# ITEM TOOLKIT®

# TUTORIAL GETTING STARTED GUIDE



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## Contents

CONTENTS	I
PREFACE	1
PURPOSE OF THIS GUIDE     STRUCTURE     CONVENTIONS	
INTRODUCING ITEM TOOLKIT	3
<ol> <li>WHAT IS ITEM TOOLKIT?</li></ol>	
INSTALLING ITEM TOOLKIT	9
1. STANDALONE INSTALLATION     2. NETWORK SERVER INSTALLATION     3. LICENSE SERVER INSTALLATION     4. NETWORK CLIENT INSTALLATION     5. PROBLEMS INSTALLING AND STARTING ITEM SOFTWARE TCPIP SERVER SERVICES     6. SILENT VERSION     7. UNINSTALLATION	9 9 9 9 9 9 9 40 61 71 71 80 82
TOOLKIT BASICS	83
<ol> <li>Standard Features of the ToolKit Interface</li></ol>	
PROJECT BASICS	
<ol> <li>CREATING A NEW PROJECT</li></ol>	100 101 102 103 104 105 105
PREDICTIONS	107
<ol> <li>INTRODUCTION</li> <li>USING TOOLKIT FOR RELIABILITY PREDICTIONS</li> <li>CREATING A PREDICTION PROJECT</li> <li>DERATING COMPONENTS</li> </ol>	

5. PREDICTIONS EDITOR SCREEN, TOOLBAR AND SHORTCUT KEYS QUICK REFERENCE	126
FMECA	132
1. INTRODUCTION	
2. ITEM TOOLKIT & FMECA ANALYSIS	
3. CREATING A FMECA PROJECT	
4. FMECA EDITOR SCREEN, TOOLBAR AND SHORTCUT KEYS QUICK REFERENCE	
RBD	158
1. INTRODUCTION	158
2. ITEM TOOLKIT & RELIABILITY BLOCK DIAGRAM	159
3. CREATING AN RBD PROJECT	
4. RBD EDITOR SCREEN, TOOLBAR AND SHORTCUT KEYS QUICK REFERENCE	171
FAULT TREE ANALYSIS	178
1. INTRODUCTION	
2. ITEM TOOLKIT & FAULT TREE ANALYSIS	179
3. CREATING A FAULT TREE PROJECT	
4. FAULT TREE EDITOR SCREEN, TOOLBAR AND SHORTCUT KEYS QUICK REFERENCE	196
MARKOV	204
1. INTRODUCTION	
2. ITEM TOOLKIT & MARKOV ANALYSIS	
3. CREATING A MARKOV PROJECT	207
4. MARKOV EDITOR SCREEN, TOOLBAR AND SHORTCUT KEYS QUICK REFERENCE	
MAINTAIN	227
1. INTRODUCTION	227
2. ITEM TOOLKIT & MAINTAIN	
3. CREATING A MAINTAIN PROJECT	230
4. MAINTAIN EDITOR SCREEN, TOOLBAR AND SHORTCUT KEYS QUICK REFERENCE	239
SPARECOST	
1. INTRODUCTION	
2. ITEM TOOLKIT & SPARECOST	
3. CREATING A SPARECOST PROJECT	
4. SPARECOST EDITOR SCREEN, TOOLBAR AND SHORTCUT KEYS QUICK REFERENCE	
EVENT TREE ANALYSIS	
1. INTRODUCTION	
2. ITEM TOOLKIT & EVENT TREE ANALYSIS	
3. CREATING AN EVENT TREE PROJECT	
4. EVENT TREE EDITOR SCREEN, TOOLBAR AND SHORTCUT KEYS QUICK REFERENCE	
WORKING WITH REPORTS	292
1. SELECTING AND PREVIEWING REPORTS	
2. CREATING REPORT TEMPLATES	

	Contents	iii
3. CUSTOMIZING REPORTS		297
4. PROBLEM SOLVING		302
IMPORT/EXPORT		304
1. CREATING A BILL OF MATERIALS IN EXCEL		304
2. IMPORTING THE BILL OF MATERIALS INTO TOOLKIT		306
3. EXPORTING A SYSTEM FROM TOOLKIT TO EXCEL		311
LIBRARY FACILITIES		315
1. CREATING A NEW LIBRARY PROJECT		315
2. ADDING AND EXTRACTING FROM LIBRARY PROJECT		317
3. SAVING AND CLOSE A LIBRARY PROJECT		319
4. LOADING AND BROWSING A LIBRARY		319
GRID VIEW CUSTOMIZATION		321
1. VIEWING/CREATING GRID TEMPLATES		321
2. Additional Grid options		322
3. SWITCHING TO A DIFFERENT GRID TEMPLATE		323
4. EXPORTING AND PRINTING THE GRID VIEW		323

## Preface

ITEM ToolKit is a suite of comprehensive Reliability, Availability, Maintainability and Safety modules. It uses globally recognized standards and methodologies to analyze components, systems, and projects.

## 1. Purpose of this Guide

This guide contains information to help you start using ITEM ToolKit. The guide presents information in a tutorial format, and is intended to explain the basic functions of the software. Advanced concepts are included in the online help system, which can be accessed from the Help menu within the ITEM ToolKit software.

## 2. Structure

This guide contains the following chapters:

Chapter 1	Introduces ToolKit.
Chapter 2	Installation of the software.
Chapter 3	Provides an overview of the ToolKit interface.
Chapter 4	Explains basic project operations, such as creating a new project, opening a project, adding libraries, selecting workspace options, importing and exporting project data, saving and closing a project.
Chapter 5	Provides an introduction to the prediction modules and explains their use through a MIL-217 example
Chapter 6	Provides an introduction to the FMECA module and explains its use through a practical example.
Chapter 7	Provides an introduction to the RBD module and explains its use through a practical example.
Chapter 8	Provides an introduction to the Fault Tree module and explains its use through a practical example.
Chapter 9	Provides an introduction to the Markov module and explains its use through a practical example.
Chapter 10	Provides an introduction to the Maintain module and explains its use through a practical example.
Chapter 11	Provides an introduction to the SpareCost module and explains its use through a practical example.
Chapter 12	Provides an introduction to the Event Tree module and explains its use through a practical example.
Chapter 13	Working with reports, covering their selection, creation and customization of templates.
Chapter 14	Import and export of data, including an example using a bill of materials.
Chapter 15	Library facilities, covering their creation, editing, saving and loading and browsing.
Chapter 16	Grid view customization.

## 3. Conventions

Throughout this guide, ITEM ToolKit and ToolKit are used interchangeably.

In examples, an implied carriage return occurs at the end of each line, unless otherwise noted. You must press the ENTER key at the end of a line of input.

The following table lists the special conventions used in this guide.

Example	Description	
Edit	Words in bold indicate the user enters / clicks that button or menu in the software.	
RETURN	Words in bold capital letters indicate names of keys and key sequences.	
ALT – P	A hyphen between key names indicates a key combination. For example, pressing ALT - P means to hold down the ALT key while also pressing the P key.	

# CHAPTER 1

## Introducing ITEM ToolKit

Welcome to ITEM ToolKit. This chapter introduces ITEM ToolKit and provides basic requirement and instructions. It contains the following sections:

- 1. What is ITEM ToolKit?
- 2. Hardware and Software Requirements.
- 3. Getting Technical Support.

The remaining chapters of this guide describe ITEM ToolKit and how you can use it to analyze components, systems, and projects.

## 1. What is ITEM ToolKit?

ITEM ToolKit is a suite of comprehensive Reliability, Availability, Maintainability and Safety modules in a single integrated environment. It uses globally recognized standards and methodologies to analyze components, systems, and projects.

ITEM ToolKit allows you to take a total system approach while dealing with individual systems and components. This enables the user to optimize design targets with respect to component selection, increase safety and reduce liability. The user can analyze reliability and availability at the component or system level and view the entire project.

ITEM ToolKit standardizes many critical functions, shortcuts, and other features that operate identically in each module to save time, effort and increase productivity. Whether one starts a new analysis or uses a different module, the essential functions remain the same.

ITEM ToolKit's graphical user interface uses standard Windows dialogs, menus, toolbars, and controls. The Multiple Document Interface (MDI) architecture allows you to simultaneously display multiple projects, systems and data views in separate viewing areas in the ToolKit workspace. The interface allows you to easily:

- Transfer and Link data between different systems and projects
- Cut, copy and paste data
- Drag and drop objects both within and between projects
- Customize the workspace toolbar
- Access online help

An integrated environment offers flexibility with convenient features that provide a consistent format for all analyses to optimize the learning curve from one module to another.

#### **ITEM ToolKit Integrated Modules**

#### • MIL-217

The MIL-217 module supports two methods of reliability prediction as described in *MIL-HDBK-217F*: **Part Stress Analysis** and **Parts Count**. The Part Stress Analysis requires more detailed information and is usually applicable later in the design phase. The Parts Count generally requires less information, typically part quantities, quality levels and the application *environment*. It is most applicable early in the design phase and during proposal formulation.

MIL-217 calculates the failure rates and MTBF for electronic components, sub-systems, and systems. It can aid in locating areas for potential reliability improvement.

#### Telcordia (Bellcore)

The Telcordia module is based on the internationally recognized Telcordia Standard that calculates the reliability of electronic equipment. The latest version of this document is the *Reliability Prediction Procedure for Electronic Equipment*, SR-332.

Telcordia reliability prediction has only one focus: electronic equipment. It can provide predictions at the component level, system level or project level for COTS (Commercial Off-The- Shelf Parts). Telcordia utilizes three methods for predicting product reliability. These are:

*Method I*: Parts Count *Method II*: Combines Method I predictions with laboratory data. *Method III*: Predictions based on field data

#### NSWC

The NSWC module uses a series of models for various categories of mechanical components to predict failure rates based on temperature, stresses, flow rates and various other parameters. It provides models for various types of mechanical devices including springs, bearings, seals, motors, brakes and clutches. NSWC is a relatively new standard, and is currently the only one of its kind.

The NSWC Standard is a commonly used model for mechanical components. Standard procedures for predicting the reliability of mechanical components, sub-systems and systems are defined in the Naval Surface Warfare Center *Handbook of Reliability Prediction Procedures for Mechanical Equipment*, NSWC.

#### IEC 62380 (RDF 2000)

The IEC 62380 module supports methods of reliability prediction as described in the French standard published by the Union Technique de L'Electricite (UTE, July 2000). IEC 62380 is a universal model for reliability prediction of electronics, printed circuit boards and equipment, which takes directly into account the influence of the environment. Environment factors are no longer used as they are replaced by mission profile undergone by the equipment. The models in the guide can handle permanent working, on/off cycling and dormant applications.

#### IEC 61709

The IEC-61709 module supports the reliability prediction methods based on the European Prediction Standard IEC-61709. This module is predominantly based on the Siemens Prediction Standard SN-29500, as well as conforming to section 19 for PCBs and section 20 for the Hybrid Circuits within the European Prediction Standard IEC-62380 (RDF 2000/UTE C 80-810).

#### CHINA 299B

The 299B module supports methods of reliability prediction as described in Chinese 299B standard. 299B is a reliability prediction guide for electronic parts in both commercial and military industries. The standard provides the user with the opportunity to take into account the environmental conditions, quality levels and stress conditions. The guide provides procedures to perform Parts Stress Analysis as well as Parts Count Analysis.

#### FMECA

The FMECA module is based on the United States Military, MIL-STD-1629A: *Procedures for Performing a Failure Mode, Effects and Criticality Analysis*. This procedure was developed to determine the effects of system and equipment failures. The module also now covers, and conforms fully to, the standards IEC 61508 and ISO 26262. This enables ITEM ToolKit to provide a full top-down modeling from Hazard Analysis to FMECA in compliance with these standards.

FMECA addresses reliability and quality problems associated with design, manufacturing, process, safety and environment. The FMECA module provides an intuitive graphical interface with multiple options for constructing and performing an analysis. With an enhanced hierarchy tree and tabular views designed for user-friendly navigation, data entry and modification have never been easier. The FMECA module provides a coherent, comprehensive method for entering data.

During a FMECA procedure, identifying the failure modes and their effects (Failure Mode Effect Analysis) is often only the beginning. Criticality Analysis is where the failure modes are ranked according to a combination of severity and the probability of that failure mode actually occurring. ITEM ToolKit provides total flexibility for applying FMECA to the full analysis.

#### RBD

The RBD module is a systems analysis tool. As part of the ITEM ToolKit integrated program, the Reliability Block Diagram (RBD) offers a wide range of capabilities. Boolean Algebra expressions are used to determine minimal cut sets or the minimum combination of failures required to cause a system failure. Three types of Importance Analysis are included. Markov analysis models standby systems with respect to maintenance arrangements. RBD calculates system failure, frequency values and unavailability. In addition to component libraries, commonly used failure models can be stored and retrieved for repeated use.

#### Fault Tree Analysis

Fault Tree Analysis is a systems reliability assessment tool, which focuses on failure path representation. The Fault Tree module provides a wide variety of both qualitative and quantitative information about the system reliability and availability.

Fault Trees are used during Reliability and Safety Risk Assessments to graphically represent the logical interaction and probabilities of occurrence of component failures and other events in a system. The interactions are captured using a tree structure of Boolean operation gates, which decomposes system level failures to combinations of lower-level events. The analysis of such Fault Trees identifies and ranks combinations of events leading to system failure and provides estimates of the system's failure probability.

Fault Tree Analysis is a well-established methodology that relies on solid theories such as Boolean Logic and Probability Theory. Boolean logic is used to reduce the Fault Tree structure into Minimal Cut Sets, which are the combinations of events leading to failure of the system. Probability Theory is then used to determine probabilities that the system will fail during a particular mission, or is unavailable at a particular point in time, given the probability of the individual events.

Additionally, probabilities are computed for individual Minimal Cut Sets, forming the basis for their ranking by importance with respect to their reliability and safety impact.

The module also includes the BDD analysis method as an alternative to the Rare Event and Esary-Proschan quantification options. It uses the Binary Decision Diagram algorithm to obtain cut-sets and quantification results. BDD algorithms distinguish themselves from conventional quantification methods by returning results that do not involve approximations. Instead, BDD algorithms produce results that are in accordance with the basic rules of probability theory.

#### Markov

The Markov module is a powerful modeling and analysis technique with strong applications in time-based reliability and availability analysis. The reliability behavior of a system is represented using a state-transition diagram, which consists of a set of discrete states that the system can be in, and defines the speed at which transitions between those states take place. As such, Markov models consist of comprehensive representations of possible chains of events, i.e., transitions, within systems, which, in the case of reliability analysis, correspond to sequences of failures and repair.

#### Maintain

The Maintain module provides an integrated environment for predicting the expected number of hours that a system or a device will be inoperative or "down" while it undergoes maintenance. A comprehensive design tool for calculating MTTR, Maintain conforms to maintenance standards established in MIL-HDBK-472, Procedure V, Method A.

#### SpareCost

The SpareCost module Calculates spares required for equipment supported at **Sites** (First and Second line maintenance by replacement) and **Bases** (Third line maintenance to support Sites and the repair of returned defective spares). It optimizes scale of spares at Sites for minimum cost. SpareCost produces full information of spares holding by replaceable item at both Site and Base. Expected number of failures for each component over a defined period is also output. SpareCost generates spares holding required at sites against a stock-out risk at the Site. This scale of spares is optimized against the cost of the spares held.

#### Event Tree Analysis

Event tree analysis is based on binary logic, in which an event either has or has not happened or a component has or has not failed. It is valuable in analyzing the consequences arising from a failure or undesired event.

Event tree analysis is generally applicable for almost any type of risk assessment application, but used most effectively to model accidents where multiple safeguards are in place as protective features. Event tree analysis is highly effective in determining how various initiating events can result in accidents of interest.

An event tree begins with an initiating event, such as a component failure, increase in temperature/pressure or a release of a hazardous substance. The consequences of the event are followed through a series of possible paths. Each path is assigned a probability of occurrence and the probability of the various possible outcomes can be calculated.

The module also includes the BDD analysis method as an alternative to the Rare Event and Esary-Proschan quantification options. It uses the Binary Decision Diagram algorithm to obtain cut-sets and quantification results. BDD algorithms distinguish themselves from conventional quantification methods by returning results that do not involve approximations. Instead, BDD algorithms produce results that are in accordance with the basic rules of probability theory.

## 2. Hardware and Software Requirements

The minimum recommended system configuration for ITEM ToolKit is:

- Microsoft Windows 11, Microsoft Windows 10, Microsoft Windows 8, Microsoft Windows 7, Microsoft Windows Vista, Microsoft Windows 2000, Microsoft Windows XP, Microsoft Windows NT 4.0 (SP6 or later) or Microsoft Windows 95/98.
- □ Microsoft Office 2000 or higher.
- □ Intel Pentium II or AMD K6-II 450MHz-based PC or higher.
- □ 128MB RAM (256MB or higher is recommended).
- □ 200MB free disk space.
- □ A 17-inch or larger monitor with display properties set to a minimum of 1280 X 768 pixels.
- □ Mouse or other pointing device.

Less capable machines (such as Pentium 133 with Windows 95/98) can run ITEM ToolKit, but the performance may be less than ideal. The use of additional memory, faster processors, bigger monitor or stable operating system such as Microsoft Windows 2000 will directly improve performance and capacity.

## 3. Getting Technical Support

The ITEM Software technical support staff is always ready to help you with answers and guidance to solve any problems that you encounter when installing or using ITEM ToolKit.

If you need technical support, contact Item Software using any of the following methods:

North American, South American, and Central American customers:		European, Far East, Middle East, and Australian customers:
+1 (714) 497 2061	Telephone	+44 (0) 1489 538 007
support@itemsoft.com	Email	support@itemsoft.com
http://www.itemsoft.com	WWW	http://www.itemsoft.com
Technical Support ITEM Software USA Inc 6789 Quail Hill Parkway Suite 510 Irvine CA 92603 U.S.A.	Address	Technical Support ITEM Software UK 1 Manor Court Barnes Wallis Road, Segensworth East Fareham, Hampshire PO15 5TH U.K.

**NOTE** *Please have your product name, version number, and system configuration information available so that the ITEM Software technical support staff can process your support requests as efficiently as possible.* 

# CHAPTER 2

## Installing ITEM ToolKit

ITEM ToolKit is designed to install quickly from the CD included in the software package. The default product directory for ToolKit is C:\Program Files\Item\ToolKit is compatible with the uninstall utility included in 32-bit Windows operating systems.

ToolKit is copy protected using a Software Key Licensing System. A license ID and password are required for activation of the ToolKit modules. The software will run in the Demo Mode as part of the default setting until the activation numbers (license ID, password or software keys) have been entered. After completing the installation process, visit the Customer Area of our website or contact one of our offices to obtain the Activation Keys.

Although the specific steps for installing ToolKit vary depending on the type of Software License purchased and the installation you perform, all installations follow the same general steps. These steps include:

- Installing the software
- Activating the software
- Verifying the software
- Loading the reliability analysis libraries

## 1. Standalone Installation

ITEM ToolKit supports four types of installations: Standalone, Network Server, License Server and Network Client. This chapter will provide you the required instruction for installing the software as Standalone. It contains the following sections:

- What is Standalone Installation?
- Installing the software
- Activating the software
- Verifying the software

## What is Standalone Installation?

Standalone Installation is one of the options that are available for installing Toolkit. This option will allow you to install ToolKit's program files to a **local** or **standalone workstation**. It is intended for a **single user license** or when the **software license is not shared through a network**.

 

 DESKTOP COMPUTER
 NETWORK

 Toolkit + License
 NETWORK

 LAPTOP COMPUTER
 Shared ToolKit

 Toolkit + License
 Project

The **Software and the license key** are installed by default on the C Drive of the desktop or laptop computer under Program Files/Item/Toolkit/Programs

**NOTE** *The following must be noted when performing a Standalone Installation:* 

- STANDALONE INSTALLATION MUST BE PHYSICALLY PERFORMED AT THE DESIGNATED WORSTATION.
- STANDALONE INSTALLATION CANNOT BE PERFORMED FROM REMOTE WORKSTATION OR SERVER.
- STANDALONE INSTALLATION REQUIRES FULL ADMINISTRATIVE RIGHTS.
- STANDALONE USERS MUST HAVE AT LEAST, "POWER USER" ACCESS RIGHTS TO THE WORKSTATION. FULL (ADMINISTRATOR) ACCESS RIGHTS IS RECOMMENDED.

## Installing the Standalone Version of the Software

- 1- Download and unzip the ITEM ToolKit zip file using the link provided by email.
- 2- Run the file IT-V\*\*\*.EXE by right mouse clicking and selecting 'Run as Administrator'.



3- At the Setup Welcome dialog click Next.



4- Click the 'accept agreement' radio button to continue.

Setup - ITEM ToolKit 9.7.3	x
License Agreement Please read the following important information before continuing.	
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.	
ITEM Software (USA) Inc.	
SOFTWARE LICENSE AGREEMENT	
IMPORTANT - READ CAREFULLY	
I do not accept the agreement	_
< Back Next > Cance	

5- Click next again and then enter the password provided by email.

Setup - ITEM ToolKit 9.7.3	X
Password This installation is password protected.	
Please provide the password, then dick Next to continue. Passwords are case-sensitive.	
Password:	
< <u>B</u> ack <u>N</u> ext >	Cancel

6- Click next and then enter the desired destination location.

Setup - ITEM ToolKit 9.7.3	×
Select Destination Location Where should ITEM ToolKit 9.7.3 be installed?	
Setup will install ITEM ToolKit 9.7.3 into the following folder.	
To continue, click Next. If you would like to select a different folder, clic	k Browse.
C:\Program Files (x86)	Browse
At least 3.1 MB of free disk space is required.	
< <u>B</u> ack Next >	Cancel

7- Click next again and the select the 'Standalone' radio button followed by next.

🚺 Se	tup - ITEM ToolKit 9.7.3
5	etup Type Installation Type Options
	Please select the option that best suits your requirements:
	License Server - Network License Server Program Only
	Network Client - Full Program installation which will connect to a Network License Server
	Network Server - Full Program installation which other Network Clients can connect to
	Standalone - Full Program installation on a Standalone Computer. No Network     Required
	< <u>Back</u> <u>Next</u> Cancel

8- Select the desired Start Menu folder and then click next.

Setup - ITEM ToolKit 9.7.3	x
Select Start Menu Folder Where should Setup place the program's shortcuts?	
Setup will create the program's shortcuts in the following Start M	ienu folder.
To continue, click Next. If you would like to select a different folder, click	Browse.
ITEM Software	Browse
< <u>Back</u> <u>N</u> ext >	Cancel

9- Select whether you wish to create a desktop icon and then click next.

💽 Setup - ITEM ToolKit 9.7.3	
Select Additional Tasks Which additional tasks should be performed?	
Select the additional tasks you would like Setup to perform while installing 9.7.3, then dick Next.	ITEM ToolKit
Additional icons:	
Create a desktop icon	
< <u>B</u> ack Next >	Cancel

**10-** Review the displayed installation details and if acceptable click Install.

Setup - ITEM ToolKit 9.7.3	
Ready to Install Setup is now ready to begin installing ITEM ToolKit 9.7.3 on your computer.	
Click Install to continue with the installation, or click Back if you want to review change any settings.	or
Server Exe Files ToolKit Property Files ToolKit Example ToolKit Spell Checker Start Menu Folder: ITEM Software Additional tasks: Additional icons: Create a desktop icon	
< Back Instal	Cancel

11- Installation will now begin.



12- Once completed, click the Finish button.



## Activating the Software

Once the software is installed, it must be activated. If the software is not activated, only the demonstration mode features will be available.

To activate ToolKit:

1- Run the newly installed software by right clicking the desktop icon and select 'Run as administrator'.



2- For a first time installation you will now see a Demo notification dialog. Click OK

Success!
Demo set to 30 day(s) from today
ОК

**3-** On the following notification screen select the Activate Online option. **This is the preferred activation type but requires internet access**. If online access is not available please contact us for alternative methods.

🕐 Demo Notification
This is an evaluation version of ITEM ToolKit. For technical or sales enquiries please contact:
ITEM Software in USA: (714) 408 7788 or ITEM Software in Europe: +44 (0) 2392 16 0707
Visit ITEM Software Website
26 days left in the evaluation period.
Activate by Email Activate Online Activate by Phone Continue

**IMPORTANT:** Internet Access is required and the License ID provided is specifically for a Standalone.

4- On the following dialog enter your provided License ID and Password. If you do not have these details then please contact us. Note that the provided License ID is specifically for a Standalone license.

Online Activation - Version 9.
License ID:
Password:
Cancel OK

5- If you have selected an alternative activation option you will see the following dialog and will need to provide us with your User Codes 1 and 2. We will then provide you with the necessary ID, Password and Reg Keys to complete the activation.

🚯 Program Activa	ation Dialog - ITEM Tooll	Kit Version 9.7.3
User Code 1: User Code 2:	299196222 3878564	ITEM Software in USA: (714) 416 7788 Rest of the World: +44 (0) 2392 16 0707
Company Name:		
License ID: Password:		Reg Key 1: Reg Key 2:
		Activate Cancel

6- Once the activation details have been entered and accepted you will see the following success dialog.



## Verifying the Software

### **To Check Which Modules Are Activated**

1- The Help 'About ITEM ToolKit' menu option will show your license details and available modules.





Please do not hesitate to contact us if you have any problems with the instructions above and we will be more than happy to call and walk you through this procedure.

## 2. Network Server Installation

ITEM ToolKit supports four types of installation: Standalone, Network Server, License Server and Network Client. This chapter will provide you the required instruction for installing the software as Network Server. It contains the following sections:

- What is Network Server Installation?
- Installing the software
- Activating and verifying the software
- Network Client Installation

## What is Network Server Installation?

Network Server Installation is designed to provide access to the License Key through a network. After installing the software on the Network Server or on a designated Network Client used as a server, the Network Client installation must be performed on the client workstation. The software can be launched on the client workstation or on the server.

This option is intended for a single user or multiple users that are required to have the software installed on a shared server. The number of users accessing the software will be limited to the number of licenses purchased.



**NOTE** *The following must be noted when installing the software on a network server:* 

- THE INSTALLATION MUST BE PHYSICALLY PERFORMED AT THE DESIGNATED NETWORK SERVER AND CANNOT BE DONE FROM A REMOTE WORKSTATION.
- TOOLKIT MUST BE INSTALLED ON THE SERVER BEFORE IT CAN BE INSTALLED ON A NETWORK CLIENT.
- SERVER INSTALLATION REQUIRES FULL ADMINISTRATIVE RIGHTS.
- THE PROGRAM INSTALLATION FOLDER (FOR EXAMPLE: C:\Program Files \Item\ Toolkit\ Programs) INSTALLED ON THE NETWORK SERVER MUST BE SHARED BETWEEN THE NETWORK SERVER AND CLIENT WORKSTATION.
- NETWORK CLIENT MUST HAVE FULL ACCESS RIGHTS TO THE PROGRAMS FOLDER (FOR EXAMPLE: C:\Program Files \Item\ Toolkit\ Programs) INSTALLED ON THE NETWORK SERVER.

## Installing the Network Server Version of the Software

- 1- Download and unzip the ITEM ToolKit zip file using the link provided by email.
- 2- Run the file IT-Vxxx.EXE by right mouse clicking and selecting 'Run as Administrator'.



3- At the Setup Welcome dialog click Next.



4- Click the 'accept agreement' radio button to continue.

Setup - ITEM ToolKit 9.7.3
License Agreement Please read the following important information before continuing.
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.
ITEM Software (USA) Inc.
© [accept the agreement]
< Back Next > Cancel

5- Click next again and then enter the password provided by email.

💽 Setup - ITEM ToolKit 9.7.3	x
Password This installation is password protected.	
Please provide the password, then click Next to continue. Passwords are case-sensitive.	
Password:	
< <u>Back</u> <u>N</u> ext >	Cancel

6- Click next and then enter the desired destination location.

Setup - ITEM ToolKit 9.7.3	×
Select Destination Location Where should ITEM ToolKit 9.7.3 be installed?	
Setup will install ITEM ToolKit 9.7.3 into the following folder.	
To continue, click Next. If you would like to select a different folder, click	Browse.
C:\Program Files (x86)	Browse
At least 3, 1 Mb of free disk space is required.	
< <u>B</u> ack Next >	Cancel

7- Click next again and the select the Network Server' radio button followed by next.

Setup - ITEM ToolKit 9.7.3
Setup Type Installation Type Options
Please select the option that best suits your requirements:
License Server - Network License Server Program Only
Network Client - Full Program installation which will connect to a Network License Server
Network Server - Full Program installation which other Network Clients can connect to
Standalone - Full Program installation on a Standalone Computer. No Network Required
< <u>B</u> ack <u>N</u> ext > Cancel

8- Select the desired type of Server Connection you wish for your Client Machines and then click next.

Setup - ITEM ToolKit 9.7.3	×
Server Installation Connection Type	
Please select the type of Server Connection you wish for the Client Machi Network Fileshare option requires Full Read/Write access to the destinatio Network Fileshare © TCP/IP	ines. The an folder.
<back next=""></back>	Cancel

9- If you have selected the TCP/IP connection option, enter the Port Number ('9998' by default) and click Next.

Setup - ITEM ToolKit 9.7.3	
Server Port Number	
Please specify Server Port Number for TCP/IP Connection	
TCP/IP Port Number:	
9998	
< <u>B</u> ack Next >	Cancel

10- Select the desired Start Menu folder and then click next.

💽 Setup - ITEM ToolKit 9.7.3	
Select Start Menu Folder Where should Setup place the program's shortcuts?	2
Setup will create the program's shortcuts in the following Start Menu folder.	
To continue, click Next. If you would like to select a different folder, click Browse.	
ITEM Software Browse	
	_
< Back Next > Cancel	

11- Select whether you wish to create a desktop icon and then click next.

💽 Setup - ITEM ToolKit 9.7.3	×
Select Additional Tasks Which additional tasks should be performed?	
Select the additional tasks you would like Setup to perform while installin 9.7.3, then dick Next. Additional icons:	g ITEM ToolKit
< Back Next >	Cancel

12- Review the displayed installation details and if acceptable click Install.

Setup - ITEM ToolKit 9.7.3	<b>- - X</b>
Ready to Install Setup is now ready to begin installing ITEM ToolKit 9.7.3 on your computer.	
Click Install to continue with the installation, or click Back if you want to revie change any settings.	ew or
Server Exe Files ToolKit Property Files ToolKit Example ToolKit Help Files ToolKit Spell Checker Start Menu folder: ITEM Software Additional tasks: Additional icons:	E
Create a desktop icon <	• • • • • • • • • • • • • • • • • • •

**13-** Installation will now begin.



14- Once completed, click the Finish button.



## Activating the Software

1- **IMPORTANT:** Once installation is complete, then please run the program **ITEM ToolKit License Manager** using the right mouse click option on the desktop shortcut **'Run as administrator'**.



2- You will be prompted with a Demo Notification. Please use the Activate Online' option.

🕜 Demo Notification		
This is an evaluation version of ITEM ToolKit. For technical or sales enquiries please contact:		
ITEM Software in USA: (714) 408 7788 or ITEM Software in Europe: +44 (0) 2392 16 0707		
Visit ITEM Software Website		
30 days left in the evaluation period.		
Activate by Email Activate Online Activate by Phone Continue		

**IMPORTANT:** Internet Access is required and the License ID provided is specifically for a Network Server License. If internet access is not available then please contact us for details on how to use one of the alternative methods of activation.

**3-** At the Online Activation dialog please enter the **License ID** and **Password** provided in the Item Software email. If you do not have these details then please contact us.

Online Activation - V	ersion 9.7.3
To obtain your ID and Password, please logon to our website customer area.	
-Internet Access Re	quired
Baceword:	
Password.	
	Cancel OK

4- If your details are correct you should be prompted by 'Activation Complete!'.

Success!	×
Activation Co	mplete!
	ок

5- Now you will need to Install and Start the License Server Service. To do this please go to the software menu option: 'IT License Server > Server Configuration'.

🚯 Item ToolKit Li	cense Manager
IT License Server	IT License Client Help
– Computer Info. –––	
User Name:	User
Computer Name:	GRAHAM-DELL
IP Address:	0.0.0.
	Cancel

🕜 П	EM ToolKit License Manager	
ΠLi	icense Server IT License Client Help	
	License information	
	License Activation By Phone	
	License Activation Online	
	Server configuration	1
	Server Log	
_		

6- Here, please switch the Radio Button from 'Thread' to 'Service'.

TCP/IP License setup	x	
Item Toolkit license setup		
Standalone Workstation     Network Client     Network Server     License path     C.\Program Files (x86)\ITEM\Toolkit\Programs     Browse		
Network Adapter Wireless Network Connection Server IP Address: 169 . 254 . 5 . 52 Server execution type	2  Port Number: 9998	
Service C Thread		
Start Server Service Stop Server Server Server Server Server Server Service Stop Server Serve	ervice Install as Service	
Start Server Thread Stop Server T	hread	
	OK Cancel	

7- Now Click on the 'Install as Service' button, followed by 'Start Server Service'.

Server execution type		
• Service C Thread		
Start Server Service	Stop Server Service	Install as Service
Start Se <b>2</b> er Thread	Stop Server Thread	1

8- In the 'Task Manager > Services' you should now have a Service running called 'IT\_LicMgr' which will monitor any calls from Client machines requesting the License. This Service needs to be running constantly on the Server for Clients to access the license. Also, please make a note of the IP Address for the Server, shown on the License Manager main window, which will be required when setting up the Client Machines.

🚺 Item ToolKit Li	cense Manager
IT License Server	IT License Client Help
- Computer Info	
User Name:	User
Computer Name:	GRAHAM-DELL
IP Address:	0.0.0.0
	Cancel

**9-** Network Server installation and activation is now complete. The software will now need to be installed on the Client Machines and link to this server. Please see Network Client Installation section for full instructions.

## Verifying the Software

## **To Check Which Modules Are Activated**

1- To check the License Information you can select 'License Information' from the software menu. This will show the license details for each module.


🚯 Server License	e Information			×
Module Name	-Network Licenses	Available Licenses	Maintenance Expiration	License ID
MIL-HDBK-217	1	1	Jan 01, 2025	L12345678
Telcordia	1	1	Jan 01, 2025	L12345678
NSWC	1	1	Jan 01, 2025	L12345678
FMECA	1	1	Jan 01, 2025	L12345678
RBD	1	1	Jan 01, 2025	L12345678
Fault Tree	1	1	Jan 01, 2025	L12345678
Event Tree	1	1	Jan 01, 2025	L12345678
Markov	1	1	Jan 01, 2025	L12345678
IEC-62380	1	1	Jan 01, 2025	L12345678
CHINA-299B	1	1	Jan 01, 2025	L12345678
SpareCost	1	1	Jan 01, 2025	L12345678
MainTain	1	1	Jan 01, 2025	L12345678
IEC-61709	1	1	Jan 01, 2025	L12345678
				ОК

Please do not hesitate to contact us if you have any problems with the instructions above and we will be more than happy to call and walk you through this procedure.

# **Network Client Installation**

- 1- Download and unzip the ITEM ToolKit zip file using the link provided by email.
- 2- Run the file IT-V\*\*\*.EXE by right mouse clicking and selecting 'Run as Administrator'.



3- At the Setup Welcome dialog click Next.



4- Click the 'accept agreement' radio button to continue.

💽 Setup - ITEM ToolKit 9.7.3	
License Agreement Please read the following important information before continuing.	2
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.	
COPYRIGHT NOTICE	
IMPORTANT - READ CAREFULLY T Important - READ CAREFULLY T I accept the agreement I go not accept the agreement	
<u>Back</u> Next > Cancel	

5- Click next again and then enter the password provided by email.

Setup - ITEM ToolKit 9.7.3	
Password This installation is password protected.	
Please provide the password, then click Next to continue. Passwords are case-sensitive.	
Password:	
< <u>B</u> ack <u>N</u> ext >	Cancel

6- Click next and then enter the desired destination location.

💽 Setup - ITEM ToolKit 9.7.3	×
Select Destination Location Where should ITEM ToolKit 9.7.3 be installed?	
Setup will install ITEM ToolKit 9.7.3 into the following folder.	
To continue, click Next. If you would like to select a different folder, click	Browse.
C: \Program Files (x86)	Browse
At least 3.1 MB of free disk space is required.	
< Back Next >	Cancel

7- Click next again and the select the 'License Server' radio button followed by next.

💽 Setup - ITEM ToolKit 9.7.3
Setup Type Installation Type Options
Please select the option that best suits your requirements:
Eldense server "Network Eldense server Program only      Network Client - Full Program installation which will connect to a Network License     Server
Network Server - Full Program installation which other Network Clients can connect to
Standalone - Full Program installation on a Standalone Computer. No Network Required
<back next=""> Cancel</back>

8- Select the correct type of Client Connection for your Server and then click next.

Setup - ITEM ToolKit 9.7.3	×
Client Installation Connection Type	
Please select Client Connection Type for the Server.           Network Fileshare           TCP/IP	
< Back Next	t > Cancel

9- If the connection type selected was TCP/IP please enter the correct 'Server Port Number' ('9998' by default) and 'Server IP Address' and then click Next.

Setup - ITEM ToolKit 9.7.3	X
Client Installation Connection Type Server TCP/IP Setting	
Please specify Server Port Number and IP Address for TCP/IP Connection Server Port Number:	
9998	
Server IP Address:	
< <u>B</u> ack Next >	Cancel

10- If the connection type selected was Network Fileshare, enter the License Path and click Next.



11- Select the desired Start Menu folder and then click next.

Setup - ITEM ToolKit 9.7.3	
Select Start Menu Folder Where should Setup place the program's shortcuts?	
Setup will create the program's shortcuts in the following Start M	lenu folder.
To continue, click Next. If you would like to select a different folder, click	Browse.
ITEM Software	Browse
< <u>B</u> ack <u>N</u> ext >	Cancel

12- Select whether you wish to create a desktop icon and then click next.

💽 Setup - ITEM ToolKit 9.7.3	
Select Additional Tasks Which additional tasks should be performed?	
Select the additional tasks you would like Setup to perform while installing 9.7.3, then dick Next.	g ITEM ToolKit
Additional icons:	
Create a <u>d</u> esktop icon	
<back next=""></back>	Cancel

13- Review the displayed installation details and if acceptable click Install.

Setup - ITEM ToolKit 9.7.3	
Ready to Install Setup is now ready to begin installing ITEM ToolKit 9.7.3 on your computer.	
Click Install to continue with the installation, or dick Back if you want to review or change any settings.	
Server Exe Files Toolkit Property Files Toolkit Help Files Toolkit Spell Checker Start Menu folder: ITEM Software Additional tasks: Additional icons: Create a desktop icon	
< Back	Cancel

14- Installation will now begin.



15- Once completed, click the Finish button.



16- **IMPORTANT:** Once installation is complete, then please run the program ITEM ToolKit using the right mouse click option on the desktop shortcut '**Run as administrator**'.



17- Once installation is complete on the Server and Client, starting the software should connect to the Server without any demo notification or any other prompts. You can refer to the separate document 'TCP/IP Server Services Problems' if you encounter any connection problems.

### Verifying the Software

#### **To Check Which Modules Are Activated**

1- To check connection to the Server and make sure the licenses are being picked up select 'About' from the Help menu and click the Network Info button.

orld Leaders In F	Reliability, Safety and Risk Assessment Software	4
Pit	em o o e	
	o item	Software (USA), In
EM ToolKit Version 9.7.3		OK
111 (0) 0000		[
eliability & Safety Analy	IC.	Network Info
ppyright (C) 2022 EM SOFTWARE (USA) IN Reliability & Safety Analy	IC.	Network Info
Appright (C) 2022 EM SOFTWARE (USA) IN Reliability & Safety Analy MIL-217 Module	IC. sis Tools include the following Modules: MIL-HDBK-217F Notice 2, ANSI/NITA 51.1 - 2008	Demo Version
MIL-217 Module MIL-217 Module	IC. sis Tools include the following Modules: MIL-HDBK-217F Notice 2, ANSI/NITA 51.1 - 2008 pelcore/felcordia SR-332 Issue 4/Issue 3/Issue 2/Issue 1, TR-332	Demo Version
ppynght (C) 2022 EM SOFTWARE (USA) IN Reliability & Safety Analy MIL-217 Module Telcordia Module IEC-62380 Module IEC-62380 Module	IC. sis Tools include the following Modules: MIL+HDBK-217F Notice 2, ANSI/NITA 51.1 - 2008 Beldorr/Firchards SR-332 Issue 4/Issue 3/Issue 2/Issue 1, TR-332 IEC-6-2380 TR 1 (UTRC 80-810) IEC 6-2179 Edites 2.0 2012 02	Demo Version Demo Version Full Version
ppynght (C) 2022 EM SOFTWARE (USA) IN Reliability & Safety Analy MIL-217 Module Telcordia Module IEC-62380 Module IEC-61709 Module IEC-61709 Module	IC. sis Tools include the following Modules: MIL+DBK-217F Notice 2, ANSI/VITA 51,1 - 2008 Belcore (Telcorde SR -322 Issue 4)Issue 3/Issue 2/Issue 1, TR-332 IEC-2320 PT 1 (UTCE 0-4) IEC-2320 Edition 3.0 2017-02	Demo Version Demo Version Full Version Demo Version Demo Version
ppyngnt (C) 2022 EM SOFTWARE (USA) IN Reliability & Safety Analy MIL-217 Module Telcordia Module IEC-62380 Module IEC-61709 Module China 2998 Module SWC Module	IC. sis Tools include the following Modules: MIL+HDBK-217F Notice 2, ANSI/VITA 51.1 - 2008 Belcore/Ficorials SR-332 Issue 4/Issue 3/Issue 2/Issue 1, TR-332 IEC-63290 Etiton 3.0 2017-02 GB/2 2989 ISSUE - 2881 FE INSUE - 0.6 FEID INSUE-11	Demo Version Demo Version Full Version Demo Version Demo Version
ppynght (C) 2022 EM SOFTWARE (USA) IN Reliability & Safety Analy MIL-217 Module Telcordia Module IEC-62380 Module IEC-61709 Module China 2998 Module NSWC Module MainTain Module	IC. sis Tools include the following Modules: MIL-HDBK-217F Notice 2, ANSI/VITA 51.1 - 2008 Belcore/Teicordia SR-332 Issue 4/Issue 3/Issue 2/Issue 1, TR-332 IEC-62309 For 1, UTCC 50-940) IEC-61709 Edition 3.0 2017-02 G3/8/ 2998 NSWC-98/JE1, NSWC-06/JE10, NSWC-11 Mantanability Standard ML HDBK-472 Procedure V	Demo Version Demo Version Full Version Demo Version Demo Version Demo Version Demo Version
pyright (C) 2022 EM SOFTWARE (USA) IN Reliability & Safety Analy MIL-217 Module Telcordia Module IEC-62300 Module IEC-6709 Module China 2998 Module China 2998 Module MainTain Module MainTain Module	IC. sis Tools include the following Modules: MIL-HDBK-217F Notice 2, ANSI/VITA 51.1 - 2008 Belcore/Fcordia SR-322 Issue 4/Issue 3/Issue 2/Issue 1, TR-332 IEC-63709 2610m 3.0 2017/02 GJB/2 2998 NSWC-96/LE1, NSWC-06/LE10, NSWC-11 Maintainability Standard MIL-HDBK-472 Procedure V Soares S-Calina and Rangino ConCost 8, ResStock	Demo Version Demo Version Full Version Demo Version Demo Version Demo Version Demo Version
EM SOFTWARE (LS 2022 EM SOFTWARE (USA) IN Relability & Safety Analy MIL-217 Module Telcordia Module IEC-61709 Module IEC-61709 Module NSWC Module SpareCost Module SpareCost Module	IC. sis Tools include the following Modules: MIL-HDBK-217F Notice 2, ANSI/VITA 51.1 - 2008 Beldore/Telcordia SR-332 Issue 4/Issue 3/Issue 2/Issue 1, TR-332 IEC-6380 FR 1 (UTEC 80-940) IEC-61709 Edition 3.0 2017-02 G3/B/2 299 NSVC-98/LE1, NSWC-06/LE10, NSWC-11 Mantanability Standard ML+DBK-472 Procedure V Sparse Scaling and Ranging OptCost & RepStock ML-STD-1629, IEC 61508 (150 20862). (50 9000	Demo Version Demo Version Full Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version
pyprint (C) 2022 EM SOFTWARE (USA) IN kelability & Safety Analy MIL-217 Module TeCordia Module IEC-63709 Module China 2998 Module China 2998 Module MainTain Module SpareCost Module FMECA Module	IC. sis Tools include the following Modules: MIL-HDBK-217F Notice 2, ANSI/NITA 51.1 - 2008 Belcore/Telcordia SR-532 Issue 4/Issue 3/Issue 2/Issue 1, TR-332 IEC-62380 IR 1 (UTCE 80-810) IEC-61709 Editom 3.0 201702 GJB/2 2996 NSWC-98/IL1, NSWC-06/LE10, NSWC-11 Maintainability Standard MIL-HDBK-472 Procedure V Spares Scaling and Ranging OptCost 8, RepStock MIL-STD-1629A, IEC 61508, ISO 26282, ISO 9000 Relability Block Diagram, Network Diagrams	Network Infr Demo Version Pemo Version Pemo Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version
Spyright (C) 2022 EM SOFTWARE (USA) IN kelability & Safety Analy MIL-217 Module Telcordia Module IEC-63709 Module China 2998 Module China 2998 Module NSWC Module NSWC Module SpareCost Module RDD Module RDD Module	IC. sis Tools include the following Modules: MIL-HDBK-217F Notice 2, ANSI/VITA 51.1 - 2008 Bellcore/Telcordia SR-332 Issue 4/Issue 3/Issue 2/Issue 1, TR-332 IEC-6380 PR 1 (UTCE 08-910) IEC-6-1709 Edition 3.0 2017-02 G3/B/2 299 NSWC-98/LE1, NSWC-06/LE10, NSWC-11 Mantanability Standard ML-DBK-472 Procedure V Sparse Scaling and Ranging OptCost & RepStock ML-STD-1629, IEC 61508, ISO 26362, ISO 9000 Relability Block Diagram, Network Diagrams Fault Tree Analysis, Safet Ya Risk Analysis	Network Infi Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version
ppyngn (C) 2022 EN SOFTWARE (USA) IN Hetelability & Safety Analy MIL-217 Module TECordia Module TEC-63709 Module China 2996 Module China 2996 Module China 2996 Module China 2996 Module China 2996 Module MainTain Module SpareCost Module FNECA Module FTA Module ETA Module	IC. sis Tools include the following Modules: MIL+DBK-217F Notice 2, ANSI/VITA 51.1 - 2008 Belcore/Telcordia SR-332 Issue 4/Issue 3/Issue 2/Issue 1, TR-332 IEC-62380 TR. 1 (UTEC 80-810) IEC-63709 Editom 3.0.2017-02 GJB/2 2999 NSWC-96/LE1, NSWC-06/LE10, NSWC-11 Maintainability Standard MIL-HDBK-472 Procedure V Spares Scaling and Ranging Op/Cloost & RepStock MIL-STD-1629A, IEC 65108, ISD 207620 fisso Rebiblity Block Dagram, Network Diagrams Fault Tree Analysis, Safety & Risk Analysis Event Tree Analysis, Safety & Risk Analysis	Network Infi Demo Version Full Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version Demo Version

🚺 Client Lic	ense Information			X	
-Module Name	# of Network Licenses	Available Licenses	License Type	Maintenance Expiration	
Mil217	0	0	Demo Version		
Bellcore	0	0	Demo Version		
NSWC	0	0	Demo Version		
FMECA	0	0	Demo Version		
RBD	0	0	Demo Version		
FaultTree	0	0	Demo Version		
EventTree	0	0	Demo Version		
Markov	0	0	Demo Version		
RDF2000	1	0	Full Version	Sep 17, 2022	
299B	0	0	Demo Version		
SpareCost	0	0	Demo Version		
MainTain	0	0	Demo Version		
IEC-61709	0	0	Demo Version		
Toolkit	Toolkit Server Version: 9.5.2 OK				

Please do not hesitate to contact us if you have any problems with the instructions above and we will be more than happy to call and walk you through this procedure.

### 3. License Server Installation

ITEM ToolKit supports four types of installation: Standalone, Network Server, License Server and Network Client. This chapter will provide you the required instruction for installing the License Server Software. It contains the following sections:

- What is License Server Installation?
- Installing the License Manager Software
- Activating and Verifying the Licenses
- Network Client Installation

# What Is License Server Installation?

License Server Installation is designed to provide access to the License Key through a network. After installing the License Manager software on the Network Server, the Network Client installation must be performed on the client workstation. Only the License Manager will be installed on the server, ITEM ToolKit will not be installed and cannot be run on the server.

This option is intended for a single user or multiple users that are required to have the Software Licenses installed on a shared license server. The number of users accessing the software will be limited to the number of licenses purchased.



**NOTE** The following must be noted when installing the software on a network server:

- THE INSTALLATION MUST BE PHYSICALLY PERFORMED AT THE DESIGNATED NETWORK SERVER AND CANNOT BE DONE FROM A REMOTE WORKSTATION.
- THE LICENSE MANAGER MUST BE INSTALLED ON THE SERVER BEFORE IT CAN BE INSTALLED ON A NETWORK CLIENT.
- SERVER INSTALLATION REQUIRES FULL ADMINISTRATIVE RIGHTS.
- THE PROGRAM INSTALLATION FOLDER (FOR EXAMPLE: C:\Program Files \Item\ Toolkit\ Programs) INSTALLED ON THE NETWORK SERVER MUST BE SHARED BETWEEN THE NETWORK SERVER AND CLIENT WORKSTATION.
- NETWORK CLIENT MUST HAVE FULL ACCESS RIGHTS TO THE PROGRAMS FOLDER (FOR EXAMPLE: C:\Program Files \Item\ Toolkit\ Programs) INSTALLED ON THE NETWORK SERVER.

### Installing the License Manager

- 1- Download and unzip the ITEM ToolKit zip file using the link provided by email.
- 2- Run the file IT-V\*\*\*.EXE by right mouse clicking and selecting 'Run as Administrator'.



3- At the Setup Welcome dialog click Next.



4- Click the 'accept agreement' radio button to continue.

