displayed. If that happens, you can update the settings and try again until the message is delivered successfully.

Subscribing to a Watch
Users can personally subscribe to “watch” specific Synthesis resources, Project Planner gates and MPC tasks that are of particular interest to them. This generates an alert (via e-mail, SMS text message and/or Synthesis portal message) each time the record is changed.
Subscribing and Unsubscribing
To personally subscribe/unsubscribe to a watch, open the resource, Project Planner gate or MPC task and select or clear the **Alert me on changes to this record** check box. The alert types shown for this option will depend on your alert preferences, as described in the section below.

![Watch](image)

Note that the “watch” feature is not applicable for the following types of resources: Variables, Maintenance Groups, Mirror Groups, Controls, Maintenance Templates (in BlockSim) or RENO-specific resources (Functions, Static Functions, Simulation Definitions and Tables).

Receiving Alerts
Alerts can be sent via e-mail, [SMS text message](#) and/or [Synthesis portal message](#), depending on the **Receive automated alerts** preference specified in your personal user account.

- Alerts via portal message are always available in any database.

- Alerts via e-mail or SMS are only available if they are enabled for the database, and a valid SMTP server has been defined. (See [Enable Alerts via E-mail or SMS](#).)

No Cascading Alerts
Alerts are generated only when the record you’re watching is edited directly. For example, if you are watching a universal reliability definition (URD):

- An alert will be sent if someone replaces Model A with Model B in the URD window.

- An alert will not be sent if there is a change to an existing model, crew, etc. that is already assigned to the URD, unless you have also subscribed to watch the dependent resource that was changed.

Special Considerations for Actions and Gates
For action resources only, there are some additional features designed to maintain continuity with prior versions of Synthesis and enhance the actions management functionality. Specifically:

- Action changes that are applied via the FMEA worksheet in Xfmea/RCM++/RBI will not initiate an alert. The change must be saved via the action properties window.

- The database can be configured to auto-subscribe watches for users with the following roles: **Action Creator**, **Person Responsible** or **Reviewer** (aka “approver”). Each user can choose to personally unsubscribe later if desired. (See [Action Alert Preferences](#).)

- The Action Monitors window allows you to specify individual users and/or groups of users who will always receive alerts for the action, regardless of whether they have...
personally subscribed to a watch. For example, this allows you to set up an alert for a user who doesn’t have access to view or modify the project (and therefore can’t personally subscribe to a watch).

A similar feature, the Gate Monitors window, is available for Project Planner gates. (See Action and Gate Monitors.)

**Action Alert Preferences**

To configure the action alert preferences for the database, choose File > Manage Repository > Repository Settings.

In a secure database, this is available only for users with the “Manage other repository settings” permission.

**What’s Changed?** In prior versions, similar preferences were defined in the E-mail and Other Settings window.

- **Introduction to each action alert sent via e-mail.** This field allows you to specify the default text (up to 1,000 characters) that will be used at the beginning of each action alert e-mail sent from this database.

- **Automatically set ‘watch’ for.** Users can personally subscribe to “watch” specific Synthesis resources and Project Planner gates that are of particular interest to them. For action resources only, the database can also be configured to auto-subscribe watches for users that have particular roles in a given action, as shown in the picture above. Note that each user can choose to personally unsubscribe later if desired (by opening the action record and clearing the check box under the Watch heading).
Action and Gate Monitors

The Action Monitors window (for action resources) and the Gate Monitors heading (for Project Planner gates) allow you to specify individual users and/or groups of users who will always receive alerts for the record, regardless of whether they have personally subscribed to a “watch.”

For example, this allows you to set up an alert for a user who doesn’t have access to view or modify the project (and therefore can’t personally subscribe to a watch).

Action Monitors

For actions, click the **Action Monitors** icon in the action’s ribbon.

This replaces the “E-mail Notifications” feature from prior versions, and you can choose any of the user groups or individual user accounts defined in the current database.

The action will also appear under the **I am monitoring** heading in **My Portal, Actions Explorer** and **Synthesis Enterprise Portal** (along with the actions that the user has personally subscribed to watch).

Gate Monitors

For Project Planner gates, the assigned users are listed under the **Gate Monitors** heading. Click the **Edit** icon to select the users you wish to assign.

This replaces the “Team” feature from Xfmea/RCM++/RBI Version 9, and you can choose to assign any of the individual user accounts in the database.

What is Your SMS Address?

If you choose to receive alerts via SMS text messaging, the address will usually be your cell phone number @ the provider’s e-mail domain. As a courtesy, the table below provides a list of domains for popular providers in the United States (as of March 2015). Of course, you may need to check with your provider to obtain the most up-to-date information.
For example, if you use T-Mobile in the US and your cell number is 555-123-4567, your SMS address will be 5551234567@tmomail.net.

<table>
<thead>
<tr>
<th>Provider</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alltel</td>
<td>@message.alltel.com</td>
</tr>
<tr>
<td>Amp'd</td>
<td>@vtext.com</td>
</tr>
<tr>
<td>Boost</td>
<td>@myboostmobile.com</td>
</tr>
<tr>
<td>AT&amp;T</td>
<td>@txt.att.net</td>
</tr>
<tr>
<td>Metrocall</td>
<td>@page.metrocall.com</td>
</tr>
<tr>
<td>Nextel</td>
<td>@messaging.nextel.com</td>
</tr>
<tr>
<td>Sprint</td>
<td>@messaging.sprintpcs.com</td>
</tr>
<tr>
<td>T-Mobile</td>
<td>@tmomail.net</td>
</tr>
<tr>
<td>US Cellular</td>
<td>@mms.uscc.net</td>
</tr>
<tr>
<td>Verizon</td>
<td>@vtext.com</td>
</tr>
<tr>
<td>Virgin (USA)</td>
<td>@vmobl.com</td>
</tr>
<tr>
<td>Windstream</td>
<td>@windstream.net</td>
</tr>
</tbody>
</table>

**History Logs**

By default, all projects and project items automatically show information about when an item was created and last updated, and by whom. For example, system hierarchy items in Xfmea/RCM++/RBI show this information under the History heading on the Properties tab, while folios and diagrams in Weibull++ and BlockSim show the information in the Item Properties window *(Project > Current Item > Item Properties)*.

In addition to the basic information provided, you have the option to activate a full history log that shows more detailed information such as the type of change that was made (e.g., add, edit or delete), the record that was changed and the specific property, and the value before and after the change.
History logs will increase the size of a database and will cause a slight degradation in performance; hence, they must be activated on a per project basis. If desired, you can configure the database to automatically activate history logs for each new project by choosing File > Manage Repository > Repository Settings, and then selecting the option under the Other Settings tab in the window. (In secure databases, this is available only if the user has the "Manage other repository settings" permission.)

Once a history log is activated, the project history log shows the changes for all items in the project, and individual record history logs show the changes for selected items only.

**Tip:** If you want to monitor and control revisions made to FMEAs, DVP&Rs or Control Plans in Xfmea/RCM++/RBI, the use of change logs may be more appropriate. See Change Logs in the Xfmea/RCM++/RBI documentation.

### Activating a Project History Log

To activate the history log for a project, choose Project > Management > History Log, or right click the project in the project list and choose the command on the shortcut menu. (In secure databases, this is available only if the user is the project owner, or has the applicable "manage all projects" permissions.)

In the Project History Log window that appears, click Activate.

Once the log has been activated, the database will start keeping records of all changes that are performed throughout the entire project for any of the Synthesis applications. You can filter the records by the last update date, application, user or type of change. 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.

You can deactivate the history log at any time from this window. When you do this, the recorded data is retained unless you select to clear it in the confirmation message that appears.

### Creating and Managing Archives

You can limit the amount of information that is visible in the log by archiving older entries that are no longer of interest. Entries that have been archived can still be viewed in the Project History Log window if you specifically select to view them, but they will no longer be visible in the Record History Log windows.
Archives are named based on the date they were created. For example, if you 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 after the current date.

To view the contents of an archive, select the archive of interest from the Archive drop-down list in the Filter Based On area. To delete an archive, click the Delete icon that appears in the field.

Note: When a restore point is created for a project or when a project is checked out, all current entries in the history log are automatically archived.

**Viewing Record History Logs**

In addition to the project history log, you can view a log that shows only the changes made to a selected item (archived entries will not be shown). The History Log icon 🗳️ will be displayed whenever the log is available:

- For folios, diagrams, multiplots (such as overlay plots), reports and worksheets, right-click the item in the current project explorer and choose Item Properties, then in the window that appears, click the History Log icon in the Identifiers tab.

- For system hierarchy items in Xfmea/RCM++/RBI and MPC, select the item then click the History Log icon in the Properties panel.

- For FMEAs, DVP&Rs and other analyses in Xfmea/RCM++/RBI, right-click the analysis’s tab in the Analysis panel and choose the History Log command on the shortcut menu.

- For resources (e.g., models, actions, etc.), the History Log icon will be available when you edit the item or view its properties.

**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 repositories. The options will vary depending on which application you are currently using.
In desktop applications, you can:

- Import data from an existing database when you are creating a new one.
- Convert and import data from prior version files.
- Import/export selected projects.

When applicable, you can also:

- Import/export selected project items or Synthesis resources.
- Import from an Excel spreadsheet or delimited text file into a data folio.
- Use XML files to import/export system configuration information in BlockSim or Lambda Predict.

These features can be accessed either from the Import/Export Wizard (Project > Management > Import/Export) or from the Backstage View.

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.

**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 database, the Import Data from Existing Repository window will be displayed.

First, use the drop-down list or browse icon to select the database that you want to import from. This can be a standard database (*.rsr11) 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.
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**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 SQL Server Logins or Using Windows Impersonation.)

**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, 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 Converting Xfmea/RCM++ 5 Databases.)

**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.

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.
   - See Converting from BlockSim 6 or 7 Files.
   - See Converting MPC 3 Databases.

*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. (See Converting Xfmea/RCM++ 5 Databases.)*
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.

### 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.

<table>
<thead>
<tr>
<th>Weibull++/ALTA</th>
<th>RGA</th>
<th>BlockSim/RENO</th>
</tr>
</thead>
<tbody>
<tr>
<td>ReliaSoft Office 7 projects (*.rso7)</td>
<td>RGA 7 projects (*.rga7)</td>
<td>BlockSim 7 projects (*.rbp)</td>
</tr>
<tr>
<td>Weibull++ 7 projects (*.rwp)</td>
<td>RGA 6 projects (*.rga)</td>
<td>BlockSim 6 projects (*.rb6)</td>
</tr>
<tr>
<td>ALTA 7 projects (*.ralp)</td>
<td></td>
<td>RENO 1 projects (*.rnp)</td>
</tr>
<tr>
<td>Weibull++ 6 projects (*.rw6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALTA 6 projects (*.ra6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOE++ 1 projects (*.rdoe)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 Converting from BlockSim 6 or 7 Files.)
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. (See Converting Xfmea/RCM++ 5 Databases.)

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

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 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:

\[
\text{Indirect cost} = \text{Average stock level} \times \text{Holding cost per item} \times \text{Simulation end time}
\]

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 recalculation 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 recalculation 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).
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- 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.

Converting Xfmea/RCM++ 5 Databases
This topic describes how to convert/import data from an Xfmea/RCM++ 5 database into a Synthesis repository.

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 *.rsr11; 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. You must be a member of the Admin group in the Synthesis enterprise repository to perform this task.
Do the following:

1. Connect with the enterprise database you want to import into.
2. Choose File > Manage Repository > Import from Version 5.
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 SQL Server Logins or Using Windows Impersonation.)

### 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 Users and 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 documentation.

**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 Security Options 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 *.rsr11 and the original *.rsm file will remain unchanged.
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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 the Synthesis version than they were in Version 3. Specifically:

- Some of the Task Types that were combined in Version 3 are now categorized separately in the Synthesis version (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 the Synthesis version, 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 the Synthesis version. 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 the Synthesis version, 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 Version 3 and the Synthesis version. 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.

<table>
<thead>
<tr>
<th>Task Type (Old Value)</th>
<th>Task Type (New Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discard (DS)</td>
<td>Discard (DIS)</td>
</tr>
<tr>
<td>Restoration (RS)</td>
<td>Restoration (RST)</td>
</tr>
</tbody>
</table>

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.

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

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 the Synthesis version of MPC 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.

  ![Interval Type and Interval Table 1](image1)

- 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 flt/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 and Interval Table 2](image2)

*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 **Time and Usage 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 > Time and Usage 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 the Synthesis version. There will be a match if
the name or abbreviation of a Synthesis version 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 "Time and Usage 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.

<table>
<thead>
<tr>
<th>Zonal (Old Value)</th>
<th>Zonal Candidate (New Value)</th>
<th>Zone (Old Value)</th>
<th>Zone (New Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer</td>
<td>Yes</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>-</td>
<td>No</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Transfer</td>
<td>Yes</td>
<td>400</td>
<td>-100</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Importing/Exporting Projects**

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

Note that when importing/exporting a project between databases, any resources and FMEAs used by the project will be automatically imported/exported along with the project as local resources, even if they were originally reference resources or global resources. If you do not want the reference resources to be converted to local resources, you must import the both the project and the reference project at the same time. (See [Local, Global and Reference Resources](#)).

To import a project, 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:

1. Use the drop-down list or browse icon to select the database that you want to import from or export to.
   - This can be any existing standard database (*.rsr11) or enterprise database connection file (*.rserp).
   - If you are exporting, you can also use the add icon to create a new standard database to export into.

2. 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. (See [Project Manager](#)).

3. Use the check boxes to select which project(s) you want to import/export then click **OK** to copy the data.
The following considerations apply:

- The names of projects must be unique within each Synthesis repository. 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."

- If the project has a category, the application will first attempt to match it to an existing category in the destination database. If a matching category does not already exist, and you have the permission to create project categories in the destination database, it will be created automatically.

- If you select a project of a type that you don’t have permission to create in the destination database (private, public or reference), it will be converted to a type that you do have permission to create. For example, if you select to import a reference project but you don’t have the "Create and own reference projects" permission in the destination database, the project will be imported as a public or private project, and any links from other projects will be broken.

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, Synthesis 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.

First, open the project you want to import to or export from. Then open the import/export window, there are two ways:

- If you have selected the Allow multiple projects option in the Synthesis Settings page of the Application Setup, you can open both projects simultaneously and then drag/drop items from one project to another.

  OR

- Choose Project > Management > Import/Export.

  ![drag icon] or ![drop icon]

  In the wizard, choose Items (not available for Xfmea/RCM++/RBI and MPC) or Resources (not available for MPC) and click OK.
Once the Import window or Export window is open, do the following:

1. Use the drop-down list or browse icon 📂 to select the database you want to import from or export to.
   - This can be any existing standard database (*.rsr11) or enterprise database connection file (*.rserp).
   - If you are exporting, you can create a new standard database and project by clicking the 📂 icon.

2. Use the tree in the Source Project or Destination Project area to select the project 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. (See Project Manager.)

3. Use the check boxes in the Items to Import or Items to Export 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 Import or Export to copy the data.

**Note**: 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**
The application will automatically copy any item/resource that is linked to the imported or exported item, even if you did not specifically select to import/export them. Some examples:

- A multilplot, such as an overlay plot, side-by-side plot, or 3D plot, will automatically import/export a copy of the folios or diagrams that were used to generate the plot.
A BlockSim diagram will automatically import/export a copy of any utilized subdiagrams and resources.

A RENO flowchart will automatically import/export a copy of any utilized subcharts, resources and Synthesis Workbooks.

A Synthesis Workbook or special analysis folio/tool (e.g., allocation analysis, stress-strength analysis, etc.) will automatically import/export a copy of its data sources.

A URD will automatically import/export a copy of the models, maintenance tasks, crews, etc. that were used to build the URD. The same applies to any resource that is built upon another resource.

Note that when importing/exporting project items between databases, the resources are imported/exported as local resources in the destination database, even if they were originally reference resources or global resources. For more information on how importing/exporting affects a resource, see Local, Global and Reference Resources.

Tip: If you do not want a RENO flowchart to import/export an associated resource or workbook, you can enclose the resource/workbook name in single quotes to reference it by name only. For example, if you export a diagram that contains a block using the expression 'Model1'(1000), Model1 will not be transferred along with that diagram. If the destination project already contains a model called Model1, that model will be used in simulating the transferred diagram.

Importing from Excel or Delimited Text Files into a Folio

In Weibull++/ALTA and RGA, 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 design folios, 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 rest of this topic describes how to map the data for import into a Weibull++, ALTA or RGA data folio.

**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.

**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 heading and maps the data to a column in the data folio.

   - If the heading displays a letter, the data in that column will not be imported.
• If the heading 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++ life data folio. Column A will not be imported. The rest of the data has been assigned to columns that are used in the folios.

3. If you are importing to an ALTA life-stress data 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.

**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.

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.

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.
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 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.

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. XML files can be used 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**.

### Attachments

All Synthesis desktop 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.

In all Synthesis desktop 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. If your organization chooses to implement a web-based Synthesis Enterprise Portal (SEP) for an enterprise database, note that File Links (i.e., stored paths to local files on your computer or network) will not be accessible in most web browsers due to security settings. When you delete a file link or URL, this simply removes the link, leaving the original file untouched.

- **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. 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 or restore point that you could roll back to).
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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.

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.

### 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.

### Project Attachments

All Synthesis desktop 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**.

### 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.

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 headings 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.

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.

Select Existing Text Window
The Select Existing Text window provides a list of existing descriptions that might apply to the current text field or analysis. This can help to save time on data entry, ensure consistency and facilitate brainstorming. The utility is used extensively in applications such as Xfmea, RCM++, RBI and MPC, and it is also available for certain text fields in other Synthesis desktop applications.
In Version 11, there are now two ways this utility might be used:

- **Replace or append text in the current field** - If you click the icon inside a text field, you can select one description and either replace the current text or append the new text to the end.

- **Create one or multiple new records** - If you use one of the ribbon commands in an FMEA or P-Diagram (e.g., Add Multiple Functions > Select Existing Text), you can select multiple descriptions and the utility will use your selection(s) to create new record(s).

The options will vary depending on the record/field type, and whether you are updating a single description or adding new records. The following example shows how the tool may be used to populate the function description in an FMEA.

**Tip:** The descriptions are sorted alphabetically under each heading. When the table has focus, you can type a letter to move to the next description that begins with the letter.

**Project and Item Filters**

This window utilizes the same project and item filters that are available in many other locations throughout Synthesis desktop applications. For example, when searching for text for an item in the system hierarchy, you could use a Project Filter to search for analyses performed by Department A and then use an Item Filter to show only those analyses that were modified in the last month.

In addition, when applicable:

- **Current Project** limits the results to data in the current project.
Current Item Branch limits the results to those found in the current branch of the system hierarchy.

Record Filter
When applicable, the Record Filter shows the possible sources for the current record type and field that you can choose to include or exclude. The specific record types vary depending on the field.

Phrase Sets
FMEA records in Xfmea, RCM++ and RBI also have the option to include text from selected phrase sets.

Field Text
Use the drop-down list in the Field Text area to specify how to match the specified keywords, then type the keywords into the input box.

- Contains returns descriptions that contain the exact string entered.
- Contains Any and Contains All allow you to enter multiple keywords (separated by commas) and returns descriptions that contain at least one (any) or all of the keywords entered.
• **Begins With** returns descriptions where the exact string entered appears at the start of the field.

• **is** returns descriptions where the exact string entered matches the whole field.

## Record Filter Options

When the descriptions can be obtained from more than one type of analysis (e.g., when PFMEA failures can be copied from FMEA causes, or when control plan operations can be copied from PFD Worksheet operations), the headings in the table identify the source. You can use the Record Filter to specify which source(s) to include.

### FMEAs

<table>
<thead>
<tr>
<th>FMEA Functions</th>
<th>System Hierarchy Items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P-Diagram Ideal Responses</td>
</tr>
<tr>
<td></td>
<td>PFD Worksheet Operations</td>
</tr>
<tr>
<td>FMEA Failures</td>
<td>P-Diagram Error States</td>
</tr>
<tr>
<td></td>
<td>FMEA Causes</td>
</tr>
<tr>
<td></td>
<td>PFD Worksheet Product Characteristics</td>
</tr>
<tr>
<td>FMEA Effects</td>
<td>FMEA Failures</td>
</tr>
<tr>
<td>FMEA Causes</td>
<td>P-Diagram Change Over Times</td>
</tr>
<tr>
<td></td>
<td>P-Diagram Control Factors</td>
</tr>
<tr>
<td></td>
<td>P-Diagram Piece-to-Piece</td>
</tr>
<tr>
<td></td>
<td>PFD Worksheet Process Characteristics</td>
</tr>
<tr>
<td>FMEA Controls</td>
<td>Control Plan Methods</td>
</tr>
<tr>
<td></td>
<td>DVP&amp;R Test/Specification Methods</td>
</tr>
<tr>
<td>FMEA Actions</td>
<td>DVP&amp;R Test/Specification Methods</td>
</tr>
</tbody>
</table>

### P-Diagrams

<table>
<thead>
<tr>
<th>Input Signal</th>
<th>System Hierarchy Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Factors</td>
<td>FMEA Causes</td>
</tr>
<tr>
<td>Error States</td>
<td>FMEA Failures</td>
</tr>
</tbody>
</table>
### Ideal Response

<table>
<thead>
<tr>
<th>Ideal Response</th>
<th>FMEA Functions</th>
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</thead>
<tbody>
<tr>
<td>Piece-to-Piece</td>
<td>Analysis Plan Assumptions</td>
</tr>
<tr>
<td></td>
<td>FMEA Causes</td>
</tr>
<tr>
<td></td>
<td>PFD Worksheet Product Characteristics</td>
</tr>
<tr>
<td>Usage</td>
<td>Analysis Plan Assumptions</td>
</tr>
<tr>
<td>Environment</td>
<td>Analysis Plan Assumptions</td>
</tr>
<tr>
<td>Change Over Time</td>
<td>Analysis Plan Assumptions</td>
</tr>
<tr>
<td></td>
<td>FMEA Causes</td>
</tr>
</tbody>
</table>

### Control Plans, PFD Worksheets and DVP&Rs

<table>
<thead>
<tr>
<th>Control Plan Part/Process Number</th>
<th>FMEA Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PFD Worksheet Operations</td>
</tr>
<tr>
<td>Control Plan Process Name/Operation Description</td>
<td>FMEA Functions</td>
</tr>
<tr>
<td></td>
<td>PFD Worksheet Operations</td>
</tr>
<tr>
<td>Control Plan Product Characteristic</td>
<td>PFD Worksheet Product Characteristic</td>
</tr>
<tr>
<td></td>
<td>FMEA Causes</td>
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<td>Control Plan Method</td>
<td>FMEA Controls</td>
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<tr>
<td>PFD Worksheet Operation Description</td>
<td>System Hierarchy Items</td>
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<tr>
<td>DVP&amp;R Test/Specification Method</td>
<td>FMEA Controls</td>
</tr>
<tr>
<td></td>
<td>FMEA Actions</td>
</tr>
</tbody>
</table>
Check Spelling

Synthesis desktop 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.

### 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.

- **Paste** pastes the contents of the Clipboard into the current control.

- **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 Special** opens the Paste Special window, which allows you to paste specific cell contents or attributes (such as formulas, formats, or comments) from the Clipboard.

- **Quick Print** sends the current document directly to the default printer without making changes.

- **Print** opens the Print window, which allows you to specify the printer and the printing options.
• **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.

### 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 desktop applications, you can open the QPE from the Model properties window or the 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++ life data folio, the 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.

### Quick Parameter Estimator 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.
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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.

**Quick Parameter Estimator Expert View**

Follow the steps below to use the Expert view of the Quick Parameter Estimator (QPE):

- 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 **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).

  • Click the **Update** button to update the model using the selected distribution, calculated parameters and selected time units.

**Quick Parameter Estimator (ALTA)**

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. You can open the QPE from the ribbon by choosing **Home > Tools > Quick Parameter Estimator (ALTA).**

You can also open the ALTA QPE from the ALTA life-stress data folio (by leaving the folio's data sheet empty and clicking Calculate), as well as the stress-dependent Monte Carlo and stress-dependent 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 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.
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.
• 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 another utility, such as the ALTA Monte Carlo tool, you may click the **Update** button if you wish to update the Monte Carlo tool with the model, parameters and time units defined in the QPE.
  
  • 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.
Chapter 18: Synthesis Resources

In Synthesis applications except MPC, 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.

Note: In a secure database, the ability to create, edit and delete resources is available only if the user a) is the project owner, b) has the applicable "resources" permissions, or c) has the applicable "manage all projects" permissions.

Types of Resources

The following tables describe 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. (In a secure database, the ability to create, edit and delete resources is available only if the user a) is the project owner, b) has the applicable "resources" permissions, or c) has the applicable "manage all projects" permissions.)

Used in Multiple Applications

<table>
<thead>
<tr>
<th>Resource</th>
<th>Used In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal reliability definitions (URDs)</td>
<td>BlockSim, RCM++, Xfmea, RBI</td>
</tr>
<tr>
<td>Variables</td>
<td>BlockSim, RENO</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Universal reliability definitions (URDs) describe a set of reliability and maintenance characteristics for a particular component/assembly.

Variables store numerical values that can be programmatically varied during simulation.
**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.

Can be **published** from analyses in Weibull++, ALTA, BlockSim, RGA and Lambda Predict, or created manually. Used in BlockSim, RENO, Xfmea, RCM++ and RBI.

<table>
<thead>
<tr>
<th>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.</th>
<th>Can be <strong>published</strong> from analyses in Weibull++, ALTA, BlockSim, RGA and Lambda Predict, or created manually. Used in BlockSim, RENO, Xfmea, RCM++ and RBI.</th>
</tr>
</thead>
</table>

**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.

Used in BlockSim, RCM++, RBI

<table>
<thead>
<tr>
<th>Tasks represent maintenance activities:</th>
<th>Used in BlockSim, RCM++, RBI</th>
</tr>
</thead>
</table>

**Task packages** represent groups of tasks that are performed together at scheduled intervals.

Used in BlockSim, RCM++, RBI

<table>
<thead>
<tr>
<th>Task packages represent groups of tasks that are performed together at scheduled intervals.</th>
<th>BlockSim, RCM++, RBI</th>
</tr>
</thead>
</table>

**Crews** represent the personnel who will perform a maintenance task.

Used in BlockSim, RCM++, RBI

<table>
<thead>
<tr>
<th>Crews represent the personnel who will perform a maintenance task.</th>
<th>BlockSim, RCM++, RBI</th>
</tr>
</thead>
</table>

**Spare part pools** determine whether a spare part will be available, how long it will take to obtain and how much it will cost.

Used in BlockSim, RCM++, RBI

<table>
<thead>
<tr>
<th>Spare part pools determine whether a spare part will be available, how long it will take to obtain and how much it will cost.</th>
<th>BlockSim, RCM++, RBI</th>
</tr>
</thead>
</table>

**Metrics** display any numerical value of interest, and track how it changes over time.

All applications except MPC via the Project Planner; analyses in Weibull++, ALTA, BlockSim, RGA, Xfmea, RCM++ and RBI

<table>
<thead>
<tr>
<th>Metrics display any numerical value of interest, and track how it changes over time.</th>
<th>All applications except MPC via the Project Planner; analyses in Weibull++, ALTA, BlockSim, RGA, Xfmea, RCM++ and RBI</th>
</tr>
</thead>
</table>

**Maintenance groups** are used to model situations in which some event within the group can trigger maintenance or state changes for other components/assemblies.

Used in BlockSim, RCM++, RBI

<table>
<thead>
<tr>
<th>Maintenance groups are used to model situations in which some event within the group can trigger maintenance or state changes for other components/assemblies.</th>
<th>BlockSim, RCM++, RBI</th>
</tr>
</thead>
</table>

**Mirror groups** are used to represent the exact same component/event in more than one location within your analysis.

Used in BlockSim, RCM++, Xfmea, RBI

| Mirror groups are used to represent the exact same component/event in more than one location within your analysis. | BlockSim, RCM++, Xfmea, RBI |
### Chapter 18: Synthesis Resources

#### Actions
Actions describe specific assignments that need to be performed.

| All applications via My Portal; Project Planner and FMEAs in RCM++, RBI and Xfmea |

#### Controls
Controls may be used in FMEAs and/or control plans to represent methods to reduce or eliminate the risk associated with potential failures.

| RCM++, Xfmea, RBI |

#### Used Only in BlockSim

<table>
<thead>
<tr>
<th>Resource</th>
<th>Used In</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switches</strong> describe how the activity transfers between active and standby blocks in BlockSim's standby containers/gates.</td>
<td>BlockSim</td>
</tr>
<tr>
<td><strong>Maintenance templates</strong> define the activities that will be performed during a maintenance phase in a phase diagram.</td>
<td>BlockSim</td>
</tr>
</tbody>
</table>

#### Used Only in RENO

<table>
<thead>
<tr>
<th>Resource</th>
<th>Used In</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RENO functions</strong> store equations that are evaluated based on input values passed to the function during simulation.</td>
<td>RENO</td>
</tr>
<tr>
<td><strong>RENO static functions</strong> store equations that are evaluated before simulation begins.</td>
<td>RENO</td>
</tr>
<tr>
<td><strong>RENO simulation definitions</strong> 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.</td>
<td>RENO</td>
</tr>
<tr>
<td><strong>RENO tables</strong> store arrays of values in rows and columns.</td>
<td>RENO</td>
</tr>
</tbody>
</table>
Chapter 18: Synthesis Resources

Used Only in ALTA

<table>
<thead>
<tr>
<th>Resource</th>
<th>Used In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profiles</td>
<td>ALTA</td>
</tr>
</tbody>
</table>

Profiles represent values that vary with time. They can be used to describe stress levels under test conditions.

Local, Global and Reference Resources

There are three types of resources:

Local resources can be used only within the project in which they were created, and are therefore available only to users with permissions within that project.

Reference resources (which are resources created in a reference project) can be used in any project throughout the database. However, in a secure database, they can be created and edited only by users who have the "Create/edit/delete local resources" permission within the reference project. These resources can be selected by any user who has at least the "Read" permission in the reference project. Users without permissions in the reference project can see the reference resources wherever they are used, but they will not be able to select or modify them.

Global resources can be used in any project throughout the database. In a secure database, they can only be created and edited by users who have the “Create/edit/delete global resources” permission. However, they can be selected by any database user.

To make a resource global, select it in the Resource Manager and choose Home > Actions > Make Global.

Making a resource global cannot be undone and this option is not available for all resource types. 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, regardless of whether it was originally local or reference).

Parent/Child Resource Relationships

Certain resources can have other resources assigned to them (e.g., URDs can have models and tasks assigned to them, tasks can have models, crews and spare part pools assigned to them, etc.). This can be considered a "parent/child" relationship.
When you create a resource from within its parent, the child resource will be of the same type as its parent. For example, if you are working with a global URD and you add a model to it, the model will be global. If you are working with a reference task and you add a crew to it, the crew will be added to the reference project that contains the task.

When you assign existing resources to a parent resource, the following rules apply:

- Any resource assigned to a reference resource must be either a reference resource within the same project or a global resource (e.g., a local model cannot be assigned to a reference URD, nor can a model in "Reference Project 2" be assigned to a URD in "Reference Project 1").

- Any resource assigned to a global resource must be either a reference resource or a global resource (e.g., a local model cannot be assigned to a global URD).

**Keeping Resources Together**

The application will automatically keep copies of a project's resources and linked FMEAs when the project is restored, checked out, imported or exported.

- When you create a restore point, any reference resources, global resources or linked FMEAs used in the project are converted to local resources/FMEAs and stored with the backup.

- When you check out a project for local editing, any reference resources, global resources or linked FMEAs used in the project are converted to local resources/FMEAs and stored with the project.

- When importing/exporting a project item that uses reference resources, global resources or linked FMEAs:
  - If you import/export within the same database, the references will remain unchanged.
  - If you import/export between databases, the destination project will contain local copies of the original resources/FMEAs.

- When importing/exporting a project:
  - If you import/export a project that uses global resources, the destination project will contain local copies of the original resources.
  - If you import/export a project that uses reference resources or linked FMEAs:
    - The references/FMEAs will be maintained if you also import/export the reference project at the same time.
If you don’t import/export the reference project at the same time, the new project will instead contain copies of the original resources/FMEAs.

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 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.

(In a secure database, the ability to create, edit and delete resources is available only if the user a) is the project owner, b) has the applicable "resources" permissions, or c) has the applicable "manage all projects" permissions.)

Opening a Resource Wizard

Throughout all Synthesis desktop 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.
Tip: If a resource is already assigned in the field, you can edit it directly without opening the wizard by clicking the Edit icon that appears in the field.

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.
### Chapter 18: Synthesis Resources

<table>
<thead>
<tr>
<th>Model Wizard</th>
<th>Task Wizard</th>
<th>Task Wizard</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Model Wizard" /></td>
<td><img src="image2" alt="Task Wizard" /></td>
<td><img src="image3" alt="Task Wizard" /></td>
</tr>
</tbody>
</table>

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 in the field or in the wizard.

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.
Chapter 18: Synthesis Resources

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.

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 (see 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 order in which the tasks are displayed reflects the priority with which tasks that are scheduled in the same way (see Task Scheduling) will be performed; for example, if there are two tasks scheduled based on interval and they conflict, the task higher in the priority list will be performed and the lower priority task will be disregarded. You can use the up and down arrows in the cells in this column to move the tasks up and down the priority list.
Additionally, the following are shown:

- **Identifiers** contains additional identifying information that can be used to search for this resource.

- **History** provides information about when the record was created and last updated. 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.

- **Watch** allows each individual user to subscribe to receive an alert (via e-mail, SMS text message or portal message) when the resource is changed.

### 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.
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**Trace Usage**
For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the Dependency Viewer.

**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. 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.).

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 (see 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.

**Associated Analysis**
In published models only, the Associated Analysis 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:** A published model includes one additional parameter that is not relevant for manually created models. **PNZ** stands for percent non-zero. A value of 1 indicates that there are no zero failure times in the data set (which is the most common scenario in life data analysis). A decimal value indicates that the data set does include zero failure times (such as out-of-the-box failures, for example). In such cases, the parameters are calculated based on the non-zero failure times, and then the PNZ value is used as a multiplier when calculating certain metrics (e.g., reliability, unreliability).

- **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 programatically 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.

**Additional Tools**
Additionally, the following are shown:

- **Identifiers** contains [additional identifying information](#) that can be used to search for this resource.
- **History** provides information about when the record was created and last updated. 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.
- **Trace Usage**. For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the Dependency Viewer.

**Publishing Models**
This topic 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 Weibull++/ALTA 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 desktop applications, the following model publishing tools are found on the Publishing page of the control panel. In Lambda Predict, they are located on the Publishing 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, 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 Publishing 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:

<table>
<thead>
<tr>
<th>Associated Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Name</td>
</tr>
<tr>
<td>Source</td>
</tr>
<tr>
<td>Application</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Status</td>
</tr>
</tbody>
</table>

- **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 life data 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 view 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.

**Tasks**

To properly analyze repairable systems, we first need to understand how components in these systems are restored (i.e., the maintenance activities that are performed on the components). In general, maintenance is defined as any action that restores failed units to an operational condition or keeps non-failed units in an operational state. For repairable systems, maintenance plays a vital role in the life of a system. It affects the system's overall reliability, availability, downtime, cost of operation, etc.
In Synthesis applications, maintenance activities are represented using tasks, which are resources that can be shared among analyses and can be managed via the Resource Manager. 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.

- **Scheduled tasks** can be performed on a known schedule, based on time, component condition or other factors. These include:
  - Preventive tasks
  - Inspection tasks
  - On condition tasks

Tasks are assigned to URDs, which are in turn used to represent a set of properties that can be applied to standard blocks in RBDs and to events in fault trees.

The Maintenance Task window allows you to create, view and edit all classes of maintenance tasks. It can be accessed by clicking the Create New or View/Edit icon in the Task wizard, which is accessed from Task fields in properties windows (e.g., the Corrective Maintenance Task field in the Universal Reliability Definition window).

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 (see 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.

- **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. 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).
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- **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 block 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 nth 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 block 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**

<table>
<thead>
<tr>
<th>Time</th>
<th>Time Since Last Repair</th>
<th>Effective Age Before Repair</th>
<th>Effective Age After Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start = 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 years</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>9 years</td>
<td>3</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>10.5 years</td>
<td>1.5</td>
<td>6</td>
<td>5.25</td>
</tr>
</tbody>
</table>

**All Accumulated Damage**

<table>
<thead>
<tr>
<th>Time</th>
<th>Time Since Last Repair</th>
<th>Effective Age Before Repair</th>
<th>Effective Age After Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start = 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 years</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th></th>
<th>9 years</th>
<th>12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>


- **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** contains [additional identifying information](http://www.reliawiki.org/index.php/Repairable_Systems_Analysis_Through_Simulation) that can be used to search for this resource.

- **History** provides information about when the record was created and last updated. If the [history log](http://www.reliawiki.org/index.php/Repairable_Systems_Analysis_Through_Simulation) has been activated at the project level, you can click the [View Item History](http://www.reliawiki.org/index.php/Repairable_Systems_Analysis_Through_Simulation) icon to open the Record History Log for the record.

- **Watch** allows each individual user to subscribe to receive an alert (via e-mail, SMS text message or portal message) when the resource is changed.

- **Trace Usage**. For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the [Dependency Viewer](http://www.reliawiki.org/index.php/Repairable_Systems_Analysis_Through_Simulation).

**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, 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 block. The downtime, etc. will depend on the preventive task properties.
    - If a corrective task is performed upon inspection and an inspection finds the block 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 block will never be restored. This could happen under either of the following circumstances:

- Neither an inspection nor a preventive task is specified for the block.
  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 corrective and preventive tasks, the simulation requests a crew as soon as a task is initiated; however, the crew does not begin performing the task 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 block 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 requested at 10 hours and will arrive at 18 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 have traveled for 8 hours, waited 40 hours for the spare part and performed the task for 5 hours for a total of 53 hours (including waiting for the spare part).

If the spare part is available without delay and all other conditions are the same, then:

- The crew will be requested at 10 hours and will arrive at 18 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 have traveled for 8 hours and performed the task for 5 hours for a total of 13 hours.
• **Task Consequences**

  • **Does this task bring the system down?:** By default, corrective tasks will not bring the system down unless having the block 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 block will always be down when a corrective task is performed, even a task with a zero duration; thus, this option cannot be changed.

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**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.

Only one preventive task can be performed on a block at any given time.

In addition to the **common task properties**, the following options are used to configure preventive tasks in the Maintenance Task window:

  • **Task Class** allows you to specify the kind of maintenance that the task performs: preventive, inspection or on condition. The options available in the Maintenance Task window will vary depending on your choice in this field.

  • **Task Scheduling** allows you to specify the circumstances under which the task will be performed. (See **Task Scheduling**.)
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.

For corrective and preventive tasks, the simulation requests a crew as soon as a task is initiated; however, the crew does not begin performing the task unless/until the spare part is available. For a complete explanation of how this affects the total time for the task, see Corrective Tasks.

Task Consequences

- **Does this task bring the system down?**: By default, preventive tasks will not bring the system down unless having the block 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 block 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 block down and the block 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 block 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.
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- **Perform this task even if the item failed before this task was scheduled to occur?** If you answer **Yes**, the task will be performed even if the item has already failed. In other words, the item's "clock" is not stopped upon failure, and the item's "virtual age" is used to trigger the task. This option is available only for preventive and inspection tasks that are scheduled based on item age.

- **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. These properties are shown only if they are enabled for the project via the interface style settings in RCM++/RBI.

- **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.

**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 previous versions of BlockSim, you could assign failure detection properties to an inspection task and set it to trigger a preventive task, thereby creating an on condition maintenance action. The Synthesis version of BlockSim offers on condition tasks, eliminating the need to create your own. Therefore, failure detection properties are now available only for on condition tasks, not for regular inspection tasks.

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.

In addition to the common task properties, the following options are used to configure inspection tasks in the Maintenance Task window:

- **Task Class** allows you to specify the kind of maintenance that the task performs: preventive, inspection or on condition. The options available in the Maintenance Task window will vary depending on your choice in this field.

- **Task Scheduling** allows you to specify the circumstances under which the task will be performed. (See Task Scheduling.)

- **Task Consequences**: An inspection task will not bring the block 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 block down and having the block 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 block will be down. Even tasks with a zero duration will bring the block down in this case.

• **Perform this task even if the item failed before this task was scheduled to occur?**: If you answer **Yes**, the task will be performed even if the item has already failed. This option is available only for preventive and inspection tasks that are scheduled based on item age, including the inspection portion of on condition tasks.

• **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. These properties are shown only if they are enabled for the project via the interface style settings in RCM++/RBI.

• **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 block at the same time.
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 BlockSim, 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. 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, 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.

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.

On condition tasks can be set to perform the preventive portion of the task even if the item failed before the approaching failure could be detected. If the inspection portion of the task is scheduled based on item age, you can answer **Yes** to the **Perform this task even if the item failed before this task was scheduled to occur?** option.

Note the following simulation assumptions regarding on condition tasks:

- An inspection that finds a block 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 block.
• 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 block 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.

**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 phase diagram starts. Please note that if the task is selected to be performed only at the start of a maintenance phase and the item that the task is associated with is not included in the maintenance phase's associated maintenance template, the task will never be performed. No further task scheduling properties are required for this option.

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. (Note that if a task has
been assigned to a task package, the task scheduling properties will be disabled and displayed in italics.)

- **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 block fails; a corrective, preventive or inspection task starts; a block is restored to operation), and choose the maintenance group(s) in which the event(s) must occur in order to trigger the task.

**Note:** For preventive and inspection tasks that are scheduled based on item age, you can use the **Perform this task even if the item failed before this task was scheduled to occur?** property to determine whether actual age or "virtual age" is considered. If you answer Yes, the task will be performed even if the item has already failed. In other words, the item's "clock" is not stopped upon failure, and the item's virtual age is used to trigger the task.

**Crews**

Crews are resources that can be shared among analyses and can be managed via the Resource Manager. You can assign the crews to maintenance tasks.

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 (see 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.
  - **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.

- If **Include logistic delay in cost** is selected, then the time spent waiting for the crew (including logistic delay and any delay incurred due to limits on the number of tasks the crew can perform simultaneously) will be included when calculating crew costs, based on the direct cost specified for the crew.

- If **Include part delay in cost** is selected, then the time spent by the crew waiting for spare parts will be included when calculating crew costs, based on the direct cost specified for the crew.

- **Identifiers** contains additional identifying information that can be used to search for this resource.
• **History** provides information about when the record was created and last updated. 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.

• **Watch** allows each individual user to subscribe to receive an alert (via e-mail, SMS text message or portal message) when the resource is changed.

• **Trace Usage.** For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the Dependency Viewer.

### Spare Part Pools

Spare part pools are resources that can be shared among analyses and can be managed via the Resource Manager. 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 (see 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. This field uses a cost per unit time model. If no model is assigned, it is assumed that there is no cost. (To determine which time unit is defined as the default, you can open the Define Units window by choosing File > Manage Repository > Time and Usage Units. The default unit is the one that is selected in the Use as Default column.)
    - If you select the **Pool has maximum capacity** check box, 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** 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, BlockSim 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
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**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** contains **additional identifying information** that can be used to search for this resource.

- **History** provides information about when the record was created and last updated. 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.

- **Watch** allows each individual user to subscribe to receive an alert (via e-mail, SMS text message or portal message) when the resource is changed.

- **Trace Usage.** For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the **Dependency Viewer**.
Metrics

A **metric** is a [Synthesis resource](#) that provides a flexible way to display any numerical value of interest, and track how it changes over time. This can be used for tracking and displaying a variety of Key Performance Indicators (KPIs) and other values, including:

- Reliability metrics (e.g., reliability, BX% life, etc.) calculated from a model resource.
- Any result from a simulated BlockSim diagram.
- The completion percentage and resource usage for Project Planner gates.
- The reliability or availability calculated from an FMRA in Xfmea/RCM++/RBI.
- Any other user-defined value that you wish to display and track.

Like any other Synthesis resource, you can create or edit metrics from the [Resource Manager](#), and while you’re performing a relevant analysis. (See [Showing Metrics in Folios/Diagrams](#), [Using Metrics in Project Planner Gates](#) and [Pushing Metrics from an FMRA](#).)

If your organization chooses to implement a web-based [Synthesis Enterprise Portal](#), it's easy to choose specific metrics that you want to access quickly from any web-enabled device.

**Note:** Metrics are always local resources. They cannot be made global. Metrics in a reference project are local to that project and can't be selected for use in other projects.
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**Metric Types**
The following pictures demonstrate the four basic options for specifying the value that will be displayed and tracked.

### Calculate from a model resource

<table>
<thead>
<tr>
<th>Metric Type</th>
<th>Reliability Given Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Model</td>
<td>Widget LDA [WB2 (1.5, 1000)]</td>
</tr>
<tr>
<td>Time</td>
<td>100 (Hr)</td>
</tr>
</tbody>
</table>

### Obtain from a BlockSim simulation diagram

<table>
<thead>
<tr>
<th>Metric Type</th>
<th>Simulation Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Diagram</td>
<td>System RBD</td>
</tr>
<tr>
<td>Result</td>
<td>Mean Availability</td>
</tr>
</tbody>
</table>

### Enter any user-defined value

<table>
<thead>
<tr>
<th>Metric Type</th>
<th>Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>100</td>
</tr>
</tbody>
</table>

### The value is "pushed" from a Project Planner gate or FMRA

| Metric Type | Application Driven Value |

**Calculated Result and Saved Values**
The **Calculated Result** field shows the latest calculated value for the metric. This will be updated automatically if the associated analysis or model changes, and the latest result will be stored in an array of saved values.

You can then click the **View Saved Values** icon to view the history of how the metric has changed over time.

| Calculated Result | 0.960071994340075 |

If you change any of the properties that affect the way the result is calculated, you will be prompted to decide whether to clear the array of values that were saved before the change. For example:

- If you change the metric from Reliability to Probability of Failure, or from 1,000 hours to 500 hours, you will probably want to clear the array so the timeline of saved values is not misleading.

- Alternatively, if you change the metric’s associated model from prototype1 to prototype2 to prototype3 at different stages of development, you may wish to keep the...
saved values after each change so the timeline shows the improvement across all three stages.

In the Metric Results Viewer, you can also choose to clear the entire history or delete only a particular saved value.

The results viewer also allows you to copy the values to the Clipboard so you can paste into another application. For example, if the metric stores the calculated reliability at different points in time, you may wish to analyze the data with a reliability growth model in RGA.

- **Copy > All rows (dates)** copies the exact dates shown in the table.
- **Copy > All rows (cumulative days)** replaces the dates with the cumulative number of days since the date of the last saved value. For example, if the first date is 1/1/2015 and the second date is 12/31/2015, the cumulative days would be 0 for the first date and 365 for the second date.

### Target Conditions and Result Indicator
The **Target Conditions** feature color-codes the current value of the metric. If all specified conditions are met, then the metric's value will be displayed in green. If one or more conditions are not met, then it will be in red. For example, in the following pictures, the result is green if the estimated system reliability is at least 80%, and red if it is not.

The **Result Indicator** feature color-codes the indicator that shows whether the value has increased or decreased since the prior saved value. If the direction of the change is desirable, the indicator will be green; if it is undesirable, the indicator will be red. As an example, the following pictures are from the SEP.

### Identifiers, History, Watch and Trace Usage
As with most other Synthesis resources:

- **Identifiers** contains additional identifying information that can be used to search for this resource.
History provides information about when the record was created and last updated. 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.

Watch allows each individual user to subscribe to receive an alert (via e-mail, SMS text message or portal message) when the resource is changed.

Trace Usage. For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the Dependency Viewer.

Showing Metrics in Folios/Diagrams

The Publishing page of the control panel shows all of the metric resources that are associated with the current analysis. (The metrics can be created and edited either from the Resource Manager or the control panel.) This applies for:

- Data sheets in Weibull++, ALTA or RGA that have a published model.
- Analytical or simulation diagrams in BlockSim that have a published model for the entire system (either a fitted model or an analytical model).
- Simulation diagrams in BlockSim that have simulation results.

This makes it easy to see the metrics that have been created for each analysis (which may also be displayed in relevant Project Planner gates or in the Synthesis Enterprise Portal website) and to see the history of how the analysis results changed over time. It also provides a convenient way to create new metrics for the analysis, if desired.

As an example, the following picture shows a typical scenario for Weibull++. In Weibull++, ALTA or RGA, the control panel shows all metrics that are associated with the model published from the current data sheet. In BlockSim, it shows all metrics that are associated with a model published from the diagram and/or obtained from the diagram’s simulation results.

- Double-click a metric to see its properties and history of saved values.
- A Watch icon will be shown beside any metric for which you have subscribed to receive an alert when the resource is changed.
- Click the Metric Summary icon to see a quick report of all the metrics displayed in the current branch.
• Click the **Create New** icon to create a new metric.

**Associating Existing Metrics with a Different Data Sheet**

When an analysis changes (e.g., new data, after a design change, etc.), you may choose to simply update the existing data sheet and recalculate, or keep the original analysis unchanged and perform the updated analysis in a new data sheet.

If you decided to create a new data sheet, there are two ways to ensure that the metrics will reflect the complete history from both analyses:

**Publish to the existing model from the new data sheet**

If you want the published model to reflect the latest analysis results, you can simply transfer both the model and the associated metrics to the new data sheet. To do that:

1. Calculate the new data sheet and then go to the Publishing page of the control panel.
2. Click **Publish to Existing Model** and then select the model from the original data sheet.

### Change the model for the existing metrics

If you want to keep the original published model associated with the original data sheet, you can publish a new model for the new data sheet and then transfer the metrics to the new model. To do that:

1. Publish a new model for the new data sheet.
2. From either the original data sheet’s control panel or the Resource Manager, open each metric that was associated with the original data sheet and change the **Associated Model**.

As a shortcut, you can click the **Select Existing** icon on the new data sheet's control panel and choose one or more existing metrics in the Select Resource window. It is important to keep in mind that when you do this, you are changing the associated model for each selected metric.

### Using Metrics in Project Planner Gates

There are two ways to utilize **metrics** in a **Project Planner** gate:

#### Relevant Metrics

For any gate in a project plan, you can choose to display up to three metrics that are relevant to this stage of the project (e.g., the target reliability, the latest calculated reliability, etc.).

Use the fields under the **Relevant Metrics** heading to select an existing metric or create a new one.
Push to Metrics
For any gate in a project plan, you can also choose to push any of the following values to a metric resource. This makes it easy to see the history of all saved values, and enables users to subscribe to receive alerts when the metric changes. You can also choose to show this information in the Synthesis Enterprise Portal if a web-based portal is implemented for the current database.

- **Percent Completed** is the percentage of the total duration of dependent actions/gates that is complete. For example, if Action 1 (duration = 3 days) is complete and Action 2 (duration = 1 day) is incomplete, the progress is 75%.

- **Actual Man Hours %** is the percentage of planned hours that have been used to complete the gate.

- **Actual Costs %** is the percentage of the budget that has actually been used to complete the gate.

Use the fields under the **Push to Metrics** heading to create a new metric or select an existing metric that is not already assigned to receive a pushed value. (Note that only unused metrics are shown in this list.)

When you first assign a metric in one of these fields, the current value will be automatically saved to the metric. Subsequently, the value will be recalculated each time an associated action or gate is changed. If the value is found to have changed, it will be saved to the metric. To see the current saved value, click inside the field. This will also display a result indicator and the **View Saved Values** icon, which you can click to see a history of all saved values.
Pushing Metrics from an FMRA

The **Push to Metrics** fields on the Properties tab of the Analysis panel in Xfmea/RCM++/RBI enable you to “push” the reliability and availability values that were calculated/simulated from the Failure Modes and Reliability Analysis (FMRA) to Synthesis metric resources.

This makes it easy to see the history of all saved values while you’re working in the FMRA, and enables users to subscribe to receive alerts when the metric changes. If desired, you can also choose to show this information in a specific Project Planner gate (under the Relevant Metrics heading), and in the Synthesis Enterprise Portal if a web-based portal is implemented for the current database.

1. Go to the FMRA tab in the system panel. (See Enabling and Viewing the FMRA in the Xfmea/RCM++/RBI documentation.)

2. Select any item in the FMRA hierarchy and use the fields under the Push to Metrics heading to create a new metric or select an existing metric that is not already assigned to receive a pushed value.

3. Calculate and/or simulate the FMRA:
   a. To calculate the reliability, choose FMRA > Calculations > Calculate (Reliability).
b. To simulate the availability, choose **FMRA > Calculations > Simulate (Availability)**.

4. Each time you calculate/simulate the FMRA, the latest value(s) will be automatically saved to the metric(s). To see the history of all saved values, click **View Saved Values**.

### Variables

A variable is a **resource** that stores a numerical value and allows you to assign a name to that value. You can then use the variable name in place of the actual value in the equations that you create. You can also use variables in functions and/or as conditional output values in conditional blocks, logic gates and branch gates.

A variable starts with an assigned initial value, which may be fixed or varied during simulation. You can use variables:

- In RENO, to act as a constant (i.e., maintain a fixed numerical value during simulation).
- In RENO, to temporarily store the output value of a block during simulation. See the next section for more information.
- In RENO, to perform a sensitivity analysis, which involves varying the value of one or two variables between **runs** (i.e., sets of simulations). For example, if you are analyzing potential investment strategies, you may wish to vary the number of years that you will be investing and/or the percentage of your income that will be invested to see how different inputs will affect the final results.
- As the basis for a **dynamic model**, which represents a fixed probability, duration or cost. The variable can be programmatically varied during simulation, thereby changing the value of the model for successive simulation runs.
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- As inputs for certain fields in BlockSim simulation RBDs via simulation worksheets, allowing programmatic variation of the field value during simulation.

**What's Changed?** In previous versions of RENO, variables that stored fixed values were known as constants, and variables that stored outputs were known as storage variables.

**Using Variables to Store Output Values in RENO**

You can use variables to hold numerical values passed to them during simulation. In RENO, the following blocks are able to store their output values in variables:

- Standard blocks
- Result storage blocks
- Flag markers
- Counter blocks

Depending on your choice in the **When to Reset** field of the variable's properties window, you can configure the variable to retain the value passed to it during simulation or reset the variable to its initial value at specific times. The options are:

- **Reset After Each Simulation** (i.e., reset after a single pass through the flowchart)
- **Reset After Each Run** (i.e., reset after each set of simulations)
- **Reset After Analysis** (i.e., reset after each set of runs)
- **Never Reset**

When the simulations end, the variable always returns to its initial starting value unless you have selected **Never Reset**. If you wish to keep the value used during simulation, you can use a result storage block to store it.

**Example**

The following example demonstrates two things: a) how a variable may be used to store an output value and b) how a variable may be used in an equation.

In the following configuration, the first block calculates the gross profit from a sale, and then stores its output into a variable called "Profit." The conditional block determines whether the gross profit exceeds 500. If the output is true, the third block deducts the sale's commission from the profit, and overwrites the stored value with the new output.
The following picture shows the properties window of the variable called "Profit." The initial value of this variable is set to 0.

The following picture shows the Block Properties window of the first block in the example. The output of the equation is stored in the variable.
The following picture shows the Block Properties window of the third block in the flowchart. The equation shows that the commission is deducted from the existing value in the variable, and then the variable is overwritten with the new result. At the end of the simulation, the result storage block in the flowchart stores the final value of the variable, and then the variable resets to 0.
Profiles

New in Version 11, a profile is a Synthesis resource that allows you to represent a value that varies with time. It consists of a basic pattern that either repeats as a cycle or occurs once and then continues from its last defined setting.

What's Changed? The profile resource replaces the stress profile functionality that was available in previous versions of ALTA PRO.

This topic describes how to create profiles, which can be defined by entering values manually or by importing data from nCode GlyphWorks.

To learn how to use profiles in ALTA life-stress data folios, see Time-Dependent Stress Profiles in the ALTA documentation.

Creating Profiles

Like any other Synthesis resource, you can create or edit profiles from the Resource Manager, and while you're performing a relevant analysis. To create a profile:

1. Define a pattern for how a stress level will change over a specified period of time. The pattern you will define consists of a series of segments, where each segment has a specified duration and either:
   - a constant stress value, or
   - a function that takes a time value and returns a stress value.

These segments are defined in the spreadsheet, as shown next.

<table>
<thead>
<tr>
<th>Segment Start</th>
<th>Segment End</th>
<th>Stress S(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1100</td>
<td>328</td>
</tr>
<tr>
<td>1100</td>
<td>2200</td>
<td>338</td>
</tr>
<tr>
<td>2200</td>
<td>3300</td>
<td>348</td>
</tr>
</tbody>
</table>

- **Segment Start** is calculated automatically by the software and cannot be entered manually. The first segment's start time is always 0. For every subsequent segment, the start time is identical to the prior segment's end time.

- **Segment End** allows you to enter the end time for each segment, which must be smaller than the end time of the next segment.

- **Stress S(t)** is the stress value or function for the segment. If the stress level will stay constant during a segment, enter a constant value (e.g., 30). If the level will
change during a segment, enter the value as a function of time (e.g., at time = 20, the function \( t + 20 \) will return a value of 40). When entering a function, you must use \( t \) or \( T \) as the time variable.

**Tip:** Because stress units (e.g., volts) and time units (e.g., hours) are not defined in the profile, it is important to apply profiles only to folios that are intended to use the same stress and time units. In the Profile window, you may want to rename column headings (by right-clicking the heading) or use the Comments page as a reminder of which units are applicable to that profile.