💽 Setup - ITEM ToolKit 9.7.3	
License Agreement Please read the following important information before continuing.	٩
Please read the following License Agreement. You must accept the terms of thi agreement before continuing with the installation.	is
SOFTWARE LICENSE AGREEMENT	
IMPORTANT - READ CAREFULLY	-
<ul> <li>I go not accept the agreement</li> </ul>	
<back next=""></back>	Cancel

5- Click next again and then enter the password provided by email.

Setup - ITEM ToolKit 9.7.3	_ <b>_</b> ×
Password This installation is password protected.	
Please provide the password, then click Next to continue. Passwords are case-sensitive.	
Password:	
< <u>B</u> ack Next >	Cancel

6- Click next and then enter the desired destination location.

💽 Setup - ITEM ToolKit 9.7.3	×	
Select Destination Location Where should ITEM ToolKit 9.7.3 be installed?		
Setup will install ITEM ToolKit 9.7.3 into the following folder.		
To continue, click Next. If you would like to select a different folder, click	Browse.	
C:\Program Files (x86)	Browse	
At least 3.1 MB of free disk space is required.		
<back next=""></back>	Cancel	

7- Click next again and the select the 'License Server' radio button followed by next.

💽 Setup - ITEM ToolKit 9.7.3	
Setup Type Installation Type Options	
Please select the option that best suits your requirements:	
License Server - Network License Server Program Only	
Network Client - Full Program installation which will connect to a Network License Server	
Network Server - Full Program installation which other Network Clients can connect to	
Standalone - Full Program installation on a Standalone Computer. No Network Required	
< <u>Back</u> <u>Next</u> Cancel	

8- Select the desired type of Server Connection you wish for your Client Machines and then click next.



9- If you have selected the TCP/IP connection option, enter the Port Number and click Next.

Setup - ITEM ToolKit 9.7.3	X
Server Port Number	
Please specify Server Port Number for TCP/IP Connection TCP/IP Port Number:	
2998	
< gack Next	> Cancel

10- Select the desired Start Menu folder and then click next.

Setup - ITEM ToolKit 9.7.3		
Select Start Menu Folder Where should Setup place the program's shortcuts?		
Setup will create the program's shortcuts in the following Start Menu folder.		
To continue, click Next. If you would like to select a different folder, click	Browse.	
ITEM Software	Browse	
< <u>B</u> ack Next >	Cancel	

11- Select whether you wish to create a desktop icon and then click next.

Setup - ITEM ToolKit 9.7.3	- • ×
Select Additional Tasks Which additional tasks should be performed?	
Select the additional tasks you would like Setup to perform while installing 9.7.3, then click Next.	ITEM ToolKit
Additional icons:	
Croate a desktop icon	
< Back Next >	Cancel

12- Review the displayed installation details and if acceptable click Install.



13- Installation will now begin.

Setup - ITEM ToolKit 9.7.3	
Installing Please wait while Setup installs ITEM ToolKit 9.7.3 on your computer.	
Extracting files C:\Program Files (x86)\[TEM\[ToolKit\Programs\[T.chm	
	Cancel

14- Once completed, click the Finish button.



## Activating the Licenses

1- **IMPORTANT:** Once installation is complete, then please run the program ITEM ToolKit License Manager using the right mouse click option on the desktop shortcut **'Run as administrator'**.



2- You will be prompted with a **Demo Notification**. Please use the 'Activate Online' option.



**IMPORTANT:** Internet Access is required and the License ID provided is specifically for a Server License. If internet access is not available then please contact us for details on how to use one of the alternative methods of activation.

**3-** At the Online Activation dialog please enter the **License ID** and **Password** provided in the Item Software email. If you do not have these details then please contact us.

Online Activation - Version 9.7.3		
To obtain your ID a	and Password, please logon to our	
Internet Access Required		
License ID:	Ι	
Password:		
	Cancel OK	

4- If your details are correct you should be prompted by "Activation Complete!".

Success!	x
Activation Complete!	
ОК	

5- Now you will need to Install and Start the License Server Service. To do this please go to the software menu option: 'IT License Server > Server Configuration'.

🚺 Item ToolKit Li	icense Manager	×
IT License Server	IT License Client Help	
- Computer Info		
User Name:	User	
Computer Name:	GRAHAM-DELL	
IP Address:	0.0.0.0	
	C C	ancel



6- Here, please switch the Radio Button from 'Thread' to 'Service'

TCP/IP License setup	X		
Item Toolkit license setup			
C Standalone Workstation C Network Client	- License communication method		
License path	Network file share		
C:\Program Files (x86)\TEM\Toolkit\Programs	Browse		
Network Adapter   Wireless Network Connection 2			
Server IP Address: 169 . 254 . 5 . 52 Port Number: 9998			
Server execution type			
Start Server Service Stop Server Service	ce Install as Service		
Start Server Thread Stop Server Threa	d		
	OK Cancel		

7- Now Click on the 'Install as Service' button, followed by 'Start Server Service'.

Stop Server Service	Install as Service
Stop Server Thread	1
	Stop Server Service Stop Server Thread

8- In the 'Task Manager > Services' you should now have a Service running called 'IT\_LicMgr' which will monitor any calls from Client machines requesting the License. This Service needs to be running constantly on the Server for Clients to access the license. Also, please make a note of the IP Address for the Server, shown on the License Manager main window, which will be required when setting up the Client Machines.

🕜 Item ToolKit Li	cense Manager
IT License Server	IT License Client Help
<ul> <li>Computer Info.</li> </ul>	
User Name:	User
Computer Name:	GRAHAM-DELL
IP Address:	0.0.0.
	Cancel

9- License Server installation and activation is now complete. The software will now need to be installed on the Client Machines and link to this server. Please see Network Client Installation section for full details.

## Verifying the Software

### **To Check Which Modules Are Activated**

1- To check the License Information you can select 'License Information' from the software menu. This will show the license details for each module.



🚯 Server Licens	e Information			×
Module Name	-Network Licenses	Available Licenses	Maintenance Expiration	License ID
MIL-HDBK-217	1	1	Jan 01, 2025	L12345678
Telcordia	1	1	Jan 01, 2025	L12345678
NSWC	1	1	Jan 01, 2025	L12345678
FMECA	1	1	Jan 01, 2025	L12345678
RBD	1	1	Jan 01, 2025	L12345678
Fault Tree	1	1	Jan 01, 2025	L12345678
Event Tree	1	1	Jan 01, 2025	L12345678
Markov	1	1	Jan 01, 2025	L12345678
IEC-62380	1	1	Jan 01, 2025	L12345678
CHINA-299B	1	1	Jan 01, 2025	L12345678
SpareCost	1	1	Jan 01, 2025	L12345678
MainTain	1	1	Jan 01, 2025	L12345678
IEC-61709	1	1	Jan 01, 2025	L12345678
				ОК

Please do not hesitate to contact us if you have any problems with the instructions above and we will be more than happy to call and walk you through this procedure.

## **Network Client Installation**

- 1- Download and unzip the ITEM ToolKit zip file using the link provided by email.
- 2- Run the file IT-V\*\*\*.EXE by right mouse clicking and selecting 'Run as Administrator'.



3- At the Setup Welcome dialog click Next.

Setup - ITEM ToolKit 9.7.3	
ITEM ToolKit	Welcome to the ITEM ToolKit 9.7.3 Setup Wizard
Reliability Prediction Availability Maintainability	This will install ITEM Toolkit 9.7.3 on your computer. It is recommended that you close all other applications before continuing.
Safety	Click Next to continue, or Cancel to exit Setup.
0000	
<b>Bitem</b>	
	Next > Cancel

4- Click the 'accept agreement' radio button to continue.

💽 Setup - ITEM ToolKit 9.7.3	x
License Agreement Please read the following important information before continuing.	Ø
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.	
/	
	1
COPYRIGHT NOTICE	
ITEM Software (USA) Inc.	
SOFTWARE LICENSE AGREEMENT	
IMPORTANT - READ CAREFULLY	
Accept the accept	
I go not accept the agreement	
< <u>Back</u> Next > Car	ncel

5- Click next again and then enter the password provided by email.

Setup - ITEM ToolKit 9.7.3	
Password This installation is password protected.	
Please provide the password, then click Next to continue. Passwords are case-sensitive.	
Password:	
< Back Next >	Cancel

6- Click next and then enter the desired destination location.

💽 Setup - ITEM ToolKit 9.7.3	×
Select Destination Location Where should ITEM ToolKit 9.7.3 be installed?	
Setup will install ITEM ToolKit 9.7.3 into the following folder.	
To continue, click Next. If you would like to select a different folder, click	Browse.
C:\Program Files (x86)	Browse
At least 3.1 MB of free disk space is required.	
<back next=""></back>	Cancel

7- Click next again and the select the 'License Server' radio button followed by next.

💽 Setup - ITEM ToolKit 9.7.3	
Setup Type Installation Type Options	9
Please select the option that best suits your requirements:	
Idease server - Network Edease server Program Only     Network Client - Full Program installation which will connect to a Network License     Server	
Network Server - Full Program installation which other Network Clients can connect to	
Standaione - Full Program installation on a Standaione Computer. No Network Required	
< Back Next > Cancel	)

8- Select the correct type of Client Connection for your Server and then click next.



9- If the connection type selected was TCP/IP please enter the correct 'Server Port Number' ('9998' by default) and 'Server IP Address' and then click Next.

Setup - ITEM ToolKit 9.7.3	×
Client Installation Connection Type Server TCP/IP Setting	
Please specify Server Port Number and IP Address for TCP/IP Connectio	n.
8998	
Server IP Address:	
< Back Next >	Cancel

10- If the connection type selected was Network Fileshare, enter the License Path and click Next.



11- Select the desired Start Menu folder and then click next.

Setup - ITEM ToolKit 9.7.3	×
Select Start Menu Folder Where should Setup place the program's shortcuts?	
Setup will create the program's shortcuts in the following Start N	1enu folder.
To continue, dick Next. If you would like to select a different folder, dick	Browse.
ITEM Software	Browse
< <u>B</u> ack <u>N</u> ext >	Cancel

12- Select whether you wish to create a desktop icon and then click next.

💽 Setup - ITEM ToolKit 9.7.3	x
Select Additional Tasks Which additional tasks should be performed?	
Select the additional tasks you would like Setup to perform while installing 9.7.3, then dick Next. Additional icons: Create a desktop icon	ITEM ToolKit
< <u>Back</u> <u>N</u> ext >	Cancel

13- Review the displayed installation details and if acceptable click Install.

Setup - ITEM ToolKit 9.7.3	
Ready to Install Setup is now ready to begin installing ITEM ToolKit 9.7.3 on your computer.	
Click Install to continue with the installation, or dick Back if you want to review or change any settings.	
Server Exe Files Toolkit Property Files Toolkit Help Files Toolkit Spell Checker Start Menu folder: ITEM Software Additional tasks: Additional icons: Create a desktop icon	
< Back	Cancel

**14-** Installation will now begin.



15- Once completed, click the Finish button.



16- **IMPORTANT:** Once installation is complete, then please run the program ITEM ToolKit using the right mouse click option on the desktop shortcut **'Run as administrator'**.



17- Once installation is complete on the Server and Client, starting the software should connect to the Server without any demo notification or any other prompts. You can refer to the section 'TCP/IP Server Services Problems' if you encounter any connection problems.

# Verifying the Software

### **To Check Which Modules Are Activated**

1- To check connection to the Server and make sure the licenses are being picked up select 'About' from the Help menu and click the Network Info button.



🚯 Client Lic	ense Information				×
-Module Name	# of Network License	s Available Licenses	License Type	Maintenance Expiration	
Mil217	0	0	Demo Version		
Bellcore	0	0	Demo Version		
NSWC	0	0	Demo Version		
FMECA	0	0	Demo Version		
RBD	0	0	Demo Version		
FaultTree	0	0	Demo Version		
EventTree	0	0	Demo Version		
Markov	0	0	Demo Version		
RDF2000	1	0	Full Version	Sep 17, 2022	
299B	0	0	Demo Version		
SpareCost	0	0	Demo Version		
MainTain	0	0	Demo Version		
IEC-61709	0	0	Demo Version		
Toolkit	Server Version:	9.5.2		ОК	

Please do not hesitate to contact us if you have any problems with the instructions above and we will be more than happy to call and walk you through this procedure.

# 4. Network Client Installation

ITEM ToolKit supports four types of installation: Standalone, Network Server, Network License Server and Network Client. This chapter will provide you the required instruction for installing the software as a Network Client. It contains the following sections:

- What is Network Client Installation?
- Installing the Software
- Activating the Software
- Verifying the Software

## What Is Network Client Installation?

Network Client Installation is designed to install ITEM ToolKit on the client workstation and to create a path from the client workstation to the network server. Upon completing the installation of the Network Client (client workstation), the license keys that are installed on your network server can be accessed from the client workstation. Network server installation must be present and activated within your network prior to installing the Network Client.



**NOTE** The following must be noted when installing the software on a Network Client:

- NETWORK CLIENT INSTALLATION MUST BE PHYSICALLY PERFORMED AT THE DESIGNATED CLIENT WORKSTATION AND CANNOT BE PERFORMED FROM REMOTE WORKSTATION OR SERVER.
- TOOLKIT OR THE LICENSE MANAGER MUST BE INSTALLED ON THE NETWORK SERVER BEFORE DOING A NETWORK CLIENT INSTALLATION.
- NETWORK CLIENT INSTALLATION REQUIRES FULL ADMINISTRATIVE RIGHTS.
- THE PROGRAMS FOLDER (FOR EXAMPLE: C:\PROGRAM FILES \ITEM\ TOOLKIT\ PROGRAMS) INSTALLED ON THE NETWORK SERVER MUST BE SHARED BETWEEN THE NETWORK SERVER AND CLIENT WORKSTATION.
- NETWORK CLIENT MUST HAVE FULL ACCESS RIGHTS TO THE PROGRAMS FOLDER (FOR EXAMPLE: C:\PROGRAM FILES \ITEM\ TOOLKIT\ PROGRAMS) INSTALLED ON THE NETWORK SERVER.

### Installing the Software

- 1- Download and unzip the ITEM ToolKit zip file using the link provided by email.
- 2- Run the file IT-V\*\*\*.EXE by right mouse clicking and selecting 'Run as Administrator'.



3- At the Setup Welcome dialog click Next.



4- Click the 'accept agreement' radio button to continue.

Setup - ITEM ToolKit 9.7.3	x
License Agreement Please read the following important information before continuing.	Ø
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.	
COPYRIGHT NOTICE	
ITEM Software (USA) Inc.	
SOFTWARE LICENSE AGREEMENT	
IMPORTANT - READ CAREFULLY	
I accept the agreement	
○ I do not accept the agreement	
<back next=""> Ca</back>	ncel

5- Click next again and then enter the password provided by email.

Setup - ITEM ToolKit 9.7.3	X
Password This installation is password protected.	
Please provide the password, then dick Next to continue. Passwords are case-sensitive.	
Password:	
< <u>B</u> ack <u>N</u> ext >	Cancel

6- Click next and then enter the desired destination location.

Setup - ITEM ToolKit 9.7.3	X
Select Destination Location Where should ITEM ToolKit 9.7.3 be installed?	
Setup will install ITEM ToolKit 9.7.3 into the following folder.	
To continue, click Next. If you would like to select a different folder, cli	ck Browse.
C:\Program Files (x86)	B <u>r</u> owse
At least 3.1 MB of free disk space is required.	
< Back Next :	Cancel

7- Click next again and the select the 'License Server' radio button followed by next.



8- Select the correct type of Client Connection for your Server and then click next.

Setup - ITEM ToolKit 9.7.3	_ <b>_</b> ×
Client Installation Connection Type	
Please select Client Connection Type for the Server.	
Network Fileshare	
© TCP/IP	
< <u>Back</u> Next >	Cancel

9- If the connection type selected was TCP/IP please enter the correct 'Server Port Number' ('9998' by default) and 'Server IP Address' and then click Next.

💽 Setup - ITEM ToolKit 9.7.3	_ <b>_</b> ×
Client Installation Connection Type Server TCP/IP Setting	
Please specify Server Port Number and IP Address for TCP/IP Connection	n.
9998	
Server IP Address:	
< Back Next >	Cancel

10- If the connection type selected was Network Fileshare, enter the License Path and click Next.

Setup - ITEM ToolKit 9.7.3	
Client Installation Connection Type Network Fileshare License Path	
The license Path should be to the main Program folder on the Server, e Files (x86)" and NOT the full path. Full Read/Write access to this folder	.g. "L:\Program is also required Browse
< Back Next >	Cancel
11- Select the desired Start Menu folder and then click next.

Setup - ITEM ToolKit 9.7.3	X
Select Start Menu Folder Where should Setup place the program's shortcuts?	
Setup will create the program's shortcuts in the following Start I	Menu folder.
To continue, click Next. If you would like to select a different folder, click	Browse.
ITEM Software	Browse
< Back Next >	Cancel

12- Select whether you wish to create a desktop icon and then click next.

Setup - ITEM ToolKit 9.7.3	×
Select Additional Tasks Which additional tasks should be performed?	
Select the additional tasks you would like Setup to perform while installing 9.7.3, then click Next.	] ITEM ToolKit
Additional icons:	
R Receive and a data a local	
< <u>B</u> ack <u>N</u> ext >	Cancel

#### 68 ITEM ToolKit Getting Started Guide

13- Review the displayed installation details and if acceptable click Install.



14- Installation will now begin.

Setup - ITEM ToolKit 9.7.3	×
Installing Please wait while Setup installs ITEM ToolKit 9.7.3 on your computer.	
Extracting files C:\Program Files (x86)\ITEM\ToolKit\Programs\IT.chm	
	Cancel

15- Once completed, click the Finish button.



16- **IMPORTANT:** Once installation is complete, then please run the program ITEM ToolKit using the right mouse click option on the desktop shortcut **'Run as administrator'**.



17- Once installation is complete on the Server and Client, starting the software should connect to the Server without any demo notification or any other prompts. You can refer to the separate document 'TCP/IP Server Services Problems' if you encounter any connection problems.

## Activating the Software

A Network Client cannot be activated and once the software is installed, it should open normally and read the License Key located on the Server.

NOTE ITEM ToolKit will display error messages if:
1. The software cannot read the License Key because the Network Server is down, the connection is lost, the client is logged off or the Network Path is incorrect.
2. You have more users than licenses available.

## Verifying the Software

## **To Check Which Modules Are Activated**

1- To check connection to the Server and make sure the licenses are being picked up select 'About' from the Help menu and click the Network Info button.



🚺 Client Lie	cense Information	)			3
-Module Name	- # of Network Licens	ses Available Licenses	License Type	Maintenance Expiration	
Mil217	0	0	Demo Version		
Bellcore	0	0	Demo Version		
NSWC	0	0	Demo Version		
FMECA	0	0	Demo Version		
RBD	0	0	Demo Version		
FaultTree	0	0	Demo Version		
EventTree	0	0	Demo Version		
Markov	0	0	Demo Version		
RDF2000	1	0	Full Version	Sep 17, 2022	
299B	0	0	Demo Version		
SpareCost	0	0	Demo Version		
MainTain	0	0	Demo Version		
IEC-61709	0	0	Demo Version		
Toolkit	t Server Version:	9.5.2		ОК	

Please do not hesitate to contact us if you have any problems with the instructions above and we will be more than happy to call and walk you through this procedure.

## 5. Problems Installing and Starting ITEM Software TCPIP Server Services

If you are experiencing problem with installing and starting ITEM software TCPIP server services then please try the follow six solutions:

#### **SOLUTION 1:**

#### Network Client Program Launch Problems:

Please Login as Administrator and follow the steps below:

#### Windows 7/8/10/11:



#### **SOLUTION 2:**

- 1. REGEDIT
- 2. HKEY\_LOCAL\_MACHINE\SYSTEM\CurrentControlSet\Services\wcncsvc

Ш́	Re	egistry Editor			×
File Edit View	Favorites Help				
	Image: second	▶       Expand       New       Find       Delete       Rename       Export       Permissions       Copy Key Name	erv e I ns z	Type REG_SZ REG_SZ REG_SZ REG_D REG_B REG_E REG_SZ REG	Data ^ (value rpcss @%Sy @%Sy 0x000( 80 51 %Syst NT AL SeCha v
Computer\HKEY_L	OCAL_MACHINE\SYS	TEM\CurrentControlSet\Set	rvices	wcncsvc	.:

#### 72 ITEM ToolKit Getting Started Guide

3. In the left pane of this location, right click over the **wcncsvc** key and select **Permissions**. In the *Permissions* window, highlight the entry **Administrators**.

Permissions for wcncsvc	x
Security	
Group or user names:	_
CREATOR OWNER	
SYSTEM	
Administrators (Technoyl/Administrators)	
Add Remove	
Permissions for Users Allow Deny	
Full Control	
For special permissions or advanced settings, Advanced click Advanced.	
Learn about access control and permissions	
OK Cancel Apply	/

4. Make sure you have the **Full control** option checked as far as *Permissions* is concerned. Ensure same with **Users** entry as well. Click **Apply** followed by **OK** when down in both cases. Finally, close the *Registry Editor* and reboot the system. You should now be able to start local services without any hitch.

#### **SOLUTION 3:**

1. Programs and Features



2. Select "Turn Windows features on or off



3. Simple TCPIP services (i.e. echo, daytime etc.)

#### 74 ITEM ToolKit Getting Started Guide

- 4. OK
- 5. Restart computer

#### **SOLUTION 4:**

1. Locate and Run Command Prompt as Administrator:

Se	earch	
Eve	rywhere 🗸	
Co	ommand Prompt	P
	Course of Decemb	
	Command Prompt	
	Pin to Start Unpin from Taskbar	
— Cc	Open in new window	
со	Run as administrator	istrator
со	Open file location	

2. Installing the Service:

sc create IT\_LicMgr binPath= "C:\Program Files (x86)\Item\Toolkit\Programs\IT\_LicMgr.exe" start= "Auto" DisplayName= "IT\_LicMgr"

- 3. Writing Service Description: sc description IT\_LicMgr "ITEM Software Toolkit License Service"
- 4. Starting the Service: sc start IT\_LicMgr
- 5. Stopping the Service: sc stop IT\_LicMgr
- 6. **Deleting the Service:** sc delete IT\_LicMgr

#### **SOLUTION 5:**

Creating a New Rule for Inbound TCPIP Connection



👷 Server Manager 🛛 🎆 New Inbound Rule Wizard	
File Action View Protocol and Ports	
📁 🔿 🚺 🔲 Specify the protocols and ports to	o which this rule applies.
Server Manager (DE	
Roles Steps:	
Features   Rule Type	Does this rule apply to TCP or UDP?
Configuration     Protocol and Ports	• TCP
🗄 🕑 Task Schedl 🧉 Action	O UDP
Windows Fir     Profile	
Outbour A Name	
Connect	Does this rule apply to all local ports or specific local ports?
🛨 🌉 Monitori	O All local ports
WMI Contro	Specific local ports:     9998
🗄 💀 Local Users	Example: 80, 443, 5000-5010
🛨 📇 Storage	
	Learn more about protocol and ports
	Learn more about protocor and ports
	< Back Next > Cancel
7Start 🛃 🕢 🚞	P @ 14:30





🔓 Server Ma	🍻 New Inbound Rule Wizard		×
File Action	Name		
<	Specify the name and description	of this rule.	
E Server Mar	Steps:		
Featur     Featur     Diagno     Config     Wi     Ta     Wi     Wi     E Storag	Rule Type     Protocol and Ports     Action     Profile     Name	Name:           [TEM License Server           Description (optional):           ITEM Software License Server Rule for Communication through Port 9998	
		< Back Finish Canc	el
🔊 Start	🖣 🖉 🧾	P 🔁 👍 14	:32 5/2015 💻

🖡 Server Manager	ITEM Lincense Server Properties	<b>N</b> IN
File Action View Help	General Programs and Services Computers	
(= ->   2 💼   🛃 💼	Protocols and Ports Scope Advanced Users	
Server Manager (DELL-S2008R2)     Configuration     Task Scheduler     Windows Firewall with Adve     Monitoring     Services     Windown Strewall with Adve     Monitoring     Services     WWI Control     Monitoring     Services     WWI Control     Services     Storage	Protocols and Ports     Scope     Advanced     Users       Protocols and ports     Protocol type:     ICP     Image: Constraint of the state of th	
Core Networking - Core Networking -	Viul     Learn more about protocol and ports       Nei     Learn more about protocol and ports       Par     Par       Roi     OK       OK     Cancel	
🍂 🗾 😭 🍒	P P 14	4:27 6/2015 💻

#### **SOLUTION 6:**

**2008 R2 Service Does Not Start - The** 'User Account Control' may be activated by default and will prevent the ITEM ToolKit Service from Running.

1. Please deactivate the UAC and reboot the Server as follow:



2. Switch to Small Icons view and click on 'Change User Account Control Settings'.



3. Server Default:

User Account	nt Control he re about Use	alps prevent potentially harmful programs from making changes to your computer. Account Control settings	
Always	notify		
-	-	Default - Notify me only when programs try to make changes to my computer	
	-	Don't notify me when I make changes to Windows settings	
14	-		
-	-	Recommended if you use familiar programs and visit familiar websites.	
Never	notify		
		Sick Ca	incel

Change this to the lowest level:

Liner Arrow	ek Control b	elps neverit potentially barnful programs from making chappes to your computer.	
Tel me mor	re about Use	r Account Control settings	
Almays	notify		
-	-	Never notify me when:	
		<ul> <li>Programs bry to install software or make changes to my computer</li> </ul>	
	-	I make changes to Windows settings	
-	-		
-	<u>-</u>	Not recommended. Choose this only if you need to use programs that are not certified for Windows 7 because they do not support User Account Control.	
Never	notify		
		Rec. C	arcel

4. Click OK to validate the modification.

## 6. Silent Version

#### **Upgrade Previous Installation**

To upgrade an existing ITEM Toolkit installation, user needs to specify the following parameters:

- Installation password (highlighted in red)
- Installation Directory (highlighted in green

The command line used is as following:

#### C:>IT-V973.EXE /VERYSILENT /PASSWORD=ITEMPASSWORD /DIR="C:\Program Files (x86)"

#### Standalone Mode

To install ITEM ToolKit in standalone mode, user needs to specify the following 2 parameters:

- Installation password (highlighted in red)
- Installation Directory (highlighted in green)

The command line to be used is as below:

## C:>> IT-V973.EXE /VERYSILENT /PASSWORD=ITEMPASSWORD /DIR="C:\Program Files (x86)" /TYPE ="Standalone" /Networkmode="No" /ServerMode="No"

ToolKit installation password can be obtained from customer area.

#### Server Mode

To install ITEM ToolKit in standalone mode, user needs to specify the following 2 parameters:

- Installation password (highlighted in red)
- Installation Directory (highlighted in green)
- Network Connect (TCPIP or FILESHARE)
- Server port number (TCPIP mode only) (Highlighted in Orange)

The command line to be used for TCPIP mode is as below:

#### C:> IT-V973.EXE /VERYSILENT /PASSWORD=ITEMPASSWORD /DIR="C:\Program Files (x86)" /TYPE ="Server" /Networkmode="No" /ServerMode="Yes" /NetworkConnect="TCPIP" \ServerPort="9998"

The command line to be used for FILESHARE mode is as below:

# C:\> IT-V973.EXE /VERYSILENT /PASSWORD=ITEMPASSWORD /DIR="C:\Program Files (x86)" /TYPE ="Server" /Networkmode="No" /ServerMode="Yes" /NetworkConnect="FILESHARE"

ToolKit installation password can be obtained from customer area.

#### **Network Client Mode**

To install ITEM ToolKit in network client mode, user needs to specify the following parameters:

- Installation password (highlighted in red)
- Installation Directory (highlighted in green)
- Network Connect (TCPIP or FILESHARE)
- Server IP address (TCPIP mode only) (Highlighted in Orange)
- Server port number (TCPIP mode only) (Highlighted in Orange)
- Network Path (FILESHARE mode only)

The command line for TCPIP client installation is as following:

C:> IT-V973.EXE /VERYSILENT /PASSWORD=ITEMPASSWORD /DIR="C:\Program Files (x86)" /TYPE ="Client" /Networkmode="Yes" /ServerMode="No" /NetworkConnect="TCPIP" /ServerIP="192.168.1.1" /ServerPort="9998"

The command line for FILESHARE client installation is as following:

C:>> IT-V973.EXE /VERYSILENT /PASSWORD=ITEMPASSWORD /DIR="C:\Program Files (x86)" /TYPE ="Client" /Networkmode="Yes" /ServerMode="No" /NetworkConnect="FILESHARE" /NetworkPath="ToolKitFolder"

ToolKit installation password can be obtained from customer area.

## 7. Uninstallation

#### **Uninstall ITEM ToolKit from Control Panel**

- 1. In search on the taskbar, enter **Control Panel** and select it from the results.
- 2. Select Programs > Programs and Features.
- 3. Press and hold (or right-click) on the ITEM ToolKit program you want to remove and select **Uninstall** or **Uninstall/Change**. Then follow the directions on the screen.



#### Uninstall or change a program

To uninstall a program, select it from the list and then click Uninstall, Change, or Repair.

Organize 🔻 Uninstall								
Name	Publisher	Installed On	Size	Version				
PSON Scan		01/12/20						
Epson Stylus SX210_SX410_TX210_TX410 Manual		01/12/20						
EPSON SX210 Series Printer Uninstall	SEIKO EPSON Corporation	01/12/20						
FileZilla Client 3.59.0	Tim Kosse	23/05/22	41.0 MB	3.59.0				
📧 Google Chrome	Google, Inc.	27/07/16	50.5 MB	107.0.5304.88				
EI IcoFX 1.6.4		05/10/18						
Intel(R) Network Connections Drivers	Intel	27/07/16	916 KB	20.7				
ITEM QT 10.3.8	ITEM Software Inc.	06/09/22	409 MB					
TEM ToolKit 9.7.2	ITEM Software (USA) Inc.	01/11/22	155 MB	9.7.3				
iTunes	Apple Inc.	10/08/17	431 MB	12.6.2.20				
KensingtonWorks 2.1.19.0	Kensington	21/09/20	155 MB	2.1.19.0				

# CHAPTER 3 ToolKit Basics

ITEM ToolKit contains powerful features that make it easy to create and analyze projects. This chapter will familiarize you with the ToolKit interface. It includes information about:

- 1. Standard Features of the ToolKit Interface.
- 2. The ToolKit Workspace.
- 3. The ToolKit Menus.
- 4. The ToolKit Toolbar.

Once you are familiar with ToolKit's features, see Chapter 4 for information about creating a new project.

## 1. Standard Features of the ToolKit Interface

This section describes the general functionality of the features and command menus within ITEM ToolKit. The standard features described are used throughout all of the applications.

The use of these features and commands might be different and dependent upon the type of analysis performed. However, the functionality of the features and commands will remain the same. For example, the *ADD* command will:

- Allow you to add Systems/Analysis types to your project when creating a Project.
- Allow you to add Blocks and Components to the systems created within your Project.

For detailed instructions on how to use the standard features specific to each analysis type, please refer to the respective analysis type's section in this tutorial.

## **Multiple Document Interface**

The **ToolKit** workspace is the area you use to build your projects. It consists of menus, toolbars, and windows. All of the features in the **ToolKit** workspace follow standard Windows Graphical User Interface (GUI) conventions. The **ToolKit** workspace features a **Multiple Document Interface** (MDI), which allows you to:

- Choose which windows to display, close, minimize, move and resize. You can drag and drop **ToolKit** windows and toolbars anywhere within the MDI workspace.
- Open multiple project files so you can build several projects at the same time and compare analysis results.
- Drag and drop components between projects. This feature allows you to create a new project quickly by reusing components from other projects.

## 2. The ToolKit Workspace



## The Project Window

Located in the upper left corner (default location); the project window shows the project hierarchy with systems listed by the type of analysis. Cross tabs located on the edge of the project window allow you to select an active project when multiple projects are open. The following items and their icons are shown in the Project window hierarchy tree:



**Project File Header:** Shown with a filing cabinet icon - Listing includes project information and sum of reliability data for all reliability prediction modules, only.



**Analysis Type Header:** Shown with a file cabinet drawer icon – Systems are grouped by analysis type; this header identifies the analysis type.



**System Files**: Shown with multiple pockets, file folder icon - Listing includes system information and sum of reliability data for the total system.

## The System Window

Located in the lower left corner (default location); the system windows shows the hierarchy of the system components included in the system selected in the Project window. Cross tabs located on the edge of this window indicate the type of analysis module that is active in bold (A) along with other recently used analysis modules. The following items and their icons are shown in the System window hierarchy tree when using the prediction and FMECA modules. RBD, Markov, Event Tree and Fault Tree use additional items and icons in the hierarchy tree due to the different nature of the systems.



**System Header:** Shown with a multiple pockets file folder icon - Listing includes system information and sum of reliability data for the total system.



**System Block:** Shown with a single file folder icon – Listing includes sum of reliability data for all blocks and components attached to this block.



**Linked Block:** Shown with a single open file folder icon with a green arrow pointing to it – This is a special block that is a mirror image or direct copy of another block and its attached components. The Linked Block automatically updates when data is changed for the block to which it is linked. The Linked Block displays the same data as standard system Block (Used with reliability prediction modules only).



**Component:** Shown with a blue box icon – Listing indicates a single component and its data (lowest level of the hierarchy tree in the prediction systems).



**FMECA Component:** When using a FMECA system, the component blue box icon becomes a blue file folder icon.

**FMECA Failure Mode:** Shown with a red box icon - Indicates a failure mode (only used with the FMECA systems).

## Library System Window

The Library System window is located in the middle of the workspace (default location). This system window stores a library of frequently used systems, blocks and components that helps save time and effort in constructing future systems. The user can create their own custom libraries of components, blocks and even entire systems for later use in future projects. Item Software also has several application specific libraries available that contain thousands of components and their reliability data. The convention for icons and line items listed in the Library System window are the same as the regular System window discussed above.



#### The Data View Window

The Data View window is located on the right hand side of the workspace (default location). The window allows for the display and entry of component data in the Dialog view, displays a grid or spreadsheet view of system data, creates and displays RBD, Fault Tree, Event Tree and Markov diagrams, generates and displays preformatted and custom graphs and it displays the final calculated results of the reliability model in use. Tabs along the bottom of this window allow for selection and the display of the different types of information.



Options available in the applications window will change in accordance with the analysis performed.

The data window has seven tabs:

**The Dialog tab** displays information for the item selected in the Project or System Window and is the primary location for viewing and editing data. The tabs and information presented in the Dialog tab vary depending on the selection made in the Project or System Window.

い 🖬 쁓 MIL-217				
MIL-217 System				
Title :	MIL-217 Example	Description :	ABC Computer System Model ABC/XT	*
Name :	ABCSYS MIL-217 #1		Pentium-based Microcomputer	-
Part Number :		Function		*
LCN :	F	Description.		-
Circuit Ref.:		Notes :		*
Analyst :				-
Quantity :	1	Compiled By :		
No On Standby :	0	Approved By :		
MTTR :	0			
Target Rate :	0	Failure Rate :	22.5259	
Life Time (Hours):	24	MTBF :	44393.3	
Redundancy :	True 💌	Unavailability :	0.000540563	
Ambient Temperature (C):	30	Availability :	0.999459	
MIL-HDBK-217 Issue:	MIL-HDBK-217-FN2 💌			

The Grid tab shows the selected element data in tabular format. You can edit data in the Grid window.

- If you want to zoom in on a particular section of the grid, select the desired cells and select **Grid View Zoom In** from the **Layout** Menu.
- If you want to see more of the grid, select Grid View Zoom Out from the Layout Menu.
- Select Grid View Zoom 100% from the Layout Menu to restore the grid to normal size.

1			-			
	10	Block	Power Supply 110/240 V AC Supply, 5V/12V DC Output		PS1	1
	10.1	Capacitor	CAPACITOR, FIXED, CK, 33PF	I	CK 33PF	1
	10.2	Capacitor	CAPACITOR, FIXED, POLYESTER, 10	)nF	CQ-10NF	5
	10.3	Capacitor	CAPACITOR, FIXED, CERAMIC CHIP	, 220 pF	0805 COG	3
	10.4	Transformer	TRANSFORMER		TRANS, MODEL A7-3	1
	10.5	Capacitor	CAPACITOR, FIXED, AL. ELECT., 47	00 uF	90968G	1
	10.6	Capacitor	CAPACITOR, FIXED, SOLID TANT., 4	4.7 uF	T110-91920A	4
	10.7	Diode, Low Frequenc	DIODE, GLASS PACKAGE		Z5122	4
	10.8	Resistor	RESISTOR, FIXED, FILM, 620 OHM		SMA02075-40971AM	1
	10.9	Resistor	RESISTOR, FIXED, MET. OXIDE, 1K2	2	FP2-16264XM	6
	10.10	Capacitor	CAPACITOR, FIXED, AL. ELECT., 47	00 uF	90968G	1
	10.11	Capacitor	CAPACITOR, FIXED, POLYESTER, 10	)nF	CQ-10NF	5
	10.12	Connection	CONNECTION, CRIMP Z	oom In		1
			Z	oom Out		
			1	00 %		
			s	ipelling-Ch	eck	
						>
		<ul> <li>10.1</li> <li>10.2</li> <li>10.3</li> <li>10.4</li> <li>10.5</li> <li>10.6</li> <li>10.7</li> <li>10.8</li> <li>10.9</li> <li>10.10</li> <li>10.11</li> <li>10.12</li> </ul>	10.1         Capacitor           10.2         Capacitor           10.3         Capacitor           10.4         Transformer           10.5         Capacitor           10.6         Capacitor           10.7         Diode, Low Frequenc           10.8         Resistor           10.9         Resistor           10.10         Capacitor           10.11         Capacitor           10.12         Connection	<ul> <li>IO.1 Capacitor</li> <li>CAPACITOR, FIXED, CK, 33PF</li> <li>IO.2 Capacitor</li> <li>CAPACITOR, FIXED, POLYESTER, IO</li> <li>IO.3 Capacitor</li> <li>CAPACITOR, FIXED, CERAMIC CHIP</li> <li>IO.4 Transformer</li> <li>TRANSFORMER</li> <li>IO.5 Capacitor</li> <li>CAPACITOR, FIXED, AL. ELECT., 47</li> <li>IO.6 Capacitor</li> <li>CAPACITOR, FIXED, SOLID TANT., -</li> <li>IO.7 Diode, Low Frequenc</li> <li>DIOE, GLASS PACKAGE</li> <li>IO.8 Resistor</li> <li>RESISTOR, FIXED, FILM, 620 OHM</li> <li>IO.9 Resistor</li> <li>RESISTOR, FIXED, MET. OXIDE, 1K2</li> <li>IO.10 Capacitor</li> <li>CAPACITOR, FIXED, AL. ELECT., 47</li> <li>IO.11 Capacitor</li> <li>CAPACITOR, FIXED, AL. ELECT., 47</li> <li>IO.12 Connection</li> <li>CONNECTION, CRIMP</li> <li>Z</li> </ul>	<ul> <li>D.C. Output</li> <li>10.1 Capacitor</li> <li>CAPACITOR, FIXED, CK, 33PF</li> <li>10.2 Capacitor</li> <li>CAPACITOR, FIXED, POLYESTER, 10nF</li> <li>10.3 Capacitor</li> <li>CAPACITOR, FIXED, CERAMIC CHIP, 220 pF</li> <li>10.4 Transformer</li> <li>TRANSFORMER</li> <li>10.5 Capacitor</li> <li>CAPACITOR, FIXED, AL. ELECT., 4700 uF</li> <li>10.6 Capacitor</li> <li>CAPACITOR, FIXED, SOLID TANT., 4.7 uF</li> <li>10.7 Diode, Low Frequenc</li> <li>DIOE, GLASS PACKAGE</li> <li>10.8 Resistor</li> <li>RESISTOR, FIXED, MET. OXIDE, 1K2</li> <li>10.10 Capacitor</li> <li>CAPACITOR, FIXED, MET. OXIDE, 1K2</li> <li>10.10 Capacitor</li> <li>CAPACITOR, FIXED, AL. ELECT., 4700 uF</li> <li>10.11 Capacitor</li> <li>CAPACITOR, FIXED, POLYESTER, 10nF</li> <li>10.12 Connection</li> <li>CONNECTION, CRIMP</li> <li>Zoom In</li> <li>Zoom Out</li> <li>100 %</li> <li>Spelling-Ch</li> </ul>	<ul> <li>10.1 Capacitor</li> <li>10.2 Capacitor</li> <li>10.2 Capacitor</li> <li>10.3 Capacitor</li> <li>10.4 CAPACITOR, FIXED, CK, 33PF</li> <li>10.3 Capacitor</li> <li>10.4 CAPACITOR, FIXED, CERAMIC CHIP, 220 pF</li> <li>10.4 Transformer</li> <li>10.5 Capacitor</li> <li>10.6 Capacitor</li> <li>10.6 CAPACITOR, FIXED, AL. ELECT., 4700 uF</li> <li>10.6 Capacitor</li> <li>10.7 Diode, Low Frequenc</li> <li>10.8 Resistor</li> <li>10.9 Resistor</li> <li>10.10 Capacitor</li> <li>10.10 Capacitor</li> <li>10.10 Capacitor</li> <li>10.10 CAPACITOR, FIXED, MET. OXIDE, 1K2</li> <li>10.11 Capacitor</li> <li>10.12 Connection</li> <li>10.11 CAPACITOR, FIXED, POLYESTER, 10nF</li> <li>10.12 Connection</li> <li>10.10 CONNECTION, CRIMP</li> <li>10.10 CAPACITOR</li> <li>10.11 CAPACITOR</li> <li>10.12 Connection</li> <li>10.11 CAPACITOR, FIXED, POLYESTER, 10nF</li> <li>10.12 Connection</li> <li>10.11 CAPACITOR, FIXED, POLYESTER, 10nF</li> <li>10.12 Connection</li> </ul>

**The Diagram tab** is used to build, display and edit Reliability Block Diagrams, Fault Tree Diagrams, Markov Diagrams and Event Tree Diagrams. Selecting any of these analyses in the Project or System Window, will display the appropriate Diagram Window.



RBD Diagram



Markov Diagram



Event Tree Diagram

The Chart tab displays computation results in graphic format. By default, the Chart tab is blank until you specify graph options for the selected system. Once you have generated a chart, you can copy it to the clipboard, save it as a bmp or jpeg file, or print it.



**The Result tab** is primarily intended for displaying FMECA, Fault Tree, Event Tree, Markov and RBD analysis results. It also displays the failure rates and pi factors for selected MIL-217, Bellcore, RDF 2000, 299B and Mechanical blocks and components.

				S	ımmary View	,			
	Parameter	Value		Mean	StD	5%	50%	95%	99.00%
1	Unavailability Q	2.9201e-10	0.0		0.0	0.0	0.0	0.0	0.0
2	Failure Frequency W	2.3303e-7	0.0		0.0	0.0	0.0	0.0	0.0
3	CFI	2.3303e-7							
4	Expected Failures	2.3196e-7							
5	Unreliability	2.3196e-7							
ô	Total Down Time (TDT)	2.9051e-10							
7	Total Up Time (TUT)	1							
8	MTBF	4.3112e+6							
9	MTTE	4.3112e+6							
10	MTTR	0.0013							
11	Availability	1							
12	Reliability	1							
13	No of Cut Sets	4							
	Event	F-Vesel	v	Fault Tre	e Importance Birn	e View Baum		B-Prosch	an
		E Marad		Fault Tre	e Importance	View	1	D Dearah	
1	Event Spark 1	F-Vesel	у	Fault Tre	e Importance Birn 33e-5	e View Baum	0.0	B-Prosch	an
1	Event Spark 1. Pipe 0.3	F-Vesel	y	Fault Tre 2.41 4.80	e Importance Birn 33e-5 35e-10	e View Baum	0.0 6.2491e-	B-Prosch	an
1 2 3	Event Spark 1 Pipe 0.1 Loss of A 0.1	<b>F-Vesel</b> 998 7481	У	Fault Tre 2.41 4.80 4.00	e Importance Bim 33e-5 35e-10 36e-8	9 View Baum	0.0 6.2491e- 0.3422	B-Prosch	an
1 2 3 4	Event Spark 1 Pipe 0.0 Loss of A 0.7 Loss of B 0.7	F-Vesel 998 7481 7481	y	Fault Tre 2.41 4.80 4.00 4.00	e Importance Birn 33e-5 35e-10 36e-8 36e-8	9 View Baum	0.0 6.2491e- 0.3422 0.3422	B-Prosch	an
1 2 3 4 5	Event 1 Spark 1 Pipe 0. Loss of A 0. Loss of B 0. Power 0.	F-Vesel 998 7481 7481 2519	y	Fault Tre 2.41 4.80 4.00 7.35	e Importance Bim 33e-5 35e-10 36e-8 36e-8 58e-6	9 View Baum	0.0 6.2491e- 0.3422 0.3422 0.3457	B-Prosch	an
1 2 3 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	Event         1           Spark         1           Pipe         0           Loss of A         0           Loss of B         0           Power         0           Corrosion         0	F-Vesel 998 7481 7481 2519 002	y	Fault Tre 2.41 4.80 4.00 7.35 4.80	e Importance Bim 33e-5 35e-10 36e-8 36e-8 36e-8 58e-6 35e-10	9 View Baum	0.0 6.2491e- 0.3422 0.3422 0.3157 2.5323e-	B.Prosch	an
	Event         Spark         1           Pipe         0.2         Loss of A         0.1           Loss of A         0.1         D         D           Loss of B         0.2         D         D           Corrosion         0.1         D         D	F-Veset 998 7481 7481 2519 002	y	Fault Tre 2.41 4.80 4.00 7.35 4.80	e Importance Birn 33e-5 35e-10 36e-8 36e-8 36e-8 35e-6 35e-10	9 View Baum	0.0 6.2491e- 0.3422 0.3422 0.3157 2.5323e-	B-Prosch	an
1 2 3 4 5 6	Event           Spark         1           Pipe         0.1           Loss of A         0.0           Loss of B         0.0           Power         0.1           Corrosion         0.1	F-Veset 998 7481 7481 2519 202 Fault T	y Tree Cut S	Fault Tre 2.41 4.80 4.00 7.35 4.80	e Importance Birn 33e-5 35e-10 36e-8 36e-8 58e-6 58e-6 35e-10	9 View Baum	0.0 6.2491e- 0.3422 0.3422 0.3157 2.5323e-	B-Prosch	an
1 2 3 4 5 6	Event         1           Spark         1           Pipe         0.1           Loss of A         0.           Loss of B         0.           Power         0.1           Corrosion         0.1	F-Vese) 998 7481 7481 2519 002 Fault T Frequency (W)	y Tree Cut S	Fault Tre 2.41 4.80 4.00 7.35 4.80 Set View	e Importance Birn 33e-5 35e-10 36e-8 36e-8 36e-8 36e-6 35e-10 Events	9 View Baum	0.0 6.2491e- 0.3422 0.3422 0.3157 2.5323e-	B.Prosch	an
1 2 3 4 5 6 1	Event         Spark         1           Pipe         0.         Loss of A         0.           Loss of B         0.         O.         Corrosion         0.           Corrosion         0.         Unavailability (0)         2.1801e-10         0.	F-Veset 998 7481 2519 302 Fault T Frequency (M) 1.5915-7	y Tree Cut S Pipe	Fault Tre 2.41 4.80 4.00 7.35 4.80 Get View Spark L	e Importance Bim 33e-5 35e-10 36e-8 36e-8 36e-8 36e-6 35e-10 <b>Events</b> coss of B Li	9 View Baum	0.0 6.2491e- 0.3422 0.3422 0.3157 2.5323e-	B-Prosch	an
1 2 3 4 5 6 1 2	Event           Spark         1           Pipe         0.1           Loss of A         0.1           Loss of B         0.1           Power         0.2           Corrosion         0.1           Unavailability (0)         2.1801e-10           7.3409e-11         2.400	F-Veset 998 7481 2519 002 Fault T Frequency (W) 1.5915e-7 7.3409e-8	y iree Cut S Pipe Pipe	Fault Tre 2.41 4.80 4.00 7.35 4.80 Spark L Spark F	e Importance Bim 33e-5 35e-10 36e-8 36e-8 36e-8 36e-8 36e-8 36e-10 58e-6 35e-10 <b>Events</b> .oss of B Li	e View Baum	0.0 6.2491e- 0.3422 0.3422 0.3157 2.5323e-	B-Prosch	an
1 2 3 4 5 6 1 2 3	Event         Event           Spark         1           Pipe         0.1           Loss of A         0.           Loss of B         0.           Power         0.1           Corrosion         0.1           Unavailability (Q)         2.1801e-10           7.3409e-11         4.4172e-13	F-Vese! 996 7481 5519 002 Fault T Frequency (W) 1,5915e7 7.3409e-8 3.229e-10	y ree Cut S Pipe Pipe Corrosio	Fault Tre           2.41           4.80           4.00           4.00           7.35           4.80           5           6           View           Spark           L           Spark           A           Spark           N           Spark	e Importance Bim 33e-5 55e-10 36e-8 36e-8 36e-8 35e-10 58e-6 35e-10 <b>Events</b> 	e View Baum	0.0 6.2491e- 0.3422 0.3422 0.3157 2.5323e-	B-Prosch	an

## **ToolKit Information Bar**

The ToolKit workspace includes an information bar located along the bottom of the screen. The left-hand side of the information bar includes the name and brief information on toolbar icons. The right-hand side indicates information on size of the active system such as the number of Gates and the number of Events included in the system.

## Window Scroll Menu

The Project, System and Library windows include a pop-up scroll menu which is activated by clicking the right mouse key while pointing anywhere on the scroll bar. This scroll menu is helpful with very large files such as Library files and large system files. Menu selections allow the user to easily initiate major moves to new locations within the data, such as the top or bottom of the data list.



## **Resizing ToolKit Windows**

Another feature that allows expanding the active window viewing area is the split screen control **Check** located between the Project Window, System Window and the Data Window. Passing the mouse pointer through this area will help locate this control. The pointer changes from a simple arrow to a double solid line with small arrows pointing up and down or left and right. Once the pointer has changed, you can press and hold the left mouse button while dragging the mouse, which will resize the outer boundaries of the window.