For example, suppose the stress unit is psi and the time unit is seconds. Now suppose you wanted to define the following 120-second pattern: a stress value of 30 psi for 60 seconds, followed by a stress value of 50 psi for 30 seconds, followed by a stress function that begins at 50 psi and gradually decreases at a rate of 1 psi per second for the remainder of the pattern. For this pattern, you could fill out the spreadsheet as follows:

<table>
<thead>
<tr>
<th>Segment Start</th>
<th>Segment End</th>
<th>Stress ( S(t) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>90</td>
<td>50</td>
</tr>
<tr>
<td>90</td>
<td>120</td>
<td>50 - (t - 90)</td>
</tr>
</tbody>
</table>

Notice that the last segment of this profile uses a stress function. Since \( t \) is the test time (or, if the profile is cyclical, the time since the pattern was last restarted), \( t = 90 \) when the last segment begins. So the last segment’s stress level starts at 50 - (90 - 90) = 50. Then, at 91 seconds, the stress level will have dropped to 50 - (91 - 90) = 49. After another second it will have dropped to 50 - (92 - 90) = 48, and so on.

2. Next, choose the appropriate option in the **After Last Segment** area of the control panel. Your selection here will determine what happens after the end time of the profile’s last segment (in the above example, after time = 120).

If you select **Continue with last value**, all times after the last segment will use the value/function defined in the last segment.

If you select **Repeat cycle**, the entire pattern of segments will be treated as a repeating cycle.

For example, suppose you defined a pattern that is made up of five segments, each an hour long and increasing stepwise from the segment before. The graphs below illustrate the difference between continuing from the last stress (left) and selecting to repeat (right). In this example, the test has a duration of 20 hours, and the graphs explain what would happen through the entire duration of the test.
3. Before you can use the new profile in your analysis, you must save any changes you have made and validate the current profile settings. To do this, click the **Validate Profile** icon.

After you save the changes in your profile, the **Profile Summary** area will appear. Click the **Detailed Summary** icon to open the Results window, which shows the current profile in a worksheet that you can copy or print.

To view a stress vs. time plot of the profile, click the **Plot** icon. (See **Synthesis Plot Utilities** for general information on plots.)

**Note:** Clicking the **Validate Profile** icon will not automatically update your stress vs. time plot. To make sure your plot reflects the most recent profile information, click the **Plot** icon.

If desired, you can use the Comments page of the control panel to enter notes or other text that will be saved with the profile.

**Importing Data from nCode GlyphWorks**

New in Version 11, you can import **nCode GlyphWorks** time series data from .S3T files for use as stress profiles. The stress values in the .S3T file must be greater than zero in order for the data to be imported.
To import data from an nCode .S3T file, first create a new profile from the Resource Manager (Project > Synthesis > Resource Manager). In the Profile window, click the Import from GlyphWorks icon on the control panel.

This launches the import wizard, which guides you through the steps required to import data from the file. You can then edit the resulting imported data, if desired. Note that if you update the .S3T file in GlyphWorks, the associated profile in ALTA will not be updated automatically. You must re-import the data to reflect the changes.

**Tip:** Because stress and time units are not defined in the profile, it is important to apply profiles only to folios that are intended to use the same stress and time units. In the Profile window, you may want to rename column headings (by right-clicking the heading) or use the Comments page as a reminder of which units were used by the data imported from the nCode file.

### Maintenance Groups

Maintenance groups are resources that are available for use throughout the project and can be managed via the Resource Manager. A maintenance group is a set of blocks or system hierarchy items where some event within the group can trigger either maintenance or state changes for one or more blocks or items, either within the group or outside of it. You can use a maintenance group:

- In BlockSim: To turn a block on or off. State change triggers are used to activate or deactivate a block when items in one or more specified maintenance groups go down or are restored. The block whose state is being changed may or may not belong to any of the maintenance groups. This allows you to model a cold standby configuration (i.e., one where the component cannot fail when in standby) without using a standby container, which may be useful if you are using a parallel or complex configuration, as blocks can be connected only in series in standby containers.

- In BlockSim, RCM++ or RBI: To trigger a scheduled task (i.e., a preventive task, inspection or on condition task). You can set the task to be performed based on events in one or more maintenance groups. Triggering events within the maintenance group can include block/item failure; start of corrective, preventive or inspection tasks; and/or block/items restoration. The block(s)/item(s) affected by the task may or may not belong to any of the maintenance groups. 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. See Task Scheduling for more information on how tasks can be scheduled.

**Note:** In BlockSim diagrams, blocks that belong to a maintenance group have a red circle at the upper left corner of the block. You can change the size of the indicator via the relevant Block Corner Indicators page of the Diagram Style window. You can change the color used for each maintenance group via the Maintenance Group Manager.

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.

It can also be accessed from the Maintenance Groups page of the Resource Manager by choosing Home > Edit > New, by selecting a maintenance group and choosing Home > Edit > 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. To change the default names, choose File > Manage Repository > Default Name Formats. (In a secure database, this is available only to users with the "Manage other repository settings" permission.)

You can also enter comments about the maintenance group in this window.

For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the Dependency Viewer.

**Maintenance Group Manager**

In BlockSim only, the Maintenance Group Manager allows you to add blocks to or remove blocks from a maintenance group without having to go into each block's properties individually. This window can be accessed by choosing Project > Data Management > Maintenance Group Manager or, when you are viewing the Maintenance Groups page of the Resource Manager, by choosing Home > Actions > Maintenance Group Manager.
The **Maintenance Group** area allows you to choose an existing maintenance group from the drop-down list. In addition, you can click the **Select Existing** icon to open the Select Resource window. If there is not an existing maintenance group that meets your needs, you can create a new one by clicking the **Create New** icon to open a window that allows you to specify a name for the new maintenance group, as well as any comments. Click the **View** icon to view the characteristics of the selected maintenance group.

You can also click the **Indicator Style** icon to modify the appearance of the corner indicator that will appear on each block that belongs to the maintenance group, including:

- The indicator's background color, fill color and fill style. The background color is the underlying color applied to the indicator; the fill color is applied over the background color in the pattern specified by the fill style.
• The style (e.g., solid, dash, etc.), color and thickness of the indicator border.

You can change the size of the indicator via the relevant Block Corner Indicators page of the Diagram Style window.

The Blocks area displays all of the blocks in the maintenance group, in the format [Diagram Name][Block Name].

• To add a block to the maintenance group, you can select the diagram and block in the Add Block area and click the Add to Maintenance Group button. You also can select the block(s) in the diagram, press CTRL+SHIFT and drag the block to the list in the Blocks area of the Maintenance Group Manager.

• To view a block in the maintenance group, select the block in the list and click the Select on Diagram button. The diagram will be displayed with the block selected.

• To remove a block from the maintenance group, select the block in the list and click the Remove from List button.

Mirror Groups

Mirror groups are resources that are available for use throughout the project and can be managed via the Resource Manager. You can use a mirror group:

• In BlockSim: To place the same block in more than one location (i.e., to represent a single component more than once in a diagram or in multiple diagrams within a project). See Mirroring (Using Blocks in Multiple Locations) in the BlockSim documentation.

• In the FMRA in BlockSim, Xfmea, RCM++ or RBI: To place the same cause in more than one location in the FMRA hierarchy, in order to consider common cause failures. See Using Mirror Groups in an FMRA in the Xfmea/RCM++/RBI documentation.

Task Packages

Task packages are resources that can be shared among analyses and can be managed via the Resource Manager. They represent groups of tasks that are performed together at scheduled intervals, for the most efficient allocation of resources and downtime management.
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The Task Package window allows you to create, view and edit task packages. It can be accessed 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.

It can also 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 (see 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 Auto-Packaging Intervals fields allow you to specify a range of scheduled intervals that will automatically be incorporated into the task package if the user clicks the Auto-Package Tasks button at the bottom of the Maintenance Task Packaging window in RCM++/RBI. 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 task package to be performed at the scheduled time of the task package rather than at their individually scheduled times.

- Identifiers contains additional identifying information that can be used to search for this resource.

- History provides information about when the record was created and last updated. 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.

- Watch allows each individual user to subscribe to receive an alert (via e-mail, SMS text message or portal message) when the resource is changed.
• **Trace Usage.** For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the Dependency Viewer.

**Actions**

Throughout the Synthesis Platform, your team can use actions to track specific assignments that need to be performed. These versatile Synthesis resources can be used multiple times in different locations, if appropriate. Specifically, actions can be created, displayed and/or managed:

- via [Project Plans](#) or the [Resource Manager](#) in all Synthesis desktop applications except MPC.
- via [My Portal](#) or [Actions Explorer](#) in all Synthesis desktop applications.
- via the [Synthesis Enterprise Portal](#) (if it is implemented for your database).
- via FMEAs or Test Plans in Xfmea/RCM++/RBI.

For specific instructions regarding how to create or edit an action in each location, please consult the documentation for that particular feature. This section focuses on general considerations that will be applicable regardless of where/how the action is being used.

**Tip:** If an action is used in an FMEA, the properties window will be different depending on the current context. If you’re using Xfmea/RCM++/RBI and you open the action from the FMEA or My Portal, the window includes additional features that provide quick access to associated FMEA records (failures, causes, etc.) and the FMEA change log (if activated). These features are not available if you open the action from another location (e.g., Resource Manager, Project Planner, Actions Explorer) or in another application, because the associated FMEA can’t be opened in those situations.

**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 Project Plan, the resource will remain in the project unless/until an authorized user deletes it from the database (via My Portal, Resource Manager or Actions Explorer).
Note: Actions are always local resources. They cannot be made global. Actions in a reference project are local to that project and can't be selected for use in other projects.

Configurable Settings
Some properties for action records can be configured via interface style settings. See Configurable Settings.

Show/Hide Properties for Individual Records
You can also use the following ribbon commands to show/hide certain features for a particular action record.

✅ Generic vs. 📊 Detailed: A detailed action contains additional properties for describing a specific test that needs to be performed (Specifications, Requirements and Reports). These properties are not configurable, and they can be used in the new Test Plans features in Xfmea/RCM++/RBI. (See Test Plans in the Xfmea/RCM++/RBI documentation.)

👨‍💼 Show Resources: The resources fields (Team, Facility, Material and Additional Costs) are used for calculating costs and resource utilization. They are always enabled but you can toggle this command to hide or display them for any particular action record. The Check Utilization command provides a summary of the resources that have already been assigned. (See Costs and Man Hours.)

📝 Show Review/Approval: If the Reviewer property is enabled in the configurable settings for the current project, you can toggle this command to hide or display these fields for any given action. The Review Action command will be enabled if you are assigned to review the action and it is ready to be reviewed. (See Review and Approve Actions.)

Priority
The color-coded Priority command provides a consistent scale for prioritizing actions across all projects in the database. (The same options are also available for gates in the Project Planner.)
This is intended to be used instead of the configurable **Action Priority** field from prior versions, which can be different for different projects. When you convert from a Version 8/9 database, the software will attempt to match any priorities that were assigned with the old configurable drop-down list. For example, if you were using the default "High," "Medium" and "Low" labels that were shipped with Version 8/9 libraries, they will automatically be mapped to the corresponding options in the new ribbon command.

**Action Status and Review Status**

The action’s status bar displays two complementary status indicators. The first one is based on the actual and expected start date and completion date. It indicates that the action is not started, in progress or complete and whether it is on time or running late. (See [Action Timeline and Status](#).)

The second one is based on whether a reviewer has been assigned in the Review/Approval section and, if so, the status of that review.

**E-mail and Alerts**

The **E-mail** command will be enabled if an authorized user has defined a valid SMTP server. This allows you to manually send an e-mail containing the current action details to any valid e-mail address.

If a valid SMTP server has been defined within the database, your team can also choose to use automated alerts (via e-mail or SMS text message). Each individual user can subscribe to “watch” specific action resources, and the database can also be configured to auto-subscribe users assigned to specific roles for the action. (See [Watches and Alerts](#).)
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Click Action Monitors to specify individual users and/or groups of users who will always receive alerts for the record, regardless of whether they have personally subscribed to a “watch.” (See Action and Gate Monitors.)

Add to Outlook Calendar

The Add to Outlook Calendar command will be enabled if Microsoft Outlook is installed on your computer.

It launches Outlook’s interface for creating a new calendar event and automatically populates the subject and date. You can modify the details as needed 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.

Person Responsible and Resources

For each action resource, you can assign both an individual database user who is primarily responsible for completing the action and a team of users who are also involved. You also have the option to track the percentage of their available time that is planned to be utilized for the activity.

Tip: If a user is assigned as person responsible and also belongs to the team, the costs and utilization values will be summed. For example, the application assumes that the utilization is X% as person responsible plus an additional Y% as a member of the team.

Person Responsible

The Person Responsible field can be enabled or disabled, depending on the configurable settings for the current project. If you want to use personalized alerts, track resource utilization etc., you must select a database user. Alternatively, you can type a text description (up to 150 characters) that will be displayed in the FMEA spreadsheet.
Tip: If you want to change the person responsible for multiple actions simultaneously (e.g., if a user changes roles and his/her actions need to be reassigned), use the Actions Explorer.

If the Set action creator as 'Person Responsible' by default check box is selected in the Repository Settings window, then the person who created the action is automatically shown in the Person Responsible field, but that can be changed.

Resources

The Resources fields are always enabled but you can toggle the Show Resources command to hide or display them for any particular action record.

You can select from the teams, facilities and materials resources that have been predefined within the database (or create them on-the-fly if you have the required permissions). In a secure database, only users with the “Manage project planning resources and working days” permission will be able to create and edit these resources. (See Project Planning Resources.)

<table>
<thead>
<tr>
<th>Resources</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team</td>
<td>Gizmo Design Team (5%)</td>
</tr>
<tr>
<td>Facility</td>
<td>AES Test Lab (2%)</td>
</tr>
<tr>
<td>Material</td>
<td>N/A</td>
</tr>
<tr>
<td>Additional Costs</td>
<td>1000</td>
</tr>
</tbody>
</table>

Check Utilization

If you need to view the utilizations of users and facilities for the current action, click Check Utilization.

Action Timeline and Status

For all action resources, the status is determined automatically based on the actual and expected start/completion dates. If an action is included in the Project Planner, its expected timeline can automatically shift in response to delays in prior activities. If the action is not included in the plan, the expected dates are always identical to the originally planned dates.
The following status indicators are displayed in the status bar of the action properties window and in other relevant locations. (Note that the status bar now also displays a separate review status to indicate whether a user has been assigned to review/approve the action and, if so, the status of the review. See Review and Approve Actions.)

- **Not Started**: The action hasn't started, but it can still start on time.
- **Past Start Date**: The action hasn't started, and it is too late to start on time.
- **In Progress**: The action has started.
- **Past Due**: The action hasn't completed, and it is too late to complete on time.
- **Completed - On Time**: The action completed on time.
- **Completed - Late**: The action completed late.

**Costs and Man Hours**

For action resources, you can now track the planned vs. actual usage for both costs and man hours.

The **Planned Cost** and **Actual Cost** fields can be enabled or disabled, depending on the configurable settings for the current project. If the properties are enabled, the planned costs will always be calculated automatically based on the action duration, person responsible and project planning resources. For the actual costs, you can choose to enter manually or use the automatic calculations.

**Enter Manually**

If you prefer to enter the actual costs/hours instead of using the automatically calculated values, select Yes in the **Manually enter costs/man hours?** field.

<table>
<thead>
<tr>
<th>Manually enter costs/man hours?</th>
<th>No</th>
<th>Manually enter costs/man hours?</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Cost</td>
<td>240.00</td>
<td>Actual Cost</td>
<td>475</td>
</tr>
<tr>
<td>Actual Man Hours</td>
<td>24</td>
<td>Actual Man Hours</td>
<td>5</td>
</tr>
</tbody>
</table>

**Let the software calculate**  
**Enter the values yourself**

**Calculate Automatically**

The automatic calculations are based on:

- The Duration (the number of working days from the start date to the due/completion date).
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- The Person Responsible and/or the Team:
  - The % utilization is set in each action record.
  - The Hours per Day and Cost Category are set in each user account record.
- The Facility (e.g., test lab or other facility needed to complete the action):
  - The % utilization is set in each action record.
  - The Max Hours per Day and Cost Category are set in each facility properties record.
- The Materials (e.g., test samples or other material needed to complete the action):
  - The Quantity and Cost Category are set in the material properties record.
- Any Additional Costs that are defined directly in each action record.

The following simple examples demonstrate how each type of cost is calculated.

**Personnel Costs**

**Action Duration:** 5 working days

**Joe Engineer:** Works 8 hours per day (5 days x 8 hours = 40 hours)

Time is billed at $100 per hour (no “per instance” cost)

Assigned as Person Responsible with 5% utilization (40 hours x .05 = 2 hours)

Also belongs to the assigned Team with 1% utilization (40 hours x .01 = .4 hours)

The calculated values for Joe’s work on this action are 2.4 man hours and 2.4 x $100 = $240.

**Facilities Costs**

**Action Duration:** 5 working days

**ABC Test Lab:** Is available up to 8 hours per day (5 days x 8 hours = 40 hours)

The utilization for this action is 20% (40 hours x .20 = 8 hours)

Costs $500 “per instance” plus $50 per hour

The calculated cost for using this facility to complete the action is $500 + (8x$50) = $900.
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Materials Costs
Gizmo Prototype: Costs $5000 to produce the batch of test units (the “per instance” cost)

The test requires 10 samples

Each unit costs $500 (the “direct cost per hour or unit”)

The calculated cost for the materials required to complete the action is $5000 + (10x$500) = $10,000.

Action Status Updates
For all action resources, the Progress (Status Updates) area displays any notes that have been added to report progress. The software automatically adds these updates under certain conditions (e.g., upon review/approval), and you can also create updates manually when needed.

To add a new note, click Add Status Update in the action’s ribbon or click the heading and then click the Add icon that becomes visible.

The type that you select in the Add Status Update window can affect the actual start and completion dates of the action, and also update the action status. (See Action Timelines and Status.)

- **Not Started** allows you to record comments without entering a start date. If an actual start date has already been entered, the update will remove the date and change the action’s status back to Not Started.

- **In Progress**
  - If an actual start date is not already defined, sets the current date as the Actual Start Date and allows you to specify the % Completed. This will change the action’s status to In Progress.
• If the action is already in progress, allows you to add another note and update the completion percentage.

• **Completed** sets the current date as the **Completion Date**. This will change the action’s status to either **Completed-On Time** or **Completed Late**.

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

<table>
<thead>
<tr>
<th>Progress (Status Updates)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>In Progress</td>
<td>2/3/2015 4:04 PM - Reliability Engineer - 0 %</td>
</tr>
</tbody>
</table>
|                          | This is a short message to record progress for an action that is still in progress.

**Review and Approve Actions**

**Action resources** can be marked for review and approval. If the Reviewer property is enabled in the **configurable settings for the current project**, you can click **Show Review/Approval** in the action ribbon to hide or display these fields for any given action.

(Note that if an action has been assigned for review or is already reviewed, you can no longer hide the fields.)

**Assigning a Reviewer**

If an action has not yet been reviewed, any user who is able to edit the record can assign or change the reviewer at any time.

In a secure database, the Reviewer drop-down list contains all of the database users who have the **Approve actions** permission.

• If a user has been assigned to review the action but an actual completion date is not entered, the review status will be **Reviewer Assigned**.

• When the completion date is entered and the action is ready for review, the status will be **Pending Approval**.

**Tip:** If you want to change the assigned reviewer for multiple actions simultaneously (e.g., if a user changes roles and his/her actions need to be reassigned), use the **Actions Explorer**.
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Reviewing and Approving the Action

When you are assigned to review/approve an action that has been completed, the record will be highlighted for you in My Portal (and in the Synthesis Enterprise Portal if implemented), and you may also receive automated alerts (via e-mail and/or SMS) if applicable.

To record your decision, open the action record and choose Review Action.

In the Review Action window, you can choose one of the following options:

- **Approve action** assigns the review date/time and marks the status Approved.
- **Reject and re-open action** removes the completion date and marks the status Rejected and in progress. The team can perform any rework that is needed and resubmit the action for another review.
- **Reject and close action** marks the status Rejected and closed.

You can enter your comments directly in this window, or enter/update them later in the comments field.

<table>
<thead>
<tr>
<th>Reviewer</th>
<th>Jane Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review Status</td>
<td>Approved</td>
</tr>
<tr>
<td>Review Date</td>
<td>4/1/2015 5:31 PM</td>
</tr>
<tr>
<td>Review Comments</td>
<td>Notes related to the review/approval.</td>
</tr>
</tbody>
</table>

Configurable Settings for Actions and Controls

Some of the properties in action records and in control records are configurable via the interface style settings that have been defined for the current project. The interface style is used in Xfmea/RCM++/RBI to customize a variety of analysis fields to fit the organization’s particular preferences and needs. (See Configurable Settings in the Xfmea/RCM++/RBI documentation.)

You can view/edit the configurable settings for actions and controls from any Synthesis desktop application by clicking Configurable Settings of the action properties window or the control properties window. (In secure databases, this is available only if the user is the project owner, or has the "Edit project properties" permission.)
Any changes to these settings will apply to all records of that type in the current project.

**Actions Explorer**

The Actions Explorer is available in all Synthesis desktop applications except MPC. You can use this flexible tool to explore all of the action resources that are stored in the current database.

To access the utility, choose **Home > Synthesis > Actions Explorer**.

To reduce the amount of time required to populate the grid, first use the Project, Status, User and/or Date filters to limit your search, then click **Load Data**.

![Load Data](image)

**Add, Edit and Delete Actions**

When actions are loaded in the grid, you can use the following ribbon commands to add, edit and delete actions. (In a secure database, the ability to add or edit an action is only available for users with the "Create/edit/delete local resources" or "Create/edit/delete local resources" permission in the relevant project.)

To delete or edit multiple actions at the same time, press **CTRL** or **SHIFT** while clicking rows in the grid. Selected rows will be highlighted.

- **Add Action** creates a new action resource in the project that currently has focus.
- **Edit Action** allows you to view and edit all of the properties of the action that is currently selected.
- **Delete Action** deletes all of the actions that are currently selected. There is no undo for delete.
- **Assign Person Responsible** and **Assign Reviewer** allow you to set (or change) the person responsible or reviewer for all of the actions that are currently selected.

**Save and Apply Views**

Once you have customized the grid to suit a particular purpose (using the built-in filter, column configuration and grouping features described below), you can save the preferences as a view that can be used again whenever you need it. A view is saved in the database and available only to the user who created it.
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To create a view, first configure the grid to suit your particular needs and then click **Save View**.

To quickly apply these same preferences again at any time, click **Apply View** and select one of the saved views from the list.

**Note**: The view does not affect filtering that has been applied from the Project, Status, User and/or Date filters, or from the Relevance Panel.

**Project, Status, User and Date Filters**

The Actions Explorer can utilize the same [project filter](http://rga.reliasoft.com) that is available in many other locations throughout Synthesis desktop applications.

You can also filter by status (e.g., In Progress, Completed, etc.), user (e.g., Person Responsible or Reviewer) and date (e.g., Planned Start Date, Actual Start Date, etc.).

After you clear or change these filters, you must click **Load Data** again to update the grid.

**Relevance Panel**

The relevance panel provides a quick way to filter the actions based on how they are relevant to you (based on your personal username).

- **I am responsible for**
  - You are assigned in the **Person Responsible** field.

- **I am a team member in**
  - You belong to the team assigned in the **Team** field.

- **I need to review/approve**
  - You are assigned in the **Reviewer** field.
• **I am monitoring**
  • You are assigned in the Action Monitors window, or you have personally subscribed to “watch” the action.

• **Other actions I created**
  • You are listed in the Created By field and none of the other roles apply.

• **All actions**
  • Displays all actions, regardless of whether they’re relevant to you.

**Built-in Find/Filter, Configuration and Grouping Tools**
The Actions Explorer offers the same filter, column configuration and grouping tools that are built in to other Synthesis utilities that use a similar grid (e.g., the Resource Manager). For details about how to use each feature, see:

• [Finding and Filtering Records](#)
• [Configuring Columns](#)
• [Grouping Panel](#)

**Controls**
Controls are [Synthesis resources](#) used in FMEAs that are the methods or actions currently planned or already in place to reduce or eliminate risk. Controls can be managed via the Resource Manager.

As with any other Synthesis resource:

• Any changes to the control properties will be reflected in all locations where the resource is used.

• If you remove a control from an FMEA, it will remain in the project unless/until an authorized user deletes it from the database.

• If a control resource is not currently used in an FMEA, you can delete it via the Resource Manager. (In a secure database, this is possible only if the user a) is the project owner, b) is the control creator, or c) has the applicable "create/edit/delete resources" permission.)
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For existing resources, the link at the bottom of the window indicates how many times the resource is currently being used. If you need more information, click the link or the icon to open the Dependency Viewer.

Note: Controls are always local resources. They cannot be made global. Controls in a reference project are local to that project and can't be selected for use in other projects.

For specific instructions on using controls in FMEAs, see the "Controls in FMEAs" topic in the Xfmea/RCM++/RBI documentation.

Configurable Settings
Some properties for controls can be configured via interface style settings. See Configurable Settings.

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 that are available to all projects in the database.

To open the Resource Manager, choose Project > Synthesis > Resource Manager.

Tip: When you need to create or edit a large number of resources, you can also use Synthesis APIs to import the data from an Excel file or other data source. For example, the URDExample_V10.xlsm file at C:\Users\Public\Documents\ReliaSoft\Examples10\API enables you to quickly create/update multiple URDs with some basic properties (models and corrective tasks). If you have the necessary software coding experience, you can expand this tool or create your own custom applications to meet specific needs.
Resource Filter
The Resource Manager can utilize the same resource filter that is available in many other locations throughout Synthesis desktop applications.

Built-in Find/Filter, Configuration and Grouping Tools
The Resource Manager offers the same filter, column configuration and grouping tools that are built in to other Synthesis utilities that use a similar grid (e.g., the Synthesis Explorer, Actions Explorer, etc.). For details about how to use each feature, see:

- Finding and Filtering Records
- Configuring Columns
- Grouping Panel

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 you can go to the Batch Properties Editor to edit them in a spreadsheet format.

- Duplicate an existing resource by selecting the row in the table and choosing Home > Edit > Duplicate. You can choose to duplicate just the selected resource, or choose Cascade Duplicate to duplicate the resource and all resources assigned to it, at all levels (e.g., cascade duplicating a corrective task will also duplicate the task's duration model, the assigned crew and all models assigned to the crew, etc.).
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- 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 Publishing Models.)

---

**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.

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 and Reference Resources**

As explained in Local, Global and Reference Resources, the availability of Synthesis resources for use is determined by their scope. Local resources are available only in the current project. Reference resources are available for any project within the database, depending on the user's permissions within the reference project. Global resources are available for use in any project in the database.

The far left column in the Resource Manager displays an icon that indicates whether each resource is local, global or a reference resource.

- Local Resource
- Global Resource
- Reference Resource

http://rga.reliasoft.com
You can use the **Home > Filter > [Show Local/Show Global/Show References]** commands to toggle the types of resources shown in the Resource Manager.

**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 *Synthesis Workbook* or spreadsheet if that's available in the current application, choose **Administration > Actions > Transfer Report**.

You can send 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).

**Finding and Filtering Records**

This topic describes the find and filter tools that are built in to the Resource Manager and other Synthesis utilities that use a similar grid. Each of these tools can be used separately, or in conjunction with the others.

**Find Panel**

The Find panel allows you to search for a word or phrase across all of the available properties. When you enter text, it will:

- Show only the rows that contain the text you specified.
- Highlight all of the locations where the matching text occurs.
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To show or hide this panel, toggle the **Show Find Panel** command on the ribbon or in the shortcut menu that appears when you right-click a column heading.

To stop filtering the data, clear the text box.

**Auto Filter Row**
The Auto Filter Row allows you to automatically filter the grid by matching text in one or more columns. For example, the following grid shows only the rows in which the model name contains "Component A" and the distribution contains "Weib."

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Distribution</th>
<th>Model Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component A</td>
<td>weib</td>
<td></td>
</tr>
<tr>
<td>Component A - Reliability</td>
<td>2P-Weibull</td>
<td>Reliability</td>
</tr>
<tr>
<td>Component A - Repair Duration</td>
<td>2P-Weibull</td>
<td>Reliability</td>
</tr>
</tbody>
</table>

To display or hide this row, toggle the **Show Auto Filter Row** command on the ribbon or in the shortcut menu that appears when you right-click a column heading.

**Advanced Filters**
The Advanced Filters allow you to choose an automatically generated filter or create a quick custom filter. The automatically generated filters are based on the unique values that currently exist in the column.
For example, the following picture is based on a data set that contains models from three different categories. If you choose one of the automatically generated filters (e.g., "Reliability"), the grid will display only models of that one selected category.

If you want to see models from two of those categories (e.g., either "Reliability" or "Probability of Failure"), you can choose (Custom) and create a quick custom filter like this:

If a filter has been applied for a particular column, select (All) to remove it.

**Current Query Criteria**

When you are filtering the grid using the Auto Filter Row, Advanced Filters and/or Edit Filter window (described below), the current query criteria will be displayed at the bottom of the window. For example:

- Click the X to delete the current set of filter criteria.
• Clear the check box to remove the current set of criteria without deleting it. Select the check box if you want to re-apply it.

• Click ☑️ to choose from a list of filter criteria that were recently applied.