## **Moving ToolKit Windows**

**ToolKit** windows, except for the Data view windows, can be moved around anywhere within **ToolKit's** workspace and resized as mentioned above. To move a **ToolKit** window, simply click and hold down the left mouse key on any outside border area of the window except in the window's tab area. While holding down the mouse left key, you will be able to drag the window to any location within the work area.



## 3. The ToolKit Menus

**ITEM ToolKit** menus appear along the top of the workspace. Most of the menu functions are also available on a toolbar or in the pop-up menu that appears when you right-click an object.

The principal pull-down menu options for the applications menu are positioned along the top of the program window. Pulldown menus and their options may be selected using the left mouse button. Menu options may alternatively be selected using the keyboard. This is achieved by holding down the **Alt key** and pressing the underlined character in the required visible menu option. Accelerator keys are also provided for selected menu options.

Selection of many of the menu options will result in standard Windows dialog boxes being displayed (such as those for file or font selection). These dialog boxes contain standard Windows controls such as buttons, combo-boxes (allowing users to choose one option from a selection in a pull-down list), check boxes (allowing users to set a facility on or off) and edit controls (allowing the user to enter text). The controls for each application behave in the same manner to similar controls in other Windows applications.

Add Menu Layout Menu Menu Anal Me	Uysis enu Files\Item\Toplkit\E	Examples\V-708-Exa	nple.ITP::Dialog]
<ul> <li>File Add Edit Layout Settings Anal</li> <li>Files Edit Menu Menu Amples</li> <li>PROJECT: V-707-Example (Preuder)</li> <li>PROJECT: PROJECT: PRO</li></ul>	alysis ⊆hart <u>Window E</u> <b>Chart</b> Help Menu ample.I ediction Totals: FR=1864. 351031; Q=0.0005746595 ; FR=19.326342; Q=0.00 1.6654; Q=0.042525288; M 492; Q=8.9265195e-5; MT 3067; Q=0.00016324203; I STD-1629A)	telp Category Not S Block Info Block Name Part Num L Quar Parent Name No. of Mo Circuit F	elected

## File Menu

Project file options may be accessed via the **File** pull-down menu or the equivalent toolbar options. Project file options allow the users to save and retrieve project data from different projects or create, open and save Library files. The normal **Print** functions plus the **Import / Export** functions are also accessed from the **File** menu. **ToolKit** also includes a report engine that is available from the **File** menu. The report engine allows you to create, print and save preformatted and custom reports plus report charts.



### Add Menu

The Add menu is a multi-functional menu. The Add menu provides options for adding systems to your project and also adding blocks and components to your system.



When starting a new project, the Add menu will allow you to add different types of analysis and systems to your project.

After selecting and adding an analysis type to your project, the Add menu will change and will provide a different selection for each type of analysis/system. The type of data that can be accessed with this command is relative to the analysis that is performed. You will have different Add options for each type of analysis. Please refer to the specific analysis section for additional information on using the Add menu.

## Edit Menu

Where appropriate, choosing the Edit selection from the pull-down menu options accesses the attributes of a selected object. You can access the same Edit functions by placing the cursor over the object, selecting the object and using the Edit menu.

<u>E</u> dit	Layout	ł	<u>S</u> ettings	s !	⊆hart	<u>W</u> ind
n	Undo					
Ж	Cu <u>t</u>				Ctr	l+X
	⊆ору				Ctrl	l+c
æ	Paste				Ctr	l+V
×	Delete					Del
	rie d				~	
	Elliu				Ctr	1+F
	Keplace.				Cu	ITR
	Global <u>P</u> a	ara	ameters	s		
	Custom	Co	nnectio	ons		
	Set To D	ef	ault			
	Save As	D	efault			
	All	_				
	Allocation	n.	 			
	Non Ope	era	itional			
	Derating					
	Renumbe	er	LCN			

## Layout Menu

The arrangement of how data in the Project and System windows is displayed, and the type of information included, can be customized with the **Layout** menu. You can specify exactly what type of information is to be displayed. You can view as much, or as little, of the detailed project and system information desired, by selecting the information in the **Layout** menu. When a data display option is selected, the relevant project or system data will be displayed. You can also select from this menu to sort the data in numerous ways.



## Settings Menu

The **Settings** menu provides options for the manner and position in which your project is presented. You can adjust and customize the way numerical values are presented, customize toolbars, customize extended styles, set the workspace to default settings, set diagram measurements and size, customize the automatic backup settings and select the Auto Paginate and Auto Fit to Page Options.

Settings Analysis Chart Window Help	
Precision	
⊆ustomize	
Extended Styles	
Workspace Setup	
Set WorkSpace to Default	
Diagram Measurements and Size	
Auto Backup	
Name Generator	•
Grid Templates	
Verify Names	
AutoPaginate On/Off	
AutoFit to Page On/Off	
AutoFit	•
AutoPaginate	•
AutoArrange	•
Show Source Symbol for Repeat Gates	
Page Numbers on Transfer Gate with NO Header/Footer	•

#### Analysis Menu

The analysis menu is not used with the Failure Rate Prediction modules and does not appear when these modules are active. It is only used with the FMECA, RBD, Markov, Event Tree and Fault Tree Modules. The menu selection will be different depending on the analysis module in use. The FMECA, RBD, Markov, Event Tree and Fault Tree Modules do not automatically update their calculation when data is entered or changes are made, as do the prediction modules. The reason for this is that the calculation on these modules can take some time on highly complex projects. The **Perform** (green GO icon) menu selection is one place in the system to initiate the analysis calculation and update the results. This menu also includes selections for verifying that all data has been entered correctly, which is a major help on complex projects to insure that all required data is entered and it is entered correctly.



## Chart Menu

The Chart menu provides options for creating and customizing charts using the **ToolKit** graph engine. The menu is the same for all modules and offers the following commands:

<u>⊂</u> hart	<u>W</u> indow <u>H</u> elp			
Sa	ve Chart As <u>D</u> ib File			
Sa	ve Chart As <u>J</u> peg File			
Zo	om Out			
Edi	t Graph			
<u>W</u> izard				
Gra	aph Options			
Sel	t Layout To Default			
<u>R</u> e	fresh			

- Save Chart As Dib File: This option saves the active chart in dib (bmp) file format.
- Save Chart As Jpeg File: This option saves the active chart in jpeg file format.
- Edit Graph: Displays a dialog box that allows you to modify and edit specific areas and each piece of data displayed within the chart. It should be noted however, that modifications made to the data by using this option do not change the data inside **ToolKit**.
- Wizard: Launches the Chart Wizard that allows you to change the type of graph displayed, title, legend and other standard chart formatting items.
- **Graph Options:** Launches the Graph Options window used to select the data displayed in the graph for the selected system. It then generates the actual graph display.
- Set Layout to Default: Returns the graph style and display to the ToolKit default style.

#### Window Menu

The **Window** menu offers the following standard Windows viewing options: **Cascade**, **Tile** and **Arrange** windows. These selections apply only to the Data View window. This menu also allows you to reopen the following **ToolKit** windows that may have been closed during your analysis, such as Project window, System window, Library System window plus the Dialog, Grid, RBD, Fault Tree, Event Tree, Markov, Chart and Results Data View windows.

Wi	ndow	Help				
1	<u>C</u> ascade					
	<u>T</u> ile					
	<u>A</u> rra	nge Icons				
	Project Window					
	System Window					
	Library Window					
	Chart Window					
	Dialog Window					
	Grid Window					
	Diagram Window					
	Resu	ult Window				

## Help Menu

The Help menu provides access to the online help system and information about the Item software installation.

<u>H</u> elp		
H	lelp Topics	
E	dit License Key	
U	lpdate License Online	5
Т	CP/IP Client Setup	
Ī	TEM Software on the Web	
<b>?</b> A	bout ITEM ToolKit	

You access **ToolKit's** online Help system the same way that you access Help in a Microsoft document: simply click **Help Topics** on the **Help** pull-down menu.

## 4. The ToolKit Toolbars

Toolbars provide quick access to **ToolKit** functions. Initially, only the Default and Project toolbars are displayed. An analysis module toolbar unique to that analysis type will also appear when an analysis module is opened and/or is made active. Drawing toolbars are also made active by default when analysis modules that include a drawing (RBD, Markov and Fault Tree) are made active.

## **Default Toolbar**

Immediately below the pull-down options resides a group of buttons that form a Default (Main) Toolbar allowing the user to directly access some of the more frequently used and standard windows type menu options.



Both the contents of the menus on the menu bar and the toolbar change according to which analysis application is currently in use. The purpose of each button in the toolbar can be displayed in the form of a "tool tip" that appears alongside the button when the cursor is placed over the button.

## **Project Toolbar**

The Project Toolbar displays all available systems analysis modules and consists of the following icons:



- Mil-217 Prediction Module.
- Telcordia (Bellcore) Prediction Module.
- IEC 62380 (RDF 2000) French Prediction Module.
- 299B Chinese Prediction Module.
- NSWC Mechanical Prediction Module.
- Maintain Module.
- SpareCost Module.
- Failure Modes, Effect, and Criticality Analysis Module.
- Reliability Block Diagram (RBD) Analysis Module.
- Fault Tree Analysis Module.
- Event Tree Analysis Module.
- Markov Analysis Module.

This Toolbar is used to create a new analysis system in the Project window.

**NOTE** The selected module will only be fully functional if you have purchased a license for that module and it is activated. If a license has not been purchased, ToolKit will revert to the demo version for that module.

#### **Analysis Toolbar**

A unique Analysis toolbar will appear in the top right side of the **ToolKit** application by default when an analysis module and system is opened and/or is made active. This toolbar is different and unique to each type of analysis being used. The Mil-217 analysis toolbar is shown below for example.



The icons shown on the Analysis Toolbar are used for adding various types of Blocks to a System. The drop down dialog box in the Toolbar includes a list of Component types, in addition to the Blocks, that are available to be added to a System.

## **Drawing Toolbars**

A series of seven small drawing toolbars are made active by default when the RBD, Markov or Fault Tree window is made active. These toolbars will appear along the bottom of **ToolKit's** workspace and consist of Align, Nudge, Rotate, Layout, Canvas, Graph and Zoom. They contain drawing tools to aid in the creation of professional layouts of reliability system drawings and diagrams.

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## **Customizing Toolbars**

**ToolKit** allows you to add and delete or customize the workspace toolbars. You can also create your own custom toolbars that contain the functions you use most frequently. Information on custom toolbars is detailed later in this document under the Settings heading.

Customize		×
Toolbars         Command         Toolbars:         Default         Porjoect         Mil217         Bellcore         Mechanical         FMECA         Diagram         VFault Tree         RDF         299B         MTN         SP         MKV         Event Tree         Toolbar name:         Menu bar	✓       Show Tooltips         ✓       Cgol Look         ✓       Large Buttons	<u>N</u> ew <u>R</u> eset
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# CHAPTER 4

# **Project Basics**

ITEM ToolKit can be used at the project level to examine the overall reliability of one or more systems. Performing reliability analysis on a project can help lower costs and reduce repairs and maintenance.

A project can be analyzed under any of the methods or standards that are available as part of ToolKit. In addition, any combination of system types can be included in a project. For example; in a project containing six systems, two could be analyzed for failure rates under the MIL-217 prediction standards, the third could be analyzed for failure rates under the Bellcore prediction standards, the fourth could be analyzed for reliability analysis (RBD), and the fifth and sixth could be analyzed for failure modes and effects (FMECA)/Fault Tree analysis.

This chapter includes information about:

- 1. Creating a New Project
- 2. Opening a Project
- 3. Cutting, Copying, and Pasting Systems
- 4. Editing Project and System Properties
- 5. Saving a Project
- 6. Closing a Project
- 7. Exiting ToolKit

## 1. Creating a New Project

Creating a project is the starting point for any system analysis in ToolKit. Once a project is created, you add the systems you want to use to analyze the project.

## Creating a New Project and Adding a System

- 1. Start ToolKit.
- 2. From the **File** Menu, select **New Project**. Or click on the new project icon (**A**) A blank project opens and the project toolbar is activated.

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51	Compiled By :

3. From the Add Menu, or from the project toolbar (B), select the desired system module

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King         Main         Main <t< th=""><td>No On Standby : 0</td></t<>	No On Standby : 0			
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- 4. The selected system will be added into the project (C) and in the system window (D).
- 5. If you want to add additional systems to the project, repeat step 3.

## 2. Opening a Project

## **To Open a Project**

- 1. Start ToolKit.
- 2. From the File Menu (A), select Open Project, or click on the Open project icon (B).



3. From the Open Window, search for the file name of your project (C), select the file (D) and click on Open (E).

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4. The selected project opens.

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MIL-HDBK-217 #2::FR=0.586292::FPMH::Q=1.4071e-5::MTBF=1	Title : MIL-21/ Example Description : ABC computer System Model ABC/X1 A Pentium-based Microcomputer
Belicore/Telcordia Systems; FR=0.94918597; FPMH Q=2.2780203e-	Nome : ABCSTS MLL-HUDK-217
Image: Systems: FR=1373.6077; FPMH Q=0.03242911; MTBF=728.1	Description :
High RDF Systems: FR=1.4834193; FPMH Q=3.5601443e-5; MTBF=5/41     Film 2998 Systems: FR=6.8023067; FPMH Q=0.00016324203; MTBF=14	Circuit Ref.: Notes :
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## 3. Cutting, Copying, and Pasting Systems

To save time and avoid repetitive work, you can reuse previously created systems. You use the cut, copy, and paste functions to move systems within or between any projects displayed in the Project window.

- 1. Ensure the projects you want to work with appear in the Project window.
- 2. In the Project window, right click the header of the system you want to cut or copy (A) and select the desired operation from the pop-up menu (A). If you select **Cut**, a confirmation message appears. Click **OK**.
- 3. To paste the cut or copied system, right click the header of the target project (**B**) and select **Paste** from the pop-up menu. The system is pasted under the corresponding module header (**C**).



**NOTE** *The paste function always pastes the system under the corresponding module header. You cannot paste a system under a different module.*
## 4. Editing Project and System Properties

When you have created a project and added systems, use the dialog tab to edit the project and system properties. Editing the properties is an important step in creating a well-documented project. In addition, it can help you distinguish systems when you have multiple systems of the same type in a project.

- 1. Click the desired project (A) or system header (B) in the Project window.
- 2. Click the **Dialog** tab (C) in the Data window (if it is not already selected).
- 3. In the Dialog Window, edit or modify the system data as desired (**D**).

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4::Transformer::FR=0.00671724::FPMH	Target Rate : 0 Failure Rate : 2.91793	
5::Diode, High Frequency::FR=2.85167::FPMH	Life Time (Hours): 24 MTBF : 342709	
- 7::Capacitor::FR=0.0101886::FPMH	Redundancy : True  Unavailability : 7.00279e-5	=
8::Resistor::FR=0.0085275::FPMH	Ambient Temperature (C): 30 Availability : 0.99993	
10::Block::FR=0::FPMH		
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	MIL-HDBK-217 Issue: MIL-HDBK-217-FN2 💌	
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## 5. Saving a Project

ToolKit follows standard Windows save functionality. Each saved project is stored in a separate data file with an .ITP extension.

1. If more than one project is open, ensure the correct project is selected. The name of the currently selected project is displayed in bold on the Project window tab.

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- 2. From the File Menu (A), select Save Project (B).
- 3. If the project is newly created, the Save As dialog box appears. In the Save As dialog box, select the desired folder, enter a file name (C), and then click **Save** (D).

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🗋 <u>N</u> ew Project	Ctrl+N	Alternate Symbols 1 Alternate Symbols 2	
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4. If the project has been previously saved, the existing file is updated with the changes.

**NOTE** The Save Project and Save Project As commands save the active project only. If more than one project is open, you must save each project individually.

## 6. Closing a Project

To close the active project, select **Close Project** (A) from the **File** Menu. ToolKit closes the active project. If the project contains unsaved changes, ToolKit prompts you to save the project before closing it.

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## 7. Exiting ToolKit

To exit ToolKit, select **Exit** (**B**) from the **File** Menu. ToolKit closes all open projects. If an open project contains unsaved changes, ToolKit prompts you to save the project before closing it.

New Project	Ctrl+N				
子 Open Project	Ctrl+O				
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Save Diagram	•				
Save Grid			Yes	No	Cancel
Print	•				
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**NOTE** You can also use the X button in the top right corner of the ToolKit workspace to close the application.

# CHAPTER 5

## **Predictions**

ITEM ToolKit contains six prediction modules for use in creating reliability analyses. This chapter:

- 1. Introduces reliability predictions
- 2. Explains the ToolKit prediction modules
- 3. Outlines the creation of a Prediction Project
- 4. Describes the Predictions Editor Screen, Toolbars and Shortcut Keys

## 1. Introduction

Reliability predictions are one of the most common forms of reliability analysis. Reliability predictions predict the failure rate of components and overall system reliability. These predictions are used to evaluate design feasibility, compare design alternatives, identify potential failure areas, trade-off system design factors, and track reliability improvement.

#### **Failure Rates**

Reliability predictions are based on failure rates. A failure rate can be defined as the anticipated number of times an item will fail in a specified time period. It is a calculated value that provides a measure of reliability for a product. This value is normally expressed as failures per million hours (FPMH), but can also be expressed as failures per billion hours (FITS). For example, a component with a failure rate of 2 failures per million hours would be expected to fail 2 times in a million hour time period.

Failure rate calculations are based on component data such as temperature, environment, and stress. In the prediction model, assembly components are structured serially. Thus, calculated failure rates for assemblies are a sum of the failure rates for components within the assembly.

#### Mean Time Between Failures (MTBF)

MTBF is a basic measure of reliability for repairable items. It can be described as the passed time before a component, assembly, or system fails. It is a commonly used variable in reliability and maintainability analyses.

MTBF can be calculated as the inverse of the failure rate for constant failure rate systems. For example, for a component with a failure rate of 2 failures per million hours, the MTBF would be the inverse of that failure rate, or:

MTBF = 1,000,000 hours / 2 failures = 500,000 hours

Although MTBF was designed for use with repairable items, it is commonly used for both repairable and non-repairable items.

#### Mean Time To Failure (MTTF)

MTTF is a basic measure of reliability for non-repairable systems. It is the mean time expected to the first failure of a piece of equipment. MTTF is a statistical value and is meant to be the mean over a long period of time and large number of units. For constant failure rate systems, MTTF is the inverse of the failure rate.

If failure rate is in failures/million hours, MTTF = 1,000,000 / Failure Rate for components with exponential distributions.

#### Mean Time To Repair (MTTR)

Mean Time to Repair is defined as the total amount of time spent performing all corrective maintenance repairs divided by the total number of those repairs.

## 2. Using ToolKit for Reliability Predictions

ToolKit allows you to build reliability predictions based on Bellcore, MIL-217, NSWC, IEC-62380, IEC-61709 and 299B standards. ToolKit automatically calculates the failure rates and MTBFs associated with components as they are added to the system. In addition, it automatically updates all dependent failure rates in the system as well as the overall project failure rate.

#### MIL-HDBK-217

The most widely known and used reliability prediction handbook is Mil-217. It contains failure rate models for electronic system parts such as ICs, transistors, diodes, resistors, capacitors, relays, switches, and connectors.

#### <u> Telcordia (Bellcore)</u>

A product of Bell Communications Research, the Telcordia handbook is derived from the Mil-217 handbook. The Telcordia reliability prediction procedure is applicable to commercial electronic products. Many commercial electronic product companies are now using the Telcordia handbook for their reliability predictions.

#### <u>NSWC</u>

The NSWC Standard is a commonly used model for mechanical components. NSWC uses a series of models for various categories of mechanical components to predict failure rates based on temperatures, stresses, flow rates and various other parameters. It provides models for various types of mechanical devices including springs, bearings, seals, motors, brakes, and clutches. NSWC is a relatively new standard, and is currently the only one of its kind.

#### IEC 62380 (RDF 2000)

The IEC 62380 Module supports methods of reliability prediction as described in the French standard published by the Union Technique de L'Electricite (UTE, July 2000). IEC 62380 is a universal model for reliability prediction of electronics, printed circuit boards and equipment, which takes directly into account the influence of the environment. Environmental factors are no longer used as they are replaced by mission profile undergone by the equipment. The module can handle permanent working, on/off cycling and dormant applications.

#### IEC 61709

The IEC-61709 module supports the reliability prediction methods based on the European Prediction Standard IEC-61709. This module is predominantly based on the Siemens Prediction Standard SN-29500, as well as conforming to section 19 for PCBs and section 20 for the Hybrid Circuits within the European Prediction Standard IEC-62380 (RDF 2000/UTE C 80-810).

#### **CHINA 299B**

The 299B module supports methods of reliability prediction as described in Chinese 299B standard. 299B is a reliability prediction guide for electronic parts in both commercial and military industries. The standard provides the user with the opportunity to take into account the environmental conditions, quality levels, and stress conditions. The module provides procedures to perform Parts Stress Analysis as well as Parts Count Analysis.

## 3. Creating a Prediction Project

To demonstrate ToolKit's Prediction's Modules features, we'll create an example MIL-217 project. Creating a MIL-217 system consists of:

- Constructing the project/system.
- Adding Blocks/Components.
- Editing their Information.
- Performing analysis.

#### **Constructing the Project**

- 1. Click on the New Project icon (A) on the default toolbar, or select New Project from the File menu.
- 2. Activate your project by clicking on the Project tab or in the Project window (B).
- 3. Select the Dialog tab from the bottom of the Viewing Option window (C).
- 4. The Project Dialog Box will be displayed.

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MILL2	Completed By :   Approved By :       Apples to failure prediction systems contained in this project	
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	Redundancy : MTBF (hrs):  -1	
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#### 110 ITEM ToolKit Getting Started Guide

- 5. Enter your project information by placing the cursor or clicking in the appropriate fields (**D**).
- 6. The information entered for a project is only for the project level, and its entry is optional. The table below displays each field that is available for a project and what each field pertains to:

Field	Description
Title	The Project Title
Name	A Unique Reference Identifier
Part Number	Project Part Number
LCN	Logistic Control Number
Circuit Ref	Circuit Reference
Analyst	Person Performing the Analysis
Compiled By	Person who gathered data for analysis
Description	What the project is
Function Description	What the project/system does
Notes	Any other pertinent information on the project
Approved By	Person required to sign off on the project
Target Rate	Acceptable number of failures for the project (FPMH or FITS)
Life Time	Project life time given in hours
Redundancy	Redundancy Flag
Failure Rate	Will display total Project failure rate once analysis is complete
Unavailability	This box will display the Project unavailability once the analysis has been run
MTBF	Mean Time Between Failures for the project

#### Adding a System

A MIL-217 system may represent a single board, a sub assembly or an entire system. The system can then be broken down into sub blocks and components.

1. Select the Add menu from the menu toolbar by clicking on it (A) and click on the MS, MIL-217 System option (B).

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**Chapter 5 Predictions** 

111

- 2. Another way to add a MIL-217 System is to click on the MS icon on the system toolbar (C).
- 3. The MIL-217 system in the project window and the applicable system data in the system window will display (D).
- 4. From the Project window, select the MIL-217 System by clicking on it (E).
- 5. The System dialog box will be displayed. Enter your system information by placing the cursor or clicking in the appropriate fields (**F**).

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For Help, press F1	Blocks: 0 Comps: 0	NUM

The table below describes what could be entered and what each field pertains to.

Field	Description
Title	The System Title
Name	A Unique Reference Identifier
Part Number	System Part Number

#### 112 ITEM ToolKit Getting Started Guide

LCN	Logistic Control Number
Circuit Ref	Circuit Reference
Analyst	Person Performing the Analysis
Quantity	Number of system
No On Standby	Number of system in Standby if Quantity >1 & Redundancy set to True. Otherwise = $0$
MTTR	Mean Time To Repair of the System in hours
Description	What the system is
Function Description	What the system does
Notes	Any other pertinent information on the system
Compiled By	Person who gathered data for analysis
Approved By	Person required to sign off on the System
Target Rate	Acceptable number of failures for the System (FPMH or FITS)
Life Time	Project life time given in hours
Redundancy	Redundancy Flag
Failure Rate	Will display the System failure rate once analysis is complete
MTBF	Mean Time Between Failures for the System
Unavailability	This box will display the System unavailability once the analysis has been run

#### **Adding and Editing Blocks**

A block may be used to represent a system, a sub-system or a device/board. To add blocks into the MIL-217 system hierarchy tree:

- 1. Click on the system in the system Windows (A), and select the block from the toolbar menu (B).
- 2. Place the block cursor on the system in the system window and click once (C). The new block appears.
- 3. Multiple blocks can be added by repeating step 2. To disable the add block mode, select the Release button (D).

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- 4. Select the Dialog tab from the viewing window (E).
- 5. Select a block from the systems window.
- 6. The Dialog view will display all parameters for the selected block. Edit the fields into the General Tab.

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Field	Description
Part Number	Block Part Number
Name	A Unique Reference Identifier
Circuit Ref	Circuit Reference or Reference designator of the Block
Analyst	Person Performing the Analysis
Category	Category drop down menu selection
Update Children	Check this box to update all sub blocks and components when the selected block parameters are changed
Temperature	Control the way temperatures will be changed
Parameters Checked	Check this box when Block / Component parameters are edited and verified
Description	Users can add additional information to describe the block
Notes	Any other pertinent information on the Block
LCN	(Logistic Control Number) Internal reference number defined by the user

7. Next, edit the Quality fields in the **Physical Tab**.

🖽 General 🔛 Physical 🖽	Application III Hyperlinks	
Block		
Quality, Microelectronics :	Commercial or Unknown	-
Quality,Discrete Semicon :	Jan	•
Quality,Resistors :	Nonestablished Reliab	•
Quality,Capacitors :	Nonestablished Reliab	•
Quality,Coils :	Mil Spec	•
Quality,Relays,RY :	Class M	•
Quality,Relays,SS :	Mil Spec	•
Quality,SAW Devices :	High Quality Port	•
Quality,Other :	Mil Spec	•

Field	Description
Quality, Microelectronics	"Quality" level for "Microelectronics and Integrated Circuit" components
Quality, Discrete Semiconductors	"Quality" level for "Discrete Semiconductor" components
Quality, Resistors	"Quality" level for "Resistor" components
Quality, Capacitors	"Quality" level for "Capacitor" components
Quality, Coils	"Quality" level for "Coils and Inductive" components
Quality, Relays, MR	"Quality" level for "Mechanical Relay" components
Quality, Relays, SS	"Quality" level for "Solid State (SS) and Time Delay (TD) Relay" components
Quality, SAW Devices	"Quality" level for "Surface Acoustic Wave (SAW) Devices" or components
Quality, Other	"Quality" level for "Other" components

8. Next, edit the fields in the **Application Tab**.

Block Quantity : 1	
Quantity : 1	
,	
Repair Mode : Non-Repairable	
Environment : Ground, benign	
Connection Type : Reflow Solder	
MTTR (hrs):	
No On Standby : 0	
Temperature Input Mode : Direct Input	
Temperature (degC) : 30	
Temperature Delta (DegC) : 0	
Voltage Stress : 0.8	
Current Stress : 0.7	
Power Stress : 0.75	
Adjustment Factor : 1	

Field	Description
Quantity	The total number or quantity of Blocks
Repair Mode	Flag to switch between the Block "Repairable" or "Non-repairable" Model
Environment	Select the Block environment as per the MIL-217 standard
Connection Type	Select the type of connections components make to the Block
MTTR	Mean Time To Repair at the Block level, in hours
No On Standby	Number of Blocks on standby (used for redundant Blocks only)
Temperature Input Mode	Users can either input component temperature directly by selecting "Direct Input", or input the difference between component and parent block by selecting "Delta Input"
Temperature	Ambient temperature
Temperature Delta	Temperature difference between current component and parent block/system
Voltage Stress	Set a voltage stress for the Block reliability calculation
Current Stress	Set a current stress for the Block reliability calculation
Power Stress	Set a power stress for the Block reliability calculation
Adjustment Factor	Optional user adjustment to Block's reliability calculation

## Adding and Editing Components

A MIL-217 component represents electronic device components (e.g. resistors, capacitors, diodes). ITEM ToolKit provides data entry fields for part number, description, circuit reference and a number of other identification fields, which may be entered when adding the component, or at a later time. To add components using the toolbar:

1. Activate your system by clicking on the System cross tab or anywhere in the System window. (A).

#### 116 ITEM ToolKit Getting Started Guide

IT - Item ToolKit - Project::Dialog]		
File Add Edit Layout Settings Chart Window Help		_ <u>-</u> ×
📗 🗈 🖬 🖌 🌆 🖹 🗙 🦘 🕪 🚱 🔀 🛄 🧏 🖗 🕼 🕼 🖓	spacitor B	
IITP2         IITP2           IIIP2         IIIP2           IIIIP2         IIIP2 <tr< th=""><th>Concertal B2 Physical B2 Application B2 Hyperlinks Block Block</th><th></th></tr<>	Concertal B2 Physical B2 Application B2 Hyperlinks Block Block	
	Part Number: 2 Name: 2 Circuit Ref: Notes: 0 Category : Block	A F
TTP2           Image: State	Update Children : 🖓 LCN : F2	
C	Parameters     Non Op Parameters     View of the science of t	
For Help, press F1	Blocks: 2 Comps: 2	

- 2. From the component drop-down list in the Mil-217 toolbar, select a component (B).
- 3. Place the block cursor (C) where you would like to add the new Component on the system window and click your mouse once. The new component should appear.
- 4. Multiple components can be added by repeating step 2. To disable the add component mode, select the Release button (**D**) from the Toolbar or right click the mouse button.
- 5. To edit a component, select it from the systems window (E).
- 6. Click on the General Tab (F) to edit the general information of the selected component.

	🖽 General 🖽 Ph	ysical 🔛 Application 🛛 🖽 Hy	perlink	5		
F	Block					
	Part Number:		Q	Description:	Block	*
	Name:	2				
	Circuit Ref.:					Ŧ
	Analyst :		-	Notes:		*
	Category :	Block	1			Ŧ
	Update Children :		-	LCN :	F2	_
		Temperature	1			
		Increment				
		C Absolute Replacement				
		Parameters Checked			Non Op Parameters	

Field	Description
Part Number	Component Part Number
Name	A Unique Reference Identifier
Circuit Ref	Circuit Reference or Reference designator of the Component
Analyst	Person Performing the Analysis

Category	Category drop down menu selection
Parameters Checked	Check this box when Block / Component parameters are edited and verified
Description	Users can add additional information to describe the block
Notes	Any other pertinent information on the Block
LCN	(Logistic Control Number) Internal reference number defined by the user
Detail Model	Used to more accurately model VHSIC, VLSI/CMOS components using DMEA
Non-Op Parameters	Used to calculate non operational (dormant) failure rate of components

7. Click on the Physical Tab (H) to edit the Physical information of the selected component.

General     Physical	Application Hyperlinks	1
Block		
Ality,Microelectronics :	Commercial or Unknown	•
H Quality, Discrete Semicon :	Jan	•
Quality,Resistors :	Nonestablished Reliab	•
Quality,Capacitors :	Nonestablished Reliab	•
Quality,Coils :	Mil Spec	•
Quality,Relays,RY :	Class M	•
Quality,Relays,SS :	Mil Spec	•
Quality,SAW Devices :	High Quality Port	•
Quality,Other :	Mil Spec	•

8. Click on the Application Tab (I) to edit the Application information of the selected component. The Hyperlinks Tab (J) can be used for storing and organizing web enabled links for all blocks and components.

🖽 General 🛄 Physical 🔛	Application Hyperlinks	٢	
Block		Manage Hyperlinks	
Block Quantity : Repair Mode : Environment : Connection Type : MTTR (hrs) : No On Standby : Temperature Input Mode : Temperature Input Mode : Temperature Qeta (DegC) : Voltage Stress : Current Stress : Power Stress : Adjustment Factor :	1       Non-Repairable       Ground, benign       Reflow Solder       0       0       0       Direct Input       30       0       0.8       0.7       0.75       1	http://www.itemsoft.com	Up Down Add Delete
Adjustment Factor :	1		

**NOTE** New Components added to a Block take on the Ambient Temperature  $(T_A)$  and parameter settings of that Block if the **Update Children** box is checked on the Block's "General" tab view. If the Block **Update Children** box is not checked, the new Component added to the Block uses default values for Ambient Temperature  $(T_A)$  and parameter settings.

### **Viewing Results**

To view the project results:

- 1. Click on the system header (A) in the System Window.
- 2. Click on the Result tab (**B**) at the bottom of the ITEM ToolKit screen to display the system results.

◆ - [IT - Item ToolKit - Project::Result]									. 🗆 🛛
Tile Add Edit Layout Settings Chart Window Help								_	B X
🗅 😅 🖬 👗 🛍 🛍 🗙 🗠 🎒 😵 🛛 🗞	p 🖟 (	000	ategory Not	Selected	•				
N ITP2						MIL:0			
PROJECT: IT Project (Prediction Totals: FR	1	Failura Data	aramete		45340604		/alue		
MIL-217 Systems; FR=0.45240694; Q=1	2	ATRE			210399 3				[
MILLO.FR =0.43240634Q=1.063776	3	Jnavailability	,	1	.0857766e-5				
	4	Contribution		1	00				
للعسائل	Αµ					Failure Rate		1	1
N ITP2		Name Ca	ategory	Part Number	Description	n Circuit Referei	ice Quantity	0 15440410	24.12
	2	Diu Blo	ck.		Block		1	0.15442412	65.86
Capacitor:: 1.1::Capacitor::FR=0.010	-	. 10101	GI		DIOCK			0.20100201	03.00
Micro, EEPROM:: 1.2::Micro, EEPRC	<								>
Transistor, LF FET:: 1.3::Transistor, L     Plank:: 2::Plank:::EP=0.29799291::MTPE							Bi Last R		
Capacitor: 2.1:Capacitor:FR=0.010		Name Ca	tegon	Part Number	Description	n Circuit Peferer		Eactor	
Micro, VHSIC/VLSI CMOS:: 2.2::Micr		name   ca	negory	archamber	Description	I CITCUIT Referen		HILdctor	<u> </u>
Diode, Low Frequency:: 2.3::Diode, L							//		
		1.000				/_			2
	Dialo	u <u>⊞</u>	Grid	🗿 Diagram	Chart	🧾 🛃 Result			
For Help, press F1					Blocks:	2 Comps:	6	NUM	1 /

3. Click on the Block header (C) in the System Window to display the detailed results for the selected block.

IP2         Pirate (Block)           Product:         II Production           Product:         Failure Rate           Image: Status         0.15442412           Image: Status         0.101088557           Image: Status         1           Image: Stat	D 🖻 🖬 👗 🖻 🖻 🗙 🕫 🎒 😵	   ↓ Ø Ø	0000	ategory Not Selecte	d 💽					
Product:         Production         Value           Product:         Production         Category         Parameter         Value           Parameter         Outstand         Parameter         Outstand           Parameter         Outstand					Pi/Rate	(Block)				
MILD:FR-0.4524693-0         Name         Category         Part Number         Description         Circuit Reference         Quantity         Total F/Rate           1         1         Block         1         0.1544212         1         0.1544212         1         0.1544212         1         0.1544212         1         0.1544212         1         0.1544212         1         0.1544212         1         0.1544212         1         0.010186573         1         0.010186573         1         0.0011857302         1         1         0.061219212         1         1         0.061219212         1         1         1         0.061219212         1         1         0.061219212         1         1         0.061219212         1         1         0.061219212         1         1         0.061219212         1         1         0.061219212         1         1         1         0.061219212         1         1         1         0.061219212         1         1         1         0.061219212         1         1         1         0.06121921         1         1         0.01018657         0.01018657         0.01018657         0.01018657         0.00018697         0.00018697         0.00018697         0.00018697         0.00018697         0.000186	PROJECT: IT Project (Prediction 1     Image: MIL-217 Systems; FR=0.4524	Failur	Paramet e Rate	er O.	15442412		Value			
Name         Category         Part Number         Description         Circuit Reference         Quantity         Total F/Rate           1         Block         Block         1         0.1542412         1         0.1542412         1           3         1.2         Micro, EEPROM         Micro, EEPROM         1         0.00108657           3         1.2         Micro, EEPROM         Micro, EEPROM         1         0.00118657           Name         Category         Part Number         Description         Circuit Reference         Quantity         1           0         1.3         Transistor, LF FET         Transistor, LF FET         0.00118957         0.00018957           0         Biock         Biock         Biock         Biock         0.0018957         0.00018956           0         Micro, EEPROM         Capacitor         Capacitor         0.00189567         0.0008959           0         Biock	✓ MIL:0::FR=0.45240694::Q					Fail	ure Rate			
Image: 1         Block         Block         1         0.1542412           1         1         Capacitor         Capacitor         1         0.010188597           1         1.2         Micro, EEPROM         1         0.081567302         1           4         1.3         Transistor, LF FET         Transistor, LF FET         1         0.061567302           Image: 1         Image: 1         Image: 1         Image: 1         0.081567302         1           Image: 1         Image: 1         Image: 1         Image: 1         Image: 1         0.081567302           Image: 1         Image: 1         Image: 1         Image: 1         Image: 1         0.081567302           Image: 1         Image: 1         Image: 1         Image: 1         Image: 1         0.081567302           Image: 1         Image: 1         Image: 1         Image: 1         0.081567302         Image: 1           Image: 1         Image: 1         Image: 1         Image: 1         Image: 1         Image: 1         Image: 1           Image: 1         Image: 1         Image: 1         Image: 1         Image: 1         Image: 1         Image: 1         Image: 1           Image: 1         Image: 1         Image: 1         Im		Nam	e Catego	ry Part Nu	mber Desc	ription	Circuit Reference	Quantity	Total F/Rate	1
2         1.1         Capacitor         1         0.01018697           1         1         2         1.2         Micro, EEPROM         1         0.00169702           4         1.3         Transistor, LF FET         1         0.06169702         1           4         1.3         Transistor, LF FET         1         0.06169702         1           4         1.3         Transistor, LF FET         1         0.061219212         1           1         Capacitor         Failure Rate         0.01018065         Base Failure Rate (pmh) (BASE)         0.0009999           1         Capacitor         Capacitor         Capacitor         Capacitor         1         1.252:93           1         Capacitor         Capacitor         Capacitor         Capacitor         1         1.252:93           1         Capacitor         Capacitor         Capacitor         1         1.252:93         1	1	1	Block		Block			1	0.15442412	34
3         1.2         Micro, EEPROM         1         0.08/35/302           1.3         Transistor, LF FET         Transistor, LF FET         1         0.06/219212           Image: State S	2	1.1	Capacitor		Capacitor			1	0.010188597	6.
4         1.3         Transistor, LP FEI         Transistor, LP FEI         1         0.061219212           Image: Status         Name         Category         Part Number         Description         Circuit         Pi Factors           Image: Status         Name         Category         Part Number         Description         Circuit         Pi Factors           Image: Status         Name         Category         Part Number         Description         Circuit         Failure Rate         0.01018865           Biologic         Biologic         Emonoment (pi D)         3 <th< td=""><td>3</td><td>1.2</td><td>Micro, EEPF</td><td>ROM</td><td>Micro, EE</td><td>PROM</td><td></td><td>1</td><td>0.081567302</td><td>5.</td></th<>	3	1.2	Micro, EEPF	ROM	Micro, EE	PROM		1	0.081567302	5.
Image: Second	4	1.3	Transistor, L	FFEI	Transisto	r, ur FET		1	0.061219212	35
Image: Pictor         Pi Factor           Image: Pictor         Name         Category         Part Number         Description         Circuit         Pi Factor           Pi ML-217 System:         ML0:FF=0.452         0.0101886         0.0003999         0.0003999           Block:         Texpender         C         1.1         Capacitor         Capacitor         Capacitor         0.0101865           Block:         Texpender         C         1.1         Capacitor         Capacitor         Capacitor         0.0101865           Block:         Texpender         Circuit         Capacitor         Capacitor         1.252193           Block:         Texpender         Capacitor         Capacitor         Capacitor         Capacitor           Block:         2.80x4:FB-0.237982         Capacitor         Capacitor         Capacitor         1.252193           Block:         2.80x4:FB-0.237982         Capacitor         Capacitor         Capacitor         0.0155737           Block:         2.80x4:FB-0.237982         Capacitor         Failure Rate         0.0055737           Block:         2.80x4:FB-0.237982         Capacitor         1.1         Temperature (pi -1)         0.2376265           Block:         2.80x4:FB-0.237982         <	c						)			1
Image: State of the s							Pi Facto	rs		ŀ
IP2         Failure Rate         0.0101866           B         Mic.01:F6n.452         0.0009899           E         B         Biolon: 1860:c: Eastrated         0.0009899           E         Capacitor:         11: Capacitor:         1           E         D         Diodo: 1860:c: Eastrated         0.001866           B         Biolon: 280:cit: 11: Capacitor:         1         1           E         D         Capacitor:         1:1         Capacitor:           E         Biolon: 280:cit: 280:cit: 280:cit: 381:cit: 381         1         1           D         Biolon: 280:cit: 18: Capacitor:         3:7013701         1           E         Diode, Low Frequency: 2         1         1         1           E         Diode, Low Frequency: 2         1         1         1           2         1.2         Micro, EEPROM         EEPROM         Eerror Correction (pi.EC)         1           E         Diode, Low Frequency: 2         1         2		Nam	e Category	Part Number	Description	Circuit		Pi Factor		
2         1.2         Micro, EEPROM         Failure Rate Failure Rate         0.0156273           2         1.2         Micro, EEPROM         Failure Rate EEPROM         0.5           3         0.0017         0.2377955           4         Factor All         0.017           5         0.0017         0.2377955           6         Factor All         0.017           7         0.2377955         1           7         Factor Correction (bj. ECC)         1           1         Temperature (bj. 1)         0.2377955           2         1.2         Micro, EEPROM         EEPROM           8         Factor (Al)         0.00340801           0.25         Factor (Al)         0.00340801           0.26         Factor (Al)         0.0340801           0.27         Factor (Al)         0.0340801           28         Factor (Al)         0.03408005           29         Factor (Al)         0.0340801           29         Factor (Cl)         0.0340801           29         Factor (Cl)         0.0340000	IFP2           Image: State	1.1	Capacitor		Capacitor		$\label{eq:response} \begin{array}{l} \mbox{Failure Rate} \\ \mbox{Base Failure Rate} (\mbox{fp} \\ \mbox{Environment}(\mbox{pi} \mbox{D}) \\ \mbox{Environment}(\mbox{pi} \mbox{Pi} \mbox{Pi} \mbox{Pi} \mbox{Pi} \mbo$	mh) (I_BASI	0.010186 E) 0.000989 1 3 1.252219 0.812830 3.370370 1	35! 39! 93 05: 01
	Capaciton: 21:Capaciton:     Official Action of the Constraint of the Constrain	1.2	Micro, EEPROM		Micro, EEPROM		Failure Rate Environment (pi_E) Quality (pi_Q) Learning (pi_L) Temperature (pi_T) Error Correction (pi_E) Die Complexity Rate Package Rate ([-C2) A1 Factor (A1) A2 Factor (A2)	:CC) (I_C1)	0.081567 0.5 10 1 0.261769 1 0.0017 0.005921 0.003406 0	73( 95: 19: 30(

## **Understanding Analysis Results**

The following is a brief description of all the fields:

IT PROJECT (PREDICTIONS ONLY)					
Failure Rate	Total Failure Rate of the Project (FPH, FPMH or FITS)				
MTBF	Total MTBF of the Project (Hours)				
Unavailability	Total Unavailability of the Project				
	MIL 217				
Failure Rate	Total Failure Rate of the System (FPH, FPMH or FITS)				
MTBF	Total MTBF of the System (Hours)				
Unavailability	Unavailability of the system				
Contribution	Failure Contribution of the system				
	FAILURE RATE				
Name	Name of the Block/Component				
Category	Category Name of the Block/Component				
Part Number	Part Number of the Block/Component				
Description	Description of the Block/Component				
Circuit Reference	Circuit Reference or Reference designator of the Block/Component				
Quantity	Quantity of Block/Component				
Total F/Rate	Total Failure Rate of the Block/Component				
Contribution %	Failure Contribution of the Block/Component				
	PI FACTORS				
Name	Name of the Component				
Category	Category Name of the Component				
Part Number	Part Number of the Component				
Description	Description of the Component				
Circuit Reference	Circuit Reference or Reference designator of the Component				
Pi Factor	Pi Factor details of the Component				
Quantity	Quantity of Component				
Total F/Rate	Total Failure Rate of the Component				
Contribution %	Failure Contribution of the Component				

#### **Additional Features**

All the topics within this manual, as well as the additional features of the ITEM ToolKit prediction modules are fully discussed in the online help, provided within the full program. Some of these features include:

- Creating and customizing charts.
- Importing and exporting data.
- Derating.
- Grid view templates and customization.
- Software settings and customization.
- Automatic name generation and customization.
- Library management.
- Linking modules and projects.

## 4. Derating Components

Most equipment failures are precipitated by stress. When applied stress exceeds the inherent strength of the part, either a serious degradation or a failure will occur. To assure reliability, equipment must be designed to endure stress over time without failure.

Design stress parameters must be identified and controlled. Parts and materials must be selected which can withstand these stresses. Derating is the selection and application of parts and materials so that the applied stress is less than rated for a specific application.

For example, derating is the negative slope of a power-versus-temperature graph. It shows that as the operating ambient temperature increases, the output power of a particular component drops to ensure reliable system operation. Derating curves provide a quick way to estimate the maximum output power of a device at a given temperature.

Following are several derating standards that are included within ToolKit:

#### NAVSEA TE000-AB-GTP-010

Parts Derating Requirements and Application Manual for Navy Electronic Equipment.

#### MIL-HDBK-1547

Electronic parts, materials, and processes for space and launch vehicles.

#### MIL-STD-975M (NASA)

Part selection for electrical, electronic, and electromechanical parts used in the design and construction of space flight hardware in space missions as well as essential ground support equipment (GSE).

#### NAVAIR-AS-4613 Class A/B/C

Application and Derating requirements for electronic components, General specification F.

For all ToolKit prediction modules, you can choose a derating standard to use for the components in the system. Once a standard has been chosen, each component indicates if its current stress levels are within the derating standard or not. Graphical displays of the situation are available for ease in identifying problem areas. Parametric displays are also available to show the temperature vs. stress situation of the component.

User defined derating "standards" can also be created. They are saved as .itd files, and are associated with the project file. When a project is opened, if the components are being derated, the associated derating file is applied. If the derating file is not available, the project will still open normally, but you are presented with a warning window, and can search for the derating file if desired.

A derating file manager is also included to help manage the different derating files, whether included with ToolKit or user defined.

#### Configuring a System to be Derated

Derating is configured at the System level of your project. It only impacts component categories that are considered in the various derating standards. Optionally you can create your own derating "standard" to accommodate those components not considered in the standards.

1. For a selected system, turn on Derating via the Edit menu

<u>E</u> dit	Layout	<u>S</u> ettings	<u>⊂</u> hart	<u>W</u> indow			
Ƙ Undo							
Ж	Cu <u>t</u>		Ctrl-	+X			
Đ	⊆ору		Ctrl-	+c			
Ê.	<u>P</u> aste		Ctrl-	+V			
×	Delete		[	Del			
	<u>F</u> ind		Ctrl+F				
!	<u>R</u> eplace		Ctrl-	⊦R			
'	Global <u>P</u> a	rameters.					
	Custom C	Ionnection	IS				
:	Set To De	efault					
Save As Default							
Allocation							
Non Operational							
Derating							
Renumber LCN							

2. Select the desired Derating standard from the list.

IT Electronics Prediction Derating	×
Apply derating standard to currently selected prediction system.	
None	
NAVSEA TE000-AB-GTP-010	
MIL-STD-975M	
C MIL-STD-1547	
C AS4613 Class A	
C AS4613 Class B	
C AS4613 Class C	
Please use "File", "Derating Files" menu for user defined derating criteria.	
OK Cancel	

3. Note that once you have chosen a System to be derated, the icons change in the System window.



4. Select a component, then Edit – Derating to open the Derating window for the component. Each component category has a specific graph showing the nominal and worse case values vs. temperature. This window can remain open as you select other components. Note that the voltage stress is 0.8 on this component. While not over stressed, it is above the nominal value as per the selected derating standard.

🛈 п	i Electroni	cs Predic	tion Derat	ing							3
De	rating (AS-4	4613-Class	-A) Paramet	ic Curve							
	3 points curv oints — — — — — — — — — — — — — — — — — — —	e M	lominal	Worst Case		1.00		Derating Cu	rve		
Ro Ma	II Off Temper w. Temperatu Multipoint cu	ature [ ire [			ġ	0.75				<u> </u>	Selected
1	Nominal 0.6 0.58	0	Wors 1 1	e Case 🔨	V Stress Rat	0.50					component
3 4 5	0.52 0.31 0.16	50 75 85	0	1		0.25					
6 7 8 9		90				0.00 8. /orse C:			92. Selected	125.00	
				······································			·		rature	Cancel	

5. Lower the stress value to 0.41 (on the **Application** tab of the component) and you will see the blue dot relocated to below the nominal curve as in the next screen shot.

🗘 п	Electron	ics Predicti	on Derating				
Dei	rating (AS-	4613-Class-A	) Parametric Cu	irve			
O S Spirate V S	8 points curv oints tress Ratio	/e No	minal Wor	rst Case		1.00	Derating Curve
Ma:	Roll Off Temperature					0.75	
	Nominal		Worse C	ase 🔼	S Rat	0.60	
1	0.6	0	1	C	Stres	0.50	
2	0.58	25	1	1	>		
3	0.52	50	U	1		0.05	
5	0.51	75 85				0.25	
6	0.10	90					
7	-						
8	-					0.00 H	
9			l			Ö	22 - 83 - 31 - 31 - 31 - 31 - 31 - 31 - 31
10						(orse	Case — Nominal — Selected — 🕂
				~			Andent remperature
							OK Cancel

#### **Creating Your Own Derating Standard**

ToolKit provides a method for you to create and apply your own derating standard.

Use File – Derating Files menu option to open the user defined derating window. On this window you are able to create derating files that contain the models you wish to create/apply to the components in your systems. These files are stored as .ITD files, and should travel with your ToolKit project files. A project file without a derating file will still open properly, but the derating will not be applied to the project.

IT Derating Files				
File Edit	ile Manager			
Create Denate The	File Info.     Model Info     Derating       Name:     New File       Description:	Model Type: Category Not Selected  Apply this derating file to current p  Derate according to morinal value  ✓ Derate according to worse case v	voject es values	
			Check this box derating file ap current project.	to have the plied to the

2. On the **Derating** window, choose **File** – **New**, then **Edit** – **Add** to create a new derating file, and add a model to it. Select the **Model** tab to define the component you wish to apply a derating model to.

• IT Derating Files		
File Edit		
Create Derate File Derate File Manag	ar 🔰	
IT Derating Files File	Info.   Model Info   Derating	
My Derating	el Name: Cap. Mica NER Model Type: User Defined	
👘 New File 🛛 De	scription: Category: Capacitor	
	Sub Category: Mica,NER	
	Notes: Voltage Stress V	
	Ambient Temperature     Power Stress	
	C Junction Temperature Current Stress	
	,	
< >		
	ПК	

3. Then select the **Derating** tab to define the curves you wish to have applied.



4. When finished, click OK.

When you add a component to your system that has a user defined derating model, the component is derated according to your model. As with the included derating standards, you can see the effects of derating via the icons in the system window, and via the **Edit – Derating** menu selection for the components.

## 5. Predictions Editor Screen, Toolbar and Shortcut Keys Quick Reference



#### **The Prediction Editor Screen**

The Prediction editor can be made visible by selecting the Dialog Tab (1) or the Grid Tab (2). Its main elements are the following:

- Main Menu (3): Quick access to the main functions.
- Prediction Toolbar (4): Quick access to editing functions.
- Project Window (5): A hierarchical view of the project and systems.
- System Window (6): A hierarchical view of the system, blocks and components.
- Library Window (7): A hierarchical view of the components library.
- Dialog Window (8): The area in which the Prediction can be edited.
- Grid Window (9): In this area, the Prediction can be edited in a tabular style.

#### The Default Toolbar

Immediately below the pull-down options resides a group of buttons that form a Default Toolbar allowing the user to access directly some of the more frequently used menu options.



Tool	Name	Description
	New	Opens a new project.
2	Open	Open an existing document. The ToolKit displays the Open dialog box, in which you can locate and open the desired file.
	Save	Save the active document or template with its current name. If you have not named the document, the ToolKit displays the Save As dialog box.
Ж	Cut	Remove selected data from the document and stores it on the clipboard.
	Сору	Copy the selection to the clipboard.
	Paste	Paste the contents of the clipboard at the insertion point.
$\mathbf{x}$	Delete Item	Delete the selection.
ŝ	Undo	Reverse the last editing. Note: You cannot undo some actions.
9	Print	Print the active document.
P	About	Open the About ITEM ToolKit Window.
<b>N?</b>	Help	Open the ITEM ToolKit On-line Help.

## The Predictions System Dialog Windows Controls

All Predictions Dialog Window Contains the following Controls.

🔊 🔲 🗈 🖤

Tool	Name	Description
5	Undo Changes	Cancels the latest operation.
	Analyze	Run the Analysis of the system.

128	ITEM ToolKit Gettir	ng Started Guide
B	Set Default Values	Set the selected Component to the default values.
ABC	Check Spelling	Check the Spelling of the selected Text.

## **The Project Toolbar**

The Project Toolbar displays the available analysis options for the ToolKit application

]] <b>%</b> ™ 2	XT XF XC XN 🄑 🗞	α 🖶 😤 🚍 🗞
Tool	Name	Description
<b>Ж</b> а	MIL217	Add a MIL-HDBK-217 (Electronic) System.
$\lambda^{\mathrm{T}}$	Telcordia (Bellcore)	Add a SR-332 Telcordia (Electronic) System.
$\lambda^{\pm}$	IEC 62380 (RDF)	Add an IEC 62380 French Telecom Standard (Electronic) System.
$\lambda^{c}$	299B	Add a 299B Chinese Military Standard (Electronic) System.
$\lambda^{N}$	NSWC (Mechanical)	Add a NSWC (Mechanical) System.
ß	Maintain	Add a Maintain MIL-HDBK-472 Procedure V System.
≪2	SpareCost	Add a Spare Cost Spares Scaling and Ranging System.
α	FMECA	Add a Failure Modes Effects and Criticality Analysis (FMECA) System.
¢	RBD	Add a Reliability Block Diagram (RBD) System.
ጼ	Fault Tree	Add a Fault Tree Analysis (FTA) System.
Ψ	Event Tree	Add an Event Tree Analysis (ETA) System.
∞	Markov	Add a Markov Modeling System.

## The MIL-217 Toolbar

The MIL-217 Toolbar is used to create and control MIL-217 Systems.

Mil21	7						×
ß	Ø	₿	Ø	ß	ß	Category Not Selected	-

	Tool	Name	Description
5		End Add Mode	Cancels add mode.
Ø		Block	Creates a Block in MIL-217.
<b>*</b>		Linked Block	Creates a Linked Block in MIL-217.
1		Hybrid Block	Creates a Hybrid Block in MIL-217.
Ø		Plated Through Block	Creates a Plated Through Block in MIL-217.
ß		Surface Mount Block	Creates a Surface Mount Block in MIL-217.
Resistor	•	Category List	Add a Block / Component from the list.

## The Telcordia Toolbar

The Telcordia (Bellcore) Toolbar is used to create and control Telcordia Systems.



## The NSWC Mechanical Toolbar

The NSWC Toolbar is used to create and control NSWC Systems.

Mech R	Category Not	Selected 💽	
	Tool	Name	Description
${\bf k}$		End Add Mode	Cancels add mode.
Ø		Block	Creates a Block in the NSWC System.
<b>]</b>		Linked Block	Creates a Linked Block in the NSWC System.
Bea	ring 💌	Category List	Add a Block / Component from the list.

#### The IEC 62380 Toolbar

The IEC 62380 (RDF 2000) Toolbar is used to create and control IEC 62380 Systems.

RDF	D 🕞 🕼 🙆 Category Not S	elected	
	Tool	Name	Description
${\bf k}$		End Add Mode	Cancels add mode.
Ø		Block	Creates a Block in the IEC 62380 System.
<b>)</b>		Linked Block	Creates a Linked Block in the IEC 62380 System.
ø		PC Board	Creates a PC Board Block in the IEC 62380 System.
Ø		Hybrid Block	Creates a Hybrid Block in the IEC 62380 System.
Integ	rated Circuit	Category List	Add a Block / Component from the list.

## The 299B Toolbar

The 299B Toolbar is used to create and control 299B Systems.

299B		
🗟 🜔 📴 🙆 🖉 Category Not	Selected	•
Tool	Name	Description
€4	End Add Mode	Cancels add mode.
Ø	Block	Creates a Block in the 299B System.
0	Linked Block	Creates a Linked Block in the 299B System.
Ø	РСВ	Creates a PCB Block in the 299B System.
Ø	Hybrid Block	Creates a Hybrid Block in the 299B System.
Connector	Category List	Add a Block / Component from the list.

## **Shortcut Keys:**

Key	Function
Ctrl + N	Open a new project.
Ctrl + O	Open an existing document. Displays the Open dialog box, in which you can locate and open the desired file.
Ctrl + S	Save the active project with its current name. If you have not named the project, the Save As dialog box will open.
Ctrl + P	Print the Active View.
Ctrl + X	Remove selected data from the document and stores it on the clipboard.
Ctrl + C	Copy the selection to the clipboard.
Ctrl + V	Paste the contents of the clipboard at the insertion point.
Ctrl + W	Paste the contents of the clipboard (Gate or Event) at the insertion point as a Repeat Gate or Repeat Event.
Del	Delete the selection.
F1	Open the ITEM ToolKit On-line Help.

# CHAPTER 6

## **FMECA**

The FMECA program is documented by the standard originally developed by the United States Military, MIL-STD-1629, Procedures for Performing a *Failure Mode, Effects and Criticality Analysis*, dated November 9, 1949. This procedure was developed as a reliability technique to determine the effect of system and equipment failures.

The FMECA module also now covers, and conforms fully to, the standards IEC 61508 and ISO 26262. This enables ITEM ToolKit to provide a full top-down modeling from Hazard Analysis to FMECA in compliance with these standards.

This chapter:

- 1. Introduces FMECA systems
- 2. Describes ToolKit's FMECA features
- 3. Outlines an example FMECA system
- 4. Describes the FMECA Editor Screen, Toolbars and Shortcut Keys

#### 1. Introduction

A *Failure Mode, Effects, and Criticality Analysis* (FMECA) uses an inductive approach to system design and reliability. It identifies each potential failure within a system or manufacturing process and uses severity classifications to show the potential hazards associated with these failures.

There are two approaches to performing a FMECA:

- The functional approach is applied in projects containing hardware components that cannot be uniquely identified. In this
  scenario, the sub-system functions are weighed in terms of their function within the system.
- The hardware approach is applied in projects containing hardware components that can be uniquely identified.

A FMECA is usually applied in two steps:

- Identifying failure modes and their effects (FMEA).
- Ranking failure modes according to the combination of severity and the probability of that failure mode occurring (Criticality Analysis).

FMECA can be performed at any stage of system design. The results from a FMECA are maximized if the analysis is implemented during the early development stages and updated throughout the development. This approach also helps to educate system engineers about the system. Performing FMECA analysis near the end of the design process minimizes the influence on the system design.

FMECAs can take many forms, but at the core, these analyses are used to study a particular system and determine how that system can be modified to improve overall reliability and to avoid failures. For example, consider a simple FMECA that contains a computer monitor which has a capacitor as its only component. By analyzing the design, you determine that if that capacitor was open (one failure mode), the display would appear with wavy lines (the failure effect). If the capacitor was shorted (a second failure mode), the monitor would go blank. The second failure would be ranked as more critical than the first because the monitor becomes completely unusable. Once FMECA has identified failures, you can explore ways to prevent the failure or to lessen their criticality.

## 2. ITEM ToolKit & FMECA Analysis

The ITEM ToolKit FMECA Module provides the full framework for performing a FMECA with the MIL-STD-1629A, IEC 61508, ISO 9000 and ISO 26262 standards. Its interactive graphical facilities allow you to construct a block hierarchy representing the logical connection between the sub-systems and components constituting the overall plant or system. This hierarchy may be extended to represent failure modes at various hierarchical levels.

One of the most powerful features of the FMECA module is its ability to automatically trace failure effects, severity values and failure causes through the system hierarchy. The program automatically calculates failure rates and criticality values. The FMECA module also filters detectable and non-detectable failures in reports and determines the ratio between the frequency of detectable failures and total failures.

Creating a well-documented FMECA system requires a large amount of text entry. The FMECA Module provides a phrase table facility, which contains commonly used descriptions of component parts, failure modes and effects. These phrases can be quickly retrieved and inserted into any text field. This saves considerable data entry and ensures consistency.

ToolKit also provides other features to facilitate the construction of a FMECA project. Data may be easily transferred within the same project or between different projects using the cut, copy and paste facilities. Search and filter facilities allow you to quickly locate data. A wide range of layout options allows different data types to be displayed in the hierarchy view.

## 3. Creating a FMECA Project

To demonstrate ToolKit's FMECA features, we will create an example FMECA project for a redundant computer system.

Creating a FMECA system consists of:

- Constructing the project/system
- Adding Blocks/Components
- Adding Failure Modes, Causes and Effects and editing their Information
- Performing analysis

#### **Constructing the Project**

To construct a FMECA Project:

- 1. Click on the New Project icon (A) on the default toolbar, or select New Project from the File menu.
- 2. Activate your project by clicking on the Project tab (**B**) or in the Project window.
- 3. The Project Dialog Box will be displayed.



4. Enter your project information by placing the cursor or clicking in the appropriate fields.

Project			
Title :	FMECA Tutorial	Description :	Pump Control System
Name :	Pump Control Project		
Part Number :		Function	
LCN :		Description.	-
Circuit Ref.:		Notes :	A
Analyst:			
Compiled By :		Approved By :	
Applies to failure Target Rate : Life Time (hrs):	prediction systems contained in t 0 24	his project	Totals: Failure Rate : 0 Unavailability : 0
Redundancy:	×		MTBF (hrs): -1

The information entered for a project is only for the project level, and its entry is optional. The table below displays each field that is available for a project and what each field pertains to:

Field	Description
Title	The Project Title
Name	A Unique Reference Identifier
Part Number	Project Part Number
LCN	Logistic Control Number
Circuit Ref	Circuit Reference
Analyst	Person Performing the FMECA Analysis
Compiled By	Person who gathered data for analysis
Description	What the project is
Function Description	What the project/system does
Notes	Any other pertinent information on the project
Approved By	Person required to sign off on the project
Target Rate	Acceptable number of failures for the project (Failures Per Million Hours)
Life Time	Project life time or mission time given in hours
Redundancy	Redundancy Flag
Failure Rate	Will display total Project failure rate once analysis is complete
Unavailability	This box will display the Project unavailability once the analysis has been run
MTBF	Mean Time Between Failures for the project description

#### Adding a System

A FMECA system may represent a single board, sub assembly or an entire system. The system can then be broken down into sub blocks, components and/or functions.

1. Select the Add menu from the menu toolbar by clicking on it (A).



- 2. Select and click on the FM, FMECA System (B).
- 3. The project will display as a FMECA in the project window(C) and the applicable system data will display in the system window.
- 4. From the Project window, select the FMECA System by clicking on it. The System dialog box will be displayed.
- 5. The System level has two windows in which data can be entered: Block Info and Mode Info. Enter your system information by placing the cursor or clicking in the appropriate fields. The table below describes what could be entered and what each field and block of fields pertains to.

📾 🂱 📴 📴 FMECA		
🖽 Block Info 🛛 🖽 Mode Info 📄 🖽 Detectability	III Diagnostic Coverage SFF	
FMECA System Info.		
Title :	Description :	~
Name : FMECA:0		
Part Number :	-	
LCN : F	-	
Analyst :		~
Life Time (Hours): 1	Eunction Description :	~
Compiled By :	-	
Approved By :	-	
Use Weighted Criticality Method:	<u> </u>	
Normalize Apportionments:	Noter I	
	NUCES .	<u>^</u>
Standard  IEC 61508	<u> </u>	
Calc Engine Mode: Basic Mode	•	
		~
	Mission Phase:	
		~

Field	Description
Title	System Title
Name	Unique Reference Identifier for the System
Part Number	System Part Number
Analyst	Name of the person performing the FMECA Analysis
Life Time	Project life time or mission time given in hours
Compiled by	Name of the person who gathered the data for the FMECA Analysis
Approved by	Name of the person who signed off the FMECA project
Use Weighted Criticality Method	Provides an alternative to the MIL-1629A criticality analysis (Optional)
Normalize Apportionments	Normalize the Apportionments when checked
Description	Description for this System
Function Description	Purpose/Description of this System
Notes	Any other pertinent information about this System
Mission Phase	Description of the Mission Phase
Standard	Select the standard you wish the FMECA to conform to. These include IEC 61508 and ISO 26262 (basic and advanced)
Calc Engine Mode	Select the calculation mode you wish to implement. Choose from Basic Mode or Advanced Mode, Split and Hit

The following view is displayed in Dialog View in the Mode tab.

	Selected		0.2 Neg	ligible	Effect for small	changes FD,CP, Rer	nark
+	-				Failure Modes		
	Parent ID	Mode ID	Description	Beta	<b>Mission Critical</b>	Severity	
	0	0.1	Intermittent Operation	1		III:Marginal	
	0	0.2	Negligible Effect for smal	1	Π	IV:Minor	
	0	0.3	No effect	1	Γ	IV:Minor	
6	0	0.4	Catastrophic	1	Γ	I:Catastrophic	
	0	0.5	No operation	1	Π	ll:Critical	
- 1	- 1			G	auses / Contribu	tors	
-	-	<b>a</b> in		G	auses / Contribu	tors	
-	- Parent ID	Cause ID	Description	C	auses / Contribu	tors Cause / Contributor	
-	Parent ID	Cause ID 8	Description Incorrect Meter Reading	Ci	auses / Contribu	tors Cause / Contributor Contributor Contributor	
-	Parent ID	Cause ID 8 10	Description Incorrect Mater Reading Negligible Effect for sma	Ci ill chan	auses / Contribu ges	tors Cause / Contributor Contributor Contributor Contributor	
-	Parent ID     1     1     2     2	Cause ID 8 10 11	Description Incorrect Meter Reading Negligible Effect for sma Negligible Effect for sma Perspeture Overstrip	Ci II chani II chani	<mark>auses / Contribu</mark> ges ges	tors Cause / Contributor Contributor Contributor Contributor Contributor	
+	Parent ID 1 1 2 2 1 1 1 1 2 2 1 1 1 1 1 2 2 1	Cause ID 8 10 11 13	Description Incorrect Meter Reading Negligible Effect for sma Premature Operation Incorrect Meter Reading	Ci III chan III chan	auses / Contribu ges ges	tors  Cause / Contributor  Contributor  Contributor  Contributor  Contributor  Contributor	
+	Parent ID           1           2           2           1.1.1.1.1	Cause ID 8 10 11 13	Description Incorrect Meter Reading Negligible Effect for sma Premature Operation Incorrect Meter Reading	C. Il chan Il chan	<mark>auses / Contribu</mark> ges ges	tors Cause / Contributor Contributor Contributor Contributor Contributor Contributor Contributor Contributor Contributor	

Field	Description
Mode - Ref. ID	Failure mode reference number
Beta	Probability of current failure mode causing end effect
Severity	MIL-STD 1629A Severity Category
Mode	Failure mode description
Cause	Failure cause description
Failure Detection	Describes how the failure is detected
Compensating Provisions	Processes in place to protect against failure
Remarks	Any other notes or pertinent information

At the System level, the Detectability Panel appears with the Safe or Dangerous radio-buttons for you to choose if the System failure mode creates either situation. Safe is the default. This tab is specific to IEC61508 and can be ignored if you do not wish to us this standard for your FMECA.

Detectability						
I	) Description	Detectable	Safe or Dangerous	Lambda Safe	Lambda Dangerous	
	1 Intermittent Operation		● Safe ○ Dangerous			
2 0	Negligible 2 Effect for small changes		● Safe ○ Dangerous			
3 0	3 No effect		● Safe ○ Dangerous			
¢ 0	4 Catastrophic		● Safe ● Dangerous			
5 0	5 No operation		● Safe ○ Dangerous			
				Diagnostic Test		

The Diagnostic Coverage SFF panel lists the results of the IEC 61508 calculation related to the currently selected System, Block or Component. It is a view only panel and not editable.
#### 💖 🌩 🗣 📴 FMECA

	ID	Description	DC Safe Failures	DC Dangerous Failures	SFF	Lambda S	Lambda D	Lambda S + DD	Lambda DU	Lambda SD	Lambda DD	Lambda SU
1	1	POWER SUPPLY	1	0.0	1	5.152	0.0	5.152	0.0	5.152	0.0	0.0
2	1.1	CAPACITOR, FIXED CK	1	0.0	1	0.138	0.0	0.138	0.0	0.138	0.0	0.0
3	1.2	CAPACITOR, FIXED CB	1	0.0	1	4.864	0.0	4.864	0.0	4.864	0.0	0.0
4	1.3	CAPACITOR, FIXED CK	1	0.0	1	0.111	0.0	0.111	0.0	0.111	0.0	0.0
5	1.4	RESISTOR, FIXED RCR	1	0.0	1	0.00376	0.0	0.00376	0.0	0.00376	0.0	0.0
6	1.5	RESISTOR, FIXED RC	1	0.0	1	0.00435	0.0	0.00435	0.0	0.00435	0.0	0.0
7	1.6	I.C., DIGITAL	1	0.0	1	0.0286	0.0	0.0286	0.0	0.0286	0.0	0.0

🖽 Block Info 🛛 🖽 Mode Info 🛛 🖽 Detectability 🔤 Diagnostic Coverage SFF

## **Adding and Editing Blocks**

A block may be used to represent a system, sub-system, board or logical group of functions.

Blocks can be added to the FMECA system hierarchy tree by selecting the FMECA system tab. Select the Block options from the Add menu. Blocks can also be created or added using the equivalent toolbar option. To add blocks using the toolbar:

1. Select the block from the toolbar menu (A). The cursor should take the shape of a plus sign.

◆ - [IT - Item ToolKit - Project::Dialog]	- 7 🛛
🐼 Eile Add Edit Layout Settings Analysis Chart Window Help	_ & ×
🗅 😂 🖬 🐇 ங 🛍 X 💀 🥌 🕈 💅 🛛 🍋 Category Not Selected 🕢 🔽 🚳 😅	
Image: State	
Image: Title :         Description :           Name :         FMECA:0           Part Number :         Image: FMECA:0           LCN :         F           Analyst :         Image: FmECA:0           Completed by :         Image: FmECA:0           Approved by :         Image: FmECA:0	3
Image: Standard Interactly Method:     Image: Standard Interactly Method:       Image: Standard Interaction     Normalize Apportionments:       Image: Standard Interaction     Notes:       Image: Standard Interaction     Notes:       Image: Standard Interaction     Image: Standard Interaction       Image: Image: Standard Interaction     Image: Standard Interaction       Image: Imag	
Erry Malh Descr El	

2. Place the block cursor where you would like to add the new block on the system window and click your mouse once. The new block should appear.

#### 140 ITEM ToolKit Getting Started Guide

- 3. Multiple blocks can be added by repeating step 2. To disable the add block mode, select the Release button (**B**) from the Toolbar or right click the mouse button.
- 4. Select the Dialog tab from the viewing window (C).
- 5. Select a block from the systems window (**D**).
- 6. The Dialog view will display all parameters for the selected block. Edit the required fields.
- 7. The following view is displayed in Dialog View in the Block tab.

	· ·
	POWER SUPPLY
Function Description :	
Note	S:
Mission Phas	e:
	Description Function Description :

Field	Description			
Name/ID Unique Reference Identifier for the Block				
Part Number Block Part Number				
Quantity	Block Count defined by the user			
Parent Name/ID	Parent Name/ID of the block. Non-editable			
No. of Modes	Modes Count for the Block. Non-editable			
Circuit Ref.	Circuit Reference / Reference Designator of the Block			
Op. Time Factor	Operating time factor of the block. 1 means 100%, 0.5 means 50%			
LCN	(Logistic Control Number) Internal reference number defined by the user			
Description Additional information to describe the block or function				
Mission phase	Description of the Mission Phase			

Notes Any other notes or pertinent information

The following view is displayed in Dialog View in the Mode tab:

				, ,			
-	·			Failure Modes			
	Parent ID	Mode ID	Des	cription			Beta
	2	6	Errat	ic Operation			1
_	2	7	Erro	neous Output (Decreased)			1
	2	8	Fails	to Switch			1
_	2	9	False	e Actuation			1
_	2	10	Inter	mittent Operation			1
-				Causes / Contributors	5		
~						1	
	Parent ID	Cause I	D	Description		Cause / Co	ntributor
	Parent ID 2.3	Cause I 1	D	Description Open (Electrical)		Cause / Co Contributor	ntributor
	Parent ID 2.3	Cause I	D	Description Open (Electrical) Immediate - Direct Effec	<b>t</b> s	Cause / Co Contributor	ntributor
-	Parent ID 2.3 Parent ID	Effect ID		Description Open (Electrical) Immediate - Direct Effec Description	<u>ts</u>	Cause / Co Contributor	ntributor
	Parent ID 2.3 Parent ID 0	Cause I 1 5 6 6 6 6 6 7 6 7 7 7 7 7 7 7 7 7 7 7 7		Description Open (Electrical) Immediate - Direct Effec Description ntermittent Operation	<b>t</b>	Cause / Co Contributor	ntributor

Field	Description			
Mode - Ref. ID	Failure mode reference number			
Detectable	Detectable failure mode selection (Y/N)			
Beta	Probability of current failure mode causing end effect			
Apportionment	Proportion of failure rate attributed to current mode in %			
Description	Failure mode and Cause / Contributors description			
Cause	Failure cause description			
Immediate Effect	Consequence on the current item being analyzed			
Failure Detection	Describes how the failure is detected (via FD, CP, Remarks button)			
Compensating Provisions	Processes in place to mitigate the failure (via FD, CP, Remarks button)			
Remarks	Any other notes or pertinent information (via FD, CP, Remarks button)			

#### 142 ITEM ToolKit Getting Started Guide

#### Adding and Editing Components

A FMECA component may represent any mechanical or electronic device. FMECA components differ from FMECA blocks in that you may enter a failure rate for components, which the program then divides between the components failure modes according to their apportionment percentage.

Components can be added to the FMECA system hierarchy tree by selecting the FMECA system tab. Select the Component options from the Add menu. Components can also be created or added using the equivalent toolbar option. To add components using the toolbar:

1. Select the component from the toolbar menu (A). The cursor should take the shape of the component selected.

🛿 - [IT - Item ToolKit - Project::Dialog]	- 7 🛛
🕐 Eile Add Edit Layout Settings Analysis Chart Window Help	_ & ×
🗖 🗅 🚅 🖬 🐁 🗠 🎒 💡 🛠 🛛 🖕 🖉 👰 💻 Category Not Selected 🛛 🔽 🚳 🚥	
Image: Second	
Approved by : Use Weighted Criticality Method: Normalize Apportionments: Notes : Standard IEC 61508 Calc Engine Mode: Basic Mode Mission Phase: Dialog Dialog Grid Diagram Chart Result	
For Help, press F1 Blocks: 3 Comps: 0	NUM

- 2. Place the block cursor where you would like to add the new Component on the system window and click your mouse once. The new component should appear.
- Multiple components can be added by repeating step 2. To disable the add component mode, select the Release button (B) from the Toolbar.
- 4. Select the Dialog tab from the viewing window (C).
- 5. Select a component from the systems window (**D**).
- 6. The Dialog view will display all parameters for the selected component. Edit the required fields.
- 7. The following view is displayed in Dialog View in the Component tab.

🖽 Block Info 🛛 🖽 Mode Info 📄 🖽 Detectak	ty 🔰 🖽 Diagnostic Coverage SFF 📄	
Component / Function		
Name / ID : 2.1	Description :	
Part Number :	Q Q	
LCN : F21		
Quantity : 1		
Parent Name/ ID : 2		
No. of Modes : 0	Function	
Circuit Ref. :	Description :	
Failure Rate : 0		
Op.Time Factor: 1		
	Notes:	
	Mission Phase:	

Field	Description					
Name/ID	Unique Reference Identifier for the Component/Function					
Part Number	Component Part Number					
Quantity	Component Count defined by the user					
Parent Name/ID	Parent Name/ID of the Component. Non-editable					
No. of Modes	Modes Count for the Component. Non-editable					
Circuit Ref.	Circuit Reference / Reference Designator of the Component					
Failure Rate	Failure Rate of the component					
Op. Time Factor	Operating time factor of the component. 1 means 100%, 0.5 means 50%					
LCN	(Logistic Control Number) Internal reference number defined by the user					
Description	Additional information to describe the Component					
Notes	Additional notes added by user					
Function Description	Additional information to describe the Component					
Mission phase	Description of the Mission Phase					

The following view is displayed in Dialog View in the Mode tab.

#### 144 ITEM ToolKit Getting Started Guide

🖽 Block Info	🛚 Mode Info	🔛 Detectability	🛛 🔛 Diagno	stic Coverage SFF	
Selected		FMECA	:0. Test		FD,CP, Remarks
+ -				Failure Modes	
Parent ID	Mode ID	Description	Beta	Mission Cri Severity	
1 0	FMECA:0.1	Test	1		
+ -			Cau	ses / Contributors	
Parent ID	Cause ID	Description	Cause / Con		

Field	Description				
Mode - Ref. ID	Failure mode reference number				
Detect	Detectable failure mode Y/N				
Beta	Probability of current failure mode causing end effect				
Apportionment	Proportion of failure rate attributed to current mode in %				
Severity	MIL-STD 1629a severity category				
Mode	Failure mode description				
Cause	Failure cause description				
Immediate Effect	Consequence on the current item being analyzed				
Failure Detection	Describes how the failure is detected				
Compensating Provisions	Processes in place to mitigate the failure				
Remarks	Notes				

## FMECA Example

1. Build a system following the example below.



2. In the Dialog tab, modify the properties of each component. Use the following table as a guide.

Component	Description	Part Number	Circuit Ref	LCN	Failure Rate
1.1	Processor 1	6	CPU 1	P-1-1	0.3759
1.2	RAM 1	4	RAM 1	M-1-2	0.8426
1.3	Power Supply	15	PS 1	PS-1-3	0.0165
2	RAM 2	8	RAM 2	M-2	0.8426
3	Disk 1	12	HD 1	HD-3	0.5014
4	Disk 2	12	HD 2	HD-4	0.5014

3. The system, block and component descriptions should appear in the system window. If not, select **Show Description** from the **Layout** Menu.

## **Defining FMECA Severity**

Severity categories are assigned to system failure modes to indicate the severity of the occurrence and the related degree of damage. You must create the severity categories before they can be assigned.

To define severity categories:

1. From the Edit Menu (A), select Severity Categories (B).



2. The Severity Categories dialog box appears.

4	Seve	rity Catego	ries		X
	ID: I II III IV	Weighting: 1 1 1	Description: Catastrophic - A failure w Critical - A failure which m Marginal - A failure D Minor - A failure not	Category ID: Weighting: Description:	I 100 Catastrophic - A failure whicl C Save Phrase Get Phrase
	<			Spelling Save	Delete Sev.     Add Sev.       OK     Cancel

- 3. Click Add Sev (C). A new severity category is added to the table on the left side of the dialog box.
- 4. In the Weighting field, enter 100 (D).
- 5. In the Description field, enter Catastrophic (E).
- 6. Click Save. The table is updated with your changes.
- 7. Following the above steps, create the three other categories that appear in the dialog box above.
- 8. When all severity categories are entered, click **OK** to close the dialog box.

## Adding Failure Modes, Causes, and Effects

A **Failure Mode** is the way in which a component is expected to fail. **Causes** are the factors that are proven or deduced to directly or indirectly produce the failure of an item, component, equipment, or system. A **Failure Effect** is the effect a component Failure Mode has on its "parent" block.

There are three types of Failure Modes

- At the system level, which are End Effects.
- At the intermediate or subsystem level, which are Effects.
- At the component or lowest level, which are Failure Modes.

A lower level failure mode is the cause of the upper level failure mode, which is the effect of the lower level failure mode. Since FMECA analyses from the lowest level up, the first step is to define the failure modes of Power Supply 1.

To add a failure mode:

1. In the System Window, click the **Power Supply** component (A). The component information appears in the Dialog tab.



2. In the Dialog tab, click the Mode Info tab (B).

#### 148 ITEM ToolKit Getting Started Guide

- 3. Click the Mode + button to add a new mode to the list (C).
- 4. In the new mode box type No Power Output. (D).
- 5. With this new mode still selected, click the Cause + button to add a new cause. (E).
- 6. In the new Cause edit box, type Burned Power Supply Fuse (F).
- 7. Click the Cause + button again to add another cause to the list (E).
- 8. In the new Cause edit box, type Power Grid Down (F).
- 9. Click the Immediate Direct Effects + button to add a new effect to the list. (G)
- 10. In the Immediate Effect edit box, type No Output from Motherboard 1 (H).

**NOTE** To remove a failure mode, highlight it in the Mode list and click the - button. Use the same procedure to remove a cause or an effect.

11. Follow the above procedures to the remaining failure modes shown in the Table below. The failure modes should appear in the System Window (J). If not, select **Show Modes** from the **Layout** Menu.

Component	Mode	Cause	Effect	
Dowor Supply	No Power Output	Burned power supply fuse	No output from Motherboard 1	
Power Suppry	No Power Output	Power grid down	No output from Motherboard 1	
	Information not accessible	Overheating	Unacceptable performance of Motherboard 1	
RAM1	Information not transferred/Stored correctly	Microscopic damage to circuitry	Incorrect processing	
Processor 1	Intermittent malfunction of logic process	Overheating	Unacceptable performance of Motherboard 1	



## **Using the Phrase Library**

Your system should include accurate descriptions of each object. You can save time by adding long or frequently used descriptions to the phrase library, then retrieving the descriptions when you define object properties.

Each project has a unique phrase library. When you begin a new project, the phrase library is empty. You populate the library by adding phrases or by importing phrases from an external file.

## **Adding a Phrase**

There are two ways to add phrases to the phrase library

To enter a phrase and add it to the library:

- 1. Select a Block/Component in the System Window.
- 2. Type a description in any field in the Dialog tab.
- 3. Click **Save Phrase**. The description is added to the phrase table.



To enter a phrase in the library without adding it to a field:

- 1. Select a Block/Component in the System Window.
- 2. From the Edit Menu, select Phrase Library.
- 3. The Phrase Library dialog box appears.

🔹 Phrase Library							
ID:	Category: [	Description:					
P646	All						
ID:	Phrase:		Cancel	G,			
P462	ACCUMULATOR, HY						
P461	ACCUMULATOR, HY						
P442	ACTUATOR SOLENC						
P425	ALPHA-NUMERIC DI	ISPLAY FL	Add				
P328	ALPHA-NUMERIC DI	ISPLAY, NO LOGIC CHIPS					
P329	ALPHA-NUMERIC DI	ISPLAY, WITH LOGIC CHIPS	Delete				
P510	ANTENNA						
P195	ATTENUATOR, GEN		E				
P196	ATTENUATOR, MICH	Sort	<u> </u>				
P501	AXLE, MECHANICAL						
P551	Arcing						
P445	BATTERIES RECHAR	RGEABLE LEAD ACID					
P443	BATTERY		Delete All				
P444	BATTERY, LITHIUM						
P446	BEARING						
P46	BEARINGS						
P47	BLOWER						
P330	BLOWER, FAN	H		_			
P521	BLOWER, FAN		Import	J			
P522	BLOWER, FAN AXIAI	L					
3			Save to file				

- 4. In the text box, type the phrase you want to add (**D**).
- 5. Click Spell to check the spelling of your phrase (E).
- 6. Click Add. The phrase is added to the phrase table (F).

Save Phrase Library As	? 🔀
Save jn: 🗀 Examples 💌 🖛 🖻	📸 🎫
Failure Mode Phrases.txt Phrases.txt	
Ι	
File name: FMECA Tutoria	<u>S</u> ave
Save as type: Text Files (*.txt)	Cancel

7. Click Save to file (H). The Phrase Library will be saved in a text file (I) and can be edited.

	Open Phrase Library
	Look jn: 🔁 Examples 💽 🔶 🛅 •
K	Palure Mode Phrases.txt Phrases.txt Type: Text Document Date Modified: 08/09/11 01:04 Size: 2.22 KB L
	File name:     Failure Mode Phrases.txt     Open       Files of type:     Text Files (".txt)     Cancel

- 8. Click on Import Phrase (J) and selected the edited and saved Phrase Library (K) in the Open Phrase Library.
- 9. Click on **Open** (L) to import the Phrase Library.
- 10. When you are finished editing phrases, click OK (G) to close the Phrase Library dialog box.

## **Verifying Data**

You must verify system data before performing project analysis. Verifying data before performing an analysis can be a great time saving feature.

When verifying FMECA projects, ToolKit checks for:

- Component blocks with no failure modes
- Component failure mode apportionment that does not total 100%
- System failure modes with no severity category
- Component blocks with failure rates of zero
- Failure modes with no assigned effects

To verify FMECA data:

- 1. In the System Window, click the system header.
- 2. From the Analysis Menu, select Verify Data.
- 3. If the system contains errors, the Verification Results dialog box displays all relevant error message numbers and the message text. Use the information in the Verification Results dialog box to make corrections before performing system analysis.

۹ r	TEM ToolKit Verification Results	
1	2 Msg Text:	Save
1	Warning: Causes not defined for component failure mode 1.1.2 Warning: Causes not defined for component failure mode 1.1.3	Show me
3	Warning: Causes not defined for component failure mode 1.1.4 Warning: Causes not defined for component failure mode 1.2.1	Total Msgs:
5	Warning: Causes not defined for component failure mode 1.2.2 Warning: Causes not defined for component failure mode 1.2.2	73
7	Warning: Causes not defined for component failure mode 1.2.4 Warning: Causes not defined for component failure mode 1.2.4	Filter
9	Warning: Causes not defined for component failure mode 13.2 Warning: Causes not defined for component failure mode 1.3.2	Update
11	Warning: Causes not defined for component failure mode 1.3.3 Warning: Causes not defined for component failure mode 1.3.4	Errors
12	Warning: Causes not defined for component failure mode 1.4.1 Warning: Causes not defined for component failure mode 1.4.2	Warnings
14 15	Warning: Causes not defined for component failure mode 1.5.1 Warning: Causes not defined for component failure mode 1.5.2	15
	ОК	Cancel

4. Click on save if you want to print and review all error messages. The following window opens. Click OK to save.



5. If no errors are present, the Verification Complete – Without Errors message appears. Click OK.

## **Performing Analysis**

To analyze a FMECA project:

- 1. In the System Window, click the system header (A).
- 2. If you want to turn the weighted criticality method option on or off, click the Use Weighted Criticality Method check box
  - **(B)**.

٩	🚯 - [IT - Item ToolKit - Project::Dialog]							
	🔊 Elle Add Edit Layout Settings Analysis Chart Window Help							
	i 🚅 🖬   3 🖻 🖻 🗙 🗠 🎒 🕅	? 🛛 🖗 🛑 Category Not Selected 🔄 🚳 🔍						
🔿 ITP2	ITP2 PROJECT: IT Project (Prediction Tote FMECA  FMECA							
-	FMECA:0	Block Info B Mode Info Detectability Diagnostic Coverage SFF						
		FMECA System Info.						
		Title : Description :						
		Name : FMECA:0						
		Part Number :						
		LCN : F						
		Analyst : Function						
		Life Time (Hours): 1 Description :						
	<b>▲</b> ►	Approved By :						
		Use Weighted Criticality Method:						
		Normalize Apportionments: ) Notes :						
FMECA		Standard IEC 61508						
_		Calc Engine Mode: Basic Mode						

- 3. From the Analysis Menu, select Perform or click the GO button (C). A dialog box displaying the progress of the analysis appears.
- 4. When the analysis is complete, the Verification Msg. dialog box appears. Click OK. The objects in the System window are updated with the analysis results (**D**).
- 5. Click on the Result Tab to display the results (E). Clicking on different items in the system window will display results for this item (F).



## **ISO 9000 Information**

The ToolKit FMECA Module continues to support the addition of ISO 9000 information. However, now the point of data entry is the ISO 9000 Grid View. Using this view as the data entry and reporting function is much preferred due to the one-to-many relationship of ISO 9000 elements that only the Grid View can display clearly. Right-click the Grid and select ISO 9000. Switch between 1629A and ISO 9000 Grid Views as desired.

	Symbol	Part Name / Part Function	Potential Failure Mode	Potential Effect(s) of Failure	S E V	Delt a	Potential Cause(s) of Failure	0 C C	Design Verification	D E T	R. P. N.
1							Erroneous Input (Increased)	1		1	1
							Loss of Output	1		1	1
							Erratic Operation	1		1	1
			Intermittent Operation		1		Erroneous Output (Decreased)	1		1	1
							Intermittent Operation	1		1	1
							Intermittent Operation	1		1	1
							Loss of Input	1		1	1
		ABCSYS FMECA	Negligible Effect for small changes			I	Incorrect Meter Reading	1		1	1
						-	Negligible Effect for small chan	1		1	1
					T		Negligible Effect for small chan	1		1	1
		(112 010 1020A))					Premature Operation	1		1	1
			No effect			_	No effect	1		1	1
							No effect	1		1	1
					1		Unknown	1		1	1
							No effect	1		1	1
			Catastrophic		1		Fails to Switch	1		1	1
							False Actuation	1		1	1
							Catastrophic	1		1	1
			No operation		1		No operation	1		1	1

#### 154 ITEM ToolKit Getting Started Guide

Use the SEV, OCC, and DET fields to enter the ISO 9000 range of values appropriate for the element you are considering. The RPN number will be automatically calculated.

This view is also intended to be used as the reporting mechanism for ISO 9000 based FMECA. Simply print the Grid View as your report (File – Print Preview – Print Active View or File – Save Grid). You can also construct ISO 9000 based reports via the Report Generator, but they will not be able to represent the ISO 9000 "one-to-many" relationships as the Grid View does.

## 4. FMECA Editor Screen, Toolbar and Shortcut Keys Quick Reference

3	<u> </u>	
• V-800-Example: TIP: 1		
Eile Add Edit Layout Settings Analysis Chart	Window Help	
🗅 😅 🖬   👗 🛍 🛍 🗙 🗠   🚭 💡 📢	🕨 🔓 👂 🍺 🔲 Category Not Se	elected 🔽 🚳 📼
CVDocuments and Settings/Gemina PROJECT: IT Project (Predictio PROJECT: IT Project (Predictio PROJECT: IT Project (Predictio Project (Predictio Project (Predictio Project (Predictio Project (Predictio Predictional Systems; Project (Predictional Systems; Project (Predictio	C:\Documents and Settings\ C:\Documents and Settings\	IT - Item ToolKit - C: Vocuments and Settings\Gemina Pake\My Documents\DemoS         Image: Setting the setting the settings         Image: Setting the setting the settings         Image: Setting the setting
		1 2

## **The FMECA Editor Screen**

The FMECA editor can be made visible by selecting the Dialog Tab (1) or the Grid Tab (2). Its main elements are the following:

- Main Menu (3): Quick access to the main functions.
- FMECA Toolbar (4): Quick access to editing functions.
- Project Window (5): A hierarchical view of the project and systems.
- System Window (6): A hierarchical view of the system, blocks, components and modes.
- Library Window (7): A hierarchical view of the components and failure modes library.
- Dialog Window (8): The area in which the FMECA can be edited.
- Grid Window (9): In this area, the FMECA can be edited in a tabular style.

## **The Default Toolbar**

Immediately below the pull-down options resides a group of buttons that form a Default Toolbar allowing the user to access directly some of the more frequently used menu options.



Tool	Name	Description
	New	Opens a new project.
È	Open	Open an existing document. The ToolKit displays the Open dialog box, in which you can locate and open the desired file.
	Save	Save the active document or template with its current name. If you have not named the document, the ToolKit displays the Save As dialog box.
Ж	Cut	Remove selected data from the document and stores it on the clipboard.
Ē	Сору	Copy the selection to the clipboard.
	Paste	Paste the contents of the clipboard at the insertion point.
$\mathbf{x}$	Delete Item	Delete the selection.
ŝ	Undo	Reverse the last editing. Note: You cannot undo some actions.
6	Print	Print the active document.
8	About	Open the About ITEM ToolKit Window.
<b>N?</b>	Help	Open the ITEM ToolKit On-line Help.

## **The FMECA Dialog Windows Controls**

The FMECA Dialog Window Contains the following Controls.



Tool	Name	Description
	Analyse	Run the Analysis of the system.
ABC V	Check Spelling	Check the Spelling of the selected Text.
R.	Save Phrase	Save the phrase to the phrase library.
₽	Get Phrase	Get a phrase from the phrase library.

## **The Project Toolbar**

The Project Toolbar displays the available analysis options for the ToolKit application

Tool	Name	Description
<b>Ж</b> а	MIL217	Add a MIL-HDBK-217 (Electronic) System.
$\lambda^{\mathrm{T}}$	Telcordia (Bellcore)	Add a SR-332 Telcordia (Electronic) System.
$\lambda^{\pm}$	IEC 62380 (RDF)	Add an IEC 62380 French Telecom Standard (Electronic) System.
$\lambda^{\mathbb{C}}$	299B	Add a 299B Chinese Military Standard (Electronic) System.
$\lambda^{N}$	NSWC (Mechanical)	Add a NSWC (Mechanical) System.
ß	Maintain	Add a Maintain MIL-HDBK-472 Procedure V System.
<b>&amp;</b>	SpareCost	Add a Spare Cost Spares Scaling and Ranging System.
α	FMECA	Add a Failure Modes Effects and Criticality Analysis (FMECA) System.
¢ <mark>B</mark> )	RBD	Add a Reliability Block Diagram (RBD) System.
æ	Fault Tree	Add a Fault Tree Analysis (FTA) System.
Ψ	Event Tree	Add an Event Tree Analysis (ETA) System.
∞	Markov	Add a Markov Modeling System.

## **The FMECA Toolbar**

The FMECA toolbar is used to create and control FMECA Analysis through the commands it contains.

FMECA	×	
🗟 👂 🍘 💻 Category Not :	Selected 💽 💿 📼	
Tool	Name	Description
L3	Select	Cancels add mode.
Ø	FMECA Block	Add a Block.
Ø	Component	Add a Component.
	Failure Mode	Add a Failure mode.
Failure Mode 🔹	Category List	Add an item from the list.
<b>(1)</b>	Start FMECA Analysis	Allows the user to perform the analysis.
<b></b>	Abort FMECA Analysis	Allows the user to stop the analysis.

## **Shortcut Keys**

Key	Function
Ctrl + N	Open a new project.
Ctrl + O	Open an existing document. Displays the Open dialog box, in which you can locate and open the desired file.
Ctrl + S	Save the active project with its current name. If you have not named the project, the Save As dialog box will open.
Ctrl + P	Print the Active View.
Ctrl + X	Remove selected data from the document and stores it on the clipboard.
Ctrl + C	Copy the selection to the clipboard.
Ctrl + V	Paste the contents of the clipboard at the insertion point.
Ctrl + W	Paste the contents of the clipboard (Gate or Event) at the insertion point as a Repeat Gate or Repeat Event.
Del	Delete the selection.
F1	Open the ITEM ToolKit On-line Help.

# CHAPTER 7

## RBD

A reliability block diagram (RBD) provides a simple way to compare various configurations in an attempt to find the best overall system design.

This chapter:

- 1. Introduces RBD systems
- 2. Describes ToolKit's RBD features
- 3. Outlines an example RBD system
- 4. Describes the RBD Screen Editor, Toolbars and Shortcut Keys

## 1. Introduction

A reliability block diagram (RBD) is a drawing and calculation tool used to model complex systems. An RBD is a series of blocks representing portions of a system. Once the blocks are configured properly and data is provided, the failure rate, MTBF, reliability, and availability of the system can be calculated. As the configuration of the diagram changes, the calculation results also change.

The rational course of a RBD stems from an input node located at the left side of the diagram. The input node flows to arrangements of series or parallel blocks that conclude to the output node at the right side of the diagram.

The RBD system is connected by a series or parallel configuration.

A series connection is joined by one continuous link from the Start Node to the End Node.



A **parallel** connection is used to show redundancy and is joined by multiple links or paths from the Start Node to the End Node.



A system can contain a series, parallel, or combination of series and parallel connections to make up the network.



Successful operational systems require at least one maintained path between the system input and the system output. Boolean Algebra expressions are used to describe the minimum combination of failures required to cause a system failure. Minimal cut sets represent the minimal number of failures that can cause the system to fail.

## 2. ITEM ToolKit & Reliability Block Diagram

The RBD analysis is a module of the ITEM ToolKit application. The **ToolKit** allows for multiple analyses to be performed within a single or between multiple projects. As a result, all analysis modules of the **ToolKit** can function as a standalone or combined solution set. The **ToolKit** uses serialization files to store data. This means that all pertinent data from one analysis can be carried over into other analyses.

For example, you may choose to begin your groundwork by performing one of the prediction analyses. The failure rates data obtained can then be directly used to perform a RBD analysis or a FMECA analysis to determine the possible failure modes and their severity. The **ToolKit's** flexibility allows you to begin at any level and proceed to what is needed in order to meet requirements.

The RBD Analysis application uses a RBD workspace area where all project, system, and RBD data and graphics are entered. This area is the foundation on which you build your projects. The workspace area consists of menus, toolbars, and project and system windows.

The RBD workspace area features a Multiple Document Interface (MDI), which allows you to:

- Choose which windows to display, and move and resize all open windows.
- Open and create multiple RBD projects at the same time in order to compare analysis results.
- Drag and drop gate and event components between projects. This feature allows you to quickly create a new project by reusing components from other projects.

## 3. Creating an RBD Project

Creating a RBD Project consists of:

- Constructing the Project/System.
- Adding Blocks, Nodes and Connections.
- Adding and editing Failure Models.
- Constructing Sub-System.
- Setting the RBD View.
- Verifying Data.
- Performing analysis.

### **Constructing the Project/System**

- 1. Click on the New Project icon (A) on the default toolbar, or select New Project from the File menu.
- 2. Activate your project by clicking on the Project tab (B) or in the Project window.
- 3. The Project Dialog Box will be displayed.



4. Enter your project information by placing the cursor or clicking in the appropriate fields.

Project					
Title :	New Project	Description :			
Name :	IT Project				
Part Number :		Function			
LCN :		Description.	-		
Circuit Ref.:		Notes :			
Analyst :					
Compiled By :		Approved By :			
Applies to failure prediction systems contained in this project					
		Γ.	Totals:		
Target Rate :	0		Failure Rate : 0		
Life Time (hrs):	24		Unavailability : 0		
Redundancy :	•		MTBF (hrs): -1		

The information entered for a project is only for the project level, and its entry is optional. The table below displays each field that is available for a project and what each field pertains to:

Field	Description
Title	The Project Title
Name	Project Name
Part Number	Project Part Number
LCN	Logistic Control Number
Circuit Ref	Reference Identification Number (for internal purposes)
Analyst	The person performing the RBD calculation
Compiled By	The person who gathered the data for this analysis
Description	Description of the project
Function Description	What the project/system does
Notes	Any other pertinent information on the project
Approved By	The person required to sign off on the project
The following fields will	display results only if a prediction system is part of the project
Target Rate	Acceptable number of failures for the project (Failures Per Million Hours)
Life Time	Project life time given in hours
Redundancy	Redundancy Flag
Failure Rate	Will display total Project failure rate once analysis is complete
Unavailability	The Project unavailability once the analysis has been run
MTBF	Mean Time Between Failures for the project

5. Select the Add menu from the menu toolbar by clicking on it.



- 6. Select and click on the **RBD** System option.
- 7. The project will display as a RBD System in the project window and the applicable system data will display in the system window.
- 8. From the Project window, select the RBD System by clicking on it. The RBD System dialog box will be displayed.