**Edit Filter**
The Edit Filter window provides the most flexibility to refine and adjust a filter in either a grid or a Dashboard layout. To access the tool, click the **Edit Filter** button to the right of the current query criteria (if applicable), or choose **Edit Filter** from the shortcut menu.

As an example, the following filter from the Resource Manager will display only cost per unit time models in which the rate equals either $120 per hour or $2 per minute.

- Click a red label if you want to:
  - change the **logical operator** (And, Or, Not And, Not Or)
  - add or remove a **group**
  - add a **condition**
  - clear the entire filter

- Use the ☑️ and ❌ 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.).

• Click a gray or black label if you want to enter or change the value.

**Configuring Columns**
This topic describes the capabilities for selecting, reordering, resizing and sorting columns that are built in to the Resource Manager and other Synthesis utilities that use a similar grid.

**Selecting Columns**
To specify which columns will be displayed in the grid, click **Select Columns**.

In the utility's window or panel for selecting columns, use the check boxes to choose which columns will be displayed. As an example, the following pictures show the window and panel for model resources in the Resource Manager.
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Reordering Columns
To change the column order, drag the column heading into the desired position.

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Distribution</th>
<th>Model Category</th>
<th>Model Unit</th>
<th>Parameter 1</th>
<th>Parameter 2</th>
<th>Comments</th>
</tr>
</thead>
</table>

Resizing Columns
To resize columns, you can do any of the following:

- Drag the edge of the column heading to the desired position.
- Double-click the edge of the column heading or right-click it and choose **Fit This Column**. This will resize the column to fit its data.
- Right-click any column heading and choose **Fit All Columns**. This will resize all columns to fit their own data.

Sorting Columns
To sort the grid by one column at a time, you can simply click the column heading to sort in ascending order (↑), or click it again to sort in descending order (↓).

To sort the grid by multiple columns, right-click each column in the desired order and choose **Sort Ascending** or **Sort Descending** each time. For example, the following picture shows Synthesis Explorer data sorted first by project (ascending) and then by category (descending).

<table>
<thead>
<tr>
<th>Application Source</th>
<th>Project Name</th>
<th>Category</th>
<th>Analysis Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weibull++</td>
<td>Project 1</td>
<td>Cat B</td>
<td>Weibull++ Standard Fdlio</td>
</tr>
<tr>
<td>Weibull++</td>
<td>Project 1</td>
<td>Cat A</td>
<td>Weibull++ Standard Fdlio</td>
</tr>
<tr>
<td>Weibull++</td>
<td>Project 2</td>
<td>Cat B</td>
<td>Weibull++ Standard Fdlio</td>
</tr>
<tr>
<td>Weibull++</td>
<td>Project 2</td>
<td>Cat A</td>
<td>Weibull++ Standard Fdlio</td>
</tr>
<tr>
<td>Weibull++</td>
<td>Project 3</td>
<td>Cat C</td>
<td>Weibull++ Standard Fdlio</td>
</tr>
</tbody>
</table>

To stop sorting, right-click any column heading and choose **Clear All Sorting**.
Grouping Panel
This topic describes the grouping panel capability that is built in to the Resource Manager and other Synthesis utilities that use a similar grid.

When you are working with a large amount of data, it may be convenient to group it based on one or more properties. For example, the following picture shows resources in the Resource Manager grouped first by keyword and then by model category.

To group the data without opening the grouping panel, right-click any column heading and choose Group By This Column. Alternatively, you can choose Show Grouping Panel to display the panel and then drag column headings into or out of the panel to configure the groups.

When the grouping panel is displayed, you can also:

- Click the column heading to change the sort order between ascending (_ASC) or descending (.DESC).
- Drag column headings within the panel to change the grouping order. For example, if you prefer to group first by model category and then by keyword, drag the column headings as shown below.
To stop grouping the data, drag all column headings out of the panel or choose **Clear All Grouping**.

**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.

**Select Resource Window**
The Select Resource window allows you to choose an existing resource to use at your current location. You will see this window in situations like the following:

- When you click the Select Existing icon in any resource wizard.
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- When you are adding an existing action in an FMEA or in the Project Planner, or an existing control in an FMEA.

The Select Resource window is similar to the Resource Manager, but it shows only the resource type that you are currently working with. The functionality of the window will vary slightly depending on where you have opened the window from.

- If you can select only one resource (e.g., in a resource wizard), each row in the table will contain a radio button that allows you to select the resource for use. If you can select multiple resources (e.g., adding existing actions or controls in an FMEA), each row will have a check box instead.

- Actions, controls and metrics are always local, so the commands to show global or reference resources will not be available in these cases.

- The ability to apply an item filter is available only for resources that have a full set of Synthesis identifiers. This excludes actions and controls.

- Some resources may not be available for selection. For example:
  - In an FMEA, you can't select an action or control that is already assigned to the current cause.
  - In the project planner, an action cannot be added if it is already in use in the project plan or if its start date is either before or more than a year after the gate's start date.
  - A metric can't be selected to have a value pushed to it if it's already in use somewhere else, or if it's a type that is not compatible with the current use.

**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. 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.

![Diagram showing connections among analyses and resources](image)

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).

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 **Dependency Viewer** topic. 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.

**Batch Properties Editor**

The Batch Properties Editor is designed to support batch editing of most types of local resources in the current project. In BlockSim, it also allows you to edit the blocks used in the diagrams. It enables you to edit the properties in a convenient grid, rather than opening the properties window for each individual resource/block. This utility is available for all desktop applications except MPC.

To open the Batch Properties Editor, choose **Project > Synthesis > Batch Properties Editor**.

To use the utility, choose the type of resource or diagram that you want to work with in the navigation panel on the left side of the window. The right side of the window shows the
resources or blocks you can edit. For information on configuring the table and limiting the items shown, refer to the Configuring Columns and Finding and Filtering Records topics.

**Tip:** If you change the information in one column, it may affect the information required in another column. For example, if you are editing a model and you change the Model Type column from "Weibull-2" to "Weibull-3," then the Parameter 3 column will change from "N/A" to requiring a numerical input for the third parameter for the Weibull distribution (i.e., gamma).

The changes you make in the Batch Properties Editor will be saved when you close the window. You can also choose Home > Display > Refresh to commit your changes immediately and refresh the Batch Properties Editor to display the most current information, including recent changes by other users.

**Note the following:**

- **Gray Background.** If the property does not apply to the corresponding resource or block, "N/A" will appear in the column and the cell will have a gray background. Properties that cannot be edited via the Batch Properties Editor, such as the model category, will also have a gray background.

- **Published Models.** Models created by publishing results from an analysis in a Synthesis application cannot be edited in the Batch Properties Editor. To edit a model that was published from an analysis, you must return to the original data source, make the necessary changes, recalculate and republish the model.

- **Model Parameters.** Since the required parameters for a model will vary depending on the model type, the way you use the parameter columns in the Batch Properties Editor will vary. The parameter columns in the Batch Properties Editor for each model type are presented in the table shown next.
Spreadsheet Editor

You can choose the Spreadsheet Editor command on the ribbon to open the Spreadsheet Editor, which displays the resources or blocks in a spreadsheet-based view. This enables you to use the capabilities inherent in a spreadsheet (e.g., batch copying, formulas, etc.) to make editing multiple items easier. When you are finished editing, choose Close > OK to save your changes and close the Spreadsheet Editor or Close > Cancel to close the Spreadsheet Editor without saving your changes.

Exporting Information from the Batch Properties Editor

To print the contents of the Batch Properties Editor, choose Administration > Output > Print command on the ribbon.

To send the contents of the Batch Properties Editor to Excel, or to a built-in Synthesis Workbook or spreadsheet if that's available in the current application, choose Administration > Output > Transfer Report.
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You can send 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 Batch Properties Editor).

**Tip:** When you need to create or edit a large number of resources, you can also use Synthesis APIs to import the data from an Excel file or other data source. For example, the URDExample_V10.xlsm file at C:\Users\Public\Documents\ReliaSoft\Examples10\API enables you to quickly create/update multiple URDs with some basic properties (models and corrective tasks). If you have the necessary software coding experience, you can expand this tool or create your own custom applications to meet specific needs.
Chapter 19: Synthesis Project Planner

The Project Planner provides extensive project planning and management capabilities, including the ability to create timelines, evaluate progress, track resource usage and estimate costs. Any project in a Synthesis repository can be associated with a project plan.

The Project Planner allows you to create, edit or view the plan in any Synthesis desktop application except MPC. If the Synthesis Enterprise Portal (SEP) has been implemented for an enterprise database, you can also access a streamlined view of the plan from any web-enabled device.

Creating a Project Plan

Each project in the database can have a project plan. To view the plan from within an open project, choose Project > Management > Project Planner. (In a secure database, any user with "read" access to the project will be able to view the plan and update any actions that are assigned to them. However, only users with the “Create/edit project plans” permission will be able to create or edit the plan.)

A blank plan will be created automatically the first time you open the Project Planner in a given project. By default, the project plan shows a sample starting gate, which records the date you opened the project plan for the first time. You can edit the sample gate and start building the plan from there.

Importing or Starting Again from a Blank Plan

Alternatively, you can start again from a blank plan or import an existing project plan from another project. In the Project Planner, choose Project Planner > Plan > Create Project Plan. (In a secure database, this command is available only to users with the “Create/edit project plans” permission.)
Then choose one of the following options. In both cases, you will need to enter the date the plan will begin in the **Set Start Date** field at the bottom of the window.

- Choose **Blank** to start again from a blank plan. This will delete all of the current gates (*there is no undo for delete*). It will also remove any actions that are assigned to the plan. The action resources will remain in the database unless/until an authorized user deletes them from the database via [My Portal](http://rga.reliasoft.com), [Resource Manager](http://rga.reliasoft.com) or [Actions Explorer](http://rga.reliasoft.com).

**OR**

- Choose **Import from another project** to import an existing plan. You can import from another project in the current database or from any other existing standard or enterprise database.

Choose a source repository and source project for the import. The **Plan Preview** area shows the gates and actions (if any) in the project that is currently selected. By default, the import includes both gates and actions. If you want to import gates only, clear the **Include actions** check box at the bottom of the window.

---

**Tip:** If you want to use any of the Design for Reliability (DFR) project planning “starter” templates that were installed with Xfmea/RCM++/RBI Version 9, you can either import directly from one of your own projects (converted to Version 11), or use the "Project_Planner_Templates_Rev1" database (choose **File > Help > Open Examples Folder** then open the file in the "Project Planner" folder). To preserve the integrity of this database, a copy will be created.

---

**Project Plan Hierarchy**

In the **Project Planner**, the plan consists of gates arranged in a tree-based hierarchy to represent the different phases of a process. You can also include **action resources** that represent specific assignments that need to be performed. For example, the configuration below shows a plan with five top-level gates (Concept Phase, Design Phase, etc.), where each gate has its own sub-gates and actions.
Certain properties of higher-level gates (e.g., status and dates) are determined by the properties of their dependent gates and actions. For example, the "Concept Phase" above has two direct dependents. If these are marked as complete, then "Concept Phase" is automatically marked complete. (See Gates in the Project Plan for details on how gates inherit their properties.)

In this way, the planner makes it easy for you to monitor how the progress of individual activities relates to the completion of the entire process.

**Project Planner Columns**

To hide or display Project Planner columns, right-click the column headings then click Customize Columns. (You can also change the column order by dragging and dropping column headings into the desired positions.) These settings are stored per computer/username. Any project that you open on this computer will have the same columns displayed, but other users may have different display preferences.

- **General** columns display graphics/text to summarize the status, as well as the priority level and percent completion.

- **Planned Timeline** columns display information about the original plan, including planned start/due dates and resource usage. You can also display the percentage of the budget that is allocated to different project planning resources (i.e., teams, facilities and materials).

- **Expected Timeline** columns display expected start/completion dates given any delays that may have occurred for prior activities, as well as estimates of the costs/man hours to date. (See Project Planner Timelines.)

- **Actual Timeline** columns display actual start/completion dates, as well as the costs/man hours that were used for completed gates/actions.
• **Delta Values** columns compare two different values, such as the difference between an action's actual and planned costs.

• **Relevant Metrics** display values for up to three selected metrics. (See [Using Metrics in Project Planner Gates](http://rga.reliasoft.com).)

• **Notes** display other applicable information, including descriptions, completion notes and whether an attached file exists.

**Project Planner Timelines**

For gates in the [Project Planner](http://rga.reliasoft.com), and for any [action resource](http://rga.reliasoft.com) that is included in a project plan, three different timelines are used to track progress:

- The **Planned** timeline consists of the originally planned start/completion dates.

- The **Actual** timeline records when a gate or action has actually started or completed.

- The **Expected** timeline shows the start/completion dates that are now expected given the current situation. For project plans that use precedents, the expected dates for an activity automatically shift in response to delays in prior activities.

All of these timelines can be shown in gate/action properties and in the Project Planner hierarchy columns. The expected dates are used to determine the status (e.g., past start date, past due, etc.) and are also shown on the summary panel.

**Planned Dates**

For actions and for gates with no specified precedent, the planned start/completion dates are entered directly in the [Gate Properties window](http://rga.reliasoft.com).

For gates with precedents, the planned start date is automatically set to the working day following the precedent's due date (i.e., planned completion date). By using precedents in your plan, you guarantee that there will be no gaps between one gate's due date and the next one's start date.

In addition, the software uses the following rules to make sure a gate's planned timeline is consistent with that of its dependent gates and actions:

- If a gate's planned start date is changed (e.g., because of changes to a prior gate's planned duration), the planned dates of all dependents will be shifted in the same way.

- You cannot change a dependent's planned start date to precede that of its parent gate.

- If a dependent's due date is changed so that it comes after its parent gate's due date, the parent gate's due date will be changed to match it.
Actual Dates

Actual start/completion dates are entered directly for actions and for gates with no dependents. For gates that have dependents:

- The parent gate's actual start date is automatically set to match the earliest actual start date of its dependents.
- Once all the dependents have completion dates, the latest of those dates is set as the parent gate's actual completion.

Expected Dates

By default, expected start/completion dates are equal to the planned dates. However, if the gate/action is part of a plan that uses precedents, the two timelines can differ.

Specifically, when precedents are used, the expected dates will automatically shift in response to recorded delays in prior gates (while the planned dates remain unchanged). For example, if Gate A is the precedent of Gate B, and Gate A completes two days late, then the expected dates for Gate B will be its planned dates + two days. The same will apply to any other gates with precedents that trace back to Gate A.

As an example, consider the following Gantt chart for a plan that has not yet started. The planned and expected timelines (shown in gray and black, respectively) are identical at first.

![Gantt chart example](image)

However, if Gate A completes late (shown in red), the expected timeline shifts for the remaining gates. (The overall plan bars at the top also indicate that the expected duration for the entire plan has now increased by two days.)

![Gantt chart example](image)
Project Planner Gates

Each gate in the Project Planner has its own properties and a status that is determined based on its expected start/completion dates. Additional information about progress and resource usage is available in the summary panel.

To view the properties of a gate, double-click it, or select it and choose Project Planner > Gate > Edit Gate.

Gate Properties

- The Gate fields provide general information about the gate, including its Name, Description and:
  - **Deliverables** are what will be produced and delivered as a result of completing the gate.
  - **Priority** is a ranking of the gate's importance ("Low," "High," etc.).

- The **Precedent Gate** field identifies the gate that must be completed before the current gate can start, if any. If you choose to use precedents in a project plan:
  - The precedent gate must be on the same level in the hierarchy as the current gate. (If the Use Precedence option is selected, the precedent will be suggested automatically for each new gate you create but you can change it manually if desired.)
  - When a gate has a precedent, its planned start date will be automatically set to the working day after the precedent's due date. In addition, delays in the precedent will automatically shift the expected timeline for future gates.

- The **Planned Timeline** consists of the originally planned start/completion dates.

- The **Expected Timeline** shows the start/completion dates that are now expected given the current situation. For project plans that use precedents, the expected dates for an activity automatically shift in response to delays in prior activities. (See Project Planner Timelines.)

- The **Actual Timeline** records when a gate or action has actually started or completed. If the gate has dependents, these dates are automatically inherited in the following way:
  - The actual start date is the earliest actual start date from the dependents.
• The actual completion date is the latest actual completion date from the dependents.

• The Relevant Metrics fields let you display up to three relevant metrics in the gate. The Push to Metrics fields let you "push" the gate's percent completed and actual vs. planned resource usage to metrics so they can be tracked and displayed in other locations. (See Using Metrics in Project Planner Gates.)

• 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.

• Watch allows each individual user to subscribe to receive an alert (via e-mail, SMS text message or portal message) when the gate is changed. (See Subscribing to a Watch.)

• Gate Monitors allows you to specify individual users and/or groups of users who will receive alerts for the gate, regardless of whether they have personally subscribed to a watch. (See Action and Gate Monitors.)

**Gate Status**

The gate status (which is displayed in the summary panel and in the status bar) is determined based on the same logic used for action statuses, which takes into account the expected start/completion date and any actual dates. For example, a gate's status is "Past Start Date" if it hasn't started and it's too late to start by the expected date, while "Past Due" means it is too late to complete on time.

Actions in Project Plans

You can add actions to gates in the Project Planner in order to track specific assignments that need to be performed as part of specific phases of the plan. These are the same action resources that can be included in My Portal and Synthesis Enterprise Portal, as well as FMEAs or Test Plans in Xfmea/RCM++/RBI.

When you add an action to a gate in the Project Planner, the software will:

• Use timelines in the action that automatically shift in response to delays in prior activities, which will affect how the action's status is determined.

• Display the action's plan summary in the Action properties window.
• Use the action’s status, percent complete and resources to “roll up” to the gate it is assigned to.

Adding Actions to the Plan
With a gate selected in the Project Planner, choose Project Planner > Action > Add Action. (In a secure database, this is only available to users with the “Create/edit project plans” permission.)

• Add Action creates a new action resource.

• Reuse Action Resources allows you to select existing action(s) from the project that a) are not already used in the current plan and b) have dates that fit within the current gate. Specifically, the action’s start date can’t be before or more than a year after the gate’s start date. (See Select Resource window.)

• Reuse FMEA Actions allows you to select one or more Xfmea/RCM++/RBI system hierarchy items from the current project that have FMEAs. You can then select to use existing action(s) from those particular FMEAs in the project plan.

Project Plan Summary Panel
The project plan summary panel displays information about start/completion dates, status, progress and resource usage for an entire project plan, and for individual gates and actions.

The summary panel is accessible from multiple locations across the Synthesis Platform:

• From the Project Planner, you can select a gate or action in the hierarchy to view its summary, or you can select the project at the top of the hierarchy to view a summary of the entire plan.

• The gate/action properties window shows the summary for that gate/action.

• The Plan Summary Page in My Portal displays a summary of the entire plan for the project that currently has focus.

• These summaries are also displayed in the web-based Synthesis Enterprise Portal (SEP), if it is implemented for an enterprise database.
In most cases, this shows the current date. If you are working in the Project Planner and you want to see what the statuses would be on a different date, click the green “play” arrow (▶️) and then select a different date from the calendar. When you’re ready to return to the current date, click the green “pause” bars (● ●).

This bar displays the name of the project, gate or action that the summary applies to, followed by:

- The EXPECTED start date and completion date. (This will be the same as the planned dates unless a prior delay has caused the expected dates to shift.)
- The ACTUAL start date and completion date (if the action is in progress or complete).
- The current status. (See Action Timeline and Status.)

For actions, the progress bar shows the percentage entered by the user. For gates, it shows the percentage of the total duration of dependent actions/gates that is complete. For example, if Action 1 (duration = 3 days) is complete and Action 2 (duration = 1 day) is incomplete, the progress is 75%.
For resource usage, the black bars show the planned man hours and costs. The colored bars show either the expected usage to date (estimated based on the number of days in progress), or the actual usage if complete. (See Costs and Man Hours.)

- Yellow = In progress and usage to date is still within plan
- Orange = In progress and usage to date has exceeded plan
- Green = Complete and actual usage was within plan
- Red = Complete and actual usage exceeded plan

The pie chart will be visible only for projects or gates that have at least one action assigned (either directly or via dependent gates).

- Not Started = Actions that have not started and can complete on time
- In Progress = Actions that are in progress and can complete on time
- Completed = Actions that have a completion date
- Past Due = Actions that can no longer complete on time
Check Utilization

The Check Utilization window lets you examine the utilizations for individual users and facilities across one or more actions. It displays the total utilization for each resource on each specific date, so you can easily identify dates when the resource is over-utilized and make any adjustments that may be needed.

- To view utilizations for a specific action, open the action and choose Tools > Check Utilization.
- To view utilizations across multiple actions, open the Project Planner and choose Project Planner > Tools > Check Utilization.

If you open the utility from the Project Planner ribbon, there are two options. By default, it shows Only actions in this plan. Alternatively, you can choose to see utilizations from All actions in the project (even if they are not used in the plan).

Regardless of whether you’re checking a single action or the entire project plan, the utility shows All resource utilizations by default. Alternatively, you can choose to see Only utilizations over 100%.

Over-utilized resources (i.e., those with a utilization that exceeds 100%) are shown in red.

Double-click a resource to view its total utilization for each specific date, as well as the action(s) that use the resource on each date. For example, according to the window shown next, Joe Reliability's highest utilization for a single day exceeds 100%. By double-clicking his name, you can see that he is assigned to two actions that overlap on 1/6/2016, and as a result his combined utilization for that day is 105%.

![Check Action Resource Utilization](image-url)
**Project Planner Gantt View**

The Project Planner also includes a Gantt chart that makes it easy to visualize the timelines in your project and examine how different planning resources are utilized over time.

To access this view, click Gantt at the bottom of the Project Planner.

- Use the Gantt Type drop-down list on the control panel to specify what to display:
  - **Project Plan** shows timelines for gates and actions.
  - **Personnel Utilization** and **Facility Utilization** show the utilizations for the person responsible, team and/or facilities. (See Project Planning Resources.)

- In the Gantt Display area, select the part of the plan you want to view in the Filter drop-down list. For example you could view a specific gate (and its dependents) or a specific user (and all their utilizations). If you want to change the widths of columns that contain dates, use the Fit Mode.

- In the Date Selections area:
  - Select to view the entire plan or focus only on a specific date range.
  - Specify whether each column represents a specific number of Days, or Other increments such as weeks, months, quarters, etc.

- In the Date Display area:
  - If each column represents a single day, select whether to display Non-Working Days. If displayed, those columns will have a gray background. (See Working Days/Holidays.)
  - Use Show Planned, Show Expected and Show Actual to specify which timeline bars will be displayed.
    - To specify the colors that will be used in both the project plan Gantt chart and the timeline plot, choose View > Settings > Set Colors. (See Set Colors for Project Planner.)
  - For the planned and actual timeline bars in the project plan chart, you can also choose whether to Show Percent Completed.
• If you are using one of the utilization charts and the date columns each represent more than a single day, use the **Calculate Utilization As** area to specify how to calculate the utilization. This can be:
  
  • **The Max** (highest) daily utilization among all days in the interval. For example, if the interval is 3 days and the utilizations were 15%, 0% and 10%, the max will be 15%.
  
  • **The Average** across only the days in the interval that have utilizations. For example, if the interval is 5 days but the resource was only utilized on 3 of those days, the average will be the total utilization/3 days.
  
  • **The Overall Average** across all working days in the interval. For example, if the interval is 5 working days, the overall average will be the total utilization/5 days even if the resource was not utilized every day.

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**Project Planner Plot View**

The [Project Planner](#) includes a plot view that makes it easy to visualize the timelines in your project.

To access this view, click **Plot** at the bottom of the Project Planner.

![Plot button](#)

• Use the **Filter Options** area to select whether to filter the data by **Gate** or by using a **Date** range. You can also choose to view data for **Top Level Gates** only.

• In the Display Options area:
  
  • **Show Planned, Show Expected** and **Show Actual** determine which timelines will be shown in the plot.
  
  • To specify the colors that will be used in both the project plan Gantt chart and the plot, choose **View > Settings > Set Colors**. (See [Set Colors for Project Planner](#))

  • **Display Actions** shows the dependent actions for each gate.

  • **Show Project Item** shows the “project” gate at the top of the hierarchy.

  • **Show First Gate on Top** determines whether the gate with the earliest start date will show at the top or bottom of the chart.
• **Auto Refresh** refreshes the plot automatically whenever changes have been made. If this option is cleared, you can click the **Redraw Plot** icon ( ) to refresh the display.

• **Keep Aspect Ratio** maintains the proportional relationship between the width and height of the plot image.

### Set Colors

To open the Set Colors window for the Project Planner, choose View > Settings > Set Colors.

- The **Gate and Action Options** apply to the Gantt chart (if viewing the plan), plan hierarchy and plot.

![Gate and Action Options](GateActionOptions.png)

- The **Date Display** options apply only to the Gantt chart and plot.

![Date Display](DateDisplay.png)

- The **Utilization Threshold Colors** apply only when using the Gantt chart to view team or facility utilization.

![Utilization Threshold Colors](UtilizationThresholdColors.png)
Project Planner Dashboards

You can use the flexible Synthesis Dashboard utility for presenting data from any Project Planner in the database.

To access this feature, open the planner and choose Project Planner > Tools > Dashboard.

As with any other Synthesis dashboard, you can use the Dashboard Viewer to select any of the layouts that have been predefined for this type of data. In a secure database, only users with the "Manage dashboard layouts" permission can use the Dashboard Manager to create or edit layouts.

Data Source Drop-Down List

When you are creating a dashboard layout based on project plan data, the drop-down list at the top of the Data Source Panel gives the following options:

- **Actions** returns data only from actions in the current plan.
- **Gates** returns data only from gates in the current plan.
- **Gates/Actions** returns data from both actions and gates.
- **Facilities** returns data from the facilities assigned to actions.
- **Personnel** returns data from the person responsible and/or team assigned to actions.

Each data source allows you to choose relevant fields from the record properties, summary panel and/or project plan hierarchy.

Note that all of the data fields used within a particular dashboard item must come from the same source. For example, you can’t combine fields from the “Actions” data source and the “Gates” data source in the same chart. If you want to create a chart that includes both actions and gates, use the fields from the “Gates/Actions” data source instead.

**Examples for Different Field Types**

The icon for each field indicates the data type: text, number or date. There are many possible ways to use these fields in your own customized dashboard layouts. The following simple examples demonstrate basic applications for each data type.

**Example Using Counts**

This pie chart uses the **Count** value for a text field to show the actions in the current project plan broken down by status. The argument determines the slices shown in the pie.

*Tip:* If you want to see both the quantity and the percentage, choose **Design > Data Labels > Argument, Value And Percent.**
Example Using Numbers
This bar chart uses the **Sum** values for two number fields to show the top 5 most costly actions in the current project plan, with comparison to the planned cost. The arguments determine how the bars are labeled, grouped and sorted.

Example Using Dates
This grid uses the **Exact Date** for two date fields to show a list of all actions in the current plan that are due in the current month. (To set the criteria that filters the records shown in the grid, right-click inside the chart and choose **Edit Filter**.)
Chapter 19: Synthesis Project Planner

Project Planner Ribbon

Project Planner Tab
The Project Planner tab in the Project Planner ribbon contains the following commands.

Project Planner

👉 Refresh updates the Project Planner hierarchy, if necessary. For example, if multiple users are accessing the same plan simultaneously, this will update the plan to reflect any changes made by other users.

👉 Create Project Plan opens the Create Project Plan window so you can start again from a blank plan, or import an existing plan from another project.

召回 Delete Entire Plan deletes every gate and removes every action from the plan.
Item Properties allows you to view or edit the Synthesis Identifiers defined for the current plan. These identifiers can be used in the Synthesis Explorer to explore all of the different types of analyses (including project plans) in the current database.

Clipboard

Paste pastes the contents of the Clipboard into the level below the selected gate (or on the same level of the selected action). If you want to paste gates only (without sub-gates and actions), use the Paste Without Actions command.

Cut cuts the selected gate/action and any dependents to the Clipboard. You can paste this information into another Project Planner within the same database.

Copy copies the selected gate/action and any dependents to the Clipboard. To copy everything, use the Copy Entire Plan command. You can paste this information into another Project Planner within the same database.

Delete deletes the selected gate/action and any dependents.

Gate

Add Gate

• Add Same Level Gate adds a gate on the same level as the selected gate.
• Add Next Level Gate adds a gate one level below the selected gate.
• Add Gate adds a top-level gate to the end of the plan.
• Insert Gate inserts a gate at the selected location.

Use Precedence, when selected, automatically sets a new gate's precedent to the prior gate, which allows you to take advantage of expected timelines and ensure that there are no gaps between gates. If you clear this option, the default precedent will be "None."

Edit Gate opens the Gate Properties window.

Promote and Demote moves the selected gate to the next higher or lower level in the plan. 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.
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**Action**

- **Add Action** creates a new action resource.

- **Reuse Action Resources** allows you to select existing action(s) from the project that a) are not already used in the current plan and b) have dates that fit within the current gate. Specifically, the action’s start date can’t be before or more than a year after the gate’s start date. (See Select Resource window.)