Tale:       Name:       RBD1         Name:       RBD1       Function         LCN:       Eurotion       Function         LCN:       Description:       Function         Circuit Reit:       Parking Status       Parking Status         Analyst:       Compled By:       Parking Status         Approved By:       Parking Status       Parking Status         Unavalability Cu-Off       Cu-Off Value:       0         Cu-Off Value:       00001       Failure Frequency:       0         Not Expected Failures:       0       Conditional Failure Intensity:       0         Max Sorted Sets:       500       Total Down Time:       0         Miccelaneous       Unavailability:       0       Unavailability:       0         Use Max Rink Domant Model       Unavailability:       0       Unavailability:       0         Use Max Rink Domant Model       Unavailability:       0       Unavailability:       0         Use Max Rink Domant Model       Unavailability:       0       Unavailability:       0         Use Max Rink Domant Model       Unavailability:       0       Unavailability:       0         Use Max Rink Domant Model       Unavailability:       0       Unavailability:	BD System	
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Part Number:	Name : RBD:1	
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Circut Ref:	LCN :	Description :
Analyst:	Circuit Ref.:	
Compiled By:	Analyst :	Notes
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Cut-Off Value:         0 0001           Sort Cut Sets         6           Otf         By Frequency           Otf         By Order           Max Sorted Sets:         500           Order Cut-Off         0           Cut-Off Value:         1           Order Cut-Off         0           Cut-Off Value:         1           Use Max Rink Dormant Model         Unavailability:           Life Time:         1           No of Intermedate         20	Unavailability Cut-Off	
Sort Cut Sets         Falue Frequency         [0]           Off         By Frequency         By Greatersy         [0]           No of Expected Falues :         [0]         No of Expected Falues :         [0]           Max Sorted Sets :         [500]         [0]         Mean Time Between Falues :         [0]           Order Cut-Off         Mean Time Detween Falues :         [0]         Mean Time To Repair :         [0]           Miscellaneous         Unavailability :         [0]         [0]         [0]           Use Max Rink Domant Model         Unavailability :         [0]         [0]         [0]           OuterEmediate         [0]         [0]         [0]         [0]         [0]	Cut-Off Value : 0.0001	Failure Rate : 0
Off         By Frequency           By Unevailability         By Order           Max Sotted Stet:         500           Order Cut-Off         Conditional Failure Intensity:         0           Max Sotted Stet:         10           CucOff Value:         4         0           Miscellaneous         0         Unevailability:         0           Use Max Rink Domant Model         Unavitication Method         0           Life Time:         1         Modularize         Modularize           Modularize         20         Modularize         Modularize	Sort Cut Sets	Failure Frequency : 0
C By Unavailability         C By Order         Max Sorted Sets: 5500         Could Sets: 5	C Off C By Frequency	No of Expected Failures : 0
Max Sorted Sets:     500       Order Cu-Off     Total Down Time:       Cu-Off Value:     4       Miscelaneous     Unrelability:       Use Max Risk Domant Model     Unavailability:       Life Time:     1       No of Intermediate     20	By Unavailability By Order	Conditional Failure Intensity : 0
Order Cu-ADIf         Total Down Time : [0           Cu-ADIf Value:         [4           Miscellaneous         Unreliability:           Use Max Risk Domant Model         Unavailability:           Life Time:         1           No of Intermediate         Commit Model           Three Protection         C Rare	Max Sorted Sets : 500	Mean Time Between Failures : 0
CuckOff Value:     4       MicroBineous     Unrelability:       Use Max Risk Domant Model     Unavailability:       Life Time:     1       No of Intermedate     Castlown Method       Tope Protection     C Range Model	Order Cut-Off	Total Down Time : 0
Miscellaneous Urreitabity: [0 Unavailabity: [0 Unavailabi	Cut-Off Value : 4	Mean Time To Hepair: 0
Use Max Risk Dormant Model Life Time:  Unavaradomy:  Unavaradomy: Unavaradom	Miscellaneous	Unreliability : 0
Life Time : 1 C EasyProchan C Rare MTBF Options	Use Max Risk Dormant Model	Unavailability : 0
No of Internediate	Life Time : 1	Quantification Method
Time Points 20	No of Intermediate	Modularize
I Modularze independant sub-blocks	Time Points : 120	Modularize independant sub-blocks

9. Enter your system information by placing the cursor or clicking in the appropriate fields. The table below describes what could be entered and what each field and block of fields pertains to:

Field	Description	
Title	System Title	
Name	System Name	
Part Number	System Part Number, if applicable	
LCN	Logistic Control Number	
Circuit Ref	Circuit Reference Number	

Field	Description
Analyst	The person performing the RBD System Analysis
Compiled by	The person who gathered the system data for the RBD Analysis
Approved by	The person required to sign off on this system
Unavailability Cut-Off	Restricts the extent of the analysis
Sort Cut Sets	Sort cut sets in required order
Order Cut-Off	Set the maximum order cut sets that should be considered during analysis
Use Max Risk Dormant Model	Uses maximum risk values for dormant events
Life Time	Time over which analysis takes place
No of Intermediate Time Points	Calculates system parameters at set intervals during lifetime
Description	Description of the system
Function Description	What the system does
Notes	Any comments or pertinent information pertaining to this system
Failure Rate	Conditional failure intensity
Failure Frequency	Unconditional failure intensity
No. of Expected Failures	Number of system failures over system lifetime
Mean Time Between Failures	Average time between system failures
Total Down Time	Total time the system will spend unavailable during the system lifetime
Mean Time to Repair	Average time to repair system
Unreliability	Probability of system failing one or more times during system lifetime
Unavailability	Probability of system being unavailable at any specific time
Quantification Method	Click on the selected Quantification method and select the MTBF Options
Modularize Independent Sub-block	Group independent sections of the RBD, speeding up the analysis

## **Adding Blocks, Nodes and Connections**



## What is a Block?

Blocks (A) represent events such as sub-system and component failures. The unique IDs distinguish blocks from other blocks in a diagram. Repeating a block throughout the diagram can represent common cause failures.



#### What is a Node?

Nodes (B) connect parallel blocks. Nodes specify voting arrangements where applicable. Nodes also represent the system outputs of a block diagram for which results are required.



#### What is a connection?

Connections (C) indicate the logical flow of a block RBD. They are the lines used to connect figures in a block diagram. Connections enter the figures on the left input node and exit on the right output node.





- 1. Click the **RBD tab** (**D**).
- 2. From the RBD Toolbar, click on the **Node** icon **(E)**.
- 3. Move the cursor into the RBD canvas and click the area where you want to add the Input and Output node (F).
- 4. From the RBD Toolbar, click on the **Block** icon **(G)**.
- 5. Move the cursor into the RBD Canvas and click the area where you want to add the block (H).
- 6. From the RBD Toolbar, click on the **Connection** icon
- 7. Move the cursor into the RBD Canvas and click on the output (blue) end of the starting node, and then click on the input (green) end of the Block. The connection C1 appears on the diagram (J).
- 8. Repeat step 7 to add the connection C2 (K).
- 9. To exit the Add Node Mode, select the **Select** icon from the Diagram Toolbar (L).
- 10. From the RBD Toolbar, click on the Auto Arrange icon **(M)** to organize and align the components on the canvas.

## **Editing Block and Node Parameters**

#### To edit block parameters:

1. In the RBD Canvas, right click the desired block and select **Block Parameters** from the pop-up menu. The RBD Block Parameters dialog box appears.

RBD Block Parameters	
General Time Phase Hyperlinks Notes	D
Name: Generator Failure Model:	
Part Number: PN001632	$\square \mathbf{A}$
Vote Number: 1	
Quantity: 1 Failure Rate: 0.005	
Logic Mode: Basic   Standard Deviation:	
Circuit Ref.: Distribution: LogNormal	
LCN: F1 Interpretation: Mean & StD 💌	
Adjustment Factor: Q: 1 w: 1 Repair Rate: 1	
Uncertaincy Standard Deviation: 0	
Distribution:	
Description: Interpretation: Mean & StD 🔽	
Generator	
Description:	
Group Labels : 🔽 🗌 Capacity Block	
Spelling OK Cancel	F

#### 166 ITEM ToolKit Getting Started Guide

- 2. Select the failure model from the name drop-down list (A). If the desired model does not appear in the list, click New Model to define the failure model (B).
- Select the model type from Type combo box (C). Available model types include: Fixed, Rate, MTTF, Dormant, Standby, Weibull, LogNormal, Normal, Gamma, Beta, BiNomial, ChiSquared, Poisson, Uniform and LogUniform.
- 4. When the type is selected, the mathematical model can be displayed by clicking on the help icon (**D**).
- 5. Enter the remaining block information and parameters as necessary (E), and Time Phase tab data (G).
- 6. When you are finished entering block parameters, click **OK** to save the changes and close the dialog box (**F**).

#### To edit Nodes parameters:

- 1. In the **RBD** tab, right click the desired node and select **Node Parameters** from the pop-up menu. The Node Parameters dialog box appears.
- 2. Edit the node parameters as necessary. Nodes to the right of a parallel arrangement may be given a vote number (**H**) to indicate how many success paths must be available through the parallel arrangement (if a vote number is not specified only one path is available).
- 3. When you are finished entering node parameters, click **OK** (I) to save the changes and close the dialog box.

🔿 Node Paran	neters			×
		Descriptio	n:	
Name:	Node 1			~
Part Number:				
Circuit Ref.:			I	
Vote Number :	1			$\sim$
Group Labels :	▼ H	Spelling	OK _	Cancel

## **Constructing Sub-Systems**

#### To construct a sub-system:

- 1. In the RBD tab, click the block for which you want to create a sub-system.
- 2. On the RBD toolbar, click the Page Down icon (A). An empty RBD diagram appears.
- 3. Add the nodes, blocks, and connections for the sub-system (**B**).



4. When the sub-system is complete, click the **Page Up** icon on the RBD toolbar (C) to return to the upper level. The block icon changes to indicate the presence of a sub-system (**D**).



## Setting the RBD View

ToolKit's RBD module contains features that make it easy to create and customize an RBD system. In the diagram tab, you can:

- Use Auto Arrange icon to get a better view of the RBD.
- Select multiple components by holding the **Ctrl** or **Shift** key down while you click the desired components, or by holding the left mouse button down while you drag a box around the desired components.
- Select a component by clicking on it in the system window or in the RBD tab.
- Use the mouse to move and resize components.
- Zoom in or zoom out by right clicking any empty area in the diagram, selecting **Zoom** from the pop-up menu, then selecting the desired zoom factor.
- Set the background color by right clicking any empty area in the diagram, selecting **Canvas Color** from the pop-up menu, selecting a color, then clicking **OK**.
- Add a text box by selecting Label from the Add Menu, then clicking the diagram in the area you want to place the text box.

## **Verifying Data**

You must verify system data before performing project analysis.

#### 168 ITEM ToolKit Getting Started Guide

When verifying RBD projects, ToolKit checks for:

- Circular logic
- Invalid failure mode parameters
- A node termination for each logical path at the system level
- A single logical input and output for each sub-system page
- Failure models inputs to non-sub-system blocks

#### To verify RBD data:

- 1. In the System Window, click the system header (A).
- 2. From the Analysis Menu, select Verify Data (B).



- 3. If the system contains errors, the Verification Results dialog box (C) displays all relevant error message number and the message text. Use the information in the Verification Results dialog box to make corrections before performing system analysis.
- 4. If no errors are present, the Verification Complete Without Errors message appears. Click OK.

A dvisory Msg 🛛 🛛 🔀	
RBD Verification completed - Without errors	;
ОК	

## **Performing Analysis**

**NOTE** Before performing analysis, follow the procedure in "Verifying Data" to identify and correct any errors in the system. You cannot perform analysis until all errors are corrected.

#### To analyze the system:

- 1. In the System Window, click the system header.
- 2. From the Analysis Menu, select Perform (A). A dialog box displaying the progress of the analysis appears.
- 3. When the analysis is complete, the Verification Msg. dialog box appears. Click **OK**. The objects in the System window are updated with the analysis results.

Advisory Msg 🛛 🚺	<
RBD Verification completed - Without errors	s
ОК	

4. When the analysis is complete, select **Summary** (**B**) from the **Analysis** menu to view the results. The RBD Results dialog box appears (**C**).



5. You can view the results for each item in the hierarchy displayed on the left side of the dialog box (**D**).

#### **Understanding Analysis Results**

#### Unavailability Q

Unavailability Q represents the probability that the component or system is unavailable at any given time. "Q" equals the probability that the system is unavailable.

#### **Failure Frequency W**

Failure Frequency W, or unconditional failure intensity, is the probability that the system or component fails per unit time, given that it was working correctly at time zero. "W" is equal to the number of expected system failures.

#### CFI

Conditional Failure Intensity. This is the probability of failure per unit time, given that the component was "working-asdesigned" at time zero and is working at time t.

#### **Expected Failure**

Expected Failure is the number of times the system is expected to fail over a specified period of time (lifetime).

#### Unreliability

Unreliability represents the probability of one or more system failures over a specified period of time. The number of expected system failures (W) provides a good approximation for system unreliability for cases where  $W \le 1$ .

#### **Total Down Time (TDT)**

This is the total time that the component or system is expected to be unavailable for the specified system lifetime.

#### **Total Up Time (TUT)**

This is the total time that the component or system is expected to be available for the specified system lifetime.

#### MTBF

Mean Time Before Failure of the component or system.

#### MTTF

Mean Time To Failure of the Non-repairable component or system.

#### MTTR

Mean Time To Repair of the component or system.

#### Availability

Availability represents a measure of the degree to which a system is in an operational state at the start of a mission when the mission is called for at an unknown time.

#### Reliability

Reliability represents the probability that the system will perform without failure during the specified period of time.

#### No. Of Cut Sets

No. of Cut Sets represents a group of events that will cause system failure if and when they occur together.

## 4. RBD Editor Screen, Toolbar and Shortcut Keys Quick Reference

## The RBD Editor Screen



The RBD editor can be made visible by selecting the Dialog Tab (1) or the RBD Tab (2). Its main elements are the following:

- Main Menu (3): Quick access to the main functions.
- RBD Toolbars (4): Quick access to editing functions.
- Project Window (5): A hierarchical view of the project and systems.
- System Window (6): A hierarchical view of the system, blocks, connections and nodes.
- RBD Window or canvas (7): The area in which the RBD can be graphically edited.

## **The Default Toolbar**

Immediately below the pull-down options resides a group of buttons that form a Default Toolbar allowing the user to access directly some of the more frequently used menu options.

Default		X
D 🖻 🔒	🌡 🖻 🖥 🗙 🗠 🎒	¶ №?

Tool	Name	Description
	New	Opens a new project.
È	Open	Open an existing document. The ToolKit displays the Open dialog box, in which you can locate and open the desired file.
	Save	Save the active document or template with its current name. If you have not named the document, the ToolKit displays the Save As dialog box.
Ж	Cut	Remove selected data from the document and stores it on the clipboard.
	Сору	Copy the selection to the clipboard.
	Paste	Paste the contents of the clipboard at the insertion point.
$\mathbf{x}$	Delete Item	Delete the selection.
ŝ	Undo	Reverse the last editing. Note: You cannot undo some actions.
9	Print	Print the active document.
P	About	Open the About ITEM ToolKit Window.
<b>N?</b>	Help	Open the ITEM ToolKit On-line Help.

## The RBD Dialog Windows Controls

The RBD Dialog Window Contains the following Controls.

න 🔜 🗄

Tool	Name	Description
<b>K</b> D	Undo Changes	Cancels the latest operation.
	Analyse	Run the Analysis of the system.
ABC V	Check Spelling	Check the Spelling of the selected Text.

## The RBD Toolbar

The RBD Toolbar is used to create and control RBD Analysis through the commands it contains.

~v		
Tool	Name	Description
$\mathbf{k}$	Select	Cancels add mode.
	Block	Creates a Block symbol on the RBD diagram.
	Node	Creates a Node symbol on the RBD diagram.
P.	90 Degree Link	Creates a 90 Degree Link on the RBD diagram.
4	Orthogonal Link	Creates an Orthogonal Link on the RBD diagram.
<b>V</b> 1	Link	Creates a Simple Line Link on the RBD diagram.
+	Arrow Link	Creates an Arrow Link on the RBD diagram.
$\mathbf{A}$	Text	Allows the user to add a text component to the canvas.
	Image	Allows the user to add an image component to the canvas.
	Page Up	Allows the user to go one level up in the canvas.
Ŧ	Page Down	Allows the user to go one level down in the canvas based on selected Block
<b>₽</b>	Auto Arrange	Allows the user to organize the components on the canvas.
	Transfer to MS Word	Allows the user to transfer the RBD Canvas directly into Microsoft Word.
60	Start RBD Analysis	Allows the user to perform the analysis.
<b></b>	Abort RBD Analysis	Allows the user to stop the analysis.
<b>X</b>	Result Summary	Displays a summary of the analysis.
1	Header Footer	Allows the user to create a header and footer for all RBD pages
	Fit to Page	Allows the user to Fit the RBD diagram in one page automatically.
B	Reset Fit to Page	Allows the user to undo the Fit in one page previously done.

## <u>The Project Toolbar</u>

The Project Toolbar displays the available analysis options for the ToolKit application

<b>2™</b> 2	NT XF XC XN 🔑 🗞	α 🖶 😤 🚍 🗞
Tool	Name	Description
<b>Ж</b> а	MIL217	Add a MIL-HDBK-217 (Electronic) System.
$\lambda^{\mathbb{T}}$	Telcordia (Bellcore)	Add a SR-332 Telcordia (Electronic) System.
$\lambda^{\mathbb{Z}}$	IEC 62380 (RDF)	Add an IEC 62380 French Telecom Standard (Electronic) System.
$\mathcal{X}^{\mathbb{C}}$	299B	Add a 299B Chinese Military Standard (Electronic) System.
$\lambda^{N}$	NSWC (Mechanical)	Add a NSWC (Mechanical) System.
ß	Maintain	Add a Maintain MIL-HDBK-472 Procedure V System.
<b>4</b> 23	SpareCost	Add a Spare Cost Spares Scaling and Ranging System.
α	FMECA	Add a Failure Modes Effects and Criticality Analysis (FMECA) System.
¢	RBD	Add a Reliability Block Diagram (RBD) System.
æ	Fault Tree	Add a Fault Tree Analysis (FTA) System.
Û	Event Tree	Add an Event Tree Analysis (ETA) System.
∞	Markov	Add a Markov Modeling System.

## The Nudge Toolbar

The Nudge Toolbar contains commands for moving the selected components by one logical unit in any direction.

Tool	Name	Description
	Nudge Up	Move the selected components one logical unit up.
Ū	Nudge Down	Move the selected components one logical unit down.
<b>.</b>	Nudge Left	Move the selected components one logical unit left.
:: <b></b>	Nudge Right	Move the selected components one logical unit right.
## The Zoom Toolbar

The Zoom Toolbar contains commands for zooming and panning the canvas. Zoom options can also be accessed by right clicking in the white space on the RBD diagram.



Tool	Name	Description
	Ruler Control	Turn the ruler of the canvas on or off.
Properties		Open the properties window and allows the user to change the selected component properties.
Zoom		Changes the cursor to a magnifying glass and allows the user to zoom in by selecting the area to be zoomed in with the left mouse button and zoom out by right clicking.
Zoom to Fit		Sets the magnification level of the canvas so that all components on the canvas are visible in the view-port.
Zoom to Selection		Sets the magnification level of the canvas so that the selected components are visible in the view-port.
Ś	Pan	Changes the pointer to a hand and allows the user to grab the canvas with the left mouse button and pan in any direction.

## The Graph Toolbar

The Graph Toolbar contains commands that affect the appearance and behavior of the RBD diagram. Each selection highlights the way that Blocks and Nodes are connected through the diagram.



Tool	Name	Description
Edges Entering		Click on the Block/Nodes you wish to select on the RBD Diagram, and then click on this symbol to display the Links to the other figures the selected Block/Nodes is connected to. The Links will flash repeatedly on the screen.
Ŧ	Edges Leaving	Click on the Block/Nodes you wish to select on the RBD Diagram, and then click on this symbol to display the Links that is leaving the selected figure and connecting to the next set of connected Block/Nodes. The Links will flash repeatedly on the screen.
<b>(</b>	All Edges	Click on the selected Block/Nodes, and then click on this symbol to display the connection line that the selected Block/Nodes is entering from and going to the Block/Nodes close to it. The Links will flash repeatedly on the screen.
-	Nodes Connected From	Click on this symbol to display all the Block/Nodes connected to the selected Block/Nodes. The Block/Nodes will flash repeatedly on the screen.
	Nodes Connected To	Click on this symbol to display all the Block/Nodes connected from the selected Block/Nodes. The Block/Nodes will flash repeatedly on the screen.
1.	Nodes Connected	Click on this symbol to display all Block/Nodes that are logically connected within the RBD Diagram. Block/Nodes symbols will flash on the screen in order for you to discern which Block/Nodes are connected.

## The Rotate Toolbar

The Rotate Toolbar contains commands for rotating the selected components.



Tool	Name	Description			
Ċ	Rotate	Sets the canvas to Rotate mode. Allows grabbing a component and rotating it.			
42	Rotate Left Rotates the selected components by 90 degrees to the left.				
21	Rotate Right Rotates the selected components by 90 degrees to the right.				
⊿⊾	Flip Vertical	Flips the selected components 180 degrees about the Y-axis.			
4	Flip Horizontal	Flips the selected components 180 degrees about the X axis			

## The Canvas Toolbar

The Canvas Toolbar contains commands that affect the appearance and behavior of the canvas.



Tool	Name Description					
5	Undo	Undo the last command executed on the canvas.				
3	Redo	Redo the last undo that was performed.				
	Toggle GridTurn display of the grid on and off.					
	Snap to Grid	Toggle the snap-to-grid feature on and off.				
B	Toggle Page Bounds	Turn display of page boundaries on and off.				

## **Shortcut Keys**

Key	Function
Ctrl + N	Open a new project.
Ctrl + O	Open an existing document. Displays the Open dialog box, in which you can locate and open the desired file.
Ctrl + S	Save the active project with its current name. If you have not named the project, the Save As dialog box will open.
Ctrl + P	Print the Active View.
Ctrl + X	Removes selected data from the document and stores it on the clipboard.
Ctrl + C	Copy the selection to the clipboard.
Ctrl + V	Paste the contents of the clipboard at the insertion point.
Del	Delete the selection.
F1	Open the ITEM ToolKit On-line Help.

# CHAPTER 8 Fault Tree Analysis

Fault Tree Analysis (FTA) is used during Reliability and Safety assessments to graphically represent the logical interaction and probabilities of occurrence of component failures and other events in a system. The interactions are captured using a tree structure of Boolean operator gates, which decomposes system level failures to combinations of lower-level events. The analysis of such Fault Trees, identifies and ranks combinations of events leading to system failure, and provides estimates of the system's failure probability.

This chapter:

- 1. Introduces FTA systems
- 2. Describes Toolkit's FTA features
- 3. Outlines an example FTA system
- 4. Describes the FTA Editor Screen, Toolbars and Shortcut Keys

## 1. Introduction

Item Software's Fault Tree module provides a wide variety of both qualitative and quantitative information about the system reliability and availability.

Fault Tree Analysis is a well-established methodology that relies on solid theories such as Boolean logic and Probability Theory. Boolean logic is used to reduce the Fault Tree structure into the combinations of events leading to failure of the system, generally referred to as Minimal Cut Sets, many of which are typically found. Probability Theory is then used to determine probabilities that the system will fail during a particular mission, or is unavailable at a particular point in time, given the probability of the individual events. Additionally, probabilities are computed for individual Minimal Cut Sets, forming the basis for their ranking by importance with respect to their reliability and safety impact.

Using this detailed information, efforts to improve system safety and reliability can be highly focused, and tailored to your individual system. Possible design changes and other risk-mitigating actions can be evaluated for their impact on safety and reliability, allowing for a better-informed decision making process and improved system reliability. This type of analysis is especially useful when analyzing large and complex systems where manual methods of fault isolation and analysis are not viable.

A Fault Tree is a graphical representation of events in a hierarchical, tree-like structure. It is used to determine various combinations of hardware, software, and human error failures that could result in a specified risk or system failure. System failures are often referred to as top events. A deductive analysis using a Fault Tree begins with a general conclusion or hazard, which is displayed at the top of a hierarchical tree. This deductive analysis is the final event in a sequence of events for which the Fault Tree is used to determine if a failure will occur or, alternatively, can be used to stop the failure from occurring. The remainder of the Fault Tree represents parallel and sequential events that potentially could cause the conclusion or hazard to occur and the probability of this conclusion. This is often described as a "top down" approach.

Fault Trees are composed of events and logical event connectors (OR-gates, AND-gates, etc.). Each event node's sub-events (or children) are the necessary pre-conditions that could cause this event to occur. These conditions can be combined in any number of ways using logical gates. Events in a Fault Tree are continually expanded until basic events are created for which you can assign a probability.

The top level event must be described precisely. Defining the top event too broadly leads to an open-ended tree, showing no specific cause or causes for failure. Similarly, defining the top event too narrowly leads to possible cause omissions. An FTA needs to include all possible weaknesses, faults or failures present in the system that could cause safety hazards or reliability problems. Hardware, software, and human components of the system must be included in the Fault Tree Analysis. All interactions between the system components and elements must be fully described in the FTA.

An FTA provides a method to:

- Calculate unreliability and unavailability
- Analyze Uncertainty and Sensitivity
- Analysis Common Cause Failure (CCF)
- Produce minimal cut sets
- Fault Tree Sequencing, Initiator and Enabler, Initiator Only, Enabler Only
- Define event failure models
- Determine the importance of elements in a system

## 2. ITEM ToolKit & Fault Tree Analysis

Fault Tree Analysis is one of the many modules within the ITEM ToolKit application. Item Software's Fault Tree module can provide useful failure probability and system reliability data concerning the likelihood of a failure and the means by which such a failure could occur.

With the detailed output of each Fault Tree Analysis, efforts to improve system safety and reliability can be highly focused and tailored to your system by using the quantifying results from the data you input. Additionally, a Fault Tree Analysis can help prevent a failure from occurring beforehand, by the analysis of the system data you input.

## **Binary Decision Diagram (BDD)**

The ITEM ToolKit Fault Tree Module also incorporates Binary Decision Diagram analysis. The BDD analysis method is an alternative to the Rare Event and Esary-Proschan quantification options. It uses the Binary Decision Diagram algorithm to obtain cut-sets and quantification results. BDD algorithms distinguish themselves from conventional quantification methods by returning results that do not involve approximations. Instead, BDD algorithms produce results that are in accordance with the basic rules of probability theory.

#### 180 ITEM ToolKit Getting Started Guide

Furthermore, BDD-based algorithms are generally more efficient than other quantification methods. Depending on the model, these algorithms can identify millions or even billions of cut-sets within seconds. The BDD algorithms embedded in ITEM products identify all cut-sets for a given model, and then filter out the significant cut-sets based on probability and/or order.

BDD algorithms do not allow for truncation of probabilistically insignificant elements in the logic. Conventional methods allow models to be solved by considering only the high-probability cut-sets. Studies have shown however that the numerical results produced by conventional methods must be treated with care, due to the truncations and approximations involved in their calculations.

## **Using the Fault Tree Module**

The Fault Tree Analysis application uses a Fault Tree workspace area where all project, system, and Fault Tree data and graphics are entered. This area is the foundation on which you build your projects. The workspace area consists of menus, toolbars, and project and system windows.

The Fault Tree workspace area features a Multiple Document Interface (MDI), which allows you to:

- Choose which windows to display, and move and resize all open windows.
- Open and create multiple Fault Tree projects at the same time in order to compare analysis results.
- Drag and drop gate and event components between projects. This feature allows you to quickly create a new project by reusing components from other projects.

## 3. Creating a Fault Tree Project

To demonstrate ToolKit's Fault Tree features, we'll create an example Fault Tree project based on the following.

Consider two switches in series as shown bellow. The points A and B are points on the wire. Wire failures would be ignored



Creating a Fault tree system consists of:

- Constructing the system
- Adding Gates
- Adding Events and editing their Failure models
- Performing analysis

## **Constructing the system**

To construct a Fault Tree System:

- 1. Click on the New Project icon (A) on the default toolbar, or select New Project from the File menu.
- 2. Activate your project by clicking on the Project tab (B) or in the Project window.
- 3. Select the Dialog tab from the bottom of the Viewing Option window.
- 4. The Project Dialog Box will be displayed.



5. Enter your project information by placing the cursor or clicking in the appropriate fields.

Project				
Title :	Two Switches example	Description :	Fault Tree example for two switches in series	<b>A</b>
Name :	Fault Tree Example 01			-
Part Number :	Example - 01	Function	No output currrent if switch 1 is open or switch 2	<b>A</b>
LCN :		Description.	isopen or if no current to point A	-
Circuit Ref.:		Notes :	Wire failures would be ignored	<b>A</b>
Analyst :				-
Failure Rate :	0	Compiled By :		
Redundancy :	<b>_</b>	Approved By :		
Life Time (hrs):	8.76e+006	Target Rate :	5	
MTBF (hrs):	-1	- Unavailability :	0	

6. The information entered for a project is only for the project level, and its entry is optional. The table below displays each field that is available for a project and what each field pertains to:

Field	Description				
Title	The Project Title				
Name	A Unique Reference Identifier				
Part Number	Project Part Number				
LCN	Logistic Control Number				
Circuit Ref	Circuit Reference				
Analyst	Person Performing FT Analysis				
Redundancy	Redundancy Flag				
Life Time	Project life time given in hours				
Description	What the project is				
Function Description	What the project/system does				
Notes	Any other pertinent information on the project				
Compiled By	Person who gathered data for analysis				
Approved By	Person required to sign off on the project				
The following fields will display re	esults only if a prediction system is part of the project				
Failure Rate	Will display total Project failure rate once analysis is complete				
MTBF	Mean Time Between Failures for the project description				
Target Rate	Acceptable number of failures for the project (Failures Per Million Hours)				
Unavailability	This box will display the Project unavailability once the analysis has been run				

7. Select the Add menu from the menu toolbar by clicking on it.



- 8. Select and click on the **FT**, Fault Tree System option.
- 9. The project will display as a Fault Tree in the project window and the applicable system data will display in the system window.
- 10. From the Project window, select the Fault Tree System by clicking on it.
- 11. The Fault Tree System dialog box will be displayed.

-FaultTree System	ETA Example	Description -	_
litte :		Description.	
Name :			-
Part Number :		Function	5
LCN :	F	Description :	
Circuit Ref.:		-	-
Analyst :		Notes :	
Compiled By :			
Approved By :		-	r
-Cut-Off			
Probability		Unavailability :	
Unavailability: 9.	999999 Frequency: 0	Failure Frequency :	
Order 4		Conditional Failure Intensity :	
		No of Expected Failures :	
-Sort Cut Sets	C Pu Francisco	Unreliability :	
Off     By Upavailab	By Frequency	Total Down Time :	
Max Sorted Se	ts · 500	Failure Rate :	
		Quantification Method Analysis Options	
- Miscellaneous		Esary-Proschan Use Max Risk Dormant Mode	el
Life Time (Hou	ırs): 8760	C Rare Modularize super events	
No of Intermediate		BDD IV Full NOT Logic (Discuss Desision Discuss)	ons
Time Poin	ts :   20	(binary bedsion biagram)	
Apply Setting	gs to All Linked Fault Trees	Perform Sample Size: 500 Percentile: 99	
Dual Equiva	elent Fault Tree		

- 12. Enter your system information by placing the cursor or clicking in the appropriate fields.
- 13. The information entered here is for the system level. The table below describes what could be entered and what each field and block of fields pertains to:

Field	Description					
Title	System Title.					
Name	Unique Reference Identifier for the System.					
Part Number	System Part Number.					
LCN	Logistic Control Number.					
Circuit Ref	Circuit Reference Number.					
Analyst	Name of the person performing the Fault Tree Analysis.					
Compiled by	Name of the person who gathered the data for the Fault Tree Analysis.					
Approved by	Name of the person who was required to sign off on the Fault Tree project.					
Cut-Off	Cut-Off by Probability or by Order can be selected. If you select the Probability box, enter the Unavailability and the Frequency cut-off rate for this project. Click the Order box if you wish to have an Order Cut-Off. If you select this, you must then enter the Cut-Off value total for project.					
Sort Cut Sets	Select whether you wish to Sort Cut Sets by Unavailability, by Frequency, or by Order and enter the maximum amount of sort sets. Click "Off" if you do not wish to use Sort Cut Sets. (Cut Sets are a group of events that, when occurring together, will cause system failure.)					
Miscellaneous	Enter the project lifetime given in hours and the total number of immediate time points for the Dormant Model.					
Description	Description for this System.					
Function Description	Purpose/Description of this system.					
Notes	Any other pertinent information about this system.					
Failure Rate	This is the probability of failure per unit time, given that the component was working as designed at time <b>zero</b> , and has survived to time <b>t</b> .					
Failure Frequency	Displays the project failure frequency once analysis is complete. The unconditional failure intensity is the probability that the system fails per unit time, given that it was working as designed at time $0$ .					
No. of Expected Failures	Display the number of times the system is expected to fail over the specified lifetime (in hours) of this project once the analysis is complete.					
Conditional Failure Intensity	This is the probability of failure per unit time, given that the component was working as designed at time <b>zero</b> and is working at time <b>t</b> .					
Total Down Time	Displays the total down time for this project if and when a failure occurs during the specified system lifetime (in hours) once the analysis is complete.					
Unreliability	This is the probability that one or more failures will occur over a specified period of time.					
Unavailability	This is the probability that the component or system is unavailable at any given time.					
Quantification Method	Click on the selected Quantification method.					
Maximum Risk	Click the box to Use Maximum Risk Dormant Model for this analysis					
BDD	Click this box to enable the Binary Decision Diagram analysis facilities.					
Modularize	Click this box to modularize independent sub-blocks.					
CCF	Click this box if you wish to perform a Common Cause Failure Analysis.					
Uncertainty	Click this box if you wish to perform an Uncertainty Analysis. If you select this box, you must then enter the Sample Size and the Percentile.					
Dual Equivalent	Indicates whether 'Convert to Dual Fault Tree' has been selected in Analysis Menu.					

## What is a Gate?

A gate is used to describe the relationship between the input and output events in a Fault Tree. For example, a specific output can occur if and only if specific input events occur. These specific inputs and outputs define each gate. A Fault Tree can have several different kinds of gates. The gate type defines the appearance of the gate symbol when drawn in the Fault Tree. In addition, the gate type determines how the inputs to the gate are logically connected for the minimal cut set analysis process.

## Adding a Gate

Fault trees are created by adding gates and events directly into the Fault Tree diagram edit area. As you add gates and events to a fault tree diagram, the system will automatically position the diagram symbols in the diagram edit area.

Once a new Fault Tree System is added into a Project the TOP gate is automatically created. You can enter and add gates to the Fault Tree by using the Select and Click method from the Fault Tree Toolbar or by using the Add pull-down menu and selecting a Gate. You can continue to add gates by simply clicking on any gate.

- 1. Click on the Fault Tree Tab to open the Fault Tree Canvas (A).
- 2. Select an OR gate symbol from the Fault Tree Toolbar with the left mouse button (B).
- 3. Move the mouse cursor to a target gate within the Fault Tree canvas.
- 4. Once the target gate has been reached, click the left mouse button to add (C).
- 5. Click on the Select Symbol to stop adding Gates (**D**).



#### 186 ITEM ToolKit Getting Started Guide

- 6. Right Mouse Click on the new Gate and select Gate Parameter.
- 7. Enter "No current to point B" as Description (E).
- 8. Click OK when finished (**F**).

## **Types of Gate**

The following gates are supported in the Fault Tree module:

#### OR Gate



The OR gate indicates that the output occurs if any one of the input events occurs.

#### AND Gate

The AND gate indicates that the output occurs if all of the input events occur simultaneously.

#### PRIORITY AND Gate

The PRIORITY AND gate indicates that the output occurs if and only if all of the input events occur in the order from left to right.

#### VOTE Gate

The VOTE gate indicates how many of the gate inputs need to occur to cause the gate failure to occur. For example, if the gate has four inputs and a vote of three was specified, this indicates that at least three of the gate's four inputs would have to occur to cause the gate failure to occur.

#### XOR Gate

The XOR gate indicates that an event will occur if one but not both of the input events occur.

#### NOT Gate

The NOT gate indicates that the output event occurs if the input event does not occur.

#### NULL Gate

The NULL gate indicates a single input only. These gates are used to allow additional descriptions to be added to the fault tree for system events.

#### TRANSFER/Subsystem Gate

The TRANSFER/Subsystem gate indicates that this part of the fault tree is developed in a different part of the diagram or on a different page.

#### INHIBIT Gate

The INHIBIT gate indicates that the output event occurs if both input events occur. One of the inputs represents a conditional event.

## What is an Event?

Events appear in both Fault and Event trees, and may represent components unavailability, human errors, system failures, initiating events, etc.

## Adding an Event

- 1. Select a Basic Event symbol from the Fault Tree Toolbar with the left mouse button (A).
- 2. Move the mouse cursor to the 1.1 OR Gate within the Fault Tree canvas (B).
- 3. Once the Gate has been reached, click the left mouse button to add.
- 4. Repeat the same operation until 3 Basic Event are added below the OR Gate.
- 5. Click on the Select Symbol to stop adding Events (C).



## **Types of Event**

The following types of Event are available in the Fault Tree Module:

Basic Event

A Basic event indicates an event for which failure and repair data is available.

House Event

A House event indicates whether an event is definitely operating or definitely not operating (dormant).

#### Undeveloped Event

An Undeveloped event indicates a system event, which is yet to be developed.

#### Dormant Event

A Dormant event indicates a system event with unrevealed failures until maintenance, or inspection.

#### Conditional Event

A Conditional event is similar to a basic event but represents a conditional probability connected to an inhibit gate.

## How to Create and Add a Failure Model into an Event

Failure Models contain failure and repair information for a component, or probability of occurrence data for human errors, environmental conditions etc. A failure model is assigned to an event or events, for use in the Quantitative Analysis of the fault tree diagram.

- 1. Right Click on the first Event.
- 2. Select Event Parameters.
- 3. The Event Parameters Window opens.

O Π Event parameters	IT Event parameters	
13 General 13 Failure 13 Time P 13 Hyperlinks Notes	53 General 53 Failure 53 Time P 53 Hyperlinks Notes	
Type: BASIC	Name: SPARK 🔮 💡	2
Name: SPARK 🗨 🔍	Type (CDF): Fixed	
Part Number:	Uncertainty Uncertainty	C)
Logic Mode: Basic	Standard Deviation: 0	
Circuit Ref.:	Interpretation: Mean & StD	
LCN: F13	Failure Frequency: 1e-005	J
	Uncertainty Standard Deviation: 0	
Failure Model: SPARK	Distribution: LogNormal	
	Interpretation: Mean & StD	
Adjustment Factor: Q: 1 w: 1		
Fault Tree Sequencing		
Initiator and Enabler     O     Initiator Only     C     Enabler Only		
Description: Lock 🖌 Group Labels : 🔽	Description:	ン
Spark		
· · · · · · · · · · · · · · · · · · ·	From Library New Moel	
Change to Gate		

- 4. Input the Description of the Event "Switch 1 is open" into the general window (A).
- 5. Input the Name "Switch 1"(**B**), select the Type "Rate" (**C**) and input the Failure Rate "1.5e-006" (**D**) of the Failure Model into the Failure Model window.
- 6. Available model types include: Fixed, Rate, MTTF, Dormant, Standby, Weibull, LogNormal, Normal, Gamma, Beta, BiNomial, ChiSquared, Poisson, Uniform and LogUniform.
- 7. When completed, click OK (E).
- 8. Repeat 1 to 6 for the second Event with "Switch 1 is open" as Description, "Switch 2" as Name, "2e-006" as Failure Rate and select "Rate" for the Type.
- 9. Repeat 1 to 6 for the third Event with "No current to point A" as Description, "No Current" as Name, "3e-006" as Failure Rate and select "Rate" for the Type.



## **Performing Analysis**

Fault Tree Module provides a method to:

- Calculate unreliability and unavailability
- Analyze Uncertainty and Sensitivity
- Analysis Common Cause Failure (CCF)
- Produce minimal cut set
- Fault Tree Sequencing, Initiator and Enabler, Initiator Only, Enabler Only
- Determine the importance of elements in a system

## **To Verify the Data**

1. Select Verify Data from the Analysis Option in the menu Toolbar.



**NOTE** Before performing analysis, follow the procedure in "Verifying Data" to identify and correct any errors in the system. You cannot perform analysis until all errors are corrected.

#### 190 ITEM ToolKit Getting Started Guide

2. If no errors are detected the following windows will be displayed.



3. If the following window appears, correct the detected errors and repeat the step 1.

O ITEM "	FoolKit Verification I	Results	
1 Ms 1 2	g #: 2 Msg Type Warning	2 Msg Text: failure model not defined for event EVENT1 Fault Tree Verification completed - With warnings	Save Show me Total Msgs:
			Filter Update
			✓ Errors ✓ Warnings Show Msgs:
		ОК	100 Cancel

## To Analyze the System

- 1. In the System Window, click the system header.
- 2. From the Analysis Menu, select Perform. A dialog box displaying the progress of the analysis appears.



- 3. When the analysis is complete, the Verification Msg. dialog box appears. Click **OK**. The objects in the System window are updated with the analysis results.
- 4. The Fault Tree canvas is also updated with the analysis results.



5. Select **Summary** from the **Analysis** menu to view the results. The Fault Tree Results dialog box appears.

đ	FT Res	ults													
Γ	<b>-</b>	PLOSION	Summa	ary					Life	Time (Hours	;): 87	760		ОК	
	- A	ELEMENT A	Para	meter:	٧a	alue	Mean	St	D	5%	50%	6	95%	99.0	JO' 🔨
		ELEMENT B LEAK PROTECTION SYS PROTECTION SYS	Para Unav Failur Mean CFI Exper Unrel Total CFI Even SPAR LOSS LOSS CORF PIPE	ailability Q: e Frequency W: Unavailability Availability Am: cted Failures: iability: Down Time TDT: ance t: K OF A OF A OF B ROSION SPLIT	Va 7. 6. 7. 1 6. 0. 0. 6.	alue           7173           1587           2461           1587           0050           0055           0055           3475           F-Vesely           1           0.748090           0.748090           0.748092           0.377602           0.377602	Mean 7.7173 6.1587 343 343 343 343 343 343		Birnbau 6.3781 1.0594	5% 7.7173 6.1587 1587 4378-5 354e-7 354e-7 354e-7 354e-7 635e-10	7.71	• 17 18 18 10.34 0.34 0.34 2.00 2.30 2.30	95% 7.717 6.158 roschan 4216951 4216951 069356e- 644678e- 644678e-	111 7	
			<			11.25190	157		1 4441	h4e-5		11.3	ISBBU/S		
			Cut Se	ts											
			No:	Unavailability:	Fr	equency:	Even	s							
			1 2 3 4	3.5933883e-10 2.1801017e-10 1.2099747e-10 7.3408928e-11	2. 1. 1. 7.	6231734e 5914753e 2099747e 3408965e	-7 CORF -7 PIPE -7 CORF -8 PIPE	OSIO 5PLIT OSIO 5PLIT	N ::SPAR ::SPARK N ::SPAR ::SPARK	K ::LOSS OF ::LOSS OF B K ::POWER ::POWER	B (:LO (:LOS)	)55 0 5 OF	A A		
	<														

### **Understanding Analysis Results**

**Unavailability Q**: Represents the probability that the component or system is unavailable at any given time. "Q" equals the probability that the system is unavailable.

**Failure Frequency W**: This is the term used by the system to represent the unconditional failure intensity. The unconditional failure intensity is the probability that the system or component fails per unit time, given that it was working correctly at time zero. "W" is equal to the number of expected system failures.

**CFI**: Signifies the Conditional Failure Intensity. This is the probability of failure per unit time, given that the component was "working-as-designed" at time zero and is working at time t.

Expected Failure: This is the number of times the system is expected to fail over a specified period of time (lifetime).

**Unreliability**: Represents the probability of one or more system failures over a specified period of time. The number of expected system failures (W) provides a good approximation for system unreliability for cases where  $W \ll 1$ .

**TDT**: Represents total down time. This is the total time that the component or system is expected to be unavailable for the specified system lifetime.

**TUT**: Represents total up time. This is the total time that the component or system is expected to be available for the specified system lifetime.

Failure Rate: The Failure rate of the component or system.

MTBF: Mean Time Before Failure of the component or system.

MTTF: Mean Time To Failure of the Non-repairable component or system.

MTTR: Mean Time To Repair of the component or system.

Availability: Represents a measure of the degree to which a system is in an operational state at the start of a mission when the mission is called for at an unknown time.

Reliability: Represents the probability that the system will perform without failure during the specified period of time.

No. of Cut Sets: Represents a group of events that will cause system failure if and when they occur together.

CCF: Signifies Common Cause Failure. This is the occurrence of more than one failure event due to the same cause.

## What is a Critical Path?

A Critical Path is a group of events that has the highest probability of occurrence among all possible sets of events. Depending on the Importance Method selected, the Critical Paths in a Fault Tree may differ.

ToolKit uses three main levels of Importance Methods to measure the critical path:

#### **F-Vesely**

The F-Vesely (Fussell-Vesely) importance measure represents an event's contribution to the system unavailability. Increasing or decreasing the availability of events with a higher importance value will have the most significant effect on system availability.

#### Birnbaum

The Birnbaum measure for an event represents the sensitivity of system unavailability with respect to changes in the events unavailability.

#### **B-Proschan**

The B-Proschan (Barlow-Proschan) event importance measure takes into consideration the sequence of event failures within its calculation. It is the probability that the system fails because a critical cut set containing the event fails, taking into consideration that the event fails last.

## How to Display a Critical Path

1. Select the Analysis pull-down menu and click on Critical Path. The Critical Path window displays:



2. From this window you can select the Critical Path importance level you wish to use, add and delete levels, check all levels, uncheck all levels, and use the color palette to assign a color to a specific level.

Critical Pa	th			
Importance F-Vesely	с	Birnbaum	C B-Proscha	an
BDD Importanc © F-Vesely © Marginal	e measures - C C	Critical Diagnostic	C Risk Achie C Risk Redu	evement Worth uction Worth
	ine Width : ☑1st Level	0 Point	•	Add
				Delete Check All
Other				Uncheck All
			OK	Cancel

3. Select F-Vesely and the 1<sup>st</sup> Level, choose the path color and click OK. The Fault Tree canvas will be updated with the Critical Path.



4. Select the Analysis pull-down menu and click on Clear Critical Path. The Fault Tree canvas will return to his original state.



5. Repeat step 1 to 4 to display the Critical Path for Birnbaum or B-Proschan Importance.

## How to Transfer Fault Tree Data to Microsoft Word

A powerful export facility is provided with the Fault Tree module that will allow you to transfer data directly to Microsoft Word.

1. To access the Microsoft Word transfer facility, select the Microsoft Word icon from the Fault Tree Toolbar.



2. The Range window appears. Check all desired option and click OK.

Transfer To MS Word Dialog	×
Total Pages : 💈	
Page Range Tinclude All Linked Trees     C Current Tree Only	
C Pages from: 1 to: 2 to:	
C Selection C Current Page	
Fit To Page  Auto Arrange  Reference Table  Create Page Reference Table  Sort by name	-
Header Footer Header Add Header [Page#]	-
-Footer Add Footer [Page#] Center	-
OK Cancel	

3. The Fault Tree pages you have selected will be transferred directly into Microsoft Word. Microsoft Word does not have to be active on your desktop to perform this transfer; it will open automatically.

## 4. Fault Tree Editor Screen, Toolbar and Shortcut Keys Quick Reference

### The Fault Tree Editor Screen



The Fault Tree editor can be made visible by selecting the Dialog Tab (1) or the Fault Tree Tab (2). Its main elements are the following:

- Main Menu (3): Quick access to the main functions.
- Fault Tree Toolbars (4): Quick access to editing functions.
- Project Window (5): A hierarchical view of the project and systems.
- System Window (6): A hierarchical view of the system, blocks, connections and nodes.
- Fault Tree Window or canvas (7): The area in which the Fault Tree can be graphically edited.

## The Default Toolbar

Immediately below the pull-down options resides a group of buttons that form a Default Toolbar allowing the user to access directly some of the more frequently used menu options.

Default		X
D 🖻 🔒	🌡 🖻 🖻 🗙 🗠 🎒	¶ №?

Tool	Name	Description
D	New	Opens a new project.
È	Open	Open an existing document. The ToolKit displays the Open dialog box, in which you can locate and open the desired file.
	Save	Save the active document or template with its current name. If you have not named the document, the ToolKit displays the Save As dialog box.
Ж	Cut	Remove selected data from the document and stores it on the clipboard.
	Сору	Copy the selection to the clipboard.
	Paste	Paste the contents of the clipboard at the insertion point.
$\mathbf{X}$	Delete Item	Delete the selection.
5	Undo	Reverse the last editing. Note: You cannot undo some actions.
9	Print	Print the active document.
8	About	Open the About ITEM ToolKit Window.
N?	Help	Open the ITEM ToolKit On-line Help.

## **The Fault Tree Dialog Windows Controls**

The Fault Tree Dialog Window Contains the following Controls.



Tool	Name	Description
5	Undo Changes	Cancels the latest operation.
	Analyse	Run the Analysis of the system.
ABC V	Check Spelling	Check the Spelling of the selected Text.

## The Project Toolbar

The Project Toolbar displays the available analysis options for the ToolKit application

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Tool	Name	Description
X <sup>ra</sup>	MIL217	Add a MIL-HDBK-217 (Electronic) System.
$\lambda^{\mathrm{T}}$	Telcordia (Bellcore)	Add a SR-332 Telcordia (Electronic) System.
$\lambda^{\pm}$	IEC 62380 (RDF)	Add an IEC 62380 French Telecom Standard (Electronic) System.
$\mathcal{X}^{\mathbb{C}}$	299B	Add a 299B Chinese Military Standard (Electronic) System.
$\lambda^{N}$	NSWC (Mechanical)	Add a NSWC (Mechanical) System.
ß	Maintain	Add a Maintain MIL-HDBK-472 Procedure V System.
<b>4</b> 23	SpareCost	Add a Spare Cost Spares Scaling and Ranging System.
α	FMECA	Add a Failure Modes Effects and Criticality Analysis (FMECA) System.
¢ B	RBD	Add a Reliability Block Diagram (RBD) System.
æ	Fault Tree	Add a Fault Tree Analysis (FTA) System.
Ψ	Event Tree	Add an Event Tree Analysis (ETA) System.
∞	Markov	Add a Markov Modeling System.

## The Fault Tree Toolbar

The Fault Tree Toolbar is used to create and control Fault Tree Analysis through the commands it contains.

]  🗟 🙈	i a a a a x = &	
Tool	Name	Description
$\Box_{\mathbf{k}}$	Select	Cancels add mode.
A	OR GATE	Creates an OR GATE symbol on the Fault Tree diagram.
	AND GATE	Creates an AND GATE symbol on the Fault Tree diagram.
	PRIORITY AND GATE	Creates a PRIORITY AND GATE symbol on the Fault Tree diagram.
A	VOTE GATE	Creates a VOTE GATE symbol on the Fault Tree diagram.

	XOR GATE	Creates a XOR GATE symbol on the Fault Tree diagram.
<b>X</b>	NOT GATE	Creates a NOT GATE symbol on the Fault Tree diagram.
	NULL GATE	Creates a NULL GATE symbol on the Fault Tree diagram.
<b></b>	TRANSFER GATE	Creates a TRANSFER GATE symbol on the Fault Tree diagram.
	INHIBIT GATE	Creates an INHIBIT GATE symbol on the Fault Tree diagram.
۲	BASIC EVENT	Creates a BASIC EVENT symbol on the Fault Tree diagram.
	HOUSE EVENT	Creates a HOUSE EVENT symbol on the Fault Tree diagram.
۲	UNDEVELOPED EVENT	Creates an UNDEVELOPED symbol on the Fault Tree diagram.
	DORMANT EVENT	Creates a DORMANT EVENT symbol on the Fault Tree diagram.
۲	CONDITIONAL EVENT	Creates a CONDITIONAL EVENT symbol on the Fault Tree diagram.
$\mathbf{A}$	Text	Allows the user to add a text component to the canvas.
	Image	Allows the user to add an image component to the canvas.
	D 11	
	Page Up	Allows the user to go one level up in the canvas.
₽	Page Up Page Down	Allows the user to go one level up in the canvas. Allows the user to go one level down in the canvas based on the selected Block.
₽	Page Up Page Down Auto Arrange	Allows the user to go one level up in the canvas.         Allows the user to go one level down in the canvas based on the selected Block.         Allows the user to organize the components on the canvas.
	Page Up Page Down Auto Arrange Transfer to MS Word	Allows the user to go one level up in the canvas.         Allows the user to go one level down in the canvas based on the selected Block.         Allows the user to organize the components on the canvas.         Allows the user to transfer any Fault Tree Analysis data directly into MS Word.
	Page Up Page Down Auto Arrange Transfer to MS Word Start FTA Analysis	Allows the user to go one level up in the canvas.         Allows the user to go one level down in the canvas based on the selected Block.         Allows the user to organize the components on the canvas.         Allows the user to transfer any Fault Tree Analysis data directly into MS Word.         Allows the user to perform the necessary calculations of the analysis.
	Page Up         Page Down         Auto Arrange         Transfer to MS Word         Start FTA Analysis         Abort FTA Analysis	Allows the user to go one level up in the canvas.         Allows the user to go one level down in the canvas based on the selected Block.         Allows the user to organize the components on the canvas.         Allows the user to transfer any Fault Tree Analysis data directly into MS Word.         Allows the user to perform the necessary calculations of the analysis.         Allows the user to stop the analysis or calculations currently being performed.
	Page Up         Page Down         Auto Arrange         Transfer to MS Word         Start FTA Analysis         Abort FTA Analysis         Summary	Allows the user to go one level up in the canvas.         Allows the user to go one level down in the canvas based on the selected Block.         Allows the user to organize the components on the canvas.         Allows the user to transfer any Fault Tree Analysis data directly into MS Word.         Allows the user to perform the necessary calculations of the analysis.         Allows the user to stop the analysis or calculations currently being performed.         Displays a summary of the analysis.
	Page UpPage DownAuto ArrangeTransfer to MS WordStart FTA AnalysisAbort FTA AnalysisSummaryHeader Footer	Allows the user to go one level up in the canvas.         Allows the user to go one level down in the canvas based on the selected Block.         Allows the user to organize the components on the canvas.         Allows the user to transfer any Fault Tree Analysis data directly into MS Word.         Allows the user to perform the necessary calculations of the analysis.         Allows the user to stop the analysis or calculations currently being performed.         Displays a summary of the analysis.         Allows the user to create a header and footer for all Fault Tree pages.
	Page UpPage DownAuto ArrangeTransfer to MS WordStart FTA AnalysisAbort FTA AnalysisSummaryHeader FooterAuto Paginate	Allows the user to go one level up in the canvas.         Allows the user to go one level down in the canvas based on the selected Block.         Allows the user to organize the components on the canvas.         Allows the user to transfer any Fault Tree Analysis data directly into MS Word.         Allows the user to perform the necessary calculations of the analysis.         Allows the user to stop the analysis or calculations currently being performed.         Displays a summary of the analysis.         Allows the user to create a header and footer for all Fault Tree pages.         Allows the user to paginate a Fault Tree automatically.
	Page UpPage DownAuto ArrangeTransfer to MS WordStart FTA AnalysisAbort FTA AnalysisSummaryHeader FooterAuto PaginateUndo Auto Paginate	Allows the user to go one level up in the canvas.         Allows the user to go one level down in the canvas based on the selected Block.         Allows the user to organize the components on the canvas.         Allows the user to transfer any Fault Tree Analysis data directly into MS Word.         Allows the user to perform the necessary calculations of the analysis.         Allows the user to stop the analysis or calculations currently being performed.         Displays a summary of the analysis.         Allows the user to create a header and footer for all Fault Tree pages.         Allows the user to paginate a Fault Tree automatically.         Allows the user to undo the Auto paginate previously done.
	Page UpPage DownAuto ArrangeTransfer to MS WordStart FTA AnalysisAbort FTA AnalysisSummaryHeader FooterAuto PaginateUndo Auto PaginateFit to Page	Allows the user to go one level up in the canvas.Allows the user to go one level down in the canvas based on the selected Block.Allows the user to organize the components on the canvas.Allows the user to transfer any Fault Tree Analysis data directly into MS Word.Allows the user to perform the necessary calculations of the analysis.Allows the user to stop the analysis or calculations currently being performed.Displays a summary of the analysis.Allows the user to create a header and footer for all Fault Tree pages.Allows the user to paginate a Fault Tree automatically.Allows the user to roundo the Auto paginate previously done.Allows the user to Fit the Fault Tree diagram in one page automatically.

## The Align Toolbar

The Align Toolbar contains commands for aligning components with respect to a given anchor component.



Tool	Name	Description
	Align Top	Horizontally aligns the selected components with the top of the anchor component.
	Align Middle	Horizontally aligns the selected components with the center of the anchor component.
	Align Bottom	Horizontally aligns the selected components with the bottom of the anchor component.
	Align Left	Vertically aligns the selected components with the left edge of the anchor component.
串	Align Center	Vertically aligns the selected components with the center of the anchor component.
릐	Align Right	Vertically aligns the selected components with the right edge of the anchor component.

## The Nudge Toolbar

The Nudge Toolbar contains commands for moving the selected components by one logical unit in any direction.



Tool	Name	Description
<b>1</b>	Nudge Up	Move the selected components one logical unit up.
Ū	Nudge Down	Move the selected components one logical unit down.
•	Nudge Left	Move the selected components one logical unit left.
	Nudge Right	Move the selected components one logical unit right.

## The Rotate Toolbar

The Rotate Toolbar contains commands for rotating the selected components.

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Tool	Name	Description
Ċ	Rotate	Sets the canvas to Rotate mode. Allows grabbing a component and rotating it.
42	Rotate Left	Rotates the selected components by 90 degrees to the left.
21	Rotate Right	Rotates the selected components by 90 degrees to the right.
⊿⊾	Flip Vertical	Flips the selected components 180 degrees about the Y-axis.
4	Flip Horizontal	Flips the selected components 180 degrees about the X-axis.

## The Layout Toolbar

The Layout Toolbar contains commands for arranging components with respect to each other.



Tool	Name	Description
]⊷[	Space Across	Space the components evenly between the left-most and right-most components selected.
Ŧ	Space Down	Space the components evenly between the top-most and bottom-most components selected.
	Same Width	Change the width of the components to match the anchor component.
	Same Height	Change the height of the components to match the anchor component.
<b></b>	Same Size	Change the width and height of the components to match the anchor component.

## **The Canvas Toolbar**

The Canvas Toolbar contains commands that affect the appearance and behavior of the canvas.



Tool	Name	Description
ŝ	Undo	Undo the last command executed on the canvas.
3	Redo	Redo the last undo that was performed.
	Toggle Grid	Turn display of the grid on and off.
	Snap to Grid	Toggle the snap-to-grid feature on and off.
۵ <mark>0</mark>	Toggle Page Bounds	Turn display of page boundaries on and off.

## The Graph Toolbar

The Graph Toolbar contains commands that affect the appearance and behavior of the Fault Tree diagram. Each selection highlights the way that gates and events are connected through the Fault Tree.



Tool	Name	Description
<b>P</b>	Edges	Click on the gate you wish to select on the Fault Tree, and then click on this symbol to display the connection line to the other figures the selected gate is connected to. The connection line will flash repeatedly on the screen.
Ŧ	Edges Leaving	Click on the gate you wish to select on the Fault Tree, and then click on this symbol to display the connection line that is leaving the selected figure and connecting to the next set of connected gates and events. The connection line will flash repeatedly on the screen.
<b></b>	Edges Entering	Click on the gate you wish to select on the Fault Tree, and then click on this symbol to display the connection line that the selected gate is entering from the gate above it. The connection line from the gate on the next level up on the Fault Tree will flash repeatedly on the screen.
7	Nodes Connected From	Click on this symbol to display the connection line from the first node to the second node. The connection line from the first figure to the second figure will flash repeatedly on the screen.
•	Nodes Connected To	Click on this symbol to display the gate that all nodes are connected to. The gate will flash repeatedly on the screen. This gate is usually the gate directly below the Top Gate in the Fault Tree.
•	Nodes Connected	Click on this symbol to display all nodes that are logically connected within the Fault Tree. Node gate symbols will flash on the screen in order for you to discern which nodes are connected.

## The Zoom Toolbar

The Zoom Toolbar contains commands for zooming and panning the canvas.

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Tool	Name	Description
<u></u>	Ruler Control	Turn the ruler of the canvas on or off.
<b></b>	Properties	Opens the properties window and allows the user to change the component properties.
0	Zoom	Allows zoom in by selecting the area with the left mouse button and zoom out by clicking on the right mouse button.
<b>Po</b>	Zoom to Fit	Sets the magnification level of the canvas so that all components on the canvas are visible.
26	Zoom to Selection	Sets the magnification level of the canvas so that the selected components are visible.
$\langle m \rangle$	Pan	Changes the pointer to a hand and allows grabbing the canvas with the mouse and panning.

## **Shortcut Keys**

Key	Function
Ctrl + N	Open a new project.
Ctrl + O	Open an existing document. Displays the Open dialog box, in which you can locate and open the desired file.
Ctrl + S	Save the active project with its current name. If you have not named the project, the Save As dialog box will open.
Ctrl + P	Print the Active View.
Ctrl + X	Remove selected data from the document and stores it on the clipboard.
Ctrl + C	Copy the selection to the clipboard.
Ctrl + V	Paste the contents of the clipboard at the insertion point.
Ctrl + W	Paste the contents of the clipboard (Gate or Event) at the insertion point as a Repeat Gate or Repeat Event.
Del	Delete the selection.
F1	Open the ITEM ToolKit On-line Help.

# CHAPTER 9

## Markov

Markov Analysis is a technique used to obtain numerical measures related to the reliability and availability of a system or part of a system. Markov Analysis is performed when dependencies between the failure of multiple components as well as dependencies between component failures and failure rates cannot be easily represented using a combination of fault trees and standard time-to-failure and time-to-repair distributions. Specific examples of application areas are standby redundancy configurations as well as common cause failures.

This chapter:

- 1. Introduces Markov system
- 2. Describes ToolKit's Markov features
- 3. Outlines an example Markov System
- 4. Describes the Markov Editor Screen, Toolbars and Shortcut Keys

## 1. Introduction

## Why Use a Markov Analysis?

Markov models allow for a detailed representation of failure and repair processes, particularly when dependencies are involved, and therefore result in more realistic assessments of system reliability measures than simple time-to failure and time-to-repair models. Markov Analysis is well suited to handle rare events, unlike simulation-based analyses, and therefore allows such events to be analyzed within a reasonable amount of time.

## When is Markov Model Used?

Markov Analysis is a technique used to obtain numerical measures related to the reliability and availability of a system or part of a system. Markov Analysis is performed when dependencies between the failure of multiple components as well as dependencies between component failures and failure rates cannot be easily represented using a combination of fault trees and standard time-to-failure and time-to-repair distributions. Specific examples of application areas are standby redundancy configurations as well as common cause failures.

## **Markov Construction**

A Markov Analysis consists of three major steps:

- 1. Specification of the states the system can be in
- 2. Specification of the rates at which transitions between states take place
- 3. Computation of the solutions to the model

Steps 1 and 2 take place in the graphical Markov model editor. In this editor, drawing circles and arrows between the circles, respectively, can create states and transitions between them. The construction of larger Markov models is facilitated by the editor's ability to hierarchically construct Markov models, i.e. break down a higher-level state into lower-level states on a separate 'page', similar to the use of transfer gates in Fault Tree modeling.

Both continuous and discrete transitions can be introduced into the model. Continuous transitions are those representing events that can take place at any time within a given time interval, whereas discrete transitions take place at a specified point in time. For this purpose, individual transitions belong to a transition group, consisting of all the transitions applicable to a given time interval, or taking place at a given point in time. Between intervals, the rate at which given transitions take place may be changed, providing a powerful scheme for phased-mission Markov Models.

Another strong feature of ToolKit's Markov Module is its capability to define state groups. State groups are groups of states within the model for which the user wants to obtain combined statistics, such as total time spent in any of the states, or number of transitions in or our out of the group. One group that is defined by default is the 'Unavailable' group. Any time spent in a state that is marked by the user as belonging to this group is considered to be system downtime, which is taken into account when computing reliability and availability measures.

Once the definition of the model is complete, the user indicates which statistics should be computed, beyond the reliability measures that are computed by default. Available measures include state probabilities, time spent in a given state or state group, as well as transition rate and number of transitions in and out of a given state or state group.

After computation of the solution, Step 3, these results can be observed in the various tabular and graphical formats.

## 2. ITEM ToolKit & Markov Analysis

Markov Analysis is one of the many modules within the ITEM ToolKit application, which includes ITEM ToolKit's standard features and integration. Item Software's Markov Module provides a powerful Markov modeling and analysis technique with strong applications in time-based reliability and availability analysis.

The reliability behavior of a system is represented using a state-transition diagram, which consists of a set of discrete states that the system can be in, and defines the speed at which transitions between those states take place. As such, Markov models consist of comprehensive representations of possible chains of events, i.e., transitions, within systems, which in the case of reliability and availability analysis correspond to sequences of failures and repair.

The Markov model is analyzed in order to determine such measures as the probability of being in a given state at a given point in time, the amount of time a system is expected to spend in a given state, as well as the expected number of transitions between states, for instance representing the number of failures and repairs.

Markov models provide great flexibility in modeling the timing of events. They can be applied when simple parametric timebased models, such as Exponential or Weibull Time-to-Failure models are not sufficient to describe the dynamic aspects of a system's reliability or availability behavior, as may be the case for systems incorporating standby redundancy.

Computing the solution of a Markov model is equivalent to computing the solution of a large system of ordinary differential equations, which is done by integration. For this purpose, the Markov Analysis module relies on a state-of the- art computational engine that has seen many academic and commercial applications.

The engine is started by a simple click of a button within the ITEM ToolKit.

Highlights of the module's features are:

- Phased-mission models
- Powerful graphical Markov model editor
- Discrete and continuous-time transition models
- Flexible definition of states and groups of states.

Markov Module provides the following measures and results:

- Expected up and down time
- Number of expected failures and repairs
- Failure and repair frequencies (at given point in time)
- Availability / Reliability (at given point in time, average over mission time interval)
- Probability of being in a particular state (at given point in time, average over mission time interval)
- Customizable Report Generator
- Extensive Import / Export facility from or to Jet Database, Excel or Text.

The Markov workspace area features a Multiple Document Interface (MDI), which allows you to:

- Choose which windows to display, and move and resize all open windows
- Open and create multiple Markov projects at the same time in order to compare analysis results
- Drag and drop State and Group components between projects. This feature allows you to quickly create a new project by reusing components from other projects.

## 3. Creating a Markov Project

In this example, we will use the ITEM ToolKit Markov module to model and analyze a simple two-component standby system. The system is thought to consist of two identical components that are operated in a warm-standby mode. It is assumed that failures of the standby component are not detected until a demand is made.

- 1. Click on the New Project icon (A) on the default toolbar, or select New Project from the File menu.
- 2. Activate your project by clicking on the Project tab (**B**) or in the Project window.
- 3. Select the Dialog tab from the bottom of the Viewing Option window.
- 4. The Project Dialog Box will be displayed.

۲	🚯 - [IT - Item ToolKit - Project::Dialog]			
	<u> Eile A</u> dd Edit Layout <u>S</u> ettings <u>C</u> hart <u>W</u> indow <u>H</u> elp			
]] C	📽 🖬   X 🖻 🖻 X 🕫 🎒 🕅 X 🗤	XF XC XV 🌽 🔦 🚺 🖶 🥵 🗮 🗞 🌘		
🔿 ITP3	ITP: A PROJECT: IT Project (Prediction Totals: FR=0; Q=0; MT	PROJECT		
Ľ.	B	Title : New Project Name : IT Project Part Number : LCN :		
217	× •	Circuit Ref.: Analyst : Compiled By :		

5. Enter your project information by placing the cursor or clicking in the appropriate fields.

- Project				
Title :	Markov Tutorial	Description :	Two identical components, that are operated	<u> </u>
Name :	Two-component standby		in a warm-standby mode.	<b>T</b>
Part Number :		Function		<b>A</b>
LCN :		Description.		-
Circuit Ref.:		Notes :		-
Analyst :				-
Compiled By :		Approved By :		_
Applies to failure prediction systems contained in this project       Totals:         Target Rate :       0         Life Time (hrs):       24         Redundancy :       •				

6. The table below displays each field that is available for a project and what each field pertains to:

Field	Description	
Title	The Project Title	
Name	Project Name	
Part Number	Project Part Number	
LCN	Logistic Control Number	
Circuit Ref	Reference Identification Number (for internal purposes)	
Analyst	The person performing the Markov calculation	
Compiled By	The person who gathered the data for this analysis	
Description Description of the project		
Function Description         What the project/system does		
Notes	Any other pertinent information on the project	
Approved By	The person required to sign off on the project	
The following fields will display results only if a prediction system is part of the project		
Target Rate	Acceptable number of failures for the project (Failures Per Million Hours)	
Life Time	Project life time given in hours	
Redundancy	Redundancy Flag	
Failure Rate	Total Project failure rate once analysis are completed	
Unavailability	Project unavailability once the analysis has been run	
MTBF	Mean Time Between Failures for the project	

7. From the Add Menu, select Markov System. The Markov system and project headers are added.



- 8. In the System Window, click the Markov header. The system properties appear in the Dialog tab.
- 9. In the Dialog tab, enter your system information by placing the cursor or clicking in the appropriate fields.

Markov System				
Title :	MKV Example	Description :		*
Name :	MKV STANDBY #1			
Part Number :				*
LCN :	F	Function Description :		*
Circuit Ref.:				-
Analyst :		Notes :		*
Compiled By :				
Approved By :				~
-Miscellaneous			Unavailability :	
Mission Time (Hours): 1 No of Intermediate Time 100 Points :			Failure Frequency :	
			Conditional Failure Intensity :	
			No of Expected Failures :	
			Unreliability :	
			Total Down Time :	

10. The table below describes what could be entered and what each field and block of fields pertains to:

Field	Description
Title	The System Title
Name	A unique Reference Identifier for the System
Part Number	System Part Number
LCN	Logistic Control Number
Circuit Ref	Circuit Reference Number
Analyst	Name of the person performing the Analysis
Compiled by	Name of the person who gathered the data for the Analysis
Approved by	Name of the person who is required to sign off on the project
Description	Description for this System
Function Description	Purpose/Description of this system
Notes	Enter any other pertinent information about this system
Mission Time	Mission Time of the System in hours
No of Intermediate Time Points	No of Intermediate Time Points to be computed during the Mission Time
Failure Frequency	Failure Frequency of the System (Calculated)
No of Expected Failures	No of Expected Failures of the System (Calculated)
Conditional Failure Intensity	Conditional Failure Intensity of the System (Calculated)
Total Down Time	Total Down Time of the System (Calculated)
Unreliability	Unreliability of the System (Calculated)
Unavailability	Unavailability of the System (Calculated)

#### 210 ITEM ToolKit Getting Started Guide

- 11. The next step is to insert 5 states into the model, corresponding to the following system states: both components available, prime failed, standby failed, both prime and standby failed, and prime repaired.
- 12. From the Markov toolbar, click the State button (A). This button is used to start the insertion of new states into the model.



13. Move the mouse-pointer into the Markov canvas, and click the left mouse button once. A green circle, representing a newly created state, appears.



14. Move the mouse-pointer to an empty part of the Markov canvas, and left-click again. A second state appears in the diagram.



15. Repeat the last step three more times. A total of five states should now be visible in the Markov canvas.



- 16. We consider that at time 0, both the primary and standby components are available, and that the system therefore is in the first state. In other words, this state is the initial state.
- 17. Right-click the state S1 corresponding to the 'both components available' state. A popup menu appears.
| Cut<br>Copy             |
|-------------------------|
| 🔁 Paste                 |
| Order •                 |
| Properties              |
| Set Property As Default |
| ✓ AutoFit Text          |
| Select Phase            |
| State Parameters        |

- 18. From the popup menu, select the State Parameters... option. A dialog box will appear.
- 19. In the dialog box, enter "both available" for the Name and check the 'Initial State' option, and click OK.

Markov State	×
11 State 11 Groups	
Name: STATE1 Initial State Probability: 0 Unavailability State: Initial state:	
Description:	
, Group Labels: 🔽	
Spelling OK Cancel	

State parameters include the following.

- Name: a label used to identify the state. The names of each state must be unique among all the states in a Markov model.
- Initial state probability: a value between 0 and 1, representing the probability that the system is in the specific state at t = 0. The initial probabilities of all states in a model must add up to 1.
- Unavailability state: a flag indicating whether the state represents a system state in which the system is unavailable. The Markov model diagram indicates states for which this option is selected by a small circle next to the state.
- Initial state: a flag indicating whether the state is the sole initial state.

Repeat the steps 17 to 19 for the remaining states with the parameters listed below.

Original Name	New Name	Unavailability State	Initial State
S 2	Primary Failed		Х
S 3	Both Failed	Х	
S 4	Standby Failed		Х
S 5	Primary Repaired		Х

#### 212 ITEM ToolKit Getting Started Guide

Furthermore, we assume that the system as a whole is unavailable when both the primary and standby components are failed. While in principle any number of states can be marked as unavailable, here we will limit it.

- 20. Right-click the state corresponding to the 'both components failed' state. A popup menu appears.
- 21. In the popup menu, select the *State Parameters*... option. A dialog box opens.
- 22. In the dialog box, check the 'Unavailable State' option, and click OK.
- 23. Ensure that in the editor pane, the state is indicated as being an unavailable state of the system by a small circle (A) appearing next to the state.



24. Next, we introduce into the model the transitions representing the failures as well as repairs of the components. By inserting a transition originating in one state and leading to another, we model the possibility of an event-taking place that would bring the system from one state to another. In our simple model, we will insert eight transitions, as listed in the following Table.

From	То	Description	Rate
Both Available	Primary Failed	Failure of primary component	0.001
Both Available	Standby Failed	Failure of standby component	0.0001
Primary Failed	Both Available	Repair of primary component	0.5
Primary Failed	Both Failed	Failure of standby while primary failed	0.001
Standby Failed	Both Failed	Failure of primary while standby failed	0.001
Both Failed	Primary Repaired	Repair of primary while standby still failed	0.5
Primary Repaired	Both Available	Repair of standby	0.5
Primary Repaired	Both Failed	Repair of primary while standby under repair	0.001

25. In the Markov toolbar, click the Arrow Link Button (B). This button is used to start the creation of new transitions.



- 26. Left click on the Both Available state. A line originating from the state becomes visible as the mouse is moved around the Markov canvas.
- 27. Click on the Primary Failed state. An arrow appears between the two states. The arrow's label indicates a rate of occurrence R of 0 (C).
- 28. Right-click on the label. A popup menu appears.

- 29. Select the 'Transition Parameters' option. A dialog appears.
- 30. In the field labeled 'Transition' (**D**), enter the value 0.001, corresponding to the rate of occurrence of this transition, and then click OK. The diagram indicates the updated rate of occurrence for the transition.

both available RDEDI-
 Markov Transition
 Name: T9
 Transition Date:
 Discrete Probability: 0
 Phase Name: P1
 Description: Group Labels : 🔽 🗖 🗍
 Eailure of Primary Component
 OK Cancel Cancel

31. Repeat the process for the remaining seven transitions listed in the Table.



#### 214 ITEM ToolKit Getting Started Guide

- 32. Now that both the states and transitions have been defined, the simple model is complete.
- 33. Along with states, it is possible to define state groups. You can create state groups in case you want to obtain the aggregated results, such as the combined state probability, for two or more states combined. A state group can contain any number of states, and can therefore also consist of a single state; a given state can belong to any number of state groups. Groups are created to compute aggregate results, such as the expected time spent in any of the states in a group.
- 34. The simplest method to create a new group is to click the *Add Group* toolbar button while in the Markov model editor. The new group, with a default name, is shown in the Markov hierarchy in the lower left corner of the ToolKit window. Once states are added to a group, this will also be made visible there.



35. States are added to a group in the State Parameters dialog. To open this dialog, right-click on the state, and select the State Parameters option in the popup-menu. Then, make the Groups tab in that dialog visible.

Markov State	×
🖽 State 🛛 🖽 Groups	
MKV:0	Name: Under Repair
Both Failed     Primary Repai	Description: System is under repair
	~
	Unavailability Group 🗔
	Add new group
	Delete selected group
	Add selected state to group
	Remove selected state from group
Spellin	g OK Cancel

36. The left part of the tab lists all the groups that have been created so far. New groups can be added by clicking the *Add New Group* button. Unnecessary groups can be deleted by selecting them and clicking the *Delete Selected Group* button. Note that this will only delete the group definition, but not the states contained in the group.

- 37. When a group is selected, its name and description are made visible in the corresponding fields. The fields can be used to change names and descriptions.
- 38. To add the state to the group, click the *Add Selected State to Group* button. The list of groups will now show that the state has been attached. The *Remove Selected State from Group* button can be used to remove states from the group.
- 39. Close the dialog by clicking the *OK* button. The updated group information is shown in the Markov hierarchy in the lower left corner of the ToolKit window.
- 40. We continue the example by analyzing the model, and evaluating its results. First, we specify the mission time interval.
- 41. Click on the Dialog tab.
- 42. Set the mission time to 1000 and the number of intermediate points to 100 in the dialog window.

Miscellaneous	
Mission Time :	1000
No of Intermediate Time Points :	100

- 43. Then we start the actual analysis.
- 44. Switch back to the Markov tab, and start the analysis of the model by clicking the Go button (C) in the toolbar.



- 45. A progress indicator briefly becomes visible. Once the analysis is complete, a notification message appears, stating that the analysis has completed without errors. The results of the analysis are now ready for viewing.
- 46. Click the Result Summary button in the toolbar (**D**). The result summary dialog opens.



47. The table in the Result Summary dialog lists the key results of the Markov analysis.

Markov Result Summ	агу				
	Summary				
DOHERROCESSOR	Parameter:	Value			
	Unavailability Q:	0.00064471329			
	Mean Unavailability:	0.00037256572			
	Failure Frequency W:	0.0010324736			
	CFI	0.0010331397			
	Expected Failures:	0.001017279			
	Unreliability:	0.0010167174			
	Total Down Time TDT:	0.00037256572			
	Availability A:	0.99935529			
	Mean Availability:	0.99962743			
	Repair Frequency:	0.00064471329			
	CRI	1			
	Expected Repairs:	0.00037256572			
	Reliability:	0.99898328			
	Total Up Time TUT:	0.99962743			
	5 - 15				
	<				
		U			

### **Understanding Analysis Results**

The following shows how the various reliability measures are computed. *X* refers to the state or group of states that have been marked as 'Unavailable States'. In these definitions, the following notation is used:

x: a state.

X: a group of states.

Pr(x;t): The probability that the system is in state x at time t.

Pr(X;t): The probability that the system is any of the states belonging to group X at time t.

- $\lambda_{x \to y}$ : The rate at which transition takes place from state x to state y. These transition rates concern continuoustime transitions.
- $P_{x \to y}(t)$ : The probability of a transition from state x to state y at time t. These probabilities concern discrete-time transitions.

#### Unavailability Q: / Availability A

The point unavailability is computed as the probability that the system is in any of the states belonging to group X at time t. The availability is computed as 1 minus this value.

$$U(t) = \Pr(X;t)$$
$$A(t) = 1 - U(t)$$

#### TDT (Total Down Time): / Total Up Time (TUT)

The Total Down Time and Total Up Time are respectively computed as the expected amount of time spent in any state belonging to group X, and in any state not belonging to group X, between 0 and t.

$$TDT = \int_{\tau=0}^{t} \Pr(X;\tau) \cdot d\tau$$
$$TUT = t - TDT$$

#### Mean Unavailability: / Mean Availability

The mean unavailability is computed as the expected amount spent in X divided by the total mission time. The mean availability is computed as 1 minus this value.

$$\hat{U} = \frac{1}{t} \int_{\tau=0}^{t} \Pr(X;\tau) \cdot d\tau$$
$$\hat{A} = 1 - \hat{U}$$

#### **Expected Failure: / Expected Repair**

The expected number of repairs r is computed as the expected number of transitions from X to states outside X. The expected number of failures f is computed as the expected number of transitions from states outside X to states inside X.

$$\begin{split} r &= \sum_{i:x_i \in \mathcal{X}} \sum_{j:y_j \notin \mathcal{X}} \left[ \int_{\tau=0}^{t} \Pr(x_i; \tau) \cdot \lambda_{x_i \to y_j} \cdot d\tau + \sum_k \Pr(x_i; t_k) \cdot P_{x_i \to y_j}(t_k) \right] \\ f &= \sum_{i:x_i \in \mathcal{X}} \sum_{j:y_j \notin \mathcal{X}} \left[ \int_{\tau=0}^{t} \Pr(y_j; \tau) \cdot \lambda_{y_j \to x_i} \cdot d\tau + \sum_k \Pr(y_j; t_k) \cdot P_{y_j \to x_i}(t_k) \right] \end{split}$$

where  $t_k$ , k = 1, ..., n is the set of times  $t_k < t$  at which discrete transitions take place. Note that this definition excludes transitions that take place between states that belong to group *X*, as well as transitions that take place between states that do not belong to group *X*.

#### Unreliability

Unreliability represents the probability of one or more system failures over a specified period of time. The number of expected system failures (W) provides a good approximation for system unreliability for cases where  $W \ll 1$ .

#### Reliability

Reliability represents the probability that the system will perform without failure during the specified period of time.

#### Failure Frequency W

**Failure Frequency W** is the term used by the system to represent the unconditional failure intensity. The unconditional failure intensity is the probability that the system or component fails per unit time, given that it was working correctly at time **zero**. "W" is equal to the number of expected system failures.

#### **CFI (Conditional Failure Intensity)**

This is the probability of failure per unit time, given that the component was "working-as-designed" at time **zero** and is working at time **t**.

# How to Transfer Markov to Microsoft Word

A powerful export facility is provided with the Markov module that will allow you to transfer data directly to Microsoft Word.

1. To access the Microsoft Word transfer facility, select the Microsoft Word icon from the Markov toolbar.

Mk	⊴  ]] ⊾	•	ŧ	٠	A	<u>_</u>		60		¥	1	P 2	2
					_		ht						
. 1	5	التنب			ſ	Tran	sfer t	o Mi	cros	oft	Word	d	

2. The Range window appears. Check all desired option and click OK.

Transfer To MS Word Dialog	×
Total Pages : 🚺	1
Page Range © All	
C Pages from: 1 to: 1 to:	
C Selection C Current Page	
🔲 Fit To Page	
Reference Table	
Create Page Reference Table Sort by name	]
Header Footer	
Add Header	
[Page#]	I
Footer	-
Add Footer	1
[Page#]	1
OK Cancel	1

3. The Markov pages you have selected will be transferred directly into Microsoft Word. Microsoft Word does not have to be active on your desktop to perform this transfer, it will open automatically.



# 4. Markov Editor Screen, Toolbar and Shortcut Keys Quick Reference

#### **The Markov Editor Screen**



The Markov editor can be made visible by selecting the Dialog Tab (1) or the Markov tab (2). Its main elements are the following:

- Main Menu (3): Quick access to the main functions.
- Markov Toolbars (4): Quick access to editing functions.
- Project Window (5): A hierarchical view of the project and systems.
- System Window (6): A hierarchical view of the states, transitions and groups in the model.
- Markov Window or canvas (7): The area in which Markov can be graphically edited.

# The Default Toolbar

Immediately below the pull-down options resides a group of buttons that form a Default Toolbar allowing the user to access directly some of the more frequently used menu options.



Tool	Name	Description
	New	Opens a new project.
<b></b>	Open	Open an existing document.
	Save	Save the active document or template with its current name.
Ж	Cut	Remove selected data from the document and stores it on the clipboard.
	Сору	Copy the selection to the clipboard.
	Paste	Paste the contents of the clipboard at the insertion point.
$\mathbf{x}$	Delete Item	Delete the selection.
ŝ	Undo	Reverse the last editing. Note: You cannot undo some actions.
9	Print	Print the active document.
P	About	Open the About ITEM ToolKit Window.
<b>N?</b>	Help	Open the ITEM ToolKit On-line Help.

# The Markov System Dialog Window Controls

The Markov Dialog Window Contains the following Controls.



Tool	Name	Description
K)	Undo Changes	Cancels the latest operation.
	Analyse	Run the Analysis of the system.
ABC	Check Spelling	Check the Spelling of the selected Text.

# The Project Toolbar

The Project Toolbar displays the available analysis options for the ToolKit application

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Tool	Name Description	
214	MIL217	Add a MIL-HDBK-217 (Electronic) System.
$\lambda^{\mathrm{T}}$	Telcordia (Bellcore)	Add a SR-332 Telcordia (Electronic) System.
$\lambda^{\pm}$	IEC 62380 (RDF)	Add an IEC 62380 French Telecom Standard (Electronic) System.
$\lambda^{\mathbb{C}}$	299B	Add a 299B Chinese Military Standard (Electronic) System.
$\lambda^{N}$	NSWC (Mechanical)	Add a NSWC (Mechanical) System.
ß	Maintain	Add a Maintain MIL-HDBK-472 Procedure V System.
<b>4</b> 2	SpareCost	Add a Spare Cost Spares Scaling and Ranging System.
α	FMECA	Add a Failure Modes Effects and Criticality Analysis (FMECA) System.
¢ <mark>B</mark>	RBD	Add a Reliability Block Diagram (RBD) System.
æ	Fault Tree	Add a Fault Tree Analysis (FTA) System.
Û	Event Tree	Add an Event Tree Analysis (ETA) System.
∞	Markov	Add a Markov Modeling System.

# The Nudge Toolbar

The Nudge Toolbar contains commands for moving the selected components by one logical unit in any direction.



Tool	Name Description		
<b>(</b>	Nudge Up	Move the selected components one logical unit up.	
Ū	Nudge Down	Move the selected components one logical unit down.	
•	Nudge Left	Move the selected components one logical unit left.	
<b>.</b>	Nudge Right	Move the selected components one logical unit right.	

# The Canvas Toolbar

The Canvas Toolbar contains commands that affect the appearance and behavior of the canvas.

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Tool	l Name Description		
ŝ	Undo	Undo the last command executed on the canvas.	
2	Redo	Redo the last undo that was performed.	
	Toggle Grid	Turn display of the grid on and off.	
	Snap to Grid	Toggle the snap-to-grid feature on and off.	
B	Toggle Page Bounds	Turn display of page boundaries on and off.	

# The Markov Toolbar

The Markov Toolbar is used to create and control Markov Analysis through the commands it contains.

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Tool	Name	Description
13	Select	Cancels add mode.
$\circ$	State	Creates a State into the Markov System.
+	Arrow Link	Creates a Link into the Markov System.
	Group	Creates a Group into the Markov System.
$\mathbf{A}$	Text	Allows the user to add a text component to the canvas.
	Image	Allows the user to add an image component to the canvas.
	Transfer to MS Word	Allows the user to transfer any Markov data directly into MS Word.
60	Start Markov Analysis	Allows the user to perform the necessary calculations of the analysis.
<b></b>	Abort Markov Analysis	Allows the user to stop the analysis currently being performed.
<b>*</b>	Summary	Displays a summary of the analysis.
	Header Footer	Allows the user to create a header and footer for all Markov pages.
P 2	Phase List	Phase List Selection Pull Down Menu.

224	ITEM ToolKit Getting Started Guide		
	Fit to Page	Allows the user to fit the Markov diagram in one page automatically.	
B	Reset Fit to Page	Allows the user to undo the fit to page previously carried out.	

# The Zoom Toolbar

The Zoom Toolbar contains commands for zooming and panning the canvas. Zoom options can also be accessed by rightclicking in the white space on the Markov diagram.



Tool	Name	Description
<u></u>	Ruler Control Turn the ruler of the canvas on or off.	
	Properties	Open the properties window and allows the user to change the selected component properties.
9	Zoom	Changes the cursor to a magnifying glass and allows the user to zoom in by selecting the area to be zoomed in with the left mouse button and zoom out by clicking on the right mouse button.
20	Zoom to Fit	Sets the magnification level of the canvas so that all components on the canvas are visible in the view-port.
88	Zoom to Selection	Sets the magnification level of the canvas so that the selected components are visible in the view-port.
$\langle \! \! \! \mathfrak{S} \rangle$	Pan	Changes the pointer to a hand and allows the user to grab the canvas with the left mouse button and pan in any direction.

# The Rotate Toolbar

The Rotate Toolbar contains commands for rotating the selected components.



Tool	Name Description		
Ċ	Rotate	ate Sets the canvas to Rotate mode. Allows grabbing a component and rotating it.	
	Rotate Left	Rotates the selected components by 90 degrees to the left.	
21	Rotate Right	Rotates the selected components by 90 degrees to the right.	
⊿⊾	Flip Vertical	Flips the selected components 180 degrees about the Y-axis.	
4	Flip Horizontal	Flips the selected components 180 degrees about the X-axis.	

# The Graph Toolbar

The Graph Toolbar contains commands that affect the appearance and behavior of the Markov diagram. Each selection highlights the way that States are connected through the Markov System.



Tool	Name	Description
•	Edges Entering	Click on the state you wish to select on the Markov, and then click on this symbol to display the connection line(s) that the selected state is (are) entering from the state close to it. The connection line(s) will flash repeatedly on the screen.
Ŧ	Edges Leaving	Click on the state you wish to select on the Markov, and then click on this symbol to display the connection line(s) that is (are) leaving the selected figure and connecting to the next set of connected states. The connection line will flash repeatedly on the screen.
<b>(</b>	All	Click on the state you wish to select on the Markov, and then click on this symbol to display all the connection line(s) to the other figures the selected state is (are) connected to. The connection line will flash repeatedly on the screen.
7	Nodes Connected From	Click on this symbol to display the states connected from (leaving) the selected state. The connected states will flash repeatedly on the screen.
-	Nodes Connected To	Click on this symbol to display the states connected to (entering) the selected state. The connected states will flash repeatedly on the screen.
1	Nodes Connected	Click on this symbol to display all states that are logically connected within the Markov. Only connected State symbols will flash on the screen.

#### Shortcut Keys:

Key	Function
Ctrl + N	Open a new project.
Ctrl + O	Open an existing document. Displays the Open dialog box, in which you can locate and open the desired file.
Ctrl + S	Save the active project with its current name. If you have not named the project, the Save As dialog box will open.
Ctrl + P	Print the Active View.
Ctrl + X	Removes selected data from the document and stores it on the clipboard.
Ctrl + C	Copy the selection to the clipboard.
Ctrl + V	Paste the contents of the clipboard at the insertion point.
Ctrl + W	Paste the contents of the clipboard (Gate or Event) at the insertion point as a Repeat Gate or Repeat Event.
Del	Delete the selection.
F1	Open the ITEM ToolKit On-line Help.

# CHAPTER 10

# Maintain

A comprehensive design tool for calculating MTTR, Maintain conforms to maintenance standards established in MIL-HDBK-472, Procedure V, Method A.

This chapter:

- 1. Introduces Maintain system
- 2. Describes Toolkit's Maintain features
- 3. Outlines an example Maintain System
- 4. Describes the Maintain Editor Screen, Toolbars and Shortcut Keys

# 1. Introduction

Maintain is an engineering tool to aid in Maintainability Prediction. It provides an integrated environment for prediction of the expected number of hours that a system or device will be in an inoperative or "down state" while it is undergoing maintenance.

Maintain utilizes techniques specified in MIL-HDBK-472 Procedure V Method A to predict maintainability in quantitative terms.

The recommended application of this technique is to perform the analysis as early as possible during the design phase. This prediction should also be updated continuously as the design progresses to assure a high probability of compliance with specified requirements. Maintain facilitates and eases this analysis and iteration of it by implementing this technique in a 32Bit Windows desktop application.

Using Maintain early in a project design provides a sound basis for development. Use it throughout the project to stay on development schedules and remain in compliance with client requirement. Use it consistently to maximize productivity and ensure ongoing success.

Mission-critical operations depend on the continuing function of systems but all systems are affected by time, use and obsolescence. These factors can seriously affect end-users timelines and productivity.

When you design or develop a product, Maintain helps you to:

- Identify areas with potential maintainability problems.
- Make repair/replace and design decisions.
- Make early assessment of downtime.
- Make early assessment of personnel numbers.
- Plan for necessary tools and test equipment.
- Easily identify Replaceable Items (RIs)
- Save and export essential data for use in other RAMS analyses.

# 2. ITEM ToolKit & MainTain

Maintain provides built-in elemental maintenance action, maintenance philosophy and fault isolation. You can save common maintenance tasks to a library for repetitive use.

#### Maintain Calculates the Following for Component or Group of Components

- Total Mean Time To Repair (Total MTTR)
- Mean Time To Repair per Replaceable Items (MTTR)
- Mean Man Hour (MMH)
- Mean Man Hour per Repair (MMH/R)
- Mean Man Hour per Maintenance Action (MMH/MA)
- Mean Man Hour per Operating Hours Action (MMH/OH)
- Total Failure Rate of all Replaceable Items in a Group (F/Rate)
- Average number of Replaceable Items contained in a fault isolation result (S Avg)
- Average Preparation Time (Tp)
- Average Fault Isolation Time (Tfi)
- Average Disassembly Time (Td)
- Average Interchange Time (Ti)
- Average Reassembly Time (Tr)
- Average Alignment Time (Ta)
- Average Checkout Time (Tc)
- Average Start-up Time (Tst)

ITEM ToolKit's graphical user interface uses standard Windows dialogs, menus, toolbars, and controls. The Multi Document Interface (MDI) architecture allows you to simultaneously display multiple projects, systems and data views in separate viewing areas in the ToolKit workspace. The interface allows you to easily:

- Transfer data between different systems and projects.
- Cut, copy, and paste data.
- Drag and drop objects within and between projects.
- Customize the workspace toolbar.
- Customize Report Generator.
- Access online help.
- Import / Export from or to Jet Database, Excel or Text.
- Plot and graph.

# 3. Creating a Maintain Project

To demonstrate ToolKit's maintainability features, we'll create an example based on a simple desktop computer system.

- 1. Click on the New Project icon (A) on the default toolbar, or select New Project from the File menu.
- 2. Activate your project by clicking on the Project tab (B) or in the Project window.
- 3. Select the Dialog tab from the bottom of the Viewing Option window.
- 4. The Project Dialog Box will be displayed.



5. Enter your project information by placing the cursor or clicking in the appropriate fields.

Project			
Title :	Maintain Tutorial	Description :	Stand Alone Computer
Name :	ABC Computer System		<b>_</b>
Part Number :		Function	
LCN :		Description.	
Circuit Ref.:		Notes :	A
Analyst :			
Failure Rate :	0	Compiled By :	
Redundancy :	<b>•</b>	Approved By :	
Life Time (hrs):	24	Target Rate :	0
MTBF (hrs):	-1	- Unavailability :	0

6. The information entered for a project is only for the project level. The table below displays each field that is available for a project and what each field pertains to:

Field	Description	
Title	The Project Title	
Name	A Unique Reference Identifier	
Part Number	Project Part Number	
LCN	Logistic Control Number	
Circuit Ref	Circuit Reference	
Analyst	Person Performing the Maintain Analysis	
Redundancy	Redundancy Flag	
Life Time Project life time given in hours		
Description What the project is		
Function Description         What the project/system does		
Notes	Any other pertinent information on the project	
Compiled By	Person who gathered data for analysis	
Approved By	Person required to sign off on the project	
The following fields will display results only if a prediction system is part of the project		
Failure Rate	Will display total Project failure rate once analysis is complete	
MTBF Mean Time Between Failures for the project description		
Target Rate	Acceptable number of failures for the project (Failures Per Million Hours)	
Unavailability This box will display the Project unavailability once the analysis has been run		

7. From the Add Menu, select Maintain System. The Maintain system and project headers are added.



#### 232 ITEM ToolKit Getting Started Guide

- 8. In the System Window, click the Maintain header. The system properties appear in the Dialog tab.
- 9. In the Dialog tab, enter your system information by placing the cursor or clicking in the appropriate fields.

-MainTain System			
Title :	ABC Computer System	Description :	Stand alone Computer
Name :	Maintain Tutorial		<b>_</b>
Part Number :		Function	A
LCN :		Description.	<b>_</b>
Circuit Ref.:		Notes :	
Analyst :			
Approved By :		Compiled By :	

10. The table below describes what could be entered and what each field and block of fields pertains to:

Field	Description
Title	The System Title
Name	A Unique Reference Identifier for the System
Part Number	System Part Number
LCN	Logistic Control Number
Circuit Ref	Circuit Reference Number
Analyst	Name of the person performing the Maintain Analysis
Compiled by	Name of the person who gathered the data for the Maintain Analysis
Approved by	Name of the person who was required to sign off on the Maintain project
Description	Description for this System
Function Description	Purpose/Description of this system
Notes	Any other pertinent information about this system

- 11. Move the mouse to the System Window in the bottom left of the ToolKit screen and click the left mouse button to make this the active window.
- 12. From the Add Menu, select Replaceable Item.



- 13. Move the mouse cursor to the System Window. The mouse cursor changes to add mode.
- 14. Click the system header. The Replaceable Item is added and its properties appear in the Dialog tab.
- 15. Click the system header (A) three more times to add three more Replaceable Items. Your System Window should be similar to the example below:
- 16. Click on the End Add Mode (B) toolbar icon to return the cursor to the normal mode.
- 17. Select the first blue replaceable item under the system header (C) and, making sure the Dialog tab (D) is selected, fill in the data as shown below:

- [IT - Item ToolKit - Project::Dialog]	
🕐 Eile Add Edit Layout Settings Chart Window Help	_ & ×
	<u> </u>
Static         Part Number:         PS1         Description:         Power Supply 110/240 VAC Supply           Name:         1.1         SV/12V DC Output         SV/12V DC Output           Circuit Ref.:         Notes:         Notes:	
ITP2         Quantity:         1         Analyst:           Image: Supply 110/241         Replaceable Item:         Image: Supply 110/241         Ima	
Image: Instructure     Image: Im	

18. Enter data for the remaining Replaceable Items as follows:

Part No.	Description	Failure Rate
CPU1	CPU Board 8086 Processor + on-board logic.	8.46
MM1	Memory Board 256K RAM + 16K ROM	11.41
DP1	Display Processor Mk2 Monochrome Display board	1.85

#### Defining the Maintenance Philosophy & Fault Isolation Resolution for Each Ri Set

- 1. Select the first RI (Replaceable Item) in the system and click the "Fault Isolation to a Group of RI's in the General dialog tab. The Maintenance Philosophy & Fault Isolation dialog tab becomes active.
- 2. Click on the Maintenance Philosophy & Fault Isolation dialog tab.
- 3. Click on New Group button (A) and the RI Group name will be set as "Group 1" (B) and tick Group Replacement in the "Isolation to a Group of RI's" section (C) to set the maintenance philosophy for the group.

Static B					
	Description:				*
RI Group Name: System Unit					
Quantity In This Group: 4		I			+
Total Group Failure Rate: 22.402335178107	Notes:				*
					-
A lused Groups New Group					
		-Fault F	Resolution:		
		-Fault F	Resolution:	Add C	Delete
		-Fault F	Resolution:	Add [	Oelete
Isolation to a Group of RIs		-Fault F	Resolution:	Add C No. of Ris(<=	Oelete
Isolation to a Group of RIs		Fault F	Resolution: Resolution % 90 100	Add [ No. of RIs(<= 1 2	elete
Isolation to a Group of RIs Group Replacement: C Single Access		Fault F	Resolution: Resolution % 90 100	Add C No. of RIs(<= 1 2	Qty)

- 4. Click the Add button (**D**) twice in the Fault Resolution section (still in the Maintenance Philosophy & Fault Isolation dialog tab).
- 5. Click in the "Resolution %" for the first line just inserted (E) and change the number to 20%.
- 6. Leave the "No. of RI's" set to 1 for the first line and click in the Resolution % for the second line inserted.
- 7. Leave the "Resolution %" at 100% and change the "No. of RI's" to 2 (F).