- **Reuse FMEA Actions** allows you to select one or more Xfmea/RCM++/RBI system hierarchy items from the current project that have FMEAs. You can then select to use existing action(s) from those particular FMEAs in the project plan.

**Tools**

- **Remove Gaps in Dates** automatically assigns precedents to every applicable gate. This ensures that there will be no gaps in the planned or expected timelines, and it allows the expected dates for an activity to automatically shift in response to delays in prior activities. (See Project Planner Timelines.) You can choose to remove gaps in the Entire Plan or just for the gates that fall under the selected Branch.

- **Check Utilization** opens the Check Utilization window so you can examine the utilizations for individual users and facilities across multiple actions (e.g., is a particular user assigned to too many actions at the same time, or is a particular test facility already booked for a particular timeframe).

- **Expand All** and **Collapse All** expands or collapses the gates in the project plan hierarchy.

**Dashboard**

- **Dashboard Viewer** opens the Dashboard Viewer so you can view dashboards based on predefined layouts.

- **Dashboard Manager** opens the Dashboard Layout Manager so you can create, edit, and delete the predefined layouts that will be available for any Synthesis user to view for any project plan in the database.
**Excel Import/Export**

- **Export View to Excel** exports the entire hierarchy and all displayed columns to an Excel sheet in a format that's suitable for presentation.

- **Import Hierarchy** and **Export Hierarchy** use an Excel format that's suitable for recreating the plan hierarchy in another project plan using information about precedents, outline level, etc.

**Copy Current View** copies the currently visible contents of the plan hierarchy or Gantt chart to the Clipboard as a graphic that can be pasted to other applications.

**View Tab**
The View tab in the Project Planner ribbon contains the following commands.

**View**

- **Color Code Deltas** applies highlight colors to any “Delta Values” columns for dates or durations that are displayed in the project plan hierarchy (e.g., the difference between the planned duration and the actual duration, or between the expected completion date and the actual completion date). Highlights are applied on a gradient from blue (ahead of schedule) to red (significant delay).

- **Fit All Columns** automatically resizes all columns to fit their own data.

**Settings**

- **Customize Columns** allows you to hide or display specific columns in the plan hierarchy.

- **Save View** and **Apply View** create or apply a view that stores your preferences for which columns to display in the plan hierarchy and which colors to use for gates, actions, timelines and utilizations. Each view is saved per computer/username.

- **Set Colors** allows you to select the colors to use for gates, actions, timelines and utilizations.

**Zoom**

- **Normal Zoom** sets the degree of magnification to 100%

- **Zoom In** and **Zoom Out** increase or decrease the font size by 25% increments.
Custom Zoom allows you to specify the zoom percentage.
Chapter 20: Synthesis Plot Utilities

Synthesis applications offer a variety of plotting utilities for visual presentation of your analysis results. The following topics provide general information about built-in utilities, where the types of plots/charts available are predefined based on the analysis method and type of data you are working with. For more information about specific plot types, please consult the documentation for the relevant analysis.

Tip: In addition to the built-in plotting utilities described here, you can also create your own custom plots/charts in the Synthesis Workbooks and Synthesis Dashboards.

Basic Plot Features

This topic describes some basic features and capabilities that are available in most built-in plot utilities in Synthesis desktop applications (i.e., utilities where the types of plots available are predefined based on the analysis method and type of data you are working with). For information about creating your own custom charts in Synthesis Workbooks or Synthesis Dashboards, see Custom Charts or Dashboard Layout Designer.

Redraw Plots

A plot needs to be refreshed whenever its data source has been recalculated or when its inputs or settings have been modified. This ensures that the plot reflects the most current results. In most plot sheets, the control panel displays a status light that indicates whether the plot needs to be refreshed. A green light indicates that the data and the plot are in sync, while a red light indicates that the plot is out of sync with the latest analysis.

You can manually update a plot to reflect any changes by clicking the Redraw Plot icon in the plot’s control panel.

Alternatively, a plot can be refreshed automatically whenever changes have been made by selecting the Auto Refresh check box on the plot’s control panel.
Chapter 20: Synthesis Plot Utilities

Identify a Plot’s Source Analysis
For most plots, the control panel displays a blue link that displays the plot’s source analysis, as shown in the following example for a Weibull++ plot. You can click the link to open the folio and view the data set.

In some specialty plots (side-by-side plot, life comparison tool, etc.), you can select the source analysis for the plot by clicking the icon on the plot’s control panel or ribbon.

If the plot contains results from more than one analysis (e.g., overlay plots), the control panel includes a button that allows you to add or remove analyses from the plot, as shown in the example below for Weibull++ data sheets. In addition, you can click and drag the data sheets to the desired order.

Show or Hide Plot Items
When applicable, a plot may provide options for showing or hiding certain plot items such as data points, lines, probability scales, etc. The available options depend on the plot type and analysis. To view the options for the plot you are working with, choose Plot > Actions > Show/Hide Plot Items or right-click the plot and choose Show/Hide Items on the shortcut menu.

Select the check box for each item you want to appear in the plot, or clear the item’s check box to hide the item from view.

Scaling
When applicable, the plot control panel may display X and Y scaling boxes that show the minimum and maximum values for the x- and y-axes. You can clear the check boxes and click inside the fields to manually edit the values, or select the check boxes to have the application choose the appropriate values for the range, based on the data.
Zoom
The zoom function is available for plots that allow both X and Y scales to be adjusted. To zoom in or out of a plot, click inside the plot, point the mouse pointer over the area of interest, and then rotate the mouse wheel. Press ESC to return to the original scale.

For non-3D plots, you can also select a specific area to zoom in by holding the CTRL + SHIFT keys while clicking and dragging the mouse over the desired area. You can customize the color and line style of the zoom rectangle via the Zoom page of the Plot Setup.

Aspect Ratio
Plots are automatically resized whenever you resize the plot sheets. To maintain the proportional relationship between the width and height of the plot image, select the Keep Aspect Ratio check box on the plot’s control panel (as shown in the first example below). Clear the check box if you wish to stretch the dimensions of the plot graphic to fill the plot sheet (as shown in the second example below).
**Show Coordinates**

To show the coordinates for a location on a plot, press **SHIFT** and click the plot (no need to hold down the mouse button). To stop showing the coordinates and return the pointer to its normal mode, click the plot again.

To track the coordinates on a plot line, click the line. A crosshair shows the current location on the line. The crosshair will stay on the line and track the coordinates as you move the pointer.

When applicable, you can add a label that displays the coordinates of a location by pressing **CTRL + ALT** and then clicking the location you want labeled.
Add Custom Labels
When applicable, you can add a custom label to a plot by pressing CTRL and then clicking the plot. A label named "Default" will appear in the plot. Select the label to edit the text directly in the plot or double-click it to open the Edit Label window, which gives you the option to select a font style or format.

You can then move the label by clicking it and dragging its yellow handle to the desired location on the plot. (For more extensive annotations, see ReliaSoft Draw.)

Move Plot Items
If your plot has lines or points that are obscuring one or the other, you can move an item by pressing ALT and clicking the item. The Move Plot Item window will appear, giving you the option to move the selected item either to the front or back of the obscuring graphic.

Export or Copy Plot Graphics
You can save a plot graphic as a *.wmf, *.png, *.gif, or *.jpg file for use in other applications by clicking the Export Plot Graphic icon on the plot's control panel, or by choosing [Plot/3D Plot] > Actions > Export Plot Graphic if applicable.
In addition, you can save a plot graphic to the Clipboard by clicking the **Copy Plot Graphic** icon on the plot's control panel or by choosing [Plot/3D Plot] > **Actions** > **Copy Plot Graphic** if applicable.

When saving a 3D plot graphic to the Clipboard, the image will be in *.bmp* format. For all other types of plots there are three choices: If you will be pasting copied plots into any one of the spreadsheets built in to Synthesis desktop applications (e.g., Synthesis Workbooks or General Spreadsheets), choose **Metafile Optimized for Synthesis Spreadsheet**. If you will be pasting them into external applications, choose **Bitmap** or **Metafile Optimized for External Use**.

### Setting Confidence Bounds

If your analysis includes calculations for confidence bounds, you can display the bounds in the associated plot by clicking the **Confidence Bounds** link on the plot control panel or by choosing **Plot > Confidence Bounds > Confidence Bounds**.

Depending on the type of data you are working with, you may be presented with different options for setting up the confidence bounds on the plot. (The ReliaWiki resource portal provides information on the background theory of confidence bounds at: [http://www.reliawiki.org/index.php/Confidence Bounds](http://www.reliawiki.org/index.php/Confidence Bounds).)

In the Confidence Bounds Setup window, you will need to:

1. Select which lines to show on the plot (e.g., two-sided, bottom one-sided, etc.)

2. Select which type of bounds to show on the plot. This may be the bounds on the time estimate (Type I), bounds on the reliability/unreliability estimate (Type II: Reliability); or when applicable, bounds on functions such as number of failures, growth potential, etc. (Type II: Function).

3. Enter the percent confidence level.

To change the level of detail at which the bounds are plotted, adjust the **Resolution** slider. You can click and drag the slider or, for fine adjustments, click the slider and then use the arrow keys. The number of points plotted to create the lines is displayed next to the field name. Note that higher resolutions will take longer to plot.

To hide the confidence bounds, choose **Plot > Confidence Bounds > Hide Confidence Bounds**.
Setting Target Markers

When applicable, the plot control panel may display the Target Reliability link or the Target MTBF/Fl link. Both give you the option to display markers for target values on the plot.

You can select to show a specified target value (displayed as a horizontal line), target time value (displayed as a vertical line), and/or insert a marker at the point where the two target values intersect. Below is an example for a plot that shows the target reliability.

Click the Add + or Remove — icon to manage the list of target values to be displayed. You can add up to 5 sets of target values/markers to a plot.
Plot Setup

The Plot Setup utility provides advanced settings for customizing the look of a plot to meet your needs and preferences. It allows you to: a) make changes and apply them to the current plot; b) save the changes and use them as default settings for all new plots; c) restore previously saved default values; or c) reset all settings to the shipped defaults.

**Tip**: You can quickly set some basic default settings for all new plots created in the current Synthesis desktop application via the Plots page of the Application Setup (File > Application Setup). The Application Setup also allows you to set some default analysis settings that may affect the appearance of plots (varies depending on the Synthesis desktop application).

To open the Plot Setup, click the Plot Setup icon on the plot’s control panel.
Alternatively, you can double-click the item on the plot you wish to edit (e.g., points, lines, etc.) and the Plot Setup will open and display automatically the options associated with that item.

To apply your changes to the current plot, click **OK**. To save your changes as the new defaults, or restore previously saved defaults, or reset to shipped defaults, click the **Defaults** button. (See **Plot Defaults Window** for more information.)

**Plot Elements**

The Plot Setup is divided into pages that contain related settings for particular plot elements. The available pages/elements will depend on the type of plot you are working with.

As an example, the following picture identifies some of the basic plot elements that can be configured via the Plot Setup.

![Plot Elements Diagram](image)

**Plot Setup: 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.
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Each asterisk (*) represents the default title text. For the main title, this is defined on the Titles Text page of the Plot Defaults window. If you type new text in an input box, either alone or in addition to the asterisk, the text you type will be displayed on the plot. For example, if you add (Helicopter) to the Main Title field, the default main title will be displayed, followed by "(Helicopter)." The changes you make will be applied regardless of plot type, so the main title of a Failure Rate vs Time plot would then be "Failure Rate vs Time (Helicopter)" and the main title of a System Failures plot would be "System Failures (Helicopter)." (This assumes that you have not changed the default main titles from the ones shipped with the application.)

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 Set 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 Set Image button. The image will also appear at the left side of the header or footer text. To remove the image, click Clear Image.

Plot Setup: 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.

- **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 type new text in an input box, either alone or in addition to the asterisk, the text you type will be displayed on the plot. For example, if you add (Hours) to the Y-Axis Title field, the default y-Axis title will be displayed, followed by "(Hours)." The changes you make will be applied regardless of plot type, so the y-axis title of a Static Reliability Importance plot would then be "Static Reliability Importance (Hours)" and the y-axis title of a Throughput vs. Time plot would be "Throughput(t) (Hours)." (This assumes that you have not changed the default axis titles from the ones shipped with the application.)
• **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.

  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 reenter the settings. |

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**Plot Setup: 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. 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.)
• **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](http://rga.reliasoft.com).

• **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.
  - **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.

**Plot Setup: 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**.)

- 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.
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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.

- For bar and pie charts in BlockSim and RENO only, **Color Spectrum** allows you to set the color limits for the plot.
  - You can set both lower and upper color limits by dragging the markers on the scale between 0% and 100%.
  - **Show all values (0-100%) in legend** if selected, the legend will show the full range of values; if not selected, the legend will show only the values between the upper and lower limits that you have specified.

  The preview shows how the specified settings will appear in the legend.

**Plot Setup: 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.

### Plot Setup: 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 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 reenter the settings.

**Plot Setup: 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.

**Plot Setup: 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.
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- **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.

**Plot Setup: 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 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. You can adjust the thickness of a grid line by entering a positive integer in the input 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.

**Plot Setup: 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 BlockSim, but the settings are the same for all Synthesis desktop applications.)
Plot Setup: Zoom Page

The Zoom page allows you to customize the options used when zooming in on a plot by using the mouse wheel. Zooming works only for plots with scales. For more information, see Basic Plot Features.

Allow Zoom if selected, allows the plot zoom feature to be used.

- **Factor** use this option to set the amount of the magnification each time you use the mouse wheel on the plot. The lower the number, the greater the increase in the magnification.

- Use the **Border Color, Thickness and Style** option to set the appearance of the zoom box. 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.

- **Fill Style** allows you to select a style of hatching to be used on the zoom box.
• **Fill Color** allows you to specify a foreground color to be used on the zoom box. This color is not used if the selected fill style does not use a background color (i.e., solid or transparent fill style).

• **Background color** allows you to specify a background color to be used on the zoom box. This color is not used if the selected fill style does not use a background color (i.e., solid or transparent fill style).

**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 a Failure Rate vs. Time plot while changing the titles for a System Failures plot.

• **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.

• **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.

**Plot Defaults Window: Titles Text Page**

The Titles Text page of the Plot Defaults window allows you to customize default plot titles for each plot type.

- **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.
Plot Defaults Window: Plot Items Display Page

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

ReliaSoft Draw (RS Draw) is a metafile graphics editor that allows you to annotate and customize your plots. With RS Draw, you can insert text, draw an object, mark the coordinates of a particular point or paste another picture into your plot. You can also re-arrange the objects in your plot by selecting and moving them to the positions you desire. In addition, you can save the annotated plot in one of the following formats: *.rdc, *.jpg, *.gif, *.png or *.wmf.

RS Draw is available by clicking the icon on the plot control panel.

See ReliaSoft Draw Help for information on the features available in ReliaSoft Draw. If you do not currently have Internet access, this link will not work, but you can browse to the local copy of the help file by opening the Help\RSDraw\rsdraw.htm file in your Synthesis application directory.

Overlay Plots

Available in Weibull++, ALTA, BlockSim and RGA, overlay plots give you the ability to display results from multiple analyses in a single plot. This allows you to easily compare different data sets, analysis methods or distributions. For example, you may wish to show the reliability plots of two product designs in the same plot or compare a simulation-based data set with actual data obtained from fielded products.

Creating an Overlay Plot

Before using an overlay plot, you must first analyze the data sets (or simulate the diagrams) you wish to include in the plot. You can then add an overlay plot to the project by choosing Insert > Reports and Plots > Overlay Plot.
In the window that appears, select the data sheets/diagrams you want to include in the plot (up to a maximum of 20) and click **OK** to create the plot sheet. The plot sheet will be saved automatically under the **Multiplots** heading in the current project explorer.

**Tip:** In Weibull++, ALTA and RGA, you can add additional plot sheets to a folio by choosing [Life Data/Life-Stress Data/Growth Data] > Folio Sheets > Insert Additional Plot. The additional sheets can function as overlay plots to display results from multiple data sheets in the current folio on a single plot.

### Adding or Removing Analyses

To add or remove analyses from an overlay plot, click the button on the control panel, as shown in the example below for data sheets.

If you later delete an analysis that is referenced by the plot, the plot will remain available and will continue to show the results of the analysis until you redraw the plot (by clicking the **Redraw Plot** icon on the control panel).

Note that importing or exporting an overlay plot will automatically import/export the associated source analyses. (See Importing/Exporting Project Items or Resources.)

### Available Plot Types for Overlay Plots

The available plots depend on the analysis or type of data you are working with.

**For Weibull++/ALTA**

Probability plots, contour plots and ALTA stress plots are available only if the data sets have been calculated with the same distribution. This is because the scales or axes in those types of plots vary for different types of distributions.

In DOE design folios, plots that are intended to be viewed as singular plots will not be available for inclusion in overlay plots. These include the comparison chart, Pareto chart, interaction matrix, term effect plot, cube plot, residual histogram, residual autocorrelation plot, and Box-Cox transformation plot. In addition, only plots that are common to the type(s) of design you have selected will be available in the overlay plot. If a plot type is unavailable for any of the included design types, it will be unavailable in the overlay plot.
For BlockSim

You can compare data from analytical and simulation diagrams in the same plot, but keep in mind that analytical diagrams always show the reliability over time (does not account for repairs) while simulation diagrams always show the point reliability over time (may include repairs).

For RGA

Only plots that are common to the analyses you have selected will be available in the overlay plot. If a plot type is unavailable for any of the included analyses, it will be unavailable in the overlay plot. It is possible for the selected analyses to not have any common plot types.

Side-By-Side Plots
Available in Weibull++, ALTA and RGA, side-by-side plots give you the ability to display different plots for a single data set all in a single window for easy comparison.

To add a side-by-side plot to a project, choose Insert > Reports and Plots > Side-by-Side Plot.

In the window that appears, select the analysis/data sheet you want to plot and click OK to create the plot sheet.

To view a single plot in greater detail, double-click the plot. You can double-click the plot again to return to the side-by-side view.

Choosing Plots to Display
The control panel provides options for selecting the type of plots to display. For most analyses, the Vary area will be available, which contains two options:

- The vary Plot Types option allows you to create different plots for the same data set. For example, you might wish to display both the Reliability vs. Time plot and the Failure Rate vs. Time plot of the data set.

- The vary Distributions or Models option allows you to compare how different distributions or models fit a particular data set. For example, you might wish to display a reliability plot for different life distributions, as shown next.
3D Plots

Available in Weibull++, ALTA and for two-way sensitivity analysis in RENO, 3D plots give you the ability to graph functions with three variables, such as the reliability at a given time and stress level. In addition, Weibull++ and ALTA offer the option to create 3D overlay plots, which are similar to regular overlay plots but displayed in 3D space.

Creating 3D Plots

Before creating a plot, you must first analyze the data sets (or in RENO, you must first run the simulation for the two-way sensitivity analysis).

To add a 3D plot to the project, choose Insert > Reports and Plots > 3D Plot.

To add a 3D overlay plot to a project (Weibull++ and ALTA only), choose Insert > Reports and Plots > 3D Overlay Plot.

In both cases, the plots are automatically saved and stored in the Multiplots heading in the current project explorer.
Defining the X, Y and Z Axes

The control panel in the 3D plot folio contains basic settings for defining the X, Y and Z axes. (For advanced customization options, see 3D Plot Setup.)

The Begin and End fields, as shown next, display the minimum and maximum values for the axes. You can click inside these fields to manually edit the values, or select the Autoscale check box to have the application automatically choose the appropriate values for the range.

Whenever applicable, the Parameter fields will be displayed, as shown in the example above. Click these fields to change which parameter lies on which axis. The name of the parameter associated with the axis will be displayed next to that axis’s label.

Rotating 3D Plots

The XYZ indicator shown at the lower-left of a 3D plot represents the plot’s horizontal rotation (azimuth) and vertical rotation (elevation) in 3D space. Any changes to a plot’s rotation are reflected in the XYZ indicator, helping you to visualize the plot’s orientation on the screen.

There are several ways to rotate or manipulate a 3D plot, using the mouse, keyboard shortcuts or the view cube.
Using a Mouse and Keyboard Shortcuts

<table>
<thead>
<tr>
<th>If you want to</th>
<th>Use a mouse</th>
<th>Use keyboard shortcuts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotate the plot or change the viewing angle</td>
<td>Click anywhere in the plot area, and then press and hold the left mouse button while moving the pointer.</td>
<td>Press the Up, Down, Left or Right arrow keys.</td>
</tr>
<tr>
<td>Move the plot without changing its rotation</td>
<td>Click anywhere in the plot area, and then press and hold the right mouse button while moving the pointer.</td>
<td>Hold the SHIFT key while pressing the Up, Down, Left, or Right arrow keys.</td>
</tr>
<tr>
<td>Zoom in or out</td>
<td>Rotate the mouse wheel. Alternatively, you can choose 3D Plot &gt; Display &gt; Zoom In or Zoom out.</td>
<td>Press the W or S keys.</td>
</tr>
<tr>
<td>Automatically center the plot on canvas</td>
<td>Choose 3D Plot &gt; Display &gt; Center on Canvas.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Using the View Cube

The View Cube helps you to easily orient a 3D plot using predefined viewpoints. The cube is located at the lower-right of the 3D plot.

The letters on the cube represent a particular viewpoint. For instance, clicking the "F" side of the cube orients the plot such that you are looking directly at the plot’s front side (e.g., Y and Z plane).

- Front
You can rotate the cube in the same way you would rotate any 3D plot (i.e., press and hold the left mouse button while moving the pointer anywhere on the screen; or press the Up, Down, Left or Right arrow keys on your keyboard).

**3D Plot Setup**
The 3D Plot Setup allows you to customize the look of 3D plots to meet your needs. It gives you full control over the settings used for individual 3D plots and the default settings for all new 3D plots.

To access the 3D Plot Setup, choose *3D Plot > Actions > 3D Plot Setup*.

Alternatively, you can double-click the item on the plot you wish to edit. This will automatically open the 3D Plot Setup and display the options associated with that item. The available options in the 3D Plot Setup will vary, depending on the plot type. You can move the mouse pointer over an option to display its definition.
To apply your changes to the current plot only, click **OK**.

To save your changes and use them as the default setting for all new 3D plots, click the **Save as Default** button. This will overwrite the previous default settings.

To restore the previously saved defaults, click the **Load Defaults** button. This is an easy way to undo changes you have made in the 3D Plot Setup and re-apply default settings.

To reset all settings to the default values that were shipped with the application, click the **Reset** button.
Chapter 21: Synthesis Workbooks

The Synthesis Workbook is a custom reporting tool that is built directly in to many Synthesis applications, including Weibull++/ALTA, RGA and BlockSim. It combines two reporting modules – Spreadsheets and Word Processing – into the same flexible interface, thereby replacing the Analysis Workbook and Word Report Template functionality from prior versions.

**Tip:** If you convert a project from Synthesis 10 or earlier, any Analysis Workbooks and Word Report Templates will be automatically converted to Synthesis Workbooks.

If your organization has implemented a Synthesis Enterprise Portal (SEP) website for an enterprise database, you can choose to publish selected Synthesis Workbook reports to be accessed from any web-enabled device. See [Publishing to SEP](#).

### Synthesis Workbook Wizard

To add a new Synthesis Workbook in an existing project, choose **Insert > Reports and Plots > Synthesis Workbook.**

This launches the wizard, which gives you the opportunity to assign the first associated data source and/or select a saved template, if desired. (Note that the examples shown here are from Weibull++ but similar functionality is available in ALTA, RGA and BlockSim.)

**If you prefer to start with a blank report:**

Simply click **OK** and then click **Yes** when prompted to confirm that you want to create the report without associating a data source. (You will be able to associate data source(s) later if you wish.)

**If you want to assign the first data source:**

Click **Select** and choose one of the available analyses (i.e., a data sheet in Weibull++/ALTA and RGA, or a diagram in BlockSim). When you return to the wizard, click **OK** to create the report.

Note that you will be able to associate more data sources after the report is created, and change any of those assignments at any time. (See [Associated Data Sources](#).)
If you want to use a saved template:

Click Spreadsheet or Word Processing. Select the Based on Existing Template check box and then choose a template from either the Standard tab (templates that are installed with the software) or the User tab (templates you have saved). Then click OK to create the report. (See Synthesis Workbook Templates.)

Associated Data Sources

In Synthesis Workbooks in Weibull++/ALTA, RGA and BlockSim, you have the option to associate multiple data sources that can be used for any function that obtains data or results from an existing analysis. (To obtain results from a DOE analysis in Weibull++/ALTA, see DOE Analysis Report.)

When you create this type of function, you will have the option to use an index to specify which of the currently assigned default data sources will be used. For example, if you want to compare the reliability values calculated from two different analyses, you can use

=RELIABILITY(Default1, 1000) to get the result from the first default data source, and
=RELIABILITY(Default2, 1000) to get the result from the second default data source.

Although you will be prompted to associate the first data source when you create the report, you can add or change associated data sources for an existing report at any time.

Associating Data Sources

For Synthesis Workbooks, the Information panel (located on the right side of the window) shows which analyses are currently assigned as default data sources. To have the panel always display, click the pushpin icon into the vertical position.
To add or remove analyses, choose **Home > Report > Associate Data Sources** or click the icon in the Information panel.

The following picture shows the windows for Weibull++. Similar functionality is available in ALTA, RGA and BlockSim.

Note that:

- In **Weibull++/ALTA**, you can select any data sheet from a folio that contains a life data analysis:
  - Life data folio
  - Life-stress data folio
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- Non-parametric LDA folio
- Warranty analysis folio
- Degradation analysis folios (the results shown in the report will be based on the analysis of the extrapolated failure/suspension times)

- In **RGA**, you can select any data sheet in a growth data folio.
- In **BlockSim**, you can select any analytical diagram, simulation diagram or phase diagram. The function results can either be based directly on the analyzed/simulated diagram, or based on a model that has been fitted to the diagram. You specify this preference on the diagram’s control panel, using the **Report folio model** drop-down list on the Analysis Settings page.

### Linking Multiple Data Sources with Different Time Units

In BlockSim, function results that are time-based (e.g., downtime, time to event, etc.) will be returned in the **System Base Unit (SBU)** for the repository. However, in Weibull++/ALTA or RGA, each function result is returned in the units used by its data source. If you wish to compare the results from multiple data sources that use different time units, there are two possible scenarios:

- **Convert the data in the original data source.** For example, if one data set is in "hours" and another is in "days," you could use the **Change Units** feature to automatically convert the data in the first analysis from "hours" to "days."

  **Tip:** If you want to keep the original analysis unchanged, you could create a copy of the data sheet, then convert the duplicate data sheet to use the new units.

- **Manually adjust the functions so they return results in the same units.** For example, if the data set is in "days" and you want the results to display the B10 life in "hours," you could adjust the function by adding a conversion ratio. For example, if 1 day is equivalent to 24 hours, you could edit the function as follows:  

  \[(\text{TIMEATPF("Weibull!Week!Data1",0.1)}) \times (24)\].

### Synthesis Workbook Templates

In Synthesis Workbooks, saved templates make it easy to reuse the same report multiple times — in different analysis projects and with different data sets.
**Note:** For DOE analyses, instead of saved templates for the entire workbook, you can use saved profiles in the Doe Report Generator.

In addition to the Standard templates that are installed with the software, you can also create your own User templates that are saved from any existing report. Note that the templates are module-specific (i.e., compatible with either the spreadsheet module or the word processing module).

### Saving Your Own Templates

It is easy to create a template from any Synthesis Workbook that is currently open.

Select either the spreadsheet or the word processing module, then choose Document > Document > Save Template.

You can name and store the custom templates however you wish. To share a template with other users, you can simply send them a copy of the file, or you can save the file in a shared network location that multiple users can access.

### Using a Template

You can select a template when you create a new Synthesis Workbook. (See Synthesis Workbook Wizard.)

Alternatively, you can use the steps below to apply or change the template for an existing workbook at any time.

**IMPORTANT:** This will replace any existing content in the current module, and the change can’t be undone.

1. Select either the spreadsheet or word processing module and then choose Document > Document > Open Template.

2. Select a template from either tab then click OK to apply the template to the new or existing report.
   - The Standard tab displays the templates that are installed with the software and stored in the applicable sub-folder under C:\Users\Public\Documents\ReliaSoft\Templates.
• The User tab displays custom templates that were saved from an existing report. These can be stored in any location that is convenient for you. If the custom template you need is not displayed, click the Open icon to browse for the desired template and add it to the list.

Spreadsheet Module
The spreadsheet module in Synthesis Workbooks provides functionality similar to Microsoft Excel (with built-in functions and complete in-cell formula support), and it can be used to integrate data and/or results from multiple analyses at the same time.

Send to Excel
To export all sheets in the spreadsheet module to a Microsoft Excel file, choose Home > Report > Send to Excel.

Inserting Functions
• To build and insert functions that utilize a referenced analysis (data source), see Function Wizard - Data Sources.
• To add math, date, logic and other functions, see Function Wizard - Formulas.

Showing Formulas
To display the formulas instead of the calculated results in the worksheet cells, choose Formulas > Formula Auditing > Show Formulas.
You can toggle the formula display on and off.