	Description:
RI Group Name: System Unit	
Quantity In This Group: 4	
Total Group Failure Rate: 22.402335178107	Notes:
Delete Unused Groups New Group	E Fault Resolution: Add Delete
Isolation to a Group of RIs	Resolution % No. of RIs(<=Qty) ▲
Group Replacement: O Single Access	2 100 2
T Iterative Replacement:   Multiple Access	

- 8. You have now said that 20% of the time the operator/maintenance technician will be able to isolate the fault to 1 RI, and for the rest of the time (100%), the operator/maintenance technician will be able to isolate the fault to 2 RI's.
- 9. Select each of the remaining 3 RI's in the system; click "Fault Isolation to a group of RI's" in the General tab and make sure "Group 1" is selected in the "The Maintenance Philosophy & Fault Isolation dialog tab".

#### **Failure Rate Allocation**

1. Select the first RI item in the system, click the "Maintenance Element & Failure Rate Allocation" dialog tab and select Preparation in the Maintenance combo box (G). The following screen is displayed:

	Add	Delet	te		Add	To Library	Get From Library
	v:	Element	Description:	Time Tmv:(min)	Task No:	%Allocation	:
1	1	Reassembly		0	5	0	
2	1	Alignment		0	6	0	
3	1	Checkout		0	7	0	
ļ.	1	Startup		0	8	0	
i	1	Interchange	R & R Power Supply	3	1	100	

2. In the %Allocation column (H), enter 80% against "Computer P/S" and 20% against "Controller P/S". The screen should now look like the example below.

4	Add	Delet	te		Add	To Library	Get From Library
	v:	Element	Description:	Time Tmv:(min)	Task No:	%Allocation:	<b></b>
1	1	Reassembly		0	5	0	
2	1	Alignment		0	6	0	
3	1	Checkout		0	7	0	
4	1	Startup		0	8	0	<b>T</b>
5	1	Interchange	R & R Power Supply	3	1	100	

3. You have just allocated how you think the failures will be fixed for the selected RI. Eighty percent of the time the Power Supply will be fixed by replacing the Computer P/S and 20% of the time by replacing the Controller P/S.

#### 236 ITEM ToolKit Getting Started Guide

4. To complete the Failure Allocation, you should allocate percentages for each maintenance element, for each RI in the system.

# **Viewing Results**

To view the project results:

1. Click the system header (I) in the System Window.



2. Click on the Result tab (J) at the bottom of the ITEM ToolKit screen to display the results.

			Summary '	View													
		Parameter		Value													
	Total MT	Total MTTR (Min.)			21.7099												
2	MMH (H	MMH (Hour)			0.2778												
3	MMH/Re	MMH/Repair(Hour)			0.292												
						Tain C.	mman	Result	s								
					Main	Tain St	anniary										
	RI Gro	up Name   Qi	uantity F/	Rate(fj	маın pmh)   С	Code   9	S avg.	Тр	Tfi	Td	Ti	Tr	Та	Tc	T	st	мт
1	RI Group 1	up Name Qu 1	uantity F/	<b>Rate(fj</b> 52	маіп pmh) <mark>С</mark> В	Code 9	S avg.   8 1	<b>Tp</b> 6.7099	<b>Tfi</b> 5 0	<b>Td</b>	<b>Ti</b> ).0 (	<b>Tr</b> 0.0 (	<b>Ta</b> 0.0	<b>Tc</b> 0.0	<b>T</b> : 0.0	<b>st</b>   ) 2	<u>МТ</u> 21.7
1	RI Group 1	up Name Qu 1	uantity F/ 22.	Rate(fj 52	Main pmh)   C   B   Repla	cement	S avg.   8 1	Тр 16.7099	<b>Tfi</b> 5 0	Td 1.0 (0	<b>Ti</b> ).0 (	<b>Tr</b>   0.0 (0	<b>Ta</b> 0.0	<b>Tc</b> 0.0	T:  0.0	st   ) 2	MT 21.70
1	RI Group 1	up Name   Qi  1   Failure Rati	uantity   F/I  22.( e   Quantity	Rate(f) 52 / RI	Main pmh) C B Repla	cement	3 avg.   8 1 1 items	Tp 6.7099 Repair	Tfi 5 0	Td   1.0 (C	<b>Ti</b> ).0 ( <b>me</b>	Tr   0.0 (0	Ta D.O	0.0	T: 0.0	st   ) 2	<b>MT</b> 21.70
1	RI Group 1 Group 1 Name 1	up Name Qu 1 Failure Rate	uantity   F/   22.! e   Quantity  1	Rate(f) 52 / RI Y	Main pmh) C B Repla MTTR 10	cement 0.0833	5 avg.   8   1 1 1 items   MMH/F 0.0833	<b>Tp</b> 16.7099 Repair	Tfi 5 0 Group	Td   1.0 (C <b>p Na</b> 1	<b>Ti</b> ).0 ( <b>me</b>	Tr   0.0 (0 NxF 0.8	Ta D.O Failu	Tc 0.0	0.0	st   2	<b>MT</b> 21.70
1	RI Group 1 Group 1 Name 1 2	up Name Qu 1 Failure Ratu 0.8 8.46	uantity F// 22.9 e Quantity 1 1	Rate(f) 52 / RI Y	Main pmh) ( B Repla MTTR 10 38.3333	cement 0.0833 0.6389	<b>5 avg.</b>   8   1 1 tems   MMH/F 0.0833 0.6389	Тр 16.7099 Repair	Tfi 5 0 Group Group	Td   1.0 (C 1 1	<b>Ti</b> ).0 ( <b>me</b>	Tr   0.0 ( N×F 0.8 8.46	Ta D.O	0.0	T: 0.0	st     2	MT 21.70
1 1 1 2 3	RI Group           Group 1           Name           1           2           3	up Name Qu 1 Failure Rate 0.8 8.46 11.41	uantity F/ 22.9 e Quantity 1 1 1	Rate(f) 52 / RI Y Y Y	Main pmh) C B Repla MTTR 10 38.3333 5	cement 0.0833 0.6389 0.0833	<b>5 avg.</b>   8   1 1 tems   MMH/F 0.0833 0.6389 0.0833	Tp 16.7099 Repair	Tfi 5 0 5 0 Group Group Group	<b>Td</b> 1.0 C 1 1	Ti   ).0 ( me	Tr 0.0 0 0.8 8.46 11.41	<u>Ta</u> D.O ailu	0.0	T: 0.0	st     2	MT 21.70

# **Understanding Analysis Results**

The following is a brief description of all the fields:

	SUMMARY VIEW
Total MTTR (Min):	Mean Time To Repair, This is a failure sum of all the MTTRs in the project.
MMH (Hour)	Mean Man Hour required to repair the Nth RI.
MMH/Repair (Hour)	Mean Man Hour per Repair.
	MAINTAIN SUMMARY RESULTS
RI Group Name	Group Identifier.
Quantity	Total RI quantity in the group.
F/Rate (fpmh)	Total Failure Rate of all RIs in the Group.
Code	Maintenance Philosophy code.
S Avg.	Average number of RIs contained in a fault isolation result.
Тр	Average Preparation Time.
Tfi	Average Fault Isolation Time.
Td	Average Disassembly Time.
Ti	Average Interchange Time.
Tr	Average Reassembly Time.
Та	Average Alignment Time.
Тс	Average Checkout Time.
Tst	Average Start-up Time.
MTTR (Min):	Mean Time To Repair, This is a failure sum of all the MTTRs in the Group.

	REPLACEMENT ITEMS
Name	RI Identifier.
Failure Rate	RI Failure Rate.
Quantity	RI Quantity.
RI	Replaceable Flag (Yes or No).
MTTR	Mean Time To Repair of the RI.
MMH	Mean Man Hour required to repair the RI.
MMH/Repair	Mean Man Hour per Repair.
Group Name	RI's Group Identifier.
NxFailure Rate	RI's Total Failure Rate (RI's Failure Rate X Quantity).

# 4. Maintain Editor Screen, Toolbar and Shortcut Keys Quick Reference



# **The Maintain Editor Screen**

The Maintain editor can be made visible by selecting the Dialog tab (1). Its main elements are the following:

- Main Menu (2): Quick access to the main functions.
- Maintain Toolbar (3): Quick access to editing functions.
- Project Window (4): A hierarchical view of the project and systems.
- System Window (5): A hierarchical view of the system, blocks and RIs.
- Library Window (6): A hierarchical view of the components library.
- Dialog Window (7): The area in which Maintain can be edited.

# The Default Toolbar

Immediately below the pull-down options resides a group of buttons that form a Default Toolbar allowing the user to access directly some of the more frequently used menu options.



Tool	Name	Description
	New	Opens a new project.
À	Open	Open an existing document. The ToolKit displays the Open dialog box, in which you can locate and open the desired file.
	Save	Save the active document or template with its current name. If you have not named the document, the ToolKit displays the Save As dialog box.
ж	Cut	Remove selected data from the document and stores it on the clipboard.
	Сору	Copy the selection to the clipboard.
	Paste	Paste the contents of the clipboard at the insertion point.
$\mathbf{x}$	Delete Item	Delete the selection.
ŝ	Undo	Reverse the last editing. Note: You cannot undo some actions.
9	Print	Print the active document.
8	About	Open the About ITEM ToolKit Window.
<b>N?</b>	Help	Open the ITEM ToolKit On-line Help.

# **The Maintain Dialog Window Controls**

The Maintain Dialog Window Contains the following Controls:

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Tool	Name	Description
K)	Undo Changes	Cancels the latest operation.
	Analyse	Run the Analysis of the system.

Check Spelling Check the Spelling of the selected Text.

# **The Project Toolbar**

ABC V

The Project Toolbar displays the available analysis options for the ToolKit application

] X <sup>*</sup> X <sup>*</sup> X <sup>*</sup> X <sup>N</sup> A					
Tool	Name	Description			
<b>‰</b>	MIL217	Add a MIL-HDBK-217 (Electronic) System.			
$\lambda^{\mathrm{T}}$	Telcordia (Bellcore)	Add a SR-332 Telcordia (Electronic) System.			
$\lambda^{\pm}$	IEC 62380 (RDF)	Add an IEC 62380 French Telecom Standard (Electronic) System.			
$\lambda^{c}$	299B	Add a 299B Chinese Military Standard (Electronic) System.			
$\lambda^{N}$	NSWC (Mechanical)	Add a NSWC (Mechanical) System.			
ß	Maintain	Add a Maintain MIL-HDBK-472 Procedure V System.			
<b>&amp;</b>	SpareCost	Add a Spare Cost Spares Scaling and Ranging System.			
α	FMECA	Add a Failure Modes Effects and Criticality Analysis (FMECA) System.			
¢ <mark>B</mark>	RBD	Add a Reliability Block Diagram (RBD) System.			
æ	Fault Tree	Add a Fault Tree Analysis (FTA) System.			
Ш	Event Tree	Add an Event Tree Analysis (ETA) System.			
∞	Markov	Add a Markov Modeling System.			

# The Maintain Toolbar

The Maintain Toolbar is used to create and control Maintain Analysis through the commands it contains.

🗟 🖉 💋 🚳

Tool Name

Description

5	Select	Cancels add mode.
Ø	Block	Creates a Block in the Maintain System.
Ø	Replaceable Item	Creates a Replaceable Item in the Maintain System.
60	Start Maintain Analysis	Allows the user to perform the necessary calculations of the analysis.

# **Shortcut Keys:**

Key	Function
Ctrl + N	Open a new project.
Ctrl + O	Open an existing document. Displays the Open dialog box, in which you can locate and open the desired file.
Ctrl + S	Save the active project with its current name. If you have not named the project, the Save As dialog box will open.
Ctrl + P	Print the Active View.
Ctrl + X	Remove selected data from the document and stores it on the clipboard.
Ctrl + C	Copy the selection to the clipboard.
Ctrl + V	Paste the contents of the clipboard at the insertion point.
Ctrl + W	Paste the contents of the clipboard (Gate or Event) at the insertion point as a Repeat Gate or Repeat Event.
Del	Delete the selection.
F1	Open the ITEM ToolKit On-line Help.

# CHAPTER 11

# SpareCost

SpareCost provides methods for calculating the requirements for replacement of spares for operational systems and equipment. It generates spare holdings required at Sites (First and second line maintenance by replacement) and at Base (Third line maintenance to support Sites and repair of returned defective spares). The SpareCost Module supports algorithms and models defined in Repstock and Optcost provided by British Ministry of Defense.

This chapter:

- 1. Introduces SpareCost
- 2. Describes ToolKit's SpareCost features
- 3. Outlines an example SpareCost System
- 4. Describes the SpareCost Editor Screen, Toolbars and Shortcut Keys

# 1. Introduction

**ITEM ToolKit**'s SpareCost Module calculates the requirements for replacement spares for operational systems and equipments. It generates spares holding requirements and models the repair of defective items as defined in the Repstock and Optcost algorithms derived for the British Ministry of Defense. The main driving forces behind the calculations are the failure rate and cost of replaceable items in a system, together with an acceptable stock out risk. Spares holdings for Sites (first and second line maintenance by replacement) are calculated using the Optcost method. Base spares requirements (third line maintenance supporting Sites and repair) are handled by Repstock.

The SpareCost Module makes the following assumptions:

- The system is assumed to be "serial" in nature, i.e. if any one item fails then the whole system ceases to function and a spare will be required.
- Detection and replacement of items at site is always possible provided a spare is available.
- The time to detect and replace a faulty item is assumed as insignificant.

The SpareCost Module provides:

- Optimization scale of spares at sites for minimum cost.
- Base supported period and repair lead-time.
- Site and Base Stock-Out-Risk.
- Site and Base spare results and cost.

# 2. ITEM ToolKit & SpareCost

The SpareCost Analysis Module offers a diverse graphical user interface (GUI) in which all project and system data is entered.

This area is the foundation on which you build your project. The GUI consists of menus, toolbars, project and system windows and multiple viewing options. The following are samples of features offered by the SpareCost Module:

- Quickly create multiple systems within each project.
- Quickly create a new project by reusing data from other projects.
- Create and open multiple SpareCost projects at the same time and compare analysis results.
- Copy and Paste components and block between projects and systems.
- Simultaneously display analysis result and view components and blocks information.
- Create master libraries of components and blocks.
- Drag-and-drop components and blocks between libraries and systems.
- Display various system and project information in the hierarchy windows.
- Sort and display various information at system and block level.
- Display and chart system and block information.
- Edit project, system, block and component via Dialog and Grid view.

### **SpareCost Construction**

ToolKit offers flexible, powerful and easy ways for constructing SpareCost Analysis. You can simply transfer components, blocks and systems information from other modules within ToolKit or add different types of components and blocks in the System Window to create a hierarchy of your system and enter the appropriate information by using the dialog view.

# **Multiple Projects and Systems**

The need to create or review multiple projects at the same time has been made effortless with ToolKit. ToolKit will allow you to create or open multiple projects simultaneously. Projects can consist of many different SpareCost systems that can also be analyzed simultaneously. Merge all or a portion of each system together to create a master SpareCost project. This powerful option will enable you to manage many different projects and systems, create a new system by reusing all or a portion of an existing system that has been analyzed, plus copy/paste blocks and components between projects and /or systems.

# **User Defined Master Library**

Analyze your system once and create multiple libraries containing component and block information. ToolKit will allow you to create and open multiple libraries. This time saving feature will shorten the time for constructing a new SpareCost system. The analyzed components can simply be added to a new SpareCost System by using the drag-and drop or copy and paste feature.

# **Powerful Editing**

ToolKit offers many different ways for modifying or editing the information pertaining to components, blocks and systems. Edit information via the dialog view and the grid view.

#### Powerful Customizable Reports

ToolKit offers standard and preformatted reports and allows you to create and customize new reports.
# **Transfer Facility**

ToolKit's Transfer Facility allows the entire SpareCost system, or a selected block or component within the system to be transferred to other analysis modules within ToolKit for further analysis.

# **Link Facility**

ToolKit offers dynamic link capabilities and allows information to be linked between SpareCost Module and other modules within ToolKit.

# 3. Creating a SpareCost Project

To demonstrate ToolKit's SpareCost features, we'll create an example based on the following:

One Army Regiment will be deployed in the Middle East for 6 months. The Command Post shelter is mounted on a HEMTT and is fitted with five computer workstation. We will use SpareCost to determine the Site and Base spare results and cost, the Site and Base Stock-Out-Risk and optimized the number of spare at the site for those five computers:



- 1. Click on the New Project icon (A) on the default toolbar, or select New Project from the File menu.
- 2. Activate your project by clicking on the Project tab (B) or in the Project window.
- 3. Select the Dialog tab from the bottom of the Viewing Option window.
- 4. The Project Dialog Box will be displayed.

#### 248 ITEM ToolKit Getting Started Guide

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ITP3 PROJECT: IT Project (Prediction Totals: FR=0; Q=0; MT	や ♥ PROJECT
	Project
R	Title : New Project
	Name : IT Project
	Part Number :
	LCN :
	Circuit Ref.:
	Analyst :
28	Compiled By :

5. Enter your project information by placing the cursor or clicking in the appropriate fields.

Project-			
Title :	SpareCost Tutorial	Description :	Support and Cost for 1 computer site
Name :	IT Project		<b>*</b>
Part Number :	001	Function	A
LCN :		Description.	*
Circuit Ref.:		Notes :	
Analyst :			*
Compiled By :		Approved By :	
Applies to failure	e prediction systems contained i	in this project	
		Г	Totals:
Target Rate :	0		Failure Rate : 0
Life Time (hrs):	24		Unavailability : 0
Redundancy:	•		MTBF (hrs): -1

- 6. The information entered for a project is only for the project level, and its entry is optional.
- 7. The table below displays each field that is available for a project and what each field pertains to:

Field	Description
Title	The Project Title
Name	A Unique Reference Identifier
Part Number	Project Part Number
LCN	Logistic Control Number
Circuit Ref	Circuit Reference
Analyst	Person Performing the SpareCost Analysis
Compiled By	Person who gathered data for the analysis
Description	What the project is
Function Description	What the project/system does
Notes	Any other pertinent information on the project
Approved By	Person required to sign off on the project

The following fields will display results only if a prediction system is part of the project		
Target Rate	Acceptable number of failures for the project (Failures Per Million Hours)	
Life Time	Project life time given in hours	
Redundancy	Redundancy Flag	
Failure Rate	Will display total Project failure rate once analysis is complete	
Unavailability	This box will display the Project unavailability once the analysis has been run	
MTBF	Mean Time Between Failures for the project description	

8. From the Add Menu, select SpareCost System. The SpareCost system and project headers are added.



- 9. In the System Window, click the SpareCost header. The system properties appear in the Dialog tab.
- 10. In the Dialog tab, enter your system information by placing the cursor or clicking in the appropriate fields.

SpareCost System	٦			
Title :	SpareCost Tutorial	Description :	Support and Cost for 1 Command Post she	elter. 🔺
Name :	SP 1			-
Part Number :	1-001	Function	1	<b>A</b>
LCN :		Description.		-
Circuit Ref.:	Shelter 26	Notes :		<b>A</b>
Analyst :				-
Approved By :		Compiled By :		_
			Base Spares	
			Repair Lead Time (Days): 5	
- Site Spares		-1	Replenishment Period (Months): 24	
Stoc	ck-out-risk (%): 5		Total Number Fitted: 1	
Unsupported	Period (Days): 182		Overall Utillization (%): 100	
No. of Equip	oment per site: 1		Beyond Economic Repair (%): 10	
Average	Utilization (%): 100		Stock-out-risk (%): 5	

11. The table below describes what could be entered and what each field and block of fields pertains to:

Field	Description	
Title	System Title.	
Name	Unique Reference Identifier for the System.	
Part Number	System Part Number.	
LCN	Logistic Control Number.	
Circuit Ref	Circuit Reference Number.	
Analyst	Name of the person performing the SpareCost Analysis.	
Approved by	Name of the person who was required to sign off on the SpareCost project.	
Description	Description for this System.	
Function Description	Purpose/Description of this system.	
Notes	Any other pertinent information about this system.	
Compiled by	Name of the person who gathered the data for the SpareCost Analysis.	
	Site Spares	
Stock-out-Risk (%)	Risk a Site bears, that its spares will be insufficient during the unsupported period to meet demands due to equipment failure.	
Unsupported Period (days)	Operational period for a site during which no replenishment of spares takes place.	
No of Equipment per Site	Number of equipments being supported at the site.	
Average utilization (%)	Average percentage of time for which the equipments on a site operate.	
	Base Spares	
Repair Lead Time	Average time that it takes to repair or replace line items.	
Replenishment Period (Month)	Early in-service life for which the base stock is to be purchased.	
Total Number Fitted	Number of line items expected to be in service and supported from base at the end of the replenishment period.	
Overall Utilization (%)	Overall average utilization for all equipments throughout the period being modeled.	
Beyond Economic Repair (%)	Average proportion of failed items that will be beyond economic repair.	
Stock-out-Risk (%)	The value here is used for each item in the range. It is not the same value as the target value used for site spares optimization.	

12. Move the mouse to the System Window in the bottom left of the ToolKit screen and click the left mouse button to the system Header to make this the active window (A).

• [IT - Item ToolKit - Project::Dialog]		
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	Descri	
Name: 1		
Circuit Reh.:   NATO Stock No.:	Notes:	
LCN : F1		
Failure Rate: 0	Analyst :	
Quantity: 1		
	Entime Data Carman	
	C Prediction	
E 1.1::::Uty=1;:FH=0 □ 1.2:::Uty=1;:FR=0 □ Base	Manual	
		_
Dialog 🖽 Grid 😫 Diagram 🚮	Chart Result	
For Help, press F1	Blocks: 1 Comps: 4	NUM //

13. From the Add Menu (B), select Block.

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Ø	<u>3</u> lock			
	Compo	onent		

- 14. Move the mouse cursor to the System Window. The mouse cursor changes to add mode.
- 15. Click the system header (A). The Block is added (C) and its properties appear in the Dialog tab (D).
- 16. From the Add Menu (B), select Component.



- 17. Click the Block four times (C). Four Components are added (E) and their properties appear in the Dialog tab (D).
- 18. Click on the End Add Mode (F) toolbar icon to return the cursor to the normal mode.
- 19. Select the Block under the system header (C) and fill in the data as shown below:

- Block			
Part Number:	Site 1	Description:	Site 1 - Command Post Shelter.
Name:	1		
Circuit Ref.:		Notes	
LCN :	S-1	110(03.	
Failure Rate:	3965.39990234375		-
Quantity:	1	Analyst :	
Cost	0		,
Spareable Item:	In Range		Failure Rate Source
	🗹 Site		C Prediction
	Base		• Manual

20. The following table describes what could be entered and what each field and block of fields pertains to:

Field	Description
Part Number	Block Part Number
Name	A Unique Reference Identifier
Circuit Ref	Circuit Reference or Reference designator of the Block
LCN	(Logistic Control Number) Internal reference number defined by the user
Failure Rate	Block failure rate once analysis is complete (Can be edited only if the block is spareable)
Quantity	Number of Block (Can be edited only if the block is spareable)
Cost	Cost of the Block (Can be edited only if the block is spareable)
Spareable Item	Spareable or Non Spareable selection
In Range	Select Site, Base or both depending where this item will be used or stocked
Description	Additional information to describe the block
Notes	Any other pertinent information on the Block
Analyst	Person Performing the Analysis
Failure Rate source	Select the source of the Failure Rate (Manually entered or coming from a transferred and linked prediction)

21. Select the First Component under the Block and fill in the data as shown below:

- Component		
Part Number:	MON-90034 D	Description: 19",VGA Monitor
Name:	1.1	
Circuit Ref.:		Notes
LCN :	S-1-1	
Failure Rate:	761.4	
Quantity:	1	Analyst :
Cost:	355	
Spareable Item:	In Range	Failure Rate Source
	Site	C Prediction
	I <b>⊻</b> Base	Manual

22. The following table describes what could be entered and what each field and block of fields pertains to:

Field	Description
Part Number	Component Part Number
Name	A Unique Reference Identifier
Circuit Ref	Circuit Reference or Reference designator of the Component
LCN	(Logistic Control Number) Internal reference number defined by the user
Failure Rate	Component failure rate (Can be edited only if the block is spareable)
Quantity	Number of Component (Can be edited only if the Component is spareable)
Cost	Cost of the Component (Can be edited only if the Component is spareable)
Spareable Item	Spareable or Non Spareable selection
In Range	Select Site, Base or both depending where this item will be used or stocked
Description	Additional information to describe the Component
Notes	Any other pertinent information on the Component
Analyst	Person performing the Analysis
Failure Rate source	Select the source of the Failure Rate (Manually entered or coming from a transferred and linked

pred	iction	)
preu	liction	)

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4J.	LINU	uata	101	unc	runanning	compo	nomes as	5 10110 W.S.
					<u> </u>			

Part No.	Description	Qty	Failure Rate	Cost
MON-90034	19" VGA Monitor	5	277.8	\$355
CPU-00746	Pentium 4 CPU 1.5Ghz	5	198.4	\$950
KEY-8021	Standard Keyboard	5	347.2	\$25
MOU-73320	Serial Mouse	5	463	\$15

24. When all components are edited, go back to the system by clicking on the system header (A).

25. Edit the system parameters as follows:

SITE SPARES (**B**) Stock-out-Risk = 5% Unsupported period = 182 Days (6 Months) Number of Equipment (shelter) per site = 1 Average utilization = 100% BASE SPARES (C) Repair Lead Time = 5 Days Replenishment Period = 24 Months Total Number Fitted = 1 Overall Utilization = 100% Beyond Economic Repair = 10% Stock-out-Risk =5%



# **Viewing Results**

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To view the project results:

1. Click the system header (A) in the System Window.

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				Sumr	nary Vie	w						<u>^</u>
P2	PB0/ECT: IT Project (Prediction Totals: EB:			Parame	ter			Value				
<u>چ</u>	+ 💽 Maintain Systems;	1	Base To	tal Equipment			1					
<u> </u>	E SpareCost Systems;	2	Base Ut	1%			10	0				
	🔤 🔩 SP:1:: FR=6432;	3	Base Su	pport Period (mo	onths)		24					
		4	Base Re	pair Lead Time(E	Days)		5					
		5	Base Be	yond Econ. Rep	air Rate	(%)	10	)				
		6	Base Ta	rget S-O-R (%)			5					_
		7	Page Ca	ava Daquita	Total Nu	mber	23	3				-
		8	Dase of	are Results	Total Co	st (x10	DOO) 5.	845				
		9	Site No.	of Equip Fitted A	At Site		1					
		10	Site Uns	upported Period	(Days)		18	12				
		11	Site Util	(%)			10	0				
		12	Site Ste	ak Out Diak (%)	Target		5					
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	ITP2		Name	Descriptio	n l	0tv	Cost	E/Rate (fnmh)	Bkun Stock	Rent Stock	Total	Stock
Tair	SP:1::Support and Cost for 1 Command Post	1	1.1	19" VGA Monito	or i	5	355	277.8	1	4	5	4
dain	■ 11: MSN-90034:19"VGA Monitor:	2	12	Pentium 4 CPU	1.5Ghz	5	950	198.4	1	3	4	3
-	1.2:: CPU-\$2746::Pentium 4 CPU 1.5	3	1.3	Standard Keybo	ard	5	25	347.2	1	- 5	6	4
54	🔲 1.3:: KEY-802 Standard Keyboard:	4	1.4	Serial Mouse		5	15	463	1	7	8	2
l ≟	1.4:: MOU-73320: vial Mouse:: Qty-											
-		< _										2
COST 1								Site Spare R	esults			
are			Name	Descriptio	on	Qty	Cost	F/Rate (fpmh)	Exp No Of F	ails No. Of S	pares	Actual
g		1	1.1	19" VGA Monito	or	5	355	277.8	6.0671515	12		0.96097:
-		2	1.2	Pentium 4 CPU	1.5Ghz	5	950	198.4	4.333056	8		3.30171:
		3	1.3	Standard Keybo	ard	5	25	347.2	7.5828481	15		0.50961
		4	1.4	Serial Mouse		5	15	463	10.11192	20		0.18093
		<							$\sim$			>
	< •	Ξ	Dialog 📕	Grid 🖶	Diagram	n <b>  1</b>	Ch	art 🛃 Resu		8		
For H	elp, press F1							Blocks: 1	Comps: 4			NUM

- 2. Click on the Result tab (B) at the bottom of the ITEM ToolKit screen to display the results.
- 3. Click on the Go Icon (C) and the system results will be displayed.
- 4. Click on the Components (D) in the System Window to display the following detailed results for the selected Component.

	Base Spare Results									
	Name	Description	Qty	Cost	F/Rate (fpmh)	Bkup Stock	Repl Stock	Total Stock	Actual SO	R(%)
1	1.1	19",VGA Monitor	5	355	277.8	1 4	4	5	4.5459	
	_									
					Site Spare	Results				
	Name	Description	Qty	Cost	Site Spare F/Rate (fpmh)	e Results Exp No Of Fai	ils   No. Of S	Spares Actu	al SOR(%)	
	Name	Description 19",VGA Monitor	Qty 5	Cost 355	Site Spare F/Rate (fpmh) 277.8	Results Exp No Of Fa 6.0672	ils No. Of S	Spares Actu 0.961	al SOR(%)	

# **Understanding Analysis Results**

The following is a brief description of all the fields:

SUMMARY VIEW				
Base Total Equipment:	Number of equipments expected to be in service and supported from base.			
Base Util %:	Overall average utilization for all equipments throughout the period being modeled.			
Base Support Period (Months)	Operational period for Base during which no replenishment of spares takes place.			
Base Repair Lead Time (days)	Average time that it takes to repair or replace equipments.			
Base Beyond Econ. Repair (%)	Percentage of failed equipments that will be beyond economic repair.			
Base Target SOR (%)	Target Stock-Out-Risk at the Base.			
Base Spare Results	Total number of Spare and Total Cost (in thousands) at the Base.			
Site No of Equip Fitted at Site	Number of equipments being supported at the Site.			
Site Unsupported Period (Days)	Operational period for Site during which no replenishment of spares takes place.			
Site Util (%)	Average percentage of time for which the equipments on a Site operate.			
Site Stock-Out-Risk (%)	Target and Actual Stock-Out-Risk at the Site.			
Site Spare Results	Total number of Spare and Total Cost (in thousands) at the Site.			
	BASE SPARE RESULTS			
Name	Name of the equipment.			
Description	Description of the equipment.			
Qty	Quantity of equipment.			
Cost	Cost of the equipment.			
F/Rate (fpmh)	Failure rate of the equipment in failure per million hours.			
Bkup Stock	Number of equipments in the Back up Stock.			
Repl Stock	Replacement Stock.			
Total Stock	Total number of equipments in Stock.			
Actual SOR (%)	Actual Stock-Out-Risk at the Base.			
	SITE SPARE RESULTS			
Name	Name of the equipment.			
Description	Description of the equipment.			
Qty	Quantity of equipment.			
Cost	Cost of the equipment.			
F/Rate (fpmh)	Failure rate of the equipment in failure per million hours.			
Exp No of Fails	Expected number of equipments to fail during the unsupported period of the Site.			
No of Spares	Number of spare equipments at the Site.			
Actual SOR (%)	Actual Stock-Out-Risk at the Site.			

# 4. SpareCost Editor Screen, Toolbar and Shortcut Keys Quick Reference

### **The SpareCost Editor Screen**

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TTP2 PROJECT: IT Project (Prec SpareCost Systems; SpareCost Systems; Spit: FR=6432; 6	Spare Cost MIL-217 Main Tain	SpareCost         SpareCost System         Title :       SpareCost Tutorial         Name :       SP:1         Part Number :       Function         LCN :       F         Circuit Ref. :       Shelter 26         Analyst :       Compiled By :
Image: Set 1::Skep to control of the set 1:		Base Spares  Repair Lead Time (Days): 5  Replenishment Period (Months): 24  Total Number Fitted: 1  Overall Utilization (%): 182  No. of Equipment per site: 1  Average Utilization (%): 100  Beyond Economic Repair (%): 5  Total Number Fitted: 1  Dialog I Grid I Chart Result
For Help, press F1		Blocks: 1 Comps: 4 NUM
		Í

The SpareCost editor can be made visible by selecting the Dialog tab (1). Its main elements are the following:

- Main Menu (2): Quick access to the main functions.
- Default Toolbar (3): Quick access to the more frequently used menu options.
- SpareCost Toolbar (4): Quick access to SpareCost editing functions.
- SpareCost Dialog Window Controls (5): Quick access to Analyze, Spelling and Undo.
- Project Window (6): A hierarchical view of the project and systems.
- System Window (7): A hierarchical view of the system, blocks and Components.
- Library Window (8): A hierarchical view of the components library.
- Dialog Window (9): The area in which SpareCost can be edited.

# **The Default Toolbar**

Immediately below the pull-down options resides a group of buttons that form a Default Toolbar allowing the user to access directly some of the more frequently used menu options.



Tool	Name	Description
	New	Opens a new project.
È	Open	Open an existing document. The ToolKit displays the Open dialog box, in which you can locate and open the desired file.
	Save	Save the active document or template with its current name. If you have not named the document, the ToolKit displays the Save As dialog box.
⅀	Cut	Remove selected data from the document and stores it on the clipboard.
	Сору	Copy the selection to the clipboard.
	Paste	Paste the contents of the clipboard at the insertion point.
$\mathbf{x}$	Delete Item	Delete the selection.
5	Undo	Reverse the last editing. Note: You cannot undo some actions.
9	Print	Print the active document.
P	About	Open the About ITEM ToolKit Window.
<b>N?</b>	Help	Open the ITEM ToolKit On-line Help.

### The SpareCost Dialog Window Controls

The SpareCost Dialog Window Contains the following Controls:

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Tool	Name	Description
K)	Undo Changes	Cancels the latest operation.
	Analyse	Run the Analysis of the system.

# The Project Toolbar

ABC-

The Project Toolbar displays the available analysis options for the ToolKit application:

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Tool	Name	Description
ж <sup>а</sup>	MIL217	Add a MIL-HDBK-217 (Electronic) System.
$\lambda^{\mathrm{T}}$	Telcordia (Bellcore)	Add a SR-332 Telcordia (Electronic) System.
$\lambda^{\pm}$	IEC 62380 (RDF)	Add an IEC 62380 French Telecom Standard (Electronic) System.
$\lambda^{c}$	299B	Add a 299B Chinese Military Standard (Electronic) System.
$\lambda^{N}$	NSWC (Mechanical)	Add a NSWC (Mechanical) System.
ß	Maintain	Add a Maintain MIL-HDBK-472 Procedure V System.
<b>&amp;</b>	SpareCost	Add a Spare Cost Spares Scaling and Ranging System.
α	FMECA	Add a Failure Modes Effects and Criticality Analysis (FMECA) System.
¢ <mark>B</mark> ¢	RBD	Add a Reliability Block Diagram (RBD) System.
ጱ	Fault Tree	Add a Fault Tree Analysis (FTA) System.
Ψ	Event Tree	Add an Event Tree Analysis (ETA) System.
₿	Markov	Add a Markov Modeling System.

# **The SpareCost Toolbar**

The SpareCost Toolbar is used to create and control SpareCost Analysis through the commands it contains:



Tool Name

Description

260 ITEM		ITEM ToolKit Getting St	EM ToolKit Getting Started Guide				
	$\mathbb{Q}$	Select	Cancels add mode.				
	Ø	Block	Creates a Block into the Maintain System.				
		Replaceable Item	Creates a Replaceable Item into the Maintains System.				
	60	Start Maintain Analysis	Allows the user to perform the necessary calculations of the analysis.				

# <u>Shortcut Keys:</u>

Key	Function
Ctrl + N	Open a new project.
Ctrl + O	Open an existing document. Displays the Open dialog box, in which you can locate and open the desired file.
Ctrl + S	Save the active project with its current name. If you have not named the project, the Save As dialog box will open.
Ctrl + P	Print the Active View.
Ctrl + X	Remove selected data from the document and stores it on the clipboard.
Ctrl + C	Copy the selection to the clipboard.
Ctrl + V	Paste the contents of the clipboard at the insertion point.
Ctrl + W	Paste the contents of the clipboard (Gate or Event) at the insertion point as a Repeat Gate or Repeat Event.
Del	Delete the selection.
F1	Open the ITEM ToolKit On-line Help.

# CHAPTER 12

# **Event Tree Analysis**

Event Tree Analysis (ETA) is used to determine the consequence of an initiating event and the expected frequency of each consequence. For example, a pipe breaking in a nuclear power station may have many consequences ranging from a very small release of radiation (no significance) up to a very large release of radiation (catastrophic). Event trees model these initiators and consequences, and determine their frequencies.

This chapter:

- 1. Introduces ETA systems
- 2. Describes ToolKit's ETA features
- 3. Outlines an example ETA system
- 4. Describes the ETA Editor Screen, Toolbars and Shortcut Keys

# 1. Introduction

Event tree analysis is based on binary logic, in which an event either has or has not happened or a component has or has not failed. It is valuable in analyzing the consequences arising from a failure or undesired event.

Event tree analysis is generally applicable for almost any type of risk assessment application, but used most effectively to model accidents where multiple safeguards are in place as protective features. Event tree analysis is highly effective in determining how various initiating events can result in accidents of interest.

An event tree begins with an initiating event, such as a component failure, increase in temperature/pressure or a release of a hazardous substance. The consequences of the event are followed through a series of possible paths. Each path is assigned a probability of occurrence and the probability of the various possible outcomes can be calculated.

# **Event Tree Analysis Characteristics**

- Models the range of possible accidents resulting from an initiating event or category of initiating events.
- A risk assessment technique that effectively accounts for timing, dependence, and domino effects among various accident contributors that are cumbersome to model in fault trees.
- · Performed primarily by an individual working with subject matter experts through interviews and field inspections
- An analysis technique that generates the following:

- Qualitative descriptions of potential problems as combinations of events producing various types of problems (range of outcomes) from initiating events.
- Quantitative estimates of event frequencies or likelihoods and relative importance of various failure sequences and contributing events.
- Lists of recommendations for reducing risks.
- Quantitative evaluations of recommendation effectiveness.

# **Event Tree Analysis Process**

- **Define the system or area of interest.** Specify and clearly define the boundaries of the system or area for which event tree analyses will be performed.
- Identify the initiating events of interest. Conduct a screening-level risk assessment to identify the events of interest or categories of events that the analysis will address. Categories include such things as groundings, collisions, fires, explosions, and toxic releases.
- Identify lines of assurance and physical phenomena. Identify the various safeguards (lines of assurance) that will help mitigate the consequences of the initiating event. These lines of assurance include both engineered systems and human actions. Also, identify physical phenomena, such as ignition or meteorological conditions that will affect the outcome of the initiating event.
- Define accident scenarios. For each initiating event, define the various accident scenarios that can occur.
- Analyze accident sequence outcomes. For each outcome of the event tree, determine the appropriate frequency and consequence that characterize the specific outcome.
- Summarize results. Event tree analysis can generate numerous accident sequences that must be evaluated in the overall analysis. Summarizing the results in a separate table or chart will help organize the data for evaluation.
- Use the results in decision-making. Evaluate the recommendations from the analysis and the benefits they are intended to achieve. Benefits can include improved safety and environmental performance, cost savings, or additional output. Determine implementation criteria and plans. The results of the event tree may also provide the basis for decisions about whether to perform additional analysis on a selected subset of accident scenarios.

# 2. ITEM ToolKit & Event Tree Analysis

ITEM ToolKit Event Tree is an inductive or forward logic method to identify various sequences or set of events, started by an initiating event, that can lead to certain end consequences or accident scenarios. The idea is based upon the discretization of the real accident evolution in terms of few macroscopic events. These events are usually characterized in terms of:

- The intervention (or not) of protection systems which are supposed to take action for the mitigation of the accident (system event tree).
- The fulfillment (or not) of safety functions (functional event tree).
- The occurrence (or not) of physical phenomena (phenomenological event tree).

An event tree begins with a defined accident-initiating event, which could be a component or an external failure. It follows that there is one event tree for each different accident-initiating event considered. Thereby, all possible responses to the initiating event are listed from left to right across the page. The branch points on the tree structure usually represent the success, failure or partial failure of different systems and subsystems which can respond to the initiating event. These event branches can have their own probability models or can have models derived from attached Fault Trees gates and events. Theoretically, any probabilistic quantification model, defining the failure (or not) of the system and sub-systems, such as Predictions, RBD or Markov models can also be used for the quantification of branch probabilities.

#### 264 ITEM ToolKit Getting Started Guide

In the following example, fire protection is provided by a sprinkler system. A detector will either detect the rise in temperature or it will not. If the detector succeeds, the control box will either work correctly or it will not - and so on. There is only one branch in the tree that indicates that all the subsystems have succeeded:



Once the system events have been defined, they can be combined to derive the various end states or accident scenarios. In the graphical representation, columns depict the events, and the horizontal lines represent the success, failure or partial failure branches. Each combination of these branches from left to the right depicts a path or a scenario ending in a particular end state or consequence.

	<sup>1</sup>	3.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1		····	
Fire Starts	Fire Detected	Fire Alarm Starts	Sprinkler System Starts	Consequence	Result
		Success Fire Alem Starts	Success Sprinkler System is activated Automatically	Minimum Damage W=1∷	Seq-Q=3.021e-17::Seq-w=9.999
	Success	Successfully	Failure Sprinkler System DOES NOT Activate	Damage No Loss of Life W=2::	Seq-Q=1.11e-12::Seq-w=9.999
	Detection System	Failure	Success Sprinkler System is activated Automatically	Limited Damage / Wet People W=7::	Seq-Q=1.11e-12::Seq-w=9.999
N Fire Starts in the Main Building	-	Fire Alarm DOES NOT Start	Failure Sprinkler System DOES NOT Activate	Major Damage and Loss of Life W=90::	Seq-Q=4.081e-8::Seq-w=9.999
	Failure	Failure	Failure		
-	Fire is NOT Detected by the Detection System	Fire Alarm DOES NOT Start	Sprinkler System DOES NOT Activate	Major Damage and Loss of Life W=90::	Seq-Q=0.001::Seq-w=9.999
m .					

Once the Event Tree has been constructed, the next step is the quantification of the event probabilities. Each event, representing a system or a function failure, can be quantified using basic event quantification directly or linked to the top event (or any other gate) of a Fault Tree. Other probabilistic models such as Predictions, RBD or Markov models can also be used. Upon evaluation these fault trees (or basic events) would be linked together to derive the conditional probability of each event (or branch) and the multiplication of these conditional probabilities for each scenario shall give the probability of occurrence of final consequences or the accident scenarios.

For further risk analysis, each of the end state scenarios can be further investigated for respective cut-sets. Also, scenarios ending in same or similar end states can be joined together to get a joint probabilistic result. Weighting of the end scenarios in various categories such as financial, environmental, etc. can help devise a complete category-wise risk analysis.

# Several Types of Analysis can be Conducted Using Event Trees

#### **Qualitative Analysis:**

Include:

- The minimal cut sets of the event tree: Combination of failures contributing to a sequence.
- Qualitative failure importance: Qualitative rankings of contributions to a failure sequence.
- Minimal cut sets susceptible to Common Cause Failures: Cut sets potentially susceptible to a single failure cause.

For the qualitative evaluations, the minimal cut sets are obtained by Boolean reduction of the failure sequence. The minimal cut sets obtained are used not only in the qualitative evaluations but in all the quantitative evaluations as well. After obtaining the minimal cut sets, some idea of failure importance can be obtained by putting the minimal cut sets in order according to their size. The single component minimal cut sets being listed first, then the double order and so on. Since the failure probabilities associated with the minimal cut sets often decrease by orders of magnitude as the cut set increases, the ranking according to size gives a gross indication of the importance of the minimal cut set. Also, the minimal cut sets, even without any quantification, can be used to validate the design criteria.

#### **Quantitative Analysis:**

Include:

- Absolute probabilities: Probabilities of system and cut set failures.
- Quantitative importance of components and minimal cut sets: Rankings of contributions to failure sequence.
- Sensitivity and relative probability evaluations: Effects of changes in models and data, error determinations.
- Full consequence analysis: Probabilistic risk of each failure consequence ranked and categorized by a consequence.

Once the minimal cut sets are obtained, probability evaluations can be performed if quantitative results are desired. Quantitative analysis can be done for both point estimate as well as uncertainty values. If the failure probabilities are treated as random variables, these can be propagated to the failure sequence to determine the failure probability variations. By "failure" we mean any basic primary event shown on the fault tree/event tree. For a failure we might have a time based probability or a demand based probability. For time based failure models there can be a constant failure rate model (exponential model) or more sophisticated models with repair, standby, or distributions such as Weibull and Gamma. For Demand based failure models there can be either a fixed probability, probability distributions such as Beta and truncated Lognormal, or models such as Poisson and Binomial. Apart from mean unavailability calculated from the component failure models, other reliability characteristics are unreliability, failure rate (assuming constant failure rate), MTBF, failure frequency, Conditional Failure Intensity (CFI) and Number of failures in the lifetime of the system.

Project Events List							
C Show All			Add Global Event	Event Pa	arameters	ОК	
Show Global Events Only		Ĩ	Delete Global Event	Add t	o Gate	Locat	e
Make selection globally visible			Delete All G	lobal Events		Expor	t
Events:	Depende	encies:					
🖃 👘 V-8-Example	<u>~</u>	System Name:	Parent Name:	Name:	Description:		Type 🔺
ALARM STARTS	1	ELECTRICS A	ELECTRICS A	NOSUPDIS	NO SUPPLY FR	OM DIESEL	OR
<u> </u>							
CONI							
DGEN							
ECI							
	-						
Electric Power							
Emergency Cooling							
FIRE							
FIRE DETECTED							<b>_</b>
Fission Product Removal	▼ ▼ ▶	\Dependent Gat	tes /	4			•

#### **Binary Decision Diagram (BDD):**

The BDD analysis method is an alternative to the Rare Event and Esary-Proschan quantification options. It uses the Binary Decision Diagram algorithm to obtain cut-sets and quantification results. BDD algorithms distinguish themselves from conventional quantification methods by returning results that do not involve approximations. Instead, BDD algorithms produce results that are in accordance with the basic rules of probability theory.

Furthermore, BDD-based algorithms are generally more efficient than other quantification methods. Depending on the model, these algorithms can identify millions or even billions of cut-sets within seconds. The BDD algorithms embedded in ITEM products identify all cut-sets for a given model, and then filter out the significant cut-sets based on probability and/or order.

BDD algorithms do not allow for truncation of probabilistically insignificant elements in the logic. Conventional methods allow models to be solved by considering only the high-probability cut-sets. Studies have shown however that the numerical results produced by conventional methods must be treated with care, due to the truncations and approximations involved in their calculations.

💽 IT Event parameters
13 General 13 Failure 153 Time P 153 Hyperlinks Notes
Type: BASIC
Name: PIPE SPLIT
Part Number:
Logic Mode: Basic
Circuit Ref.:
LCN: F121
Failure Model: PIPE
Adjustment Factor: Q: 1 w: 1
Fault Tree Sequencing
Description: Lock Name : Group Labels : 🔽 Pipe Split
Change to Gate Spelling OK Cancel

🕐 IT Event parameters	X
General Failure  Time P	🖽 Hyperlinks 🛛 Notes
Name: PIPE	• ?
Type (CDF): Fixed	· 1
Unavailability: 0.007	07
Standard Deviation: 0	
Distribution: LogNo	rmal 💌
Interpretation: Mean	& StD 💌
Failure Frequency: 0.004	04
Standard Deviation: 0	
Distribution: LogNo	rmal 💌
Interpretation: Mean	& StD 💌
Description:	
	<u>^</u>
From Libr	ary New Model
Change to Gate Spelling	OK Cancel

# 3. Creating an Event Tree Project

Creating an Event Tree system consists of:

- Constructing the system
- Adding Branches
- Editing their parameters
- Performing analysis

To demonstrate ToolKit's Event Tree features, we'll create an example Event Tree project based on the following example.

In the event of a fire in the room, the fire protection is provided by a sprinkler system. A detector will either detect the rise in temperature or it will not. If the detector succeeds, the control box will either work correctly or it will not - and so on. There is only one branch in the tree that indicates that all the subsystems have succeeded:



# **Constructing the System**

To construct an Event Tree System:

- 1. Click on the New Project icon (A) on the default toolbar, or select New Project from the File menu.
- 2. Activate your project by clicking on the Project tab (B) or in the Project window.
- 3. Select the Dialog tab from the bottom of the Viewing Option window.
- 4. The Project Dialog Box will be displayed.

🚯 - [IT - Item ToolKit - Project::Dialog]					
Eile Add Edit Layout Settings Chart Window Help					
] D 🚅 🖬   ¾ 🖻 🖻 X ∽   🎒 🕈 🕺 🗍 🎢 🏹 🕷	F X X 🄑 🞕 🚺 🖶 🐥 🚍 🗞 🗍 🕅				
ITP3 ITP3 PROJEC1: II Project (Prediction Totals: FR=0; Q=0; MT	PROJECT				
B	Title : New Project Name : IT Project Part Number :				
	LCN : Circuit Ref.:				
22	Analyst : Compiled By :				

5. Enter your project information by placing the cursor or clicking in the appropriate fields.

Project						
Title :	Fire example	Description :	Case study of a fire risk in a warehouse.			
Name :	FTA ETA Example - 2		<b>_</b>			
Part Number :	Example - 02	Function	Fault Tree and Event Tree Analysis of the fire 🔺			
LCN :		Description.	nsk 🔽			
Circuit Ref.:		Notes :	A			
Analyst :	Anna Liste		<b>v</b>			
Compiled By :	Mike Krossauft	Approved By :	A. P Rouve			
Applies to failur	Applies to failure prediction systems contained in this project					
		L.	Totals:			
Target Ra	te : 0		Failure Rate : 0			
Life Time (h	Life Time (hrs): 24 Unavailability : 0					
Redundano	cy : 💽 🔻		MTBF (hrs): -1			

The information entered for a project is only for the project level, and its entry is optional. The table below displays each field that is available for a project and what each field pertains to:

Field	Description			
Title	The Project Title			
Name	A Unique Reference Identifier			
Part Number	Project Part Number			
LCN	Logistic Control Number			
Circuit Ref	Circuit Reference			
Analyst	Person Performing FT Analysis			
Redundancy	Redundancy Flag			
Life Time	Project life time given in hours			
Description	What the project is			
Function Description	What the project/system does			
Notes	Any other pertinent information on the project			
Compiled By	Person who gathered data for analysis			
Approved By	Person required to sign off on the project			
The following fields will display re	esults only if a prediction system is part of the project			
Target Rate:	Acceptable number of failures for the project (Failures Per Million Hours)			
Life Time (Hrs):	Project life time given in hours			
Redundancy:	Redundancy Flag			
Failure Rate:	Will display total Project failure rate once analysis is complete			
Unavailability:	This box will display the Project unavailability once the analysis has been run			

- MTBF (Hrs): Mean Time Between Failures for the project description
- 6. Select the Add menu from the menu toolbar by clicking on it.