<table>
<thead>
<tr>
<th>A1</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Recalculate Formulas**

By default, the spreadsheet automatically recalculates all formulas whenever you open the workbook or when the cells that a formula depends on have changed. However, if your spreadsheet contains a large number of formulas, the recalculation process may take more time and every change may require you to wait several seconds or minutes for the application to recalculate all values. In this case, you can control when calculation occurs by changing the setting to manual calculations.

To use manual calculations, choose **Formulas > Calculation > Calculation Options**, and then choose the **Manual** option. To change the settings back to automatic calculations, choose the **Automatic** option.

To recalculate all formulas when in Manual mode choose **Formulas > Calculate > Calculate Now**.

The **Calculate Now** command can also be used to refresh the spreadsheet. A spreadsheet needs to be refreshed whenever its referenced data source(s) has been recalculated. This ensures that the spreadsheet reflects the most current results.

**Adding Custom Charts**

To create your own custom chart, first select the cells that contain the relevant data, then go to **Document > Charts** and choose a chart type and style. (See **Custom Charts in Synthesis Workbooks**.)

**Defining Names**

To create variable names that reference specific spreadsheet cells, see **Defined Names**.
Word Processing Module

The word processing module in Synthesis Workbooks offers custom reporting functionality that is similar to a Microsoft Word document. You may prefer to use this tool if you want to have a more polished, professional looking report.

This module has two tabs located at the bottom of the window: Design and Review. Use the Design tab to add text, functions and plot holders. Use the Review tab to see the results before you generate the final report.

To export the report to Microsoft Word, choose Send to Word.

Using the Function Wizard

To use the Function Wizard to build and insert functions that utilize a referenced analysis (data source), choose Home > Report > Function Wizard. (See Function Wizard - Data Sources.)

Using the Plot Wizard

To use the Plot Wizard to generate a variety of plots based on a referenced analysis, choose Home > Report > Plot Wizard. These are the same types of plots that are generated in an analysis folio or diagram plot sheets. (See Plot Wizard.)

Using Spreadsheet References

To reference cells from the spreadsheet module (within the same workbook), choose Home > Report > Spreadsheet Reference and select the desired cells. The link between the word processing and spreadsheet modules is dynamic; when data in the spreadsheet is changed, the word processing module is automatically updated. (See Spreadsheet References.)

Formulas and Functions

Function Wizard - Data Sources

In both the spreadsheet module and word processing module for Synthesis Workbooks in Weibull++/ALTA, RGA and BlockSim, you can build functions that return results based on an analyzed folio or diagram.

Note: To insert math, date, logic and other functions into the spreadsheet module of a Synthesis Workbook, see Function Wizard - Formulas.
Using the Function Wizard

To open the Function Wizard in Synthesis Workbooks, choose **Home > Report > Function Wizard**.

Select a function from the navigation panel and enter any required inputs. The following picture shows the most complex configuration as an example. After entering the inputs, click **Insert** to place the function into the report at the current cursor location. You can move and/or modify the function expression after it has been inserted.

For spreadsheet functions:

- The bracketed parameters indicate that the input is optional. In the example above, the **Add Time** and **Confidence Level** parameters are optional.

- You can use cell references as inputs. For example, instead of entering 1000 for a time input, you could specify to use whatever time is currently entered into cell A10, using either the relative reference (A10) or the absolute reference ($A$10). (See **Cell References**.)

- You can use variable names as inputs. (See **Defined Names**.)

- You can type the function expressions directly in the cell once you are familiar with the syntax. For more information, see **Data Entry Tips for Functions**.

For the word processing module:

- The brackets are part of the function field and are not optional.
The functions will not return any results until you either switch to the **Review** tab or generate the report in Microsoft Word.

### Selecting a Data Source (if Applicable)

There are two ways to specify the data source:

- **Use the Data Source Name** (spreadsheets module only): This approach will return results based on a specific data sheet or diagram.

  In the Function Wizard, clear the **Use Default** check box and click the **Select** button to choose the data source, as shown next. In this example, the function will return results based on the data sheet called "Data1" in the Weibull++ life data folio called "Folio1."

![Data Source Select](image1.png)

- **Use a Data Source Index** (spreadsheet and word processing modules): This approach allows you to use the report as a template and return results based on a given data set.

  First, you must add data sources to the Synthesis Workbook (see [Associated Data Sources](#)). Then, in the Function Wizard, click the **Data Source Index** drop-down list and choose the index number of the desired data source. (In spreadsheets, select the **Use Default** check box to access the **Data Source Index** drop-down list.)

![Data Source Index](image2.png)
Function Wizard - Formulas
In the spreadsheet module for Synthesis Workbooks in Weibull++/ALTA, RGA and BlockSim, you can insert functions that perform math, date, logic and other operations.

Using the Function Library
The quickest way to add a function is to select it from the appropriate function category drop-down list, then select the cells of interest (hold down the CTRL key to select nonconsecutive cells) and press ENTER. You can move and/or modify the function expression after it has been inserted.

For example, to calculate the average reliability for the following units, you would choose Formulas > Function Library > AutoSum > Average. Select cells B3 through B9 and press ENTER. Note that the cell references can be relative (B3:B9) or absolute ($B$3:$B$9). (See Referencing a Cell.)

![Spreadsheet example](image)

Using the Function Wizard
To use the Function Wizard, choose Formulas > Function Library > Insert Function.

Select a function from the drop-down list and click OK. Then in the Function Argument window, enter the input by either selecting the cells in the sheet or typing them directly into the appropriate field. For information relating to entering text as an input, cell references, and working with date and time functions, see Data Entry Tips for Functions.
For example, to exclude the value from unit 4 (failure due to operator error) from the average, you would select cells B3 through B5 for **Number 1**, and B7 through B9 for **Number 2**.

---

### Data Entry Tips for Functions

This topic provides some data entry tips for using spreadsheet functions in Synthesis Workbooks and general spreadsheets. If you create the function using the Function Wizard, most of the syntax and formatting issues will be handled automatically. However, you have the option to create or modify function expressions directly in spreadsheet cells.

**Note**: For DOE design folios, you can disregard any tips related to **data source functions** (i.e., functions that obtain data or results from a specific data sheet or diagram). For that type of analysis, you can use the **DOE Analysis Reports** feature to obtain results from a design, multiple linear regression or one-way ANOVA folio, or any of the measurement systems analysis folios.

### Case Sensitivity

The functions are not case sensitive.

### Entering Text as an Input

When entering text as an input to a function, you must enclose it in quotation marks. This includes situations where you need to specify the data source – `DISTR("Weibull!Folio1!Data1")` – and situations where you need enter a time or date value in one of the accepted text formats – `DAY("22-Aug-2014")`. 

---
Regional Settings
If your regional settings use a comma as the decimal separator, you must use a semicolon to separate function arguments (e.g., =RELIABILITY("Weibull!Folio1!Data1";A4)).

Referencing a Cell in the Same Sheet
If you want to use another cell in the same sheet, enter the cell reference with a letter to identify the column and a number to identify the row. The cell references can be relative (e.g., B2) or absolute (e.g. $B$2).

- A relative reference points to a cell based on its relative position to the current cell (e.g., B2). When the cell containing the reference is copied, the reference is adjusted to point to a new cell with the same relative offset as the original cell.

- An absolute reference points to a cell at an exact location. Absolute references are designated by placing a dollar sign ($) in front of the row and/or column that is to be absolute. For instance, $B$2 is an absolute reference that points to the cell located in Column B, Row 2 regardless of the position of the cell containing the reference.

For example, if you want to obtain the probability of failure for the time that has been entered in cell B2, the function could be either =PROBFAIL(B2) or =PROBFAIL($B$2). You can type the cell location directly into the field or click the Function Wizard’s Insert Workbook Reference icon to insert the reference to the cell currently selected in the sheet. If you want to insert an absolute reference, press CTRL while you click the icon.

Another option is to use the Defined Names tool to assign a name to the cell and use the name in all of the function expressions that require that input. (See Defined Names.)

Referencing a Cell in a Different Sheet
To reference a cell in a different sheet from the one in which the formula is entered, use an exclamation mark (!) after the sheet name. For instance, =Sheet1!$B$2 is a reference to the cell located in Column B, Row 2 in Sheet 1. When referencing a cell in a different sheet from the one in which the formula is entered, the reference must be absolute. If the reference is not absolute, the calculations will not be carried out properly.

You can only reference sheets in the same workbook.

Referencing a Cell in a Data Source
Some functions (e.g., DATAENTRY and FMATRIX) require you to reference a particular cell in a data source. This must be defined differently than references to a cell in a spreadsheet. For data source cell references, you must identify first the row and then the column, and use a
number rather than a letter to represent the column (e.g., A=1, B=2, C=3 and so on). For example:

- \( \text{=DATAENTRY} \) (Default1, 2, 1) returns the value that was entered into cell A2 in the Weibull++, ALTA or RGA folio that is the data source for this function.
- \( \text{=FMATRIX} \) (Default1, 2, 1) returns the value from the second row in the first column of the Fisher variance/covariance matrix that was calculated for that data source.

Creating Composite Functions

It is possible to combine different types of data sources and/or functions to create a composite function. For example, in the following formula, two different data sources are used to return the difference between the reliability at 100 hours calculated from the specific Weibull++ life data folio data sheet called "Weibull!Target!Data1" and the reliability at 100 hours calculated from any given Weibull++ data sheet that is currently first in the list of associated data sources for the workbook or General Spreadsheet.

\[
= \text{RELIABILITY}("\text{Weibull!Target!Data1}", 100) - \text{RELIABILITY}(\text{Default1}, 100)
\]

In the next example, nested functions are used to round up the returned reliability result to the nearest two decimals.

\[
= \text{ROUNDUP}(\text{RELIABILITY}(\text{Default1}, 1000), 2)
\]

Omitting Optional Inputs in the Middle of a Function

If you do not use an optional input in the middle of the function, the function expression must specifically indicate that the input is being omitted. For example, when using the Weibull++ reliability function \( \text{RELIABILITY} \) (Data_Src, Age, [Add Time], [Confidence Level]), if you want to get the confidence bound on the reliability, you must use two commas (,,) to indicate that the [Add Time] input is intentionally blank, before entering the [Confidence Level] in its usual fourth position (e.g., \( =\text{RELIABILITY}(\text{Default1}, 1000,, 0.95) \)).

Note that this is handled automatically if you use the Function Wizard to build and insert the function expression.

Working with Date Functions

When using one of the spreadsheet date functions (\( \text{DAY} \), \( \text{DAYS360} \), \( \text{MONTH} \), \( \text{WEEKDAY} \) and \( \text{YEAR} \)) to enter a date, you can use one of the following accepted text formats:

- Month/Day/Year ("8/22/2014"). For example, \( =\text{DAY}("8/22/2014") \) returns 22.
- Day-Month-Year ("22-Aug-2014"). For example, \( =\text{MONTH}("22-Aug-2014") \) returns 8 (because August is the 8th month).
If you do not include the year (e.g., “8/22” or “22-Aug”), the current year is assumed. Alternatively, you can use the date’s serial number (which is the number of elapsed days since January 1, 1900). For example, =YEAR(41873) returns 2014.

- You can obtain a date's serial number using either of the following two functions. This may be helpful in cases where you want to filter, sort or use the date(s) in calculations.
  - The DATE function uses the inputs of other cells to obtain the serial number. For example, if you have dates specified in three cells where A2=Year, B2=Month and C2=Day, =DATE(A2, B2, C2) returns the serial number for that date.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year</td>
<td>Month</td>
<td>Day</td>
</tr>
<tr>
<td>2</td>
<td>2014</td>
<td>8</td>
<td>22</td>
</tr>
</tbody>
</table>

- The DATEVALUE function requires you to enter the date in an accepted text format. For example, =DATEVALUE("8/22/2014") returns 41873.

Finally, you can also use the results of other functions within a date function. For example:

- To return the month from today’s current date, use: =MONTH(TODAY())
- To return the day of the week for a date that is specified in three separate cells (A2=Year, B2=Month and C2=Day), use: =WEEKDAY(DATE(A2, B2, C2))

Working with Time Functions
When using one of the spreadsheet time functions (HOUR, MINUTE and SECOND) to enter a time, you can use one of the following valid text formats:

- Hour:Minute[:Second] [AM/PM]. For example, =HOUR("4:48:10 PM") returns 16 (the hour using the 24 hour system).
- Month/Day/Year Hour:Minute[:Second] [AM/PM]. For example, =MINUTE("8/22/2014 4:48:10 PM") returns 48.
Alternatively, you can use the hour, minute or second’s serial number (which is the fractional portion of a 24 hour day). For example, =MINUTE(0.70011574) returns 48 (as the specified serial number represents 4:48 PM).

- You can calculate a time’s serial number using either of the following two functions. This may be helpful in cases where you want to filter, sort or use the time(s) in calculations
  - The **TIME** function uses the inputs of other cells to obtain the serial number. For example, if you have dates specified in three cells where A2=Hour, B2=Minute and C2=Second, =Time(A2, B2, C2) returns the serial number for that time.

<table>
<thead>
<tr>
<th>D2</th>
<th>=TIME(A2, B2, C2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>Hour</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

- The **TIMEVALUE** function requires you to enter the time as text in one of the accepted text formats. For example, =TIMEVALUE("4:48:10 PM") returns 0.70011574.

Finally, you can also use the results of other functions within a time function. For example:

- To generate current values, you can use the **NOW** function. If the current time is 4:48 PM, then =HOUR(NOW()) returns 16.

### Returning Confidence Bounds

For functions in Weibull++/ALTA and RGA that return confidence bounds, note that the **Function Wizard** for data sources only inserts one-sided bounds. If you want to show two-sided bounds, you can insert the same function twice — once at the lower confidence bound and once at the upper confidence bound. For example, for a 90% confidence level, you would set the lower confidence bound at 5% and the upper confidence bound at 95%.
• In a spreadsheet, you can use the same function (with different input parameters) to obtain any of the three values. For example, in Weibull++:

\[ \text{=RELIABILITY(Default1,1000)} \text{ returns the estimated value} \]

\[ \text{=RELIABILITY(Default1,1000,,0.05)} \text{ returns the lower one-sided bound at 5\%} \]

\[ \text{=RELIABILITY(Default1,1000,,0.95)} \text{ returns the upper one-sided bound at 95\%} \]

Note that the above function expressions for the confidence bounds uses two commas (,,) to indicate that another optional input ([Add Time]) was intentionally left blank. For more information about the syntax for functions containing multiple optional inputs, see Data Entry Tips for Functions.

• In a word processing module for Synthesis Workbooks, the wizard provides separate functions for confidence bounds. For example, use the Reliability function to get the estimated value and use the Bound on Reliability function to get each one-sided confidence bound.

Plot Wizard

In the word processing module for Synthesis Workbooks in Weibull++/ALTA, RGA and BlockSim, you can use the Plot Wizard to generate a variety of plots based on a referenced analysis. These are the same types of plots that are generated in folio or diagram plot sheets. Although you also have the option to copy/paste a static plot graphic from any folio or diagram plot sheet into the report, using the Plot Wizard makes it easy to change the associated data source when you reuse the template and ensures that the plot in the generated report will always show the latest analysis. (For DOE design folios, you can use the DOE Analysis Reports feature to insert plots from a design, multiple linear regression or one-way ANOVA folio, or any of the measurement systems analysis folios.)

To open the Plot Wizard, choose Home > Report > Plot Wizard.
The following picture shows the plot wizard in Weibull++. Similar functionality is available for RGA and BlockSim.

There are three steps to use this tool:

1. Select the plot type (and enter the inputs, if applicable)
2. Select the data source
3. Insert the plot holder

**Select the Plot Type**
First, select one of the available plot types from the panel on the left side. The right side of the wizard displays some information about the plot that is currently selected.

If applicable, this area also allows you to make relevant inputs (e.g., for ALTA plots that require you to select a specific stress column).

**Select the Data Source**
To specify the data source that the plot will be based on, choose a number from the Data Source Index drop-down list, as shown next. Using the index makes it easy to reuse the same template with a variety of different data sets.
Insert the Plot Holder

When the plot is fully defined, click **Insert** to place it at the current cursor location. You can move and/or resize the plot holder after it has been inserted. The plot holder shown next will return the reliability vs. time plot for whatever data source is currently second in the list of associated data sources.

Plot holders will not return any results until you view it in the Review tab or generate the report (**Home > Report > Send to Word**).
Custom Charts
In the spreadsheet module for Synthesis Workbooks, you can use the Document > Chart commands to insert your own custom charts. The charts can be placed anywhere in the spreadsheet, and are dynamic (automatically update when the data used to create the chart is changed).

Adding a Chart
1. Select the cells that contain the data of interest. In the example data below, the headings are included in the selection and will be used as the legend labels.

2. Choose Document > Charts. Choose the chart type, and then click a chart subtype that you want to use.
3. To move the chart, click and drag the chart to the desired location.

4. To resize the chart, click the chart and then drag the sizing handles to the desired size.

Changing the Data Displayed on an Axis
To change the way the data series is displayed on the axes, click the chart, then choose **Design > Data > Switch Row/Column.**

Changing the Chart Type and/or Data Set
You can change the type of chart and/or the data that is used in a chart at any time. To do this, click the chart and then:

- To change the chart type, choose **Design > Type > Change Chart Type.** Select the desired type.
To change the data set, choose Design > Data > Select Data. Select the cells that contain the data of interest.

**Applying a Chart Layout and/or Chart Style**

- To apply a predefined chart layout, choose Design > Chart Layouts. As an example, the following picture shows some of the options for 2-dimensional bar charts. To see the rest, click the arrow in the bottom-right corner.

If none of the predefined options are suitable for your chart, choose Layout > Labels, then select the option you want to customize. The following picture shows the options for the vertical axis.

- To apply a predefined chart style, choose Design > Chart Styles.

**Renaming Chart and Axes Titles**

When displaying chart and/or axes titles, you can rename the titles by right-clicking the chart and selecting the appropriate title option from the shortcut menu. For example, choosing Change Chart Title opens the following window:
Modifying the Axes and Gridlines

To hide or display axes and/or gridlines, choose **Layout > Axes > Axes** or **Gridlines**.

- When displaying axes, you can change direction of the x-axis and/or change the scale of the y-axis.
- When displaying gridlines, you can increase or decrease the number of gridlines for both the axes.

Defined Names

In the **spreadsheet module** for Synthesis Workbooks and general spreadsheets in Weibull++/ALTA and RGA folios, you can create variable names that reference specific spreadsheet cells. The names can then be used in any formula or function within the same workbook.

For example, say you want to obtain the reliability of a Weibull++ data set. The operating time is stored in cell B5 of the spreadsheet:

```
=RELIABILITY(“Weibull!Bulb!Data1!"$B$5))
```

You can create a defined name for the operating time to make the formula easier to understand and maintain. In this case, the formula might be rewritten as:

```
=RELIABILITY(“Weibull!Bulb!Data1!"OpTime)
```

You can then use the defined name **OpTime** in any other formula in the workbook that requires the operating time.

Syntax Rules for Names

- The first character of a name must be a letter or an underscore. The remaining characters can be letters, numbers, periods and underscores. Names are not case sensitive.
• Spaces are not allowed as part of a name. An underscore (_) or period (.) can be used as a word separator.

• Symbols, except for underscores (_), periods (.) and backslashes (\), aren't allowed.

Managing Names
To view and manage defined names:

• In Synthesis Workbooks, choose Formula > Defined Names > Name Manager.

• In general spreadsheets, choose Sheet > Format and View > Defined Names.

You can then use the New, Edit, or Delete commands in the window to create or modify the names.

Defining Names
There are several ways to define a name.

Define a Name via the Name Manager
This method applies to both Synthesis Workbooks and general spreadsheets.

1. Select a cell or range of cells.

2. Create a new name:

   • In Synthesis Workbooks choose Formulas > Defined Names > Define Name (or choose Formulas > Defined Names > Name Manager, then click the New button in the window).

   • In general spreadsheets, choose Sheet > Format and View > Defined Names. Then in the window, click the New button.

3. Type a name into the Name field. In the Scope drop-down list, choose whether this name will be used for the entire workbook or a specific sheet. The Comment field is optional.

   The selected cell/range will already be defined in the Refers to field, but you can click into the spreadsheet and select different cells, if desired.
Define a Name via the Name Box (Synthesis Workbook Only)
This method applies only to the spreadsheet module of Synthesis Workbooks. Select the cell or range of cells, click the Name box and type a name. Press Enter to create the name.

Define a Name via the Selection Command (Synthesis Workbook Only)
If the fields are already labeled in the spreadsheet, you can use them to create names.

1. Select the cells of interest (including the row or column labels), then choose Formulas > Defined Names > Create from Selection.

2. In the window, select the location of the labels. Click OK.
Spreadsheet References

In Synthesis Workbooks, the spreadsheet reference feature provides integration between the spreadsheet and word processing modules in the same workbook. You can insert a reference from any cell, or consecutive range of cells, from the spreadsheet into a desired location in the word processing document. If the referenced cells in the spreadsheet are changed, the word processing module is automatically updated. The changes are visible when you use the Review tab to see a preview or generate the Word report.

To insert a spreadsheet reference, place the cursor at the desired location in the word processing document and choose Home > Report > Spreadsheet Reference.

Note that you can also use the Spreadsheet Reference function in the word processing module’s Function Wizard.

The Select Cells window shows the contents of the spreadsheet module in the current workbook. Select a cell or range of consecutive cells and click OK.
For the example data shown above, the entry would look like this:

\[
[TBLSSREF(Sheet1!B2:D10)]
\]

**DOE Analysis Reports**

The DOE Analysis Reports feature allows you to insert selected analysis results and plots into a Synthesis Workbook.

This feature is available for any analyzed response in a design, multiple linear regression, one-way ANOVA or measurement systems analysis folio. The report can display any result that's available in the folio's Analysis Summary window for the selected response, as well as any applicable plot.

This topic describes how to build and insert a DOE analysis report, and how to use saved profiles for reports that you need to generate frequently. Note that you can insert multiple reports into the same spreadsheet or word processing document, if desired. Each additional report will be appended to the end.
Inserting a DOE Analysis Report

1. Select either the spreadsheet or word processing module in a Synthesis Workbook and choose Home > Report > DOE Analysis Report.

2. In the Select Response window, choose an analyzed response to copy the results from and click OK.

3. In the DOE Analysis Report window, the Available Report Items area (left) shows all of the available results and plots for the selected response. The Selected Report Items area (middle) shows the selected results/plots, in the order in which they will appear. You can:
   a. Choose Profiles > Open Profile to apply all of the relevant selections from a saved report profile. (See Using DOE Report Profiles.)
   b. Build/modify the list using double-click, drag and drop or the Add/Remove and Up/Down buttons.

   Note that you can include multiple instances of the same report item, if desired.

4. When you click each selected report item, the Item Properties area (right) allows you to view/change the name (heading) that will be used in the report, if desired.

   For plots, you can also click the Preview Plot button to see what the plot will look like in the report. Any plot settings you change in the plot preview will be used in the generated report but will not affect the folio the report is based on.


Using DOE Report Profiles

When the DOE Analysis Report window is open, you can save the current settings (i.e., report item selections), or load settings that were previously saved.

- To save all your current report settings for use in future reports, choose Profiles > Save Profile.

Then specify the name and location of the DOE report file (*.drt) that will store the settings.
• To overwrite all the settings in the DOE Analysis Report window and use the settings from a DOE report file instead, choose **Profiles > Open Profile**.

Then select the *.drt file that has all the desired settings.

*Note:* When you load report items from a DOE report file, only the items that apply to the selected folio/response will be included in the report.
Chapter 22: Synthesis Dashboards

The dashboard is a flexible tool for graphical presentation of data. This can include bar and pie charts, gauges, maps, etc.

All Synthesis users can view dashboards based on predefined layouts (see Dashboard Viewer). The viewer is available in the following locations in Synthesis desktop applications:

- Project Planner
- Synthesis Explorer
- Simulation diagram results in BlockSim (see FMEA in the BlockSim/RENO documentation)
- FMEA and FMRA data in Xfmea/RCM++ (see FMEA Dashboards in the Xfmea/RCM++/RBI documentation)
- Synthesis Data Warehouse (SDW) data in Weibull++ and RGA

In a secure database, only users with the "Manage dashboard layouts" permission can manage and create predefined layouts (see Dashboard Layout Manager and Dashboard Layout Designer).

If your organization chooses to implement a web-based Synthesis Enterprise Portal (SEP) for an enterprise database, you can also share selected dashboards to be accessed from any web-enabled device!
Chapter 22: Synthesis Dashboards

Dashboard Viewer

Any user can access the Dashboard Viewer in a variety of locations throughout Synthesis desktop applications for graphical presentation of the latest analysis data.

When dashboard functionality is available for the data you’re working with (e.g., Project Planner, Synthesis Explorer, simulation diagrams in BlockSim, etc.), choose Dashboard > Dashboard Viewer to open the viewer.

Select any of the predefined dashboard layouts from the drop-down list to see the latest charts for the current data set.

Resizing Panels

To resize the dashboard items vertically and/or horizontally, click between two items and drag the resize cursor (↕) to the height and/or width you want. This option is available when a dashboard contains multiple items.
Showing Details in Charts and Pies
To see more details about the underlying data, move the mouse pointer over a bar or slice. For example, when the pointer is over a bar in a chart, the values for the x and y axes will be displayed in the tooltip.

Drill Downs and Master Filters
For information about how to use charts that have been configured for a drill down, see Viewing Drill Downs. For information about how to use charts that have been configured with master filters, see Using Master Filters.

Sorting and Filtering Data in a Grid
- To sort the data in ascending or descending order, click the column heading.
- To filter the data, click the Advanced Filter icon to see a drop-down list of filters that you can apply. The dashboard uses the same advanced filters functionality that is built in to other Synthesis utilities (e.g., Resource Manager, Synthesis Explorer, etc.). (See Finding and Filtering Records.)

Printing or Exporting the Dashboard
To print the entire dashboard, or export it as a *.pdf file or as an image, click the Export To icon.
Viewing Drill Downs

An easy way to determine if the dashboard was configured for drill down is to look for the arrow in the caption bar, if the bar is visible.

To drill down, double-click an area of interest.

To drill up, click the arrow (▲) until you have reached the desired level or right-click the chart, then choose Drill Up.
Using Master Filters
When a dashboard with master filters is created, it can be configured for single or multiple filtering. If you see either of the following, then filtering is enabled:

- For **single** filtering, the dashboard title is followed by light gray text.

  ![Dashboard Server 1](image)

- For **multiple** filtering, the **Clear Master Filter** icon displays in the caption bar, if the bar is visible.

  ![Component Icon](image)

Note that if you see both the icon and light gray text, this means that multiple filtering is enabled, but only one item in the filter is selected.

**Single Filtering**
For single filtering, you can only select one item at a time. You will not be able to clear the view, only select a different item.

**Multiple Filtering**
For multiple filtering, you can select as many filter items as you want to view. Hold down **SHIFT** while clicking to select consecutive elements or hold down **CTRL** while clicking for nonconsecutive items.

In the example shown next, the grid was set up as the master multiple filter. The chart and pie charts display the data for the four parts selected in the grid.
To reset the view, click the **Clear Master Filter** icon or right-click, then choose **Clear Master Filter**.

### Dashboard Layout Manager

You can use the Dashboard Layout Manager to create, edit and delete the predefined dashboard layouts that will be available for any Synthesis user to view for a particular data set. (In a secure database, this is available only for users with the “Manage dashboard layouts” permission.)

To open the Dashboard Layout Manager, choose the command from any Synthesis interface that supports dashboard functionality (e.g., Project Planner, Synthesis Explorer, simulation diagrams in BlockSim, etc.). It will display only the layouts for that particular data type.
You can also open the Dashboard Layout Manager from the Backstage view (File > Manage Repository > Dashboard Manager). It will display all of the layouts for any data type. If you want to see only the layouts specific to the application you are using, select the check box.

Show in Viewer
Use the check boxes in the Show in Viewer column to select which of the predefined layouts will be available to all database users via the Dashboard Viewer. If you clear a check box, the layout will not show in the viewer’s drop-down list but will remain in the manager’s list.

<table>
<thead>
<tr>
<th>Name</th>
<th>Show in Viewer</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Dashboard</td>
<td>✔️</td>
</tr>
<tr>
<td>BlockDashboard</td>
<td>✔️</td>
</tr>
<tr>
<td>Crew Dashboard</td>
<td></td>
</tr>
</tbody>
</table>

Use the up/down arrows to change the order of the layouts that are shown in the viewer’s drop-down list.

Layout Properties
For all dashboard layouts that are selected to show in the Dashboard Viewer, the name that will be visible in the list is set from the Layout Properties window. To view or change these properties, select a row in the table and click the Properties button (or right-click and choose Properties).

The description and update history are available to help you manage the layouts; that information is not visible to all database users.
**Importing Layouts**

It is easy to reuse dashboard layouts that were created in other databases. Click the **Import** button and then select the database you want to import from. If you are using the Dashboard Layout Manager in the Backstage view, you can import layouts of any type. If you’re using a manager from one of the locations where dashboards are used, you can only import layouts of the current type.

![Import button](http://rga.reliasoft.com)

**Dashboard Layout Designer**

You can use the Dashboard Layout Designer to create or edit each predefined dashboard layout. (In a secure database, this is available only for users with the "Manage dashboard layouts" permissions.)

To access this window, first open the Dashboard Layout Manager and then choose to either create a new layout or edit an existing one.

**Separate Layouts for Each Data Type**

Each dashboard layout is designed to be used with a specific data type, which determines which fields are available and where the dashboard can be viewed. For information about creating dashboards for each particular type of data, see:

- Project Planner Dashboards
- Synthesis Explorer Dashboards
- Simulation Diagram Dashboards (in the BlockSim/RENO documentation)
- FMEA Dashboards (in the Xfmea/RCM++/RBI documentation)
- Synthesis Data Warehouse (SDW) Dashboards (available in Weibull++/ALTA and RGA)

**Configuring a Dashboard Item**

This topic demonstrates some of the basic steps for configuring a dashboard item (bar chart, pie chart, gauges, etc.) in the Dashboard Layout Designer. The simple bar chart in this example is based on block-level simulation results from a reliability block diagram in BlockSim. The data source options will be different for other locations where dashboards are available, see Project Planner, Synthesis Explorer, Simulation Diagram Dashboards (BlockSim/RENO), FMEA Dashboards (Xfmea/RCM++/RBI) or SDW Dashboards (Weibull++/ALTA and RGA).
In a secure database, only users with the "Manage dashboard layouts" permissions can create layouts.

**Add the Chart**
Add a chart to the Layout panel by choosing **Home > Insert > Chart**.

**Define the Chart Data**

1. Select a data source from the drop-down list in the Data Source panel, if applicable.

2. Choose the data field (or fields) that will be displayed in the y-axis of the bar chart, then drag each field into the **Values** area in the DATA ITEMS panel. For this example, the chart will display total operating cost, cost from preventive maintenance and cost from corrective maintenance.

Note that when different data sources are available, all of the data fields used within a chart must come from the same source.
Tip: To replace a data item, drag a new field on top of the current one. To remove a field, drag it anywhere outside of the data item; and to completely clear the DATA ITEMS panel, right-click the chart and select Remove Data Items.

3. Use the drop-down list to see which values are available for this data field (e.g., count, sum, average, etc.) and choose one to display in the chart. Note that the same option must be selected for all values in the same chart.

Because we want the total cost from all blocks that meet the given criteria, we use the default Sum for this example.

4. If appropriate, use the Rename command to change the name that will be displayed in the chart legend, tooltip, etc.

5. Choose the data field that will be displayed in the x-axis, then drag it to the Argument bar.
Filter the Data
To filter the data displayed in the chart, choose Data > Filtering > Edit Filter.

Use the Filter Editor to define the criteria. For this example, we’re using the “Not And” operator to exclude any blocks with a name that contains “Hub.”

Tip: You can use hidden data items to filter based on fields that are not displayed in the chart.

Sort by “Top N”
To configure the chart to show only the top 5, bottom 10, etc., use the Top N command in the Argument data item’s drop-down list.
For this example, we’re showing only the Top 5 blocks, based on total operating cost. The results are displayed from highest to lowest and the order cannot be changed.

**Tip:** Alternatively, you could use the **Sort by** command to sort by the argument data item — which is labeled (Value) in this menu — or by any of the value data items. Click the Argument bar to toggle the sort between ascending and descending order.

**Other Design Options**

Click the **Design** tab on the ribbon to access other configurable options for this type of chart. For example:

1. To hide or display the caption bar above the chart, choose **Show Caption**.

   ![Show Caption](image)

   We will keep it displayed for this example.

2. To change the title in the caption bar to something more meaningful, choose **Edit Names**.

   ![Edit Names](image)

   For this example, we will set the Dashboard item name to “Top 5 Blocks by Total Operating Cost” and clear all of the **Series** fields to make sure the latest data item name (set via the **Rename** command in the data item’s drop-down list) will always be used in the chart legend and tooltip.
3. To change the y-axis title to a more meaningful name, choose **Y-Axis Settings**.
Available Dashboard Items
The following dashboard items can be added to any layout. You can add the same type of item more than once, if desired. To insert an item, choose Home > Insert, then click one of the following options.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pivot</td>
<td>Chart</td>
</tr>
<tr>
<td>Gauges</td>
<td>Choropleth Map</td>
</tr>
<tr>
<td>Range Filter</td>
<td>Scatter Chart</td>
</tr>
<tr>
<td>Grid</td>
<td>Pies</td>
</tr>
<tr>
<td>Cards</td>
<td>Geo Point Map</td>
</tr>
<tr>
<td>Text Box</td>
<td>Image</td>
</tr>
</tbody>
</table>

Data Types
There are two types of data that can be used in a dashboard item: measure or dimension.

- **Measure** data is calculated (sum, count, average, etc.). For example, the values on the y-axis of a chart, the size of a slice in a pie or a target value in a card or gauge. Values and targets are forms of measure data.

- **Dimension** data can be sorted but is not calculated. For example, the bars in chart, slices in a pie or text in a grid column. Arguments and series are forms of dimension data.

Data Shaping
You can use the Dimensions and/or Measures bars in the HIDDEN DATA ITEMS panel when you want to perform data shaping (filtering, sorting or Top N) but do not want the data to be displayed in the dashboard item. Data shaping is available for any dashboard item, except text boxes and images.

- The data fields contained in the **Dimensions** bar can be used in Filter Editor window to create filter conditions based on their values. Dimensions in this area have the same sorting functionality that is available in the argument, attribute or series DATA ITEMS area.

- The data fields contained in the **Measures** bar can be used in the Sort by submenu and in the Top N Values window for data sorting. Measures in this area have the same calculation functionality that is available in the values and target DATA ITEMS area.
Configuring a Drill Down

Drill down can be enabled for the following dashboard items:

- Grids: Specify two or more columns
- Charts and pies: Specify two or more arguments and/or series
- Gauges: Specify two or more series
- Cards: Specify two or more series

Configuring a Drill Down Sequence

1. In the Dashboard Layout Designer window, select the chart or grid you want to drill down.
2. Drag the additional data fields into the Arguments area in the appropriate order for the desired drill down sequence.

For example, you can use the following sequence to configure a pie chart in a Synthesis Explorer dashboard to first show analyses by application source, then drill down to analysis type.

3. Choose Data > Filtering > Drill Down. This command is a toggle; choose the command again to disable the drill down.

When any user views this layout in the Dashboard Viewer, he/she will be able to double-click inside the chart to drill down, and use the arrow (↑) to drill back up. (See Viewing Drill Downs.)

Tip: To make it easy to identify a drill down in the Dashboard Viewer, display the dashboard item’s caption bar (Design > Common > Show Caption).

Filtering

Using the Filter Editor

You can use the Filter Editor to incorporate filters into dashboard items that contain dimension data. Arguments and series are forms of dimension data.
This type of filtering only applies to the dashboard item you have selected. To filter the data across the entire dashboard, see Configuring a Master Filter.

**Dimension Data Locations**
Dimension data can be used in any or all of the following areas:

- Dimension bar in the HIDDEN DATA ITEMS panel.
- Dimension, argument and/or series bars in the DATA ITEMS panel.

An easy way to determine if a data field is a dimension, argument or series, is to look for the sort arrow to the left of the data field name.

![Dimension Data Locations](image)

**Configuring a Filter**
1. In the Dashboard Layout Designer widow, select a dashboard item, then choose Data > Filtering > Edit Filter. This command is also available in the shortcut menu when you right-click the dashboard item.

2. In the Filter Editor window, define the criteria. The dashboard uses the same Edit Filter functionality that is built in to other Synthesis utilities (e.g., Resource Manager, Synthesis Explorer, etc.). (See Finding and Filtering Records.)

In the following example, a chart was created for data that was extracted from XFRACAS into the **Synthesis Data Warehouse (SDW)** in Weibull++.
Because we are interested in only the chandelier parts (not the whole unit) and data from 2010 and later, we can apply the following filter to remove the unwanted data:

**Configuring a Master Filter**

A master filter can be used to filter data across the entire dashboard. Grids, pies, charts, gauges, cards and maps dashboard items can be used as master filters.

There are two types of master filters that can be configured:

- **A Single filter** allows you to select one item at a time. You will not be able to clear the filter, only select a different item.
A Multiple filter allows you to select one or more items at a time. You can also clear the filter to view all items at any time. This is the most flexible option.

For example, suppose your layout contains a grid, a chart and a pie, and the grid is configured as the multiple master filter. When you select items in the grid, only the data for those items will display in the chart and pie.

Configuring a Master Filter
In the Dashboard Layout Designer window, select the dashboard item, then enable the master filtering by choosing Data > Interactivity > [Single Master Filter/Multiple Master Filter]. This command is a toggle; choose the command again to disable it.

When any user views this layout in the Dashboard Viewer, he/she can use the filter to view only the data of interest. (See Using Master Filters.)

Note that you can prevent a specific dashboard item from being affected by master filters, by selecting it in the Layout panel and then choosing Data > Interactivity settings > Ignore Master Filters. This command is a toggle; choose the command again to disable it.

Tip: To make it easy to identify that a dashboard item is configured for filtering in the Dashboard Viewer, display the item's caption bar (Design > Common > Show Caption).
Chapter 23: Synthesis Data Warehouse

Available in Weibull++, ALTA and RGA, the Synthesis Data Warehouse (formerly called “Reliability Data Warehouse”) enables you to access data from an XFRACAS incident tracking system for the purpose of life data analysis (in Weibull++/ALTA) or repairable system/reliability growth analysis (in RGA). You can also set up custom connections to obtain reliability-related data from external data sources (including Access, Oracle and SQL Server). You can also get data directly from your own custom reports created in ReliaSoft’s XFRACAS.

You can then transfer the data to an analysis folio in Weibull++, ALTA or RGA, or use the flexible Synthesis Dashboard utility to explore and present the data in a variety of graphical charts and grids. (See Transferring from the SDW to an Analysis Folio or SDW Dashboards.) In addition, if a Synthesis Enterprise Portal has been implemented for an enterprise database, users can also access SDW dashboards from any web-enabled device.

To open the SDW in Weibull++, ALTA or RGA, choose Home > Synthesis > Synthesis Data Warehouse.

Managing Data Sources

The available data sources are listed in the data source manager on the left side of the window. They may include:

- Static data collections that were extracted from XFRACAS at a particular point in time (and will not change if incidents are later added or updated). These can be either Weibull++/ALTA data or RGA data. (See Extracting Data from XFRACAS.)

- Custom connections that have a live link to a specified external database or to a predefined report created in XFRACAS. (See Custom Connections in the SDW.)

- Static data collections that were extracted from a custom connection at a particular point in time (and will not change if the original data source changes). (See Import to a Static Data Collection.)

If you are working with a long list of available data sources, this panel can utilize the same categories, identifiers and item filters that are available in many other locations throughout Synthesis desktop applications.

To create, delete, rename or edit the properties for these data sources, use the Manage Data Sources commands, or right-click inside the panel.
The Properties window allows you to enter identifiers for each data source, and to view its history.

**Built-in Find/Filter, Configuration and Grouping Tools**
Double-click any data source to display the data in a grid on the right side of the window. The SDW offers the same filter, column configuration and grouping tools that are built in to other Synthesis utilities that use a similar grid (e.g., the Synthesis Explorer, Actions Explorer, etc.). For details about how to use each feature, see:

- Finding and Filtering Records
- Configuring Columns
- Grouping Panel

**Building the Data Set**
The "Include in Analysis?" column shows whether each row will be included in the data set when it is transferred to Weibull++, ALTA or RGA, or viewed in a dashboard.

- **Include**: Data points that will be included in the data set are shown in green.
- **Invalid**: In XFRACAS data collections, incidents with a State Time of less than 0 are automatically set as invalid. These rows are shown in red.
- **Ignore**: In XFRACAS data collections, incidents with a State Time of 0 that are marked as suspensions in the State FS column are automatically set to be ignored. These rows are shown in gray.
- **Exclude**: Incidents that have been manually excluded are shown in blue.

By default, incidents that are marked as Invalid or Ignore will be excluded from the data set. To manually include or exclude specific data points, select the row(s) and choose **Build Data Set > Include** or **Build Data Set > Exclude**.
To view only those rows that are included, choose **View > Show Only Included**. You can toggle this command off to show all records.

In XFRACAS data collections, you can also select the row and choose **Build Data Set > 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 (which is set via the XFRACAS administrative interface).

---

**Extracting Data from XFRACAS**

When you are working with an enterprise database that contains XFRACAS data, or a standard database that has a connection to external XFRACAS tables, you can use the **Synthesis Data Warehouse** to extract static data collections. These can be either Weibull++/ALTA data or RGA data, and the collections will not change if incidents are later added or updated in XFRACAS. (Alternatively, if you need a live link to a predefined report that has already been created in XFRACAS, see **Connect to XFRACAS Report**.)

To extract a static data collection from XFRACAS, first open the SDW in Weibull++, ALTA or RGA and then choose **Manage Data Sources > Get XFRACAS Data**.

(In a secure database, this is available only to users with the "Create/edit/delete SDW data collections" permission. Additionally, users must have the "Synthesis - Read Data" permissions for the associated XFRACAS tables.)

In the XFRACAS to SDW window, choose an **Entity** to import from, then select the check box for each part that you want to extract the incident (i.e., failure) data for. If needed, you can use the Auto Filter Row to filter the grid by matching text in one or more columns. (For extremely large data sets, this row will be hidden and a Filter window will be available instead.)
Chapter 23: Synthesis Data Warehouse

Click [Next], then specify other settings or fields to import:

- **Time Metric** allows you to choose which metric to use with the data. The options are based on the metrics that your system administrator has enabled for the XFRACAS entity.

- **Incident Detail Fields** allow you to map customized detail fields from the XFRACAS incident to one of the user-defined field columns in the SDW collection. The following field types can be mapped:
  - **StringUDF1-3**: Alphanumeric Input Box, Check Box, Company, Contacts, Currency, Date, Numeric Input Box, Users, Yes/No Button, or the Select List, Administrative Controlled field type
  - **NumberUDF1-3**: Currency or Numeric Input Box
  - **DateUDF1-3**: Date

- In RGA, additional options are available:
  - **Include Non-Chargeable** extracts incidents that are marked as either chargeable or non-chargeable in XFRACAS. If you clear the check box, it will extract only chargeable incidents.
  - **Only System Down Events** extracts only those incidents that brought the system down.
  - **Filter by Date Commissioned** extracts only incidents for systems that were commissioned between the specified dates.

Click [Next], then enter a name for the data collection and any **Synthesis identifiers** that you want to use.

When you click [OK], the extraction process will begin. Depending on the amount of data that you are extracting, this may take some time.
You can then use the data collection to transfer data to an analysis folio or explore/present in the dashboard utility. For information about the fields that will be available either in the Build Data Set tab or in the Dashboard Designer, see Data Fields for XFRACAS Data Collections.

### Data Fields for XFRACAS Data Collections

The following fields are available for use in dashboard layouts for XFRACAS data collections and for data sets created via the Synthesis API. These are the same columns available in the Build Data Set tab. The fields in custom connections will depend on the data source itself.

- **Address Location**: the location of the owner of the system. This corresponds to the Location field in the XFRACAS contact.

- **Category**: the incident category. This corresponds to the Category field in the XFRACAS incident and, in conjunction with the failure type assigned during part repair/replacement, determines whether the data row is chargeable (i.e., is considered a failure for reliability calculations) or non-chargeable (i.e., is considered a suspension). For more information, see the “Incident Disposition Area” topic in the XFRACAS documentation.

- **Chargeable**: the chargeable code value (where 0 = non-chargeable, 1 = chargeable): equivalent to the Category Chargeable and Category Non-Chargeable lists in the XFRACAS Admin List page. This is to be used to calculate the failure state (StateFS). XFRACAS categories can also be viewed within an XFRACAS incident.

- **CompanyOwner**: the owner of the system. This corresponds to the Company field in the XFRACAS contact.

- **DataID**: the database ID of the row.

- **DataSetID**: the ID of the data set that the row belongs to. This is useful if you are viewing multiple data sets at the same time.

- **DateUDF1-3**: user-defined fields for dates. You can choose up to 3 detail fields in XFRACAS incidents to import to these columns.

- **ExtractedBy, ExtractedDate** and **ExtractedName**: identify the user who extracted the data from XFRACAS, the date of extraction and the name of the SDW data collection.

- **FailureMode**: the failure mode associated with the incident. This is chosen or created in the Failure Mode field in the XFRACAS incident.

- **IncidentAction**: the action taken to address the incident (whether a part was removed or installed). This is not related to XFRACAS actions. In XFRACAS data sets, repaired and
replaced parts will be represented using two rows of data—one will be for removing the part, and one for installing it.

- **IncidentEntityDisplayID**: the incident number assigned by XFRACAS, which includes the prefix for the entity that it is associated with (e.g., E1-201).
- **IncidentID**: the database ID of the incident.
- **IncidentOccurrenceDate**: the date when the incident happened. This corresponds to the **Occurrence Date** field in the XFRACAS incident.
- **IncidentRepairDate**: the date that part repair or replacement was completed. This corresponds to the **Completed Date** field that applies to the XFRACAS incident resolution.
- **IncidentResolution**: notes regarding the resolution of the incident. This corresponds to the **Incident Resolution** field in the XFRACAS incident.
- **IsLRU**: indicates whether the item is a line replaceable unit (LRU). This does not correspond to an XFRACAS field; it can be used when creating data sets via the Synthesis API.
- **LastInspectedTime**: the last inspected time. For exporting XFRACAS data sets to Weibull++, this is equal to the state time for the data row. For exporting XFRACAS data sets to RGA, it is the amount of time the system has accrued at the last reported incident.
- **NumberInState**: equivalent to the Number in State column in a Weibull++ life data folio for grouped data. In data sets from XFRACAS, this value will always be 1.
- **NumberUDF1-3**: user-defined fields for numbers. You can choose up to 3 detail fields in XFRACAS incidents to import to these columns.
- **ParentPartID**, **ParentPartName**, **ParentPartNumber** and **ParentPartVersion**: identifiers for the "parent" of the part that the incident pertains to. If the part doesn't have a parent (i.e., it is a top level part), this information will be identical to the information for the part itself.
- **PartHID** and **PartID**: the part’s hierarchy identification number and database identification number. In XFRACAS, these are assigned by the system and shown in the HID and Part ID fields that are displayed for the generic part on the Template page.
- **PartName**, **PartNumber** and **PartVersion**: identifiers for the part that the incident pertains to. In XFRACAS, this information is specified for the generic part, and serialized parts based on the generic part will use the same information.
• **PartOrder**: the order in which the part was replaced. This corresponds to the order in the repair/replace table in the XFRACAS incident.

• **PartSerialHID, PartSerialMfgCode and PartSerialNumber**: relevant only if the incident was assigned to a part in a serialized system. They represent the part’s serial hierarchy identification number, manufacturing code and serial number. In XFRACAS, the PartSerialHID is assigned by the system and shown in the Serial HID field that is displayed for the serialized part on the Serialized page.

• **ReportType**: how the incident was reported. This corresponds to the type chosen in the **Report Type** field in the XFRACAS incident.

• **RootCause**: the root cause of the failure mode. This is chosen or created in the **Root Cause** field in the XFRACAS incident.

• **StateFS**: This allows the user to understand if a data row is considered a failure (F) or a suspension (S) for the purposes of reliability calculations. In XFRACAS data sets, this is based on the incident category assigned in the XFRACAS incident, in conjunction with the failure type assigned during part repair/replacement. For more information, see the “Incident Disposition Area” topic in the XFRACAS documentation.

• **StateTime**: the amount of time accrued on the part. This is based on the run hours calculated by XFRACAS.

• **StateTimeRestore**: the amount of time required for the repair. This corresponds to the **Repair Duration** field in the XFRACAS incident.

• **StringUDF1-3**: user-defined fields for strings. You can choose up to 3 detail fields in XFRACAS incidents to import to these columns.

• **TimeMetric**: the time metric to use for the data. The options are based on the metrics that have been enabled for the XFRACAS entity.

• **TopLevelCommissionDate**: the commission date of the top level part in the system. This corresponds to the commission date of the associated CSI in XFRACAS.

• **TopLevelPartID, TopLevelPartName, TopLevelPartNumber and TopLevelPartVersion**: identifiers for the top level part in the system that the incident pertains to.

• **TopLevelSerialHID and TopLevelSerialNumber**: relevant only if the incident was assigned to a part in a serialized system. They represent the serial hierarchy identification number and serial number of the top level part in the serialized system. This information is used by RGA and Weibull++ to distinguish the system in which the failure occurred.
Transferring from the SDW to an Analysis Folio

Follow the steps below to transfer a data set from the Synthesis Data Warehouse (SDW) to a Weibull++, ALTA or RGA analysis folio.

1. In Weibull++, ALTA or RGA, choose Home > Synthesis > Synthesis Data Warehouse.

2. In the SDW, double-click the data you want to transfer to an analysis folio.

3. In the data table, use the Include in Analysis? column to mark any data points that need to be excluded from the transfer. You can double-click the cell to toggle the options, or select the row and choose Build Data Set > Include or Exclude.

   In data collections imported from XFRACAS:
   
   - Incidents with StateTime = 0 and StateFS = S (suspension) are automatically marked Ignore.
   - Incidents with StateTime < 0 are automatically marked Invalid.

<table>
<thead>
<tr>
<th>Include in Analysis?</th>
<th>StateTime</th>
<th>StateFS</th>
<th>LastInspectedTime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invalid</td>
<td>-10</td>
<td>S</td>
<td>-10</td>
</tr>
<tr>
<td>Include</td>
<td>121</td>
<td>F</td>
<td>121</td>
</tr>
<tr>
<td>Ignore</td>
<td>0</td>
<td>S</td>
<td>0</td>
</tr>
<tr>
<td>Include</td>
<td>1000</td>
<td>S</td>
<td>1000</td>
</tr>
<tr>
<td>Include</td>
<td>131</td>
<td>S</td>
<td>131</td>
</tr>
<tr>
<td>Ignore</td>
<td>0</td>
<td>S</td>
<td>0</td>
</tr>
<tr>
<td>Exclude</td>
<td>1000</td>
<td>S</td>
<td>1000</td>
</tr>
<tr>
<td>Include</td>
<td>2160.02</td>
<td>S</td>
<td>2160.02</td>
</tr>
<tr>
<td>Ignore</td>
<td>0</td>
<td>S</td>
<td>0</td>
</tr>
<tr>
<td>Exclude</td>
<td>1000</td>
<td>S</td>
<td>1000</td>
</tr>
<tr>
<td>Include</td>
<td>2160.02</td>
<td>S</td>
<td>2160.02</td>
</tr>
</tbody>
</table>

4. Choose Transfer > Transfer to New Folio.
Follow the on-screen prompts to select the data type and map the SDW fields to columns in the new analysis folio.

**Tips for Mapping the Columns**

- **State F or S** (in Weibull++/ALTA) indicates whether a data point represents a failure (F) or suspension (S). If the data source field does not use the F and S codes, use the **Define Values as Failures/Suspension** area to specify which value(s) represents each state.

![Map Records for Transfer](image)

- **Event** (in RGA) indicates whether the data point represents a failure (F) that will be transferred for analysis, or some other event that will not be analyzed as a failure. When a data point is marked as a suspension (S) for transfer to RGA, it will be considered only if it affects the recorded system end time. For example, if the System End Time column indicates that the system was last inspected at 1,000 hours but there is a suspension for that system at 1,100 hours, the later time will be used in the folio.

- Time and quantity columns, such as **State End Time** and **Number in State**, can only be mapped to fields with a numeric data type (e.g., number, currency, etc.).

- **Classification** and **Mode** columns (in RGA) can be mapped to any SDW user-defined field that contains the data. (See [Extracting Data from XFRACAS](#).)
Chapter 23: Synthesis Data Warehouse

- **Subset ID** columns (in Weibull++/ALTA) or **Comment** columns (in RGA) allow you to choose multiple SDW fields to display in the same folio column. The data from the fields will be concatenated and separated by dashes (e.g., "Report Type – Category"). Use the check boxes to select the fields and then use the arrows to specify the order.

### SDW Dashboards

This topic describes how to use the **Synthesis Dashboard utility** for exploring and presenting data from the **Synthesis Data Warehouse**. If a **Synthesis Enterprise Portal** has been implemented for an enterprise database, users can also access SDW dashboards from any web-enabled device.

For static data collections, a variety of dashboard layouts can be predefined. For custom connections, there can be only one layout for each connection.

1. In Weibull++, ALTA or RGA, choose **Home > Synthesis > Synthesis Data Warehouse**.

2. Double-click the static data collection or custom connection that contains, or links to, the data you want to view in the dashboard.

3. On the Build Data Set tab, select which rows to include or exclude. (See **Building the Data Set**.)

4. If an appropriate dashboard layout has already been predefined, switch to the Dashboard Viewer tab or choose **Dashboard > Dashboard Viewer**. If multiple layouts are available, use the drop-down list at the top of the viewer to choose what to display.

5. If you need to create a new layout, choose **Dashboard > Dashboard Manager** (for a static data collection) or **Dashboard Designer** (for a custom connection).
(In a secure database, the Dashboard Layout Manager and the Dashboard Layout Designer are available only for users with the “Manage dashboard layouts” permission.)

For information on the data fields available for use in dashboard layouts for SDW data collections, see Data Fields for XFRACAS Data Collections.

Custom Connections in the SDW

The Custom Connections feature in the Synthesis Data Warehouse allows you to create a live link to an external data source (Access, Oracle or SQL Server). This enables you to get data from your own custom and third-party databases for transferring to an analysis folio in Weibull++, ALTA or RGA, or for viewing in the SDW dashboards.

You can also get data directly from your own custom reports created in XFRACAS.

A custom connection data source always shows the latest information from the original database or report and you can only create one dashboard layout per connection. You can also use these connections to import data into a static Weibull++/ALTA or RGA data collection, if desired.

Connect to an External Database

To create a live link to an external database:

1. Choose Manage Data Sources > Add Custom Connection > To External Database.

2. In the Add Custom Connection window:
   a. Enter the Display Name that will identify this custom connection in the SDW data source list.
   b. Enter the connection settings for a Microsoft SQL Server, Oracle or Access database. (See Connection Issues below for more information about the Use impersonation option for SQL Server.)
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c. After you have specified the database, the **Table Name** field shows a list of the available tables. Select the main one that contains the data you want to use in the SDW.

d. If you want to create aliases for column names, build a query that combines data from multiple tables or enter your own SQL, select the **Open Query Editor/Builder** check box.

e. If you want to create the dashboard layout for this data source immediately after defining the connection/query, select the **Open Dashboard Designer** check box.

f. Click **OK** to proceed.

3. If you selected to customize the query, you can use the Query Editor to type or paste your own query, or select a stored procedure. If you need further tools, click the **Run Query Builder** button. The Query Builder can serve three purposes:

   a. The bottom-center panel shows the fields that will be included in the data set. If desired, you can use the Alias column to change the names that will be displayed in the SDW grid and dashboard layouts.

   b. If the tables are linked by foreign keys, you can use the tool to build a query that combines fields from multiple tables.

   c. You can also enter your own SQL in this tool; select the **Allow SQL Editing** check box and type or paste your own query.

   When you are finished in the Query Builder, click **OK** to return to the Query Editor, where you can click **Finish** to save your changes.

4. If you selected to open the Dashboard Designer, you can use it to create a single **dashboard layout** for this data source.

If you want to change the query or create/modify the dashboard layout at a later time, select the custom connection in the data source manager and choose **Dashboard > Dashboard Designer**.

From within the Dashboard Designer window, choose **Home > Query > Edit** to customize the query.
Connection Issues

There will be a "connection failed" message if the database is not found at the specified name/location or if you don’t have permission to access it.

If your organization has implemented a Synthesis Enterprise Portal (SEP) website, the administrator may need to take additional steps to make the dashboards visible to all users via the SEP website. For details, consult the print-ready implementation guide (*.pdf).

- **Oracle** - the password is stored with the custom connection; therefore, both the desktop applications and SEP website will attempt to connect in the same way for all users.

- **SQL Server** - the Use impersonation option in the custom connection allows you to enter a login for a one-time extraction to an SDW data collection, but this login is not saved in SDW.

  For subsequent attempts, the desktop applications will connect with the current user’s Windows login, whereas the SEP website will use the login that the website uses to connect with the Synthesis repository (if the Synthesis repository is SQL Server) or with the IIS "application pool identity" (if the Synthesis repository is Oracle).

- **Access** - the SDW can only connect with databases that are not password protected and must have access to the folder where the database is stored. It is recommended to use the UNC pathname (e.g., \servername\foldername rather than P:\foldername) when you create the custom connection.

  The desktop applications will attempt to access the file with the current user’s Windows login, whereas the SEP website can only access files stored directly on the web server or in a network folder that can be accessed by the website’s IIS "application pool identity."

  **Tip:** For Access databases with the *.accdb file type, the dashboard can only be displayed if the database was created with the same version of Microsoft Office (32-bit vs. 64-bit) that is installed on each individual user’s computer (for Synthesis desktop applications) or on the web server (for SEP).

  To ensure that the dashboard will display regardless of which version of Microsoft Office is installed, use the *.mdb file type instead of *.accdb.

Connect to XFRACAS Report

Creating a custom connection to a predefined XFRACAS report enables you to use the SDW to view any type of XFRACAS data (not just data collections extracted for life data or repairable systems analysis). If a Synthesis Enterprise Portal has been implemented for an enterprise
database, users can also access the dashboards created for these reports from any web-enabled device.

**Tip:** For information about creating SDW reports in XFRACAS, see the "Report Builder" topic in the XFRACAS documentation.

To create a live link to an SDW report that has already been created in XFRACAS:

1. Choose **Manage Data Sources > Add Custom Connection > To XFRACAS Report**.

2. In the Select Report window, select any of the XFRACAS SDW reports that have been predefined in the database.

3. Click **OK** to load the data.

**Import to a Static Data Collection**

In the **Synthesis Data Warehouse**, a **custom connection** provides a live link to an external database or XFRACAS report, while a static data collection stores Weibull++/ALTA or RGA data that was extracted at a particular point in time.

A static data collection can contain **data extracted directly from XFRACAS**. If desired, you can also create a static Weibull++/ALTA or RGA data collection by importing data from a custom connection. To do this:

1. Right-click the custom connection in the data source manager and choose **Import**.

2. In the Import Data from Custom Connection window:
   a. The **Map Data Source Fields to Columns** section specifies which field from the custom connection will be mapped to a column that’s available in a Weibull++/ALTA or RGA data collection.
   b. The **Define Values as Failures/Suspensions** section displays all of the unique values from the field that is currently mapped to the State FS column. Specify whether each value should be considered a failure or a suspension.
   c. The Preview tab allows you to see what the data collection will look like based on your selections.

3. Click **OK** to create the static data collection.
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If your organization chooses to implement a web-based Synthesis Enterprise Portal (SEP) for an enterprise database, the entire team – including managers and colleagues who don't have Synthesis desktop applications installed – will have the opportunity to access key analysis and project management details from any web-enabled device.

In Version 11, the website has a completely redesigned interface with more at-a-glance summaries and better usability on mobile devices.

**SEP Home**

Completely redesigned in Version 11, the personalized SEP home page provides an intuitive, at-a-glance overview of the information you’re tracking via the website, such as actions, recent messages, reports, metrics and more.

For example, this panel shows the status of the gates and actions for the project plan that is currently active for you in SEP. Use the drop-down list to choose a different project or click to see the full project plan.

You can choose which panels are displayed in your own home page, and also change the order (see Customizing the SEP Home Page).
Chapter 24: Synthesis Enterprise Portal

**Project Plans**
The SEP website shows a streamlined view of the project plan for each project you have permission to view. Project plans are created and edited via the Synthesis desktop applications (except MPC) and the website always displays the most recent information from the plan.

![Project Plan Table](image)

New in Version 11, the "My Projects" feature makes it easy to access the projects that you frequently need to view in SEP (see My Projects in SEP).

**Actions and Portal Messages**
The SEP website allows you to create, view and edit the same actions and portal messages that are visible to you from the desktop applications (see Portal Messages and Managing Actions in SEP).

Redesigned in Version 11, the web interfaces now offer better display from mobile devices, and more capabilities (including links/attachments).

**Project and Analysis Summaries**
The SEP website shows a summary from each analysis project you have permission to view. This may include:

- The overall status of the project plan, and all of the actions (from FMEAs, the project plan or standalone) that are being tracked for the project.
- The KPIs (metric resources) that have been defined for the project.
- The analysis summaries and reports that have been published to SEP from Weibull++/ALTA, BlockSim/RENO, RGA or Lambda Predict (see Publishing to SEP).
- All of the files and website resources that have been linked or attached to the project.
System Hierarchies and FMEAs
The SEP website shows the system hierarchies and FMEAs created in Xfmea/RCM++/RBI. The website always displays the most recent information from the project.

You can also access any generated reports that have been published to the website in Word, Excel, PDF or HTML format (see Save/Publish Reports in the Xfmea/RCM++/RBI documentation).

Dashboards & Reports
Redesigned in Version 11, the "Watch This Report" feature makes it easier to manage the specific dashboards and reports you want to be able to access quickly via the SEP website. This includes:

- A wide variety of graphical dashboards based on predefined layouts for different types of data (project plans, Synthesis Explorer, simulation diagram results, FMEAs or Synthesis Data Warehouse).
- A flexible, web-based "spreadsheet viewer" and "document viewer" for Synthesis Workbook reports that have been published to SEP.

For details, see Dashboards & Reports in SEP.

Metrics (Key Performance Indicators)
The SEP website shows all of the KPIs (metric resources) that have been created in desktop applications for the projects you have permission to view – no publishing required.

Redesigned in Version 11, the metrics are now easier to scan "at-a-glance" to help you monitor performance and support decision making.
Synthesis Explorer and Synthesis Data Warehouse

The SEP website shows all of the Synthesis Explorer or Synthesis Data Warehouse (SDW) dashboards that have been predefined in the desktop applications.

- **Synthesis Explorer dashboards** provide a flexible way to explore all the different analyses that are stored in the Synthesis repository (e.g., application source, analysis type, created by, last update, etc.).

- **SDW dashboards** present charts and results from any of the data collections or custom connections that have been created in Weibull++/ALTA or RGA. This can include data extracted from ReliaSoft's XFRACAS or from external databases and systems (CMMS, EAM, etc.).

**XFRACAS**

ReliaSoft's XFRACAS is a highly configurable web-based failure reporting, analysis and corrective action system (FRACAS) with integrated capabilities for part tracking, root cause analysis and team-based problem resolution.

If your organization implements both the SEP and XFRACAS websites for the same enterprise repository, the SEP can include links to the XFRACAS reports, charts, actions and incidents of particular interest to each user (see SEP and XFRACAS).

**How to Implement the SEP**

This topic provides a general overview of the steps required to implement a web-based Synthesis Enterprise Portal for your organization.

When you are ready to configure a website, the print-ready implementation guide (*.pdf) provides more detailed instructions for each step.
Establish the Database and Web Server(s)
The SEP is a web-based system based on the .NET Framework and is designed to be n-tier, scalable, distributable, robust and able to be deployed across multiple servers or on a single computer.

If you plan to host the database and website on the same server, you will need:

- Windows 2008 R2 or Windows 2012 (*Windows 2003 is not supported*)
- .NET 4.0
- IIS with support for serving ASP.NET
- SQL Server 2008 or newer OR Oracle 10g or newer (32-bit and 64-bit versions of all, full version only)

Install the Website and Connect to a Synthesis Repository
Once you have established the database and web server(s), a system administrator will need to:

1. Run the **Synthesis Enterprise Portal setup** to create the website.
2. Run the **Product Activation tool** to activate your SEP license.
3. Run the **Synthesis Admin tool** to either create a new Synthesis repository or connect to an existing one. You can also use this utility to create Synthesis Platform user accounts if desired.

Remember that ReliaSoft’s XFRACAS, Synthesis desktop applications and the SEP website are all designed to connect with the same data repository. If you already have a database established, you can use the admin tool to integrate it with the SEP.

Set Up Synthesis Platform User Accounts and Permissions
Once the Synthesis repository has been created, you can use the **Synthesis Admin tool** or any of the desktop applications to create Synthesis Platform user accounts and set access permissions. You must create an account for anyone who will be able to edit or view data in the Synthesis desktop applications or SEP website. (User accounts for the XFRACAS website are managed separately.)

If your organization uses Microsoft Active Directory, you can save time by importing user information from the directory to create the user accounts.
Assign SEP Access to Users
Once the Synthesis Platform user accounts have been created (via desktop application or the Admin tool), you can use the SEP website to specify which of the database users will have access to the web portal.

Click the SEP Admin link in the top-right corner of the website and then use the Select SEP Users section to specify which user accounts will have website access.

The counters above the user table identify how many more SEP users are allowed under your current license.

Enable Publish to Synthesis Enterprise Portal
Some SEP-related features in Synthesis desktop applications (e.g., the ability to publish analysis summaries, workbooks, reports, etc.) will be visible only if the Enable publish to Synthesis Enterprise Portal option is set to "Yes" for the database.

This can be set from the SEP Admin page in the website or from the Repository Settings window in any of the desktop applications.

Configure Custom Content for Home
The optional "Custom Content" area in the SEP home page enables your organization to integrate a banner or other custom content into the site, if desired. This can be configured from the SEP Admin page in the website.
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The SEPDefault.htm file is installed in the CustomContent folder under the root directory for the SEP website. You can choose to edit this file on the web server or replace it with a URL to another web page.

**Configure ‘Custom Content’ for the home page:**

- **Visible:** ✔
- **Height in pixels:** 100
- **Caption:** Title of the Panel in the Home Page
- Use SEPDefault.htm on the application web server
- Use a page from another website (HTTP only)
  
  http://www.mysite.com/banner_page.htm

*Note:* If the content of the page is taller than the specified **height in pixels**, users with IOS devices will not be able to scroll.

### Configure URLs for Links to Actions in SEP

When an SEP website is implemented for a Synthesis repository, the action alert e-mails and portal messages generated by any of the Synthesis applications can include links to view the action details in SEP. The applications build the links based on the settings specified on the SEP Admin page in the website. If an administrator has not specified an IIS prefix, the action alerts will not include links to SEP.

- **SEP Server - IIS Prefix:** enter the server name and folder for the website that you see in the browser’s address bar (e.g., servername/SEP).
- **Website Uses SSL (https for URLs):** select Yes if the web server has been configured with a Secure Socket Layer (SSL) certificate for the SEP website and the URLs need to start with https rather than http.

If these settings do not match your website configuration, the links attached to the action alerts will give an error message when users attempt to open the page in a web browser (e.g., "File or directory not found," "Access forbidden" or "This page can’t be displayed").
Configure Links Between XFRACAS and SEP

If your organization implements both the SEP and XFRACAS websites for the same enterprise repository, you can use the Admin Preferences page in XFRACAS (Admin > Configure > Preferences) to enable links between the two websites.

- SEP → XFRACAS:
  - Specify the **XFRACAS Server - IIS Prefix** (e.g., servername/XFRACAS)

- XFRACAS → SEP:
  - Specify the **Synthesis Enterprise Portal Server - IIS Prefix** (e.g., servername/SEP)
  - Set **Synthesis - Display Synthesis Enterprise Portal (SEP) Command** to True

Distribute SEP Website Link to All Users

Once the web portal has been implemented, users can access the site with any web browser that supports the following doctype. If the site is private (e.g., http://InternalServer/SEP), the system administrator may need to provide users with instructions for how to access the website on the internal network from their mobile devices (e.g., via VPN or some other method).

```html
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
```

Customizing the SEP Home Page

The personalized SEP home page provides an intuitive, at-a-glance overview of the information you're tracking via the website.

Custom Content

The optional "Custom Content" area enables your organization to integrate a banner or other custom content into the site if desired. This can be configured on the SEP Admin page by any user with "administrative" permissions in the repository (see How to Implement the SEP).

If the custom content is enabled for a repository, the same panel will be displayed at the top of the home page for all SEP users.

Home Page Panels

For the rest of the home page panels, each user can choose which panels are displayed, and also change the order.
To modify your personalized home page, click Edit Home Layout in the top-right corner of the page.

When the page is in the edit mode, the panels will have a yellow background color and a (+) or (-) icon will appear in each title bar:

- Use the title bar to drag and drop a panel into a different position on the page.
- Use the icon to hide (-) or show (+) the panel.

To save your preferences and leave the edit mode, click Save Layout.

Tip: If you click the Restore Defaults button on the User Preferences page, your personalized home page layout will be reset to the default.

My Projects in SEP

New in Version 11, the "My Projects" feature makes it easy to access the projects that you frequently need to view in the Synthesis Enterprise Portal (SEP) website.

For any SEP page that shows data from a particular project (e.g., project plan, project summary or any of the analysis summaries), the Change Project button in the top-right corner allows you to view that same type of data from another project.

The first popup provides quick access to the projects that you have personally selected for quick access in SEP.
Click **Select Projects** to modify this list or view a project that's not already in the list.

The right side shows your list of "My Projects" (i.e., the short list of projects that will appear first whenever you click **Change Project**).

The left side shows all the projects in the database that you have permission to view. You can apply any of the project filters that were created in Synthesis desktop applications, or use the **Find** box to filter by specific text in the project name.

- **Add to My Projects**
- **View Now** (i.e., view the project without adding it to your list)
- **Remove from My Projects**
- Indicates that the project is already in your list.

http://rga.reliasoft.com
Tip: If you want to have quick access to the same set of projects while working in the Synthesis desktop applications, you can create a project filter that contains the same list. Select to filter based on Selected projects in the Project Filter window.

Managing Actions in SEP

If your organization chooses to implement the Synthesis Enterprise Portal (SEP) website for an enterprise repository, the entire team can view the latest project plans and FMEAs from any web-enabled device. This includes the assigned actions that are incorporated into those analyses, as well as any other standalone actions that are being tracked through the Synthesis Platform.

With major enhancements and usability improvements in Version 11, the options for managing actions in SEP are better than ever.

My Actions Panel in SEP Home

The "My Actions" panel in the SEP home page shows actions that are relevant to you and still require action of some kind (i.e., not started, not completed or need to be reviewed). They are listed in the order of urgency, up to the maximum number that will fit in the panel.

This may include any of the actions that are eligible to be displayed for you on the Actions page of My Portal in Synthesis desktop applications. To specify your preferences for the website, click your name on the right side of the header to open the User Preferences page, and select any of the following options:

Select actions to list on the home page:

- I need to review/approve
- I am responsible for
- I am a team member in
- I am monitoring
- Other actions I created

My Actions Page

The My Actions page displays all of your actions in a flexible table that you can filter, sort and group to meet your needs. It also provides the option to create a new action directly from the website.
Create Action
When you click the Create Action button in the top-right corner of the page, this will add a new action in the project that is currently active for you in the SEP.

If you want to create the action in a different project, click the link in the header, as shown below, to go to the Project Summary page, and then use the Change Project button to select a different project.

Filter, Sort and Group the Table
The table can display all actions that are relevant to you in some way and still require action of some kind, including actions that did not fit in your home page. You can filter, sort and group the table on-the-fly to display the actions that are of interest at any given time. These settings will be reset to the defaults when you navigate away from the page.

- **Relevance** - the check boxes at the top of the page provide a quick way to filter the table based on how the actions are relevant to you. This is independent from your settings on the User Preferences page, which only affect the SEP home page.

- **Find Panel** - when you type in the input box, the table will show the actions that contain the text in any of the visible fields, and it will highlight all locations where the matching text occurs.

- **Grouping Panel** - the grouping panel (located under the input box) determines how the actions are grouped in the table. Drag and drop column headings into or out of this panel to change the grouping.
• **Column Headings**

  - To change the column order, drag and drop the column headings into the desired position.
  - When applicable, click the ▲ con to sort the property in ascending or descending order.
  - When applicable, click the ◀ to apply one of the built-in filters (blanks, non blanks or unique values).

**Actions in a Project Summary**

The Project Summary page provides a list of all the actions that have been assigned within the current project.

To access this page, select **Projects** in the SEP menu and use the **Change Project** button to specify which project summary is currently displayed.
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Actions in a Project Plan or FMEA

The website includes full details for any actions that are incorporated into a project plan or FMEA. If you have permission to edit an action in a desktop application, you can perform the same updates via the website.

- To access a project plan, select Project Plans in the SEP menu and use the Change Project button to specify which project’s plan you want to view. In the project plan, click an action link to view the full details.

- To access an FMEA, click Projects in the SEP menu and use the Change Project button to specify which project’s system hierarchy and FMEAs you want to view. Then click the Xfmea/RCM++/RBI link.

In the system hierarchy, click an action link to view the full details.
Links to SEP from Action Alert E-mails and Portal Messages

The action alert e-mails and portal messages generated by any of the Synthesis applications can include links to view the action details in the SEP. The applications build the links based on the settings specified on the SEP Admin page in the website.

If these links are not working properly for your SEP website, see How to Implement the SEP.

Publishing to SEP

The Synthesis Enterprise Portal website does not display all of the analyses that were performed in Synthesis desktop applications. Instead, your team can decide which analyses to make available via the web, and publish selected analysis summaries and reports.

These features are only available when:

- You are connected to an enterprise database that has an SEP website implemented and the Enable publish to Synthesis Enterprise Portal option is set to "Yes" for the database.
- You have the "Publish to Synthesis Enterprise Portal" permission.

<table>
<thead>
<tr>
<th>Synthesis Application</th>
<th>What can be published</th>
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<tbody>
<tr>
<td>Weibull++/ALTA</td>
<td>- Synthesis Workbooks</td>
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<td></td>
<td>- Life Data analyses</td>
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<td></td>
<td>- Non-Parametric LDA analyses</td>
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<td>- Parametric RDA analyses</td>
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<td>- Life-Stress Data analyses</td>
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<td>- DOE Designs</td>
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<td>- One Way ANOVA</td>
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<td>- Measurement Systems analyses</td>
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<td>- Multiple Linear Regression</td>
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<tr>
<td>RGA</td>
<td>- Synthesis Workbooks</td>
</tr>
<tr>
<td></td>
<td>- Growth Data analyses</td>
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</tbody>
</table>
## Data Sheets or Diagrams

To publish an analysis summary from Weibull++/ALTA, RGA or BlockSim/RENO, open the data sheet or diagram and click **Publish SEP Summary** on the Publishing page of the control panel. (For DOE design folios, the "Data" tab with analyzed response data must be selected.)

### BlockSim/RENO
- Synthesis Workbooks
- Analytical RBDs and Fault Trees
- Simulation RBDs and Fault Trees (including dashboards)
- Phase Diagrams (including dashboards)
- Markov Diagrams
- RENO Flowcharts

### Lambda Predict
- Generated reports published directly to SEP
- Stored plot graphics

### Xfmea, RCM++ and RBI
- Generated reports saved with the project
- *System hierarchy and FMEAs, including dashboards, are also visible on the website — no publishing required*

**Note:** If you have published analysis summaries and you get a "Link is not properly formatted" message when you open the original analysis (e.g., "Open in Weibull++"), the link may be corrupted or is using old encryption. Republish the analysis to refresh the link.
For data sheets, this displays a preview of the spreadsheet summary. Click **Publish SEP Summary** again to complete the process.

After publishing, the panel displays "Synchronized" if the web version reflects the latest results from the analysis. If the analysis has been modified (e.g., if more data has been added, an analysis setting has changed, etc.), it displays "Out of Sync" and you will need to recalculate and republish to update the website.

To remove the summary from the website, click **Remove SEP Summary**.

### Synthesis Workbooks

To publish a **Synthesis Workbook** from Weibull++/ALTA, RGA or BlockSim/RENO, open the module in the workbook that you want to share (spreadsheet or word processing document), then click **Home > SEP > Publish Report**.

The status bar indicates that the spreadsheet or document is visible via the SEP website, and when the web version was last updated.

If you subsequently make a change in the desktop application, you will need to republish to update the website.

If you want to remove the report from the website, open the module and click **Home > SEP > Remove Report**.

### Prediction Reports and Plots

To publish a report or plot from Lambda Predict, select any standard item or block in the prediction folio and choose **Prediction Tools > Share > Publish SEP Summary** (or click the icon on the Publishing tab of the Properties panel).

Then use the Select Report window to build the report and click **OK**. (See Lambda Predict Reports in the Lambda Predict documentation.)
You can publish multiple reports from the same prediction folio, but only one report for each standard item/block. For example, the following picture shows two reports published from the same folio. If you later republish from the same standard item/block, the new report will replace what was previously published.

**Xfmea/RCM++/RBI Reports**

To publish a report generated in Xfmea/RCM++/RBI, use the Reports window to build the document, select at least one of the *Save/Publish* file formats on the ribbon (Word, Excel, or PDF) and click *Generate Report*.

To see all of the generated report documents that have been saved with the project (and therefore will be visible via SEP), click *Published Reports Manager*. You can also use the manager to edit the name and description that will show in the website.

For more information, see *Save/Publish Reports* in the Xfmea/RCM++/RBI documentation.

**Dashboards and Reports in SEP**

Dashboards and Synthesis Workbook reports are available throughout the *Synthesis Enterprise Portal (SEP) website* when you view different types of data.

For example, when you view a particular project plan in the website, you can select to view the latest information from the plan in any of the *dashboard layouts* that are currently available for that type of data.

Likewise, when you review the Weibull++/ALTA, RGA or BlockSim/RENO analyses for a particular project, you can see any *Synthesis Workbook reports* (spreadsheets or documents) that were published to the website.
Save, Copy or E-mail the URL

When you view a dashboard or Synthesis Workbook in the SEP website, the link for the web page (URL) includes the identifiers required to open the same report again later if the data/report is still visible in SEP and the user has permission to view the data.

- For dashboards, this will display the latest data from the analysis using the latest version of the predefined layout.
- For Synthesis Workbooks, this will display the latest published version of the report.

You can use the Save URL, Copy URL and E-mail URL links at the top of the web page, or copy/paste the URL from the browser’s address bar.

Watch This Report

Redesigned in Version 11, the "Watch This Report" feature makes it easier to manage the specific dashboards and reports you want to be able to access quickly via the SEP website.

What’s Changed? This replaces the "Share" feature that was used in SEP 10. If you upgrade a Version 10 database, any dashboards and reports that were "shared" with you in Version 10 will be "watched" by you in Version 11.

To watch a report, navigate to it in the website and click the Watch button or link, then enter the name and description that will show in your personalized list of "My Dashboards & Reports."
If you have an XFRACAS website that is linked to the SEP, the sites will automatically create a watch in SEP for any charts or reports that you are watching in XFRACAS. If you delete or rename the SEP watch, this will not change the original watch in XFRACAS.

Click **Reports** in the SEP menu to see the list of dashboards and reports you are currently watching in SEP. You can filter by name/description, project or report type.

If you want to change the sort order, first clear all the filters and then click to drag and drop the reports into the desired position.

The first 5 reports will show in your personalized SEP home page (unless you have chosen to hide the "My Dashboards & Reports" panel).

### SEP and XFRACAS
ReliaSoft's XFRACAS is a highly configurable web-based failure reporting, analysis and corrective action system (FRACAS) with integrated capabilities for part tracking, root cause analysis and team-based problem resolution.

If your organization implements both the SEP and XFRACAS websites for the same enterprise repository, the SEP can include links to XFRACAS records that are of interest to the user.

### Configure Links Between Websites
In order to enable links between SEP and XFRACAS, a user with administrative permissions in XFRACAS must specify the paths that will be used in URLs for each website. (See [How to Implement the SEP](#)).

When these preferences are set, SEP's menu will include a link to XFRACAS, and XFRACAS's ribbon will include an icon for SEP.
XFRACAS Reports and Charts
The "watch" feature in XFRACAS provides a quick and convenient way to access the XFRACAS reports and charts that you use most often (e.g., incident count by responsible part, all open incidents for a particular system, etc.).

When the websites are linked, these XFRACAS reports and charts will be automatically added to the list of dashboards and reports that you are watching in SEP. If you later decide to modify or delete the duplicate watch in SEP, this will not affect your settings in XFRACAS. (See Dashboards and Reports in SEP.)

XFRACAS Actions
The actions in XFRACAS (called "XFRACAS actions") are managed separately from the actions in Synthesis desktop applications and SEP (called "Synthesis actions"). The SEP always shows the Synthesis actions that are relevant to a particular user and project (see Managing Actions in SEP.)

If you also want to see your XFRACAS actions in SEP, choose to show the "XFRACAS Actions" panel in the SEP home page. (See Customizing the SEP Home Page.)

The SEP panel shows the same XFRACAS actions that you have chosen to display under Uncompleted Actions in your XFRACAS portal. (See XFRACAS Portal in the XFRACAS documentation.)

Tip: You can also choose to show Synthesis actions in your XFRACAS Portal, if desired. Open the My Portal Preferences page in XFRACAS and configure the Display My Open Synthesis Actions option.

XFRACAS Incidents
If you want to see XFRACAS incidents in SEP, choose to show the "XFRACAS Incidents" panel in the SEP home page.

The SEP panel shows the same XFRACAS incidents that you have choose to display under Display My Unclosed Incidents in your XFRACAS Portal.

Quick Links in SEP
The Quick Links feature allows you to create your own personalized list of links within the Synthesis Enterprise Portal (SEP) website. In Version 11, these links are now visible in the SEP menu.
Link to a Page in SEP
To create a link to a page in the SEP website (e.g., for quick access to a particular project summary, FMEA system hierarchy, assigned action, etc.), navigate to the page and then click the **Save URL** link at the top-right corner of the page. You will be prompted to specify the name that will show in your list of quick links.

![Save URL button](image)

Link to an External Website
To create a link to an external website (e.g., a company intranet, document management system, etc.), click the **Quick Links** heading or icon in the SEP menu to open the My Quick Links page.

Use the **Add New Link** section to specify the name and URL.

```
Add New Link

Name: Acme Intranet
URL: https://OurIntranet

Save
```

*Note:* When entering a URL link, this can only be to a web address. It cannot be to a network share path.

Move, Rename or Remove a Link
To move a link, change the name that shows in the menu or remove a link, click the **Quick Links** heading or icon in the SEP menu to open the My Quick Links page.

In the **Manage Current Links** section, you can change where the link displays, edit the link name or delete the link. For online links, you can also edit the URL.
SEP User Preferences

The User Preferences page in the Synthesis Enterprise Portal (SEP) allows you to manage your own personal preferences for the website.

Click your name in the top-right corner of the website to open the page.

Change interface language

Use the drop-down list to choose any of the languages that are available for Synthesis desktop applications.

This will update the interface labels, but the data and configurable settings that have been entered by users will remain in the original language. For example, this includes (but is not limited to):

- Names, descriptions, identifiers and remarks that are entered by users
- Action property labels that are configurable within each project
- Published analysis summaries and reports
- System hierarchies and FMEA data
- Etc.
Chapter 24: Synthesis Enterprise Portal

**When starting the SEP always load**
This setting determines which project will be displayed first for SEP features that show information from a particular project (e.g., project plan, project summary or creating a new action). You can choose:

- The last project used in any Synthesis application
- The last project set/used in the SEP web interface

You can use the Change Project button and "My Projects" feature at any time to change the project that is currently active in SEP.

**Select actions to list on the home page**
This setting allows you to choose which of the actions that may be relevant to you will be shown in the "My Actions" panel on the home page. (Note that if you’re also using Synthesis desktop applications, your preferences for the Actions page of My Portal will be managed separately.)

- **I need to review/approve**
  - You are assigned in the Reviewer field.

- **I am responsible for**
  - You are assigned in the Person Responsible field.

- **I am a team member in**
  - You belong to the team assigned in the Team field.

- **I am monitoring**
  - You are assigned in the Action Monitors window, or you have personally subscribed to “watch” the action.

- **Other actions I created**
  - You are listed in the Created By field and none of the other roles apply.

**Receive automated alerts**
These are the same options that you can set from the User Login and Contact Information window in a Synthesis desktop application. (See Watches and Alerts.)

Note that alerts via e-mail and SMS text are available only if a valid SMTP server has been defined for the database and your user account has an e-mail address/SMS contact defined. (See Enable Alerts via E-mail or SMS.)
Number of decimals for metrics in SEP
This preference determines how many decimal places will be used in the metric element on SEP web pages. If you are also using Synthesis desktop applications, this may be different than your preference in the Application Setup (File > Application Setup).
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Click Wrap Agreement at time of product installation

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8.2 If, within the Warranty Period, you notify the Licensor in writing of any defect or fault in the Software Product in consequence of which it fails to perform substantially in accordance with the Documentation, and such defect or fault does not result from you having amended the Software Product or used it in contravention of the terms of this License Agreement, the Licensor will, at its sole option, i) repair or replace the Software Product, provided that you make available all information that may be necessary to assist the Licensor in resolving the defect or fault, including sufficient information to enable the Licensor to recreate the defect or fault, or ii) terminate this License Agreement immediately by notice in writing to you and the Licensor will refund or if the Software Products have been purchased from an Authorised Reseller will procure that the Authorised Reseller shall refund; any of the fees paid as at the date of termination (less a reasonable sum in respect of your use of the Software Product to the date of termination) on return of the Software Product and all copies thereof. The Licensor’s obligation under this clause 8.2 is subject to your compliance with clause 6.1(b).

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(b) loss of business profits or contracts;
(c) business interruption;
(d) loss of the use of money or anticipated savings;
(e) loss of information;
(f) loss of opportunity, goodwill or reputation;
(g) loss of, damage to or corruption of data; or
(h) any indirect or consequential loss or damage of any kind howsoever arising and whether caused by tort
(including negligence), breach of contract or otherwise;

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