- 7. Select and click on the ET, Event Tree System option.
- 8. The project will display as an Event Tree in the project window and the applicable system data will display in the system window.
- 9. From the Project window, select the Event Tree System by clicking on it.
- 10. The Event Tree System dialog box will be displayed.

-Event Tree System	n			
Title :	Fire Protection System	Description :	Event Tree Example 1:	<b>A</b>
Name :	Event Tree Example 1		Fire Protection System	
Part Number :	ETA Example 1			
LCN :	F	Function Description :		<u></u>
Circuit Ref.:				<b>T</b>
Analyst :	Anna Liste	Notes :		
Compiled By :	Mike Krossauft			
Approved By :	A. P Rouve			<b>v</b>
Mission / Life tim No of Intermedi Quantification M © Esary-Prosch	e Life Time : 87600 ate Time Points : 20 ethod an C Rare	Uncertair Perfo	nty	Sample Size: 200 Percentile: 95
Cut-Off Probability	Unavailability: 0.0001 Frequency: 1e-006 Order: 4	Miscellan	eous	
Sort Cut Sets O Off Off By Frequency O By Unavailability O By Order Max Sorted Sets : 500			ny Event Tree Max Risk Dormant Model Iarize super events rm Common Cause Failure	: Analysis

- 11. Enter your system information by placing the cursor or clicking in the appropriate fields.
- 12. The information entered here is for the system level. The following table describes what could be entered and what each field and block of fields pertains to:

Field	Description			
Title	System Title			
Name	Unique Reference Identifier for the System			
Part Number	System Part Number			
LCN	Logistic Control Number			
Circuit Ref	Circuit Reference Number			
Analyst	Name of the person performing the Event Tree Analysis			
Compiled by	Name of the person who gathered the data for the Event Tree Analysis			
Approved by	Name of the person who was required to sign off on the project			
Mission / Life Time Project lifetime given in hours and the total number of immediate time points				
Quantification Method	nod Select one of the two methods			
Cut-Off	If you select the Probability box, enter the unavailability and the Frequency cut-off rate for this project. Click the Order box to have an Order Cut-Off, and then enter the cut-off value for this project			
Sort Cut Sets	Select whether you wish to Sort Cut Sets by unavailability, by frequency, or by order and enter the maximum amount of sort sets. Click "Off" if you do not wish to use Sort Cut Sets			
Description	Enter the description for this System			
Function Description         Enter the purpose/Description of this system				
Notes	Enter any other pertinent information about this system			
Uncertainty Click this box if you wish to perform an Uncertainty Analysis. If you select this box then enter the Sample Size and the Percentile				
Miscellaneous	Select the option you wish to use			

# **Editing the Event Tree Diagram**

Creating an Event Tree system automatically generates a default Diagram starting at the left side with an initiating event column (A) followed by 3 events column (B, C, D), the consequence column (E) and the result column (F). Click on the Event Tree Diagram view (G) to see the diagram.



# **Editing Columns**

- 1. Click on the Event Tree Tab to open the Event Tree Canvas (H).
- 2. Double Click on the Initiator Column Header (I). The Column Parameters window appears.
- 3. Enter the Column Name, Description, and Notes.
- 4. Select Event List (J).



- 5. Click on Event List and the Project Events List window opens.
- 6. Click on Add Global Event (**K**).

📀 Project Events List		
C Show All Show Global Events Only C Show Non Global Events Only Make selection globally visible Events:	Delete All Unused Add Global Event Delete Global Event Dependencies:	Event Parameters OK Add to Gate Locate Make All Global Maport
ALARM STARTS     ALARM STARTS     C1     C2     C0I     COI     CON     C	Dependent Gates	×

- 7. Click on the event (L) and then on Event Parameters (M).
- 8. The Event Parameters window opens.

● IT Event parameters	Ο Π Event parameters
General III Failure III Time P III Hyperlinks Notes	General      General      Failure     III Time P     EII Hyperlinks Notes
Type: BASIC	Name: PIPE 👤 💡
Name: PIPE SPLIT	Type (CDF): Fixed
Part Number:	Unavailability: 0.00707
Logic Mode: Basic	Standard Deviation: 0
Cirquit Ref.:	Distribution: LogNormal
LON:   F121	
	Standard Deviation: 0
Failure Model: PIPE	Interpretation: Mean & StD
Adjustment Factor: Q: 1 w: 1 Fault Tree Sequencing Fault Tree Sequencing Initiator and Enabler C Initiator Only C Enabler Only Sequencing Order	Description:
Pipe Split	÷.
1	From Library New Model
Change to Gate Spelling OK Cancel	Change to Gate Spelling OK Cancel

#### 274 ITEM ToolKit Getting Started Guide

- 9. Add a new Failure Model and edit the parameters. Click OK in the Event Parameters window, in the Project Events List window and in the Column Parameters window when finished.
- 10. Edit the rest of the columns according to the following table:

Column Name	Event Name	Failure Model Type	Data 1	Data 2
Fire Starts	Fire Starts	Fixed	Unavailability = 0.0015	Failure Frequency = 10
Fire Detected	Fire Detected	Rate	Failure Rate = 0.00012	Repair Rate = 0
Fire Alarm Starts	Alarm Starts	Rate	Failure Rate = 0.00024	Repair Rate = 0
Sprinkler Starts	Sprinkler Starts	Rate	Failure Rate = 0.00048	Repair Rate = 0

11. The column headings should looks like the following:

	0 I I I I I			4	5
-	Fire Starts	Fire Detected	Fire Alarm Starts	Sprinkler Starts	
-					

# **Editing the Consequences**

1. Click on the Event Tree Tab to open the Event Tree Canvas (A).



- 2. Double Click on the Consequence Column Header (B) or click on Edit (C) then on Consequences.
- 3. The Consequences Parameters window appears (D).
- 4. Click on Safety (E) and then on Edit (F) and select Add Consequences.
- 5. Repeat Add Consequences to have a total of 4 consequences.

• Consequences					- 🗆 🗙
Edit				0	к
V-707-Example	Conse	quence Category			
E 🖉 Safety		Name: Safet	у		
Enviromental	Descr	iption: Safet	v Pelated Consequences such as	rick to injur	ies or los
		Jarco	y Nolacea Consequences sach as	s risk to ingai	103 01 10.
		Notes:			
( <u>E</u> )		voces.			
		Category:	Name:	Weight:	<b>_</b>
	1	Safety	Minimum Damage	1	
	2	Safety	Damage No Loss of Life	2	
	3	Safety	Limited Damage / Wet People	7	
	4	Safety	Major Damage and Loss of Life	90	
	5	Safety	Core Cooled	1	
	6	Safety	Slow Melt	9	
	7	Safety	Melt	90	
					-
		Consoduoned			<b>_</b>
1		Consequence			

6. Edit the consequences according to the following table:

Name:	Weight:
Major Damage and Loss of Life	90
Limited Damage/Wet people	7
Damage No Loss of Life	2
Minimum Damage	1

• Consequences					
Edit 🔻				ОК	
V-707-Example  Safety Minimum Damage Damage No Loss of Life Limited Damage / Wet Pe Major Damage and Loss  Financial	Conseq Descrij N	uence Category Name: Safety ption: Safety lotes:	/ / Related Consequences such as	: risk to injurie	es or lo:
		Category:	Name:	Weight:	<b>_</b>
	1	Safety	Minimum Damage	1	
	2	Safety	Damage NoLoss of Life	2	
	3	Safety	Limited Damage / Wet People	7	
	4	Safety	Major Damage and Loss of Life	90	
<		Consequence	s/		- 

7. Click OK when finished.

# **Editing Branches**

A branch is a graphical representation of an accident sequence.

The following table lists branch types supported in ITEM ToolKit's Event Tree Module, and how they are symbolized:

Event Type	Symbol on System Hierarchy	Symbol on Grid view	Symbol on Event Tree Canvas	Symbol on Event Tree Tool Bar	Description
Failure		4	Failure Branch	Ч	Indicates a Failure Branch
Success	٦.	μ	Success Branch	~	Indicates a Success Branch
Initiator		4	Initiator Branch	—	Indicates a Initiator Branch
Null		-	Null Branch	—	Indicates a Null Branch



1. Click on the Event Tree Tab to open the Event Tree Canvas (A).

- 2. Double Click on the Initiator Branch (B). The Branch Parameters window appears.
- 3. Enter the Branch Name, Description, and Notes.
- 4. Click OK when finished (C).
- 5. Edit the branches according to the following table:

Column Name	Туре	Branch Name	Description				
Fire Starts	Initiator	B1	Fire Starts in the Main Building				
Fire Detected	Success	B2	Fire is Detected by the Detection System				
File Delected	Failure	B3	Fire is NOT Detected by the Detection System				
	Success	B5	Fire Alarm Starts Successfully				
Fire Alarm Starts	Failure	B6	Fire Alarm DOES NOT Start				
	Failure	B8	Fire Alarm DOES NOT Start				

#### 278 ITEM ToolKit Getting Started Guide

Column Name	Туре	Branch Name	Description	Consequence
	Success	B9	Sprinkler System is activated Automatically	Minimum Damage
~	Failure	B10	Sprinkler System does not Activate	Damage No Loss of Life
Sprinkler Starts	Success	B11	Sprinkler System is activated Automatically	Limited Damage / Wet People
Starts	Failure	B12	Sprinkler System does not Activate	Major Damage and Loss of Life
	Failure	B16	Sprinkler System does not Activate	Major Damage and Loss of Life

6. The Diagram should looks like the following:

		1	]]		•
-1[	Fire Starts	Fire Detected	Fire Alarm Starts	Sprinkler Starts	
4					
jl.			<u> </u>		
				Success	
				Sprinkler System is	
			· · · Success · · · · ·	activated .	
			Fire Alarm Starts		
			Successfully	Failure	
		_		Sprinkler System	
			-	· does not Activate · · · ·	
		the Detection Queters			
		tue Detection System		<u> </u>	
H				oprinkier oystem is	
-1			Fallure		
13	· Fire Starts in the · · ·		· · · · · Start· · · · · ·	· · · Foilure · · · · ·	
11	Main Building			Sprinkler System	
				does not Activate	
		Failure		Failure	
		Fire is not Detected	Fire Alarm does not	Sprinkler System	
		· by the Detection · · ·	· · · · Start · · · · · ·	does not Activate	
-1					
			i i		1

# **Performing Analysis**

Event Tree Module provides a method to:

- Calculate Importance values.
- Calculate Event Sequence Unavailability and Frequency.

**NOTE** Before performing analysis, follow the procedure in "Verifying Data" to identify and correct any errors in the system. You cannot perform the analysis until all errors are corrected.

# **To Verify the Data**

1. Select Verify Data from the Analysis Option in the Menu Toolbar.



2. If no errors are detected the following windows will be displayed.

Advisory Msg	×
ET Analysis completed - Without e	rrors
(OK]	

3. If the following window appears, correct the detected errors and repeat the step 1.

6	Ъ	EM ToolKit	Verifica	tion Res	sults	Đ	K
F	1	Msg #:	2 Ms	д Туре	2 Msg Text:	Save	
	1		Error		Not all sequences have an end branch, ET System Fire P	Show me	
						Total Msgs:	
						1	
						Filter	
						Update	
						Errors	
						Warnings	
	*					100	
I.	٢					100	
					OK	Cancel	

# To Analyze the System

- 1. In the System Window, click the system header.
- 2. From the Analysis Menu, select Perform. A dialog box displaying the progress of the analysis appears.



#### 280 ITEM ToolKit Getting Started Guide

3. When the analysis is complete, the Verification Msg. dialog box appears. Click OK.



4. The Event Tree canvas is also updated with the analysis results in the Result column.

Fire the D	Success	Success Fire Alarm Starts Successfully	Success Sprinkler System is activated Failure Sprinkler System	Minimum Damage W=1:: Damage No Loss of Life W=2::	Seg-Q=0.0000096::Seg-w=5.624 Seg-Q=0.000063::Seg-w=5.624
Fire the D	Success	Fire Alarm Starts Successfully	Failure Sprinkler System	Damage No Loss of Life W=2::	Seg-Q=0.000063::Seg-w=5.624
Fire the D			does not Activate		
	re is Detected by Detection System	Failure	Success Sprinkler System is activated	Limited Damage/Wet people W=7::	Seq-Q=0.00000687::Seq-w=5.624
Initiator Fire Starts in the Main Buildinα		Fire Alarm does not Start	Failure Sprinkler System does not Activate	Major Damage and Loss of Life W=90::	Seq-Q=0.000453:: Seq-w=5.624
Fire bv	Failure re is not Detected ov the Detection	Failure Fire Alarm does not Start	Failure Sprinkler System does not Activate	Major Damage and Loss of Life W=90::	Seq-Q=0.000843:: Seq-w=5.624

5. Select Summary from the Analysis menu to view the results. The Event Tree Results dialog box appears.

ET Results										• ET Results								
End Branch     Consequence	Summary				Life Time	(Hours):	87600	ОК	ĺ	C End Branch Consequence	Risk of Major Damage a Summary	nd Loss of Li	e Consequer	nce =	Life Time	(Hours):	87600	ок
E Protection System	Parameter:	Value	Mean	StD	5%	50%	95%	95.00%		🖃 👘 Fire Protection Syster	Parameter:	Value	Mean	StD	5%	50%	95%	95.00%
816	Linavailability O:	0.0014	0	0	0	0	0	0		🖻 🕐 Safety	Unavailability Q:	0.0014	0	0	0	0	0	0
-F B11	Failure Frequency W:	9.9991	0	0	0	0	0	0		🧐 Major Damagi	Failure Frequency W:	9.999455	0	0	0	0	0	0
- B12	No of Cut Sets:	1								😔 Limited Dama	No of Cut Sets:	2						
- B10										😔 Damage No Li								
<b></b> B9										- 🧐 Minimum Dam								
	Importance										Importance							
	Event: E-Veselv:			Birph	Bimbaum: B-Proschan					Event:	F-Vesel	v:	Birnb	iaum:	B	-Proschan		
	FIRE	1	,,,	0.99	991838	1	rioscian				FIRE	1		1.99	98368	1	.9999456	
	FIRE DETECTED	1		0.00	4999184	4	.8975709e-	13			ALARM STARTS	1		0.00	29998368	9	.7948752e-	13
	ALARM STARTS	1		0.00	4999184	4	.8975709e-	13			SPRINKLER STARTS	1		0.00	29998368	9	.7948752e-	13
	SPRINKLER STARTS	1		0.00	14999184	4	.8975709e-	13			FIRE DETECTED	0.9999	7279	0.00	14999184	4	.8974376e-	13
	<							>			<							>
	Cut Sets										Cut Sets							
	No: Unavailabili	ty: Fr	equency:	Even	ts						No: Unavailabil	ity: Fr	equency:	Even	its			
	1 0.0014998	776 9.	9991838	ALAP	M STARTS ::	FIRE :: FIR	E DETECTED	::SPRI			1 0.0014998	776 9.	9991838	ALAP	M STARTS :	FIRE :: FIR	E DETECTER	:::SPRL
											2 4.0809759	e-8 0.	00027206503	7 ALAF	RM STARTS :	-FIRE DET	ECTED::FIR	E ::SPRI
<	<							>		< >	<							>

# **Understanding Analysis Results**

**Unavailability Q**: Represents the probability that the component or system is unavailable at any given time. "Q" equals the probability that the system is unavailable.

**Failure Frequency W**: This is the term used by the system to represent the unconditional failure intensity. The unconditional failure intensity is the probability that the system or component fails per unit time, given that it was working correctly at time zero. "W" is equal to the number of expected system failures.

No. of Cut Sets: Represents a group of events that will cause system failure if and when they occur together.

# **Importance**

#### **F-Vesely**

The F-Vesely (Fussell-Vesely) importance measure represents an event contribution to the system unavailability. Increasing or decreasing the availability of events with a higher importance value will have the most significant effect on system availability.

#### Birnbaum

The Birnbaum measure for an event represents the sensitivity of system unavailability with respect to changes in the event's unavailability.

#### **B-Proschan**

The B-Proschan (Barlow-Proschan) event importance measure takes into consideration the sequence of event failures within its calculation. It is the probability that the system fails because a critical cut set containing the event fails, taking into consideration that the event fails last.

• ET Results										- 🗆 🛛	
<ul> <li>End Branch</li> <li>Consequence</li> </ul>	Summary					Life Time (Hours): 87600 OK					
🖃 👘 Fire Protection System	Parameter:	Value	Mean	StD		5%	50%	. 9	5%	95.00%	
	Unavailability Q:	0.0014	0	0		0	0	0		0	
B11	Failure Frequency W:	9.9991	0	0		0	0	0		0	
	No of Cut Sets:	1									
- B10											
<b>_</b> ⊏ <sub>B9</sub>											
	Importance										
	Event:	E-Vese	E-Veselv:			Birphaum:			B-Proschan		
	FIRE	1	1 1 1 1 1			0,99991838 0,0014999184 0,0014999184 0,0014999184		1			
	FIRE DETECTED	1						4.8975709e-13 4.8975709e-13 4.8975709e-13			
	ALARM STARTS	1									
	SPRINKLER STARTS	1									
	<							>			
	Cut Sets										
	No: Unavailabilit	:y: Fi	Frequency:		Events						
	1 0.00149987	776 9	9.9991838		ALARM STARTS ::FIRE ::FIRE DETECTED ::SPRI						
	<									>	
## How to Transfer Event Tree Data to Microsoft Word

A powerful export facility is provided with the Event Tree module that will allow you to transfer data directly to Microsoft Word.

1. To access the Microsoft Word transfer facility, select the Microsoft Word icon from the Event Tree Toolbar.

l⊳ <b>~</b>		60 = 🕅 🗉 🖿	
	3	Transfer to Microsof	t word
ted	Fire Alarm Starts	Sprinkler Starts	Con
			1 Pining
		Success	พรกแกน

2. The Range window appears. Check all desired options and click OK.

Transfer To MS Word Dialog
Total Pages : 💈
Page Range (* All
C Pages from: 1 = to: 2 =
C Selection
Reference Table
Create Page Reference Table Sort by name 💌
Header Footer
Add Header
[Page#]
-Footer Add Footer
[Page#]
OK Cancel

3. The Event Tree pages you have selected will be transferred directly into Microsoft Word. Microsoft Word does not have to be active on your desktop to perform this transfer; it will open automatically.

Fire Starts Fire Dete	cted Fire Alarm Starts	Sprinkler Starts	Consequence	Result
-----------------------	------------------------	------------------	-------------	--------



## 4. Event Tree Editor Screen, Toolbar and Shortcut Keys Quick Reference

## **The Event Tree Editor Screen**



The Event Tree editor can be made visible by selecting the Dialog Tab (1) or the Event Tree Tab (2). Its main elements are the following:

- Main Menu (3): Quick access to the main functions.
- Default Toolbar (4): Quick access to the more frequently used menu options.
- Event Tree Toolbars (5): Quick access to Event Tree editing functions.
- Diagram Editing Toolbar (6): Quick access to Diagram editing functions.
- Project Window (7): A hierarchical view of the project and systems.
- System Window (8): A hierarchical view of the system, blocks, connections and nodes.
- Event Tree Window or canvas (9): The area in which the Event Tree can be graphically edited.

## The Default Toolbar

Immediately below the pull-down options resides a group of buttons that form a Default Toolbar allowing the user to access directly some of the more frequently used menu options.

Default								×
D 🖻 🖬	Ж	Ē	ß	×	n	9	Ţ	₩?

Tool	Name	Description
	New	Opens a new project.
<b>2</b>	Open	Open an existing document. The ToolKit displays the Open dialog box, in which you can locate and open the desired file.
	Save	Save the active document or template with its current name. If you have not named the document, the ToolKit displays the Save As dialog box.
ж	Cut	Removes selected data from the document and stores it on the clipboard.
	Сору	Copy the selection to the clipboard.
<b>C</b>	Paste	Paste the contents of the clipboard at the insertion point.
$\times$	Delete Item	Delete the selection.
5	Undo	Reverse the last editing. Note: You cannot undo some actions.
4	Print	Print the active document.
P	About	Open the About ITEM ToolKit Window.
<b>N</b> ?	Help	Open the ITEM ToolKit On-line Help.

## The Event Tree Dialog Window Controls

The Event Tree Dialog Window Contains the following Controls.

い 🔜 💞

Tool	Name	Description
K)	Undo Changes	Cancels the latest operation.
	Analyse	Run the Analysis of the system.



## **The Project Toolbar**

The Project Toolbar displays the available analysis options for the ToolKit application:

] <b>%</b> 2	$\mathfrak{X}$ $\mathfrak{X}$ $\mathfrak{X}$ $\mathfrak{X}$ $\mathfrak{Y}$ $\mathfrak{P}$ $\mathfrak{A}$ $\mathfrak{Q}$ $\mathfrak{A}$ $\mathfrak{A}$ $\mathfrak{P}$					
Tool	Name	Description				
<mark>Ж</mark> а	MIL217	Add a MIL-HDBK-217 (Electronic) System.				
$\lambda^{\mathrm{T}}$	Telcordia (Bellcore)	Add a SR-332 Telcordia (Electronic) System.				
$\lambda^{\pm}$	IEC 62380 (RDF)	Add an IEC 62380 French Telecom Standard (Electronic) System.				
$\lambda^{c}$	299B	Add a 299B Chinese Military Standard (Electronic) System.				
$\lambda^{N}$	NSWC (Mechanical)	Add a NSWC (Mechanical) System.				
<i>S</i>	Maintain	Add a Maintain MIL-HDBK-472 Procedure V System.				
<b>&amp;</b>	SpareCost	Add a Spare Cost Spares Scaling and Ranging System.				
α	FMECA	Add a Failure Modes Effects and Criticality Analysis (FMECA) System.				
¢ <mark>B</mark>	RBD	Add a Reliability Block Diagram (RBD) System.				
æ	Fault Tree	Add a Fault Tree Analysis (FTA) System.				
Ш	Event Tree	Add an Event Tree Analysis (ETA) System.				
∞	Markov	Add a Markov Modeling System.				

## **The Canvas Toolbar**

The Canvas Toolbar contains commands that affect the appearance and behavior of the canvas.



288	ITEM	ToolKit	Getting	Started	Guide
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Tool	Name	Description
ŝ	Undo	Undo the last command executed on the canvas.
C.	Redo	Redo the last undo that was performed.
	Toggle Grid	Turn display of the grid on and off.
	Snap to Grid	Toggle the snap-to-grid feature on and off.
٥	Toggle Page Bounds	Turn display of page boundaries on and off.

## **The Event Tree Toolbar**

The Event Tree Toolbar is used to create and control Event Tree Analysis through the commands it contains.



Tool	Name	Description
$\square$	Select	Cancels add mode.
~	Success Branch	Creates a Success Branch symbol on the Event Tree diagram.
5	Failure Branch	Creates a Failure Branch symbol on the Event Tree diagram.
—	Null Branch	Creates a Null Branch symbol on the Event Tree diagram.
*i*	Insert Column	Insert a New Column on the Event Tree diagram.
	Image	Allows the user to add an image component to the canvas.
$\mathbf{A}$	Text	Allows the user to add a text component to the canvas.
<b>₽</b>	Auto Arrange	Allows the user to organize the components on the canvas.
	Transfer to MS Word	Allows the user to transfer any Event Tree Diagram directly into MS Word.
60	Start ETA Analysis	Allows the user to perform the necessary calculations of the analysis.
<b></b>	Abort ETA Analysis	Allows the user to stop the analysis or calculations currently being performed.
*	Summary	Displays a summary of the analysis.
<b>E</b>	Header Footer	Allows the user to create a header and footer for all Event Tree pages.

<b>∃</b> ∎	Fit to Page	Allows the user to Fit the Event Tree diagram onto one page automatically.
₽₽	Reset Fit to Page	Allows the user to undo the Fit to page previously carried out.

## The Zoom Toolbar

The Zoom Toolbar contains commands for zooming and panning the canvas.



Tool	Name	Description
	Ruler Control	Turn the ruler of the canvas on or off.
<b>P</b>	Properties	Opens the properties window and allows the user to change the component properties.
9	Zoom	Allows zoom in by selecting the area with the left mouse button and zoom out by clicking on the right mouse button.
B	Zoom to Fit	Sets the magnification level of the canvas so that all components on the canvas are visible.
8	Zoom to Selection	Sets the magnification level of the canvas so that the selected components are visible.
$\langle \! \! \! \! \rangle$	Pan	Changes the pointer to a hand and allows grabbing the canvas with the mouse and panning.

## **Shortcut Keys:**

Key	Function
Ctrl + N	Open a new project.
Ctrl + O	Open an existing document. Displays the Open dialog box, in which you can locate and open the desired file.
Ctrl + S	Save the active project with its current name. If you have not named the project, the Save As dialog box will open.
Ctrl + P	Print the Active View.
Ctrl + X	Removes selected data from the document and stores it on the clipboard.
Ctrl + C	Copy the selection to the clipboard.
Ctrl + V	Paste the contents of the clipboard at the insertion point.
Del	Delete the selection.
F1	Open the ITEM ToolKit On-line Help.

## CHAPTER 13

## **Working with Reports**

ITEM ToolKit has a long list of pre-built reports that you can choose from, or use as a foundation for customized reports. Each module within Toolkit (MIL, FMECA, RBD, etc.) contains many reports specific to the type of information you would expect to see in a report from the module.

Report templates (pre-built and customized) are stored under the Reports folder within the Toolkit installation on your PC. The template files have a .trt extension and can be sent to other Toolkit users for their use as needed.

This chapter covers:

- 1. Selecting and Previewing Reports
- 2. Creating Report Templates
- 3. Customizing Reports
- 4. Problem solving

## 1. Selecting and Previewing Reports

It is important that the default printer you have associated with ITEM ToolKit be functional and configured to support the printing of Reports. Be sure to check that the printer defined in **File – Print Setup** is online and is configured to support the page format of the reports you wish.

Additionally, it is important that your Analysis results are complete and current. The Report Generator will advise you if the results are out of date, but you will have to determine if the Analysis is complete enough for reporting purposes.

## Locating the Reports

Reports are located under **File** – **Print** – **Reports** or **File** – **Print Preview** – **Reports**. The window that appears has four main tabs to perform work on. The following sections cover the tasks that you can perform on each of these tabs.

## Selection Tab

On the **Selection** tab you can select one or more reports to have the Report Generator create for you. On the left is a list of the currently open Projects/Systems in ToolKit. On the right is a list of the available Reports (pre-built and any custom reports you have made).

Choose the Project/System you wish a report for, check the box next to the specific report, and then click the **Preview** tab. You can always click the Print button if you want to go directly to printing the checked report(s). The Report you selected will appear in the **Preview** tab for further actions.

IT Reports	
Previous Rep	rt Next Report Print OK Cancel
Selection       Preview       Templates       Customize         Project / System Selection:       Projects       ITP2 :: IT Project         Projects       ITP2 :: IT Project         Projects       MIL-217 Systems;         Projects       MIL-217 Systems;         Projects       Mechanical Systems;         Projects       RDF Systems;         Project       Project         Projects       MainTain Systems;         Project / Systems;       Project         Projects       RBD Systems;         Projects       FT Systems;         Projects       Functor Systems;         Projects       FT Systems;         Projects       Functor Systems; <td< th=""><th>t     Next Report     Print     OK     Cancel</th></td<>	t     Next Report     Print     OK     Cancel

## **Preview Tab**

After selecting a report, click the **Preview** tab to see the generated report. From this tab you can browse through the reports(s) page by page, zoom in/out, print, and export/save to other report file formats.

To view a different report, return to the Selection tab, select the desired report, then return to the Preview tab.

IT Reports										
Selection Previe	w Templates	Prev	vious Report Next	: Report	:	Print		ОК		Cancel
× 😂 🕭 🗲 Preview	50%	•		1 of	<sup>-</sup> 1+	•	▶  =	4		
Name: A BCS Pareni Name Fallure Rabe:	Y'S RDF 2000 (IBC 62 1666.8345	2380 TR Ed.1)	RDF Failu	re R	epor	t		Dai T	e : 29/09/2011 me : 09:52:48	
Part Na	me Pavert Name	Category	Description	Clicuit Ref	Quantity	Pallure Rate	N×Pallure Rate	Percert	M7BF	
Number PS1 0	ABCSYS R0 2000 (IEC 62380 TR	Description IF Block	Power Supply 110/240 V AC Supply, SV/12V DC Oulput		1	87.934311	87.934311	Contribution 5.2753692%	11372125	
СК ЗЭРҒ 10	.1 10	Capacilor, Fixed Plasilo Paper	Capacilor, Fixed Plasic Paper Dielechic	C 1	1	0.13869857	0.13869857	0.15772976%	7.2098794e4	
CQ-10NF 10	2 10	Dielechic Capacilor, Fixed Plasilc Paper	Capacilor, Fixed Plasic Paper Dielechic	ce <mark>ado.</mark>	Circuit F	Ref (Memo	).13576856	0.15439769%	7.3654763e4	
0805 COG 10	.3 10	Dielechic Capacilor, Fixed Plasilc Paper	Capacilor, Fixed Plasic Paper Dielechic	сэся	1	0.13576855	0.13576855	0.15439769%	7.3654763e4	
TRANS. 10 Model A7-3	.4 10	Dielechic Inductor / Transformer	Inductor / Transformer	тı	1	0.31689171	0.31689171	0.36037 322%	3.1556521e4	
909686 10	.5 10	Capacilor, Fixed Plasic Paper Dielechic	Capacilor, Fixed Plasic Paper Dielechic	C2	1	0.13576855	0.13576855	0.15439769%	7.3654763e4	
T110-919 10 20A	10	Capacilor, Fixed Plasic Paper Dielechic	Capacilor, fixed Plasic Paper Dielechic	C 13-16	1	0.13576855	0.13576855	0.15439769%	7.3654763e4	
23122 10	10	plode, LED	ploge, LED	01-04	1	83.937339	83.937339	95.454593%	1965283.5	
	Clicanot	k the enve her file fo ML, XML	elope icon to expo ormat, such as PDF , etc.	rt the 1 F, RTF	report , Exce	to l,				
							The .	1		

## **Choices**

At this point you can decide if the pre-built reports will suit your needs. If not, continue to the next sections to learn how to modify the existing reports, or build your own.

## 2. Creating Report Templates

## **Templates Tab**

As mentioned earlier, each report (pre-built or custom) is stored as a .trt file under the Reports folder where ToolKit is installed on your PC. You can Load an existing template, edit it and save it on the Templates tab, or you can create a new template from scratch.

Once you have created or edited your template, be sure to save it with a meaningful name. Once it is saved, return to the **Selection** tab, locate the report, and then **Preview**.

#### 296 Item ToolKit Tutorial

This is an example of a template being created. A few parameters have been selected from the list on the left, and the **arrow** buttons have been used to move the parameters over to the right side for inclusion in the template.

If you want to move any parameter up or down the list, select it, and then use the **blue up/down** arrows to change the order of the parameters.

• IT Reports		
Previous R	Report Next Report Print OK	Cancel
Selection Preview Templates Gustomize		
Available Fields / Parameters	Load Template New Template Save Save As	
E- Reports	Template Name	
⊡… IIII MIL217:	Selected Fields	
	Nex Table Field	r I
Image: Constraint of the second se	No:     Table     Field       1     MIL217: :General     Part Number       2     MIL217: :General     Name       3     MIL217: :General     Analyst       4     MIL217: :General     Description       5     MIL217: :General     Description       5     MIL217: :General     Description       6     MIL217: :General     Unavailability	
	button to give the template a meaningful name.	

## 3. Customizing Reports

<u>Customize Tab</u> This tab provides you access to the specific elements that make up the report. Column widths, header/footers, graphics, etc. are all controlled on this tab.

## Header Tab

IT Reports		
	Previous Report Next Report Print OK Cancel	
Selection Drewiew Templaten C	untaniza ]	
Report Template Selection:	Header ields Footer Group Header Group Footer Paper Size / O	ve
Reports	Horizontal Justification	Δ<
MIL217 Reports:		
Failure Rate	MIL-217 Failure Report	iroup
Parts List	Fields to include in beather section Vertical Justification	
Parameters	C Top Centered C Bottom	
Pi Factors		
Allocation		٦
🔁 NonOp Failure	When you choose the report template	
NonOp Pi Facto	On the left side, the list of fields	
🕞 NonOp Pi Parai	af the report appear in a list on the	
MIL-217 Failure	Header tab. Check those you wish to	
MIL-217 Parts	Si see in the header of the report.	
MIL-217 Pi Fac		
	Additionally, you can edit the	
	look/justification of the header with	
	$\square$	
BBD Reports:	Be sure to Save your settings before	
E FI Reports:	previewing again.	
	Approved By	
H Markov Reports:	Failure Rate	
🗐 👘 SpareCost Reports 🥃	Bitmap	
	Unavailability Insert	
Peport 'East Type' selection	Instituction	
Report Fond Type Selection		
Inserting a graphic	c in the header is	
done here		

#### **Inserting a Graphic**

One aspect of customizing a report would be to add your company logo or other graphic to the header of the report. This is easily done, but there are positioning and size limitations. Use the **Insert/Remove** and **Justification** buttons at the bottom of the **Header** tab to work with graphics.

Use the **Insert** button to locate the graphic. Typically used file formats are available in the drop-down list. Be sure that the graphic you are intending on using is small enough to fit within the bounds of the Header area on the report.

Use the **Justification** button to move the graphic left, center, or right within the header, and top, center, bottom of the header area. Caution: If you have other information already in the header, it may be covered up by the graphic if they occupy the same space. You can make small adjustments to the graphic position by using the numeric fields provided.

IT Report Image Justification	
Horizontal Justification	.eft -1
Vertical Justification	Гор: -1
ОК	Cancel

These settings place the graphic in the upper-right corner of the header. Note in this example that the graphic has covered up some information. You will need to remove or move those fields of data in the Header tab to solve the issue.

17 Failure	Rate	Re	por	rt		
00552 ENVI: Ground benian	TEMP: 45	Analyst:				
	Circuit Ref	Quantity	Failure Rate	NxFailure Rate	Percent Contributio	МТІ
, Al Bect		1	0.0191	0.0191	0.142	5210
ser		1	13.417	13.417	99.563	7452
l Circuit		1	0.039	0.039	0.289	2560
		1	0.0	0.0	0.0	Non

## **Fields Tab**

The **Fields** tab is where you can adjust how the columns of your report are fitted to the data. You can have the column fit either the heading, the data itself, or you can specify exactly how wide the column is. (1 TWIP = 1/1440 of an inch)

Many times, the number or width of the columns will cause them to run off the right side of the paper. Use this tab to make the necessary adjustments to the column widths to fit the report on the paper as you desire.

• IT Reports			
Selection Preview Templates Cur	Previous Report Next Report stomize Heade Fields Foster Group	Print OK	Cancel
Reports     MIL217 Reports:     MIL217 Re	Fields selected for report  Fields selected for report  Report: Failure Rate  Part Number  Name  Parent Name  Parent Name	Field Heading Name Field Width Fit Heading Fit Data TWIP5 Chart Axes	Save As
1 Allocation 1 MonOp Failure 1 NonOp Pi Facto 1 NonOp Pi Parai 1 MIL-217 Failure	🕍 Category Descriptic 🏠 Description 🏠 Circuit Ref 🏠 Quantity 🏠 Failure Rate	X >>   Choose the select how the data.	e column, and then it will be fitted to
	🎦 NxFailure Rate 🎦 Percent Contributio 🚰 MTBF	Heading     Fields       Font     Arial       Style     Italic       Size     10       Underline     Underline	
FMECA Reports: RBD Re FT Rep Event Markov Reports: SpareCost Reports:	ta range that include.	Background Color Heading Fields Preview Data Range Border	
Report 'Font Type' selection	< >	Blocks Only     Components Only     Remove Field	

The Field Width setting controls whether the column width follows the Heading of the column, the width of the data, or a specific width set in TWIPs. (1 TWIP is 1/1440 of an inch)

Name: MIL217: Parent Name: Failure Rate: 13 MTBF: 74204.0	3 3.476 156	AAMIL	217	Failure
Name: Funcatio	onal Device	1xFR: 13.476	1xCR: 0.000552	ENM: Ground,benign
Part Number	Name	Category Description	Description	
56789	Funcation al	Capacitor	Capacitor, Al Bect	
zxczxc	Device.1 Funcation al	Diode, Laser	Diode, Laser	Note how the data wraps in the column. This
asdasd	Funcation al	Micro, Digital	Integrated Circuit	column is set to follow the width of the Heading
ZXCZXC	Funcation al Device.4	External	External	uie meauilig.

# **17 Failure Rate Report**



00552 ENVI: Ground,benign	TEMP: 45	Analyst:				
'n	Circuit Ref	Quantity	Failure Rate	NixFailure Rate	Percent Contributio n	MTE
, Al Bect		1	0.0191	0.0191	0.142	5215
ser		1	13.417	13.417	99.563	7452
Note how these two columns of c compressed to fit on the page. Ye	lata are ou will	1	0.039	0.039	0.289	2560
need to go into the <b>Fields</b> tab and adjustments to make these fit nic	l make ely.	1	0.0	0.0	0.0	None
						1.

## Footer Tab

The Footer tab, similar to the Header tab, controls the information that is displayed in the footer of the report.

## **Group Header and Footer Tabs**

If you have checked the Group box, the report will group the results by component categories, parent names, and other aspects of the system. You can control the header/footer for the Groups in the same manner as you do with the report header/footer.

### Paper Size Tab

The Paper Size tab is used to define the dimensions of the paper you want the report to fit on, as well as the margins. Be sure your printer supports the paper dimensions you wish to use.

• IT Reports		
	Previous Report Next Report Print	OK Cancel
Selection Preview Templates	Customize	1
Report Template Selection:	Header Fields Footer Group Header Group Footer Paper	Size / O Save
Reports MIL217 Reports: Failure Rate Parts List Parameters Pi Factors Allocation MonOp Failure MIL-217 Failure MIL-217 Parts MIL-217 Parts MIL-217 Parts MIL-217 Pi Fact MIL-217 Pi Fact Fi Bellcore Reports: Fi Construction MIL-217 Pi Fact MIL-217 Pi Fact Fi Bellcore Reports: Fi Construction MIL-217 Pi Fact Fi Construction MIL-217 Pi Fact Fi Construction Markov Reports: Fi Construction Report 'Font Type' selection	Paper Size A4 Source Lower Orientation Portrait © Landscape Margins Left 350 300 Bottom Right	Save As Group

## 4. Problem Solving

Listed below are some common issues you may encounter while working with Reports.

#### When I preview a report it is blank.

Be sure that you have matched the type of System you have selected (MIL, Telcordia, Fault Tree, etc.) to the type of report that you have selected. If you have a MIL System selected, yet select a FMECA report, the resulting report will be blank.

#### Some of the columns in my report are blank.

There are many opportunities to enter data into ToolKit. If you leave blanks such things as Descriptions, Names, Part Numbers, etc. when you run a report, these columns will appear blank.

#### Column widths and data wrapping within the column makes the report look messy. What can I do?

Using the **Fields** tab on the **Customize** tab, you can adjust how the width for each column is determined. You can choose to either follow the column heading width, the width of the data (which changes), or fix the width in TWIPs. Depending on the nature of the columns and your data, you may have to adjust each column differently.

#### I make a change to a template, but it does not seem to "stick".

After you make a change to a template, be sure you Save the template. Additionally, be sure you have the correct template selected for preview.

## When I choose columns for a template, some come up blank, but others have data in them on the report. I know those blank columns have data in them.

Certain combinations of columns will result in this effect. For example, if you want to see System level information, and Component level information all in the same row of the report, some combinations of this cannot track with each other.

#### The columns are cut off on the right side.

Depending on your data and columns selected, you may reach the physical limits of the paper. In this case you will have to either remove columns, use larger paper, or adjust the column widths. Often times it is better to remove columns that to try to fit everything on to one page.

#### One column seems to take up all the room on the page.

This is common with Description fields. The only real solution is to force the column into a specific width and let the data wrap as needed.

#### I don't understand where some of the values in the columns came from?

Some column values are ones you have entered, while others are calculated by ToolKit for you. Find these values in the Results window within ToolKit.

## CHAPTER 14

## Import/Export

One of the powerful features of ToolKit is the ability to import and export data to/from a variety of formats, Microsoft Excel and Access are just two of the choices.

This chapter covers:

- 1. Creating a bill of materials in Excel
- 2. Importing the bill of materials into ToolKit
- 3. Exporting a system from ToolKit to Excel

## 1. Creating a Bill of Materials in Excel

### Importing a Bill of Materials into a Project or Library

You have an Excel worksheet BOM that contains component information that you wish to import it into a MIL-217 System within a ToolKit Project. The columns of data in the worksheet have names, but you are not sure if they match the MIL-217 General, Physical, or Application parameter names used in ToolKit.

#### Preparation

The first step is to make sure the columns and values in the worksheet are closely related to the MIL-217 parameters found in ToolKit. This will enable you to use the Auto-Match button during the field mapping process. You may discover that you are not using all of the possible parameters that MIL allows. By looking at the parameters via ToolKit for the components you will be using, you can quickly identify the ones typically used.

Add a few of your common components to a MIL-217 System, then view the General, Physical, and Application tab panels on the Dialog window for the system. Here you will see all of the parameters for the components. Following are those commonly used:

For Resistors – Category, Description, Rated Power, Applied Power, Power Stress For Capacitors - Category, Description, Rated Voltage, Capacitance, Applied Voltage, Voltage Stress

**Note:** You can also Export any system to an Excel spreadsheet to see the specific column requirements. Build a system with blocks and components, then **File – Export.** Follow the Wizard to produce an Excel file. Yes, you can then use this generated Excel file as a template for your BOM.

In addition to the MIL-217 parameters, you can have the following columns in your worksheet for ITK to import:

ID – a unique, sequential ID number for each block and component row in the sheet

**System ID** – a static number indicating the system that the block/component is a part of (used only if you have more than one System in the Project)

**Parent ID** – a static number that points to the block that the component is part of. (0 for blocks, 1 for components)

Name - should be unique, or left blank, ITK will assign a unique numerical name to the block/component

**Category Keyword** – this is a two letter designator for the block/component (BK for block, CR for a cap, RS for a resistor. (See the ToolKit Help text for a listing)

## Make the Worksheet

1. Now that you understand the columns required in your worksheet, you can begin constructing an example. We suggest the following:

ID	System ID	Parent ID	Name	Category Keyword	Description	Capacitance
1	1	0		BK	Block 1	
2	1	1		CR	Cap, .22 uf	.22
3	1	1		CR	Cap, 440 uf	440
4	1	1		RS	Res 10K	
5	1	1		RS	Res 100K	

Rated Voltage	<b>Rated Power</b>	Applied Voltage	<b>Applied Power</b>
50		25	
25		50	
	.25		.20
	.5		.45

Notice how all Components are assigned to the same System ID, the Block is Parent 0, and each Component is assigned to the first Parent (the Block).

Using this pattern, you can see all of the required/optional fields to meet the import and MIL-217 requirements.

- 2. Name this worksheet "Blocks & Components". Excel menu: Format Sheet Rename
- 3. Then, add two more worksheets to your Excel file (Excel menu: Insert Worksheet), one named "Physical", the other "Application". Make a copy of the B&C worksheet and paste it into the Physical and Application worksheets. Now you have the same data in three different worksheets within the same Excel file.
- 4. Save and Close your Excel file.

## 2. Importing the Bill of Materials into ToolKit

### **Ready for Import**

With this properly formed set of worksheets, you are ready to begin the import process. Open/create a new ITK Project file, add a MIL-217 System to the Project and be sure it is selected in the System window.

1. Click File - Import. If the "Save As" dialog appears, save your Project file before continuing.

The Import Wizard dialog now appears.

Import Wizard !		K
Eile 🗙		
Import Wizard	Input File Step 1 of 4	1
	Pathname: Browse	
¥		
NAME MADE NAME NAME NAME MADE NAME MADE NAME NAME NAME NAME NAME NAME	Require to colort Excel	
×	If you have saved a successful import template, select it here to avoid remapping.	
	<< Back	1

- 2. Since we are using an Excel file in this example, select **Excel** in the Format field, and Browse to locate your Excel file. Click **Next**.
- 3. In this step, you map the individual **worksheets** to the MIL-217 **output tables** for the import processing. Start with the Block, and then match the Physical and Application to the respective Output tables. Only match Input Tables that have a \$ at the end of their name.

Import Wizard !			
Eile 🔻			
Import Wizard	Tables Input Tables 'Blocks & Components\$' Physical\$ Application\$ If the table and fields names match exactly, you can use the Auto Match button.	Output Tables MIL 217 Application Parameters MIL 217 Blocks and Components MIL 217 Physical Parameters MIL 217 System	<u>Clear</u> <u>Clear</u> All <u>Auto Matchi</u>
	<u> </u>	<< Back	Cancel

- 4. Click Next.
- 5. This step matches the **Tables** to the **Input/Output fields**. For each Table, click the **Auto Match** button to match the Input and Output fields. Warning: If your column names do not match the MIL-217 parameter names exactly, the Auto-Match will not work completely. You will have to manually associate the fields together.
- 6. After using the Auto Match, click **each Input field** to see the Output field it has been mapped to. Verify that the mapping is correct.
- 7. Additionally, for each Table you need to be sure the ID and System ID fields are matched. These fields identify each component in the list and the System they are a part of.

• Import Wizard !				
<u>F</u> ile 🔻				
Import Wizard	Fields Table Association: Blocks & Components\$->MIL 21 Physical\$->MIL 217 Physical Para Application\$->MIL 217 Application	Input Fields: ID System ID Parent ID Name Category Keyword Description Capacitance Rated Voltage Rated Voltage Rated Voltage Applied Voltage Applied Power	Output Fields: ID System ID Parent ID Category Keyword Part Number Reference ID LCN Analyst Description Notes Quantity Number On Standby Adjustment Factor Mean Time To Repair Name Update Children Temperature Increment Base Failure Rate	Step 3 of 4
		<< <u>B</u> ack	Next >>	Cancel

- 8. Click Next.
- 9. The final step is to confirm the settings and click **Finish**. It will take a moment for the Excel data to be imported into the MIL system within your Project.

• Import Wizard !						
Eile 🔻						
Import Wizard	Outpu Pathn C:\P	ıt ame: rogram Files\Item\Toolkit\F	rograms\IT_DB\V-800-E:	ample.ITP.r	ndb Browse	Step 4 of 4
<b>I</b> III	Import Options C Overwrite Existing Records Append to Existing Records Overwrite / Append to Existing Records Data mport in progress				hed blocks	
***	Previe	w :				
XXXX XXX XXX XXX		ID	Descri	tion	Category Keyword	<b>≜</b>
	1	1.000000e+000	Block 1		ВК	
	2	2.000000e+000	Cap, .22 uf			
$\sim$	3	3.000000e+000	Cap, 440 uf	lf ye	ou have a library open o	during the
$\checkmark$	4	4.000000e+000	Res 10K	imp	import, and the part numbers ma	
	5	5.000000e+000	Res 100K	Too	lKit will lookup the co	mponent
parameters in the library and pl information in the system.					nd place that	
	••	\ 'Blocks <u>Componen</u>	ts\$' { Physical\$ {	•		Þ
			<	< <u>B</u> ack	Einish	<u>C</u> ancel

10. If you wish to save your settings for future imports of this specific BOM, click Yes. Otherwise, click No on the following dialog box.



Now you can go to your System in your Project and confirm the blocks, components, and the parameter values you just imported.



## Errors That Can Happen

As with any import type function, errors can be caused for many reasons. Listed below are a few typical errors that could be encountered.

An error log in generated and placed in the Toolkit/Programs\IT\_DB folder when errors do occur.

- Numeric field overflow caused by a true number being in a column that has been formatted as a Text column. Place a single quote ' in front of the true number.
- Parent ID equals Component ID this is caused by blank rows between the Column Names and the first row of data. Also, if there are blank rows below the fields of data, they too can be confused as data.
- No ID field defined You must have a unique ID for each components and block across pages in the Excel file.
- Import process seems to complete, but no blocks or components are imported Be sure you have selected the proper System you want to import to in Toolkit before starting the import process.

## Easy Import

If you simply want to import a list of components into ToolKit, with no Category definitions, or if you have a Library open with matching part numbers that has all of the component details included, the following options are available to you:

- Create an Excel spreadsheet with a single column named **Part Number**. Enter just the part numbers for the components.
- Import the spreadsheet, matching the single column to the Part Number field with ToolKit.
- The list of Part Numbers is imported, yet the components are categorized as External for manual editing later.

### 310 Item ToolKit Tutorial

• If however, you have a Library open during the import that has matching part numbers to those in the spreadsheet, ToolKit will match the part numbers and bring in the information on the parts contained in the Library into the Project file.

## 3. Exporting a System from ToolKit to Excel

The export function enables you to extract all of the information you have entered into ToolKit, and the calculated values/results that ToolKit has made for you. Not only do you get the information in a spreadsheet, database, or text file, but the relationships between the blocks, components, and other elements of your systems are maintained. Any system created using any ToolKit module can be exported.

One common use of an export is for review purposes by colleagues who do not have ToolKit. Then, once they have made their changes to the values in the exported spreadsheet, it can be re-imported back into ToolKit.

## To export a System from ToolKit:

1. Select the system you wish to export on the System window.



- 2. Go to File Export to open the Export Wizard.
- 3. The first step of the Wizard is indicating the source of the exported data, which is an internally created Access database containing your data. Click **Next** to continue.

Export Wizard !		
Eile 🔻		
	Input File	Step 1 of 4
	Pathname: C:\Program Files\Item\Toolkit\Programs\IT_DB\V-800-Example.ITP.mdb	
× ×		
Export Wizard		
	Show Preview 🔽 << Back	<u>C</u> ancel

4. On this window, you select the tables from within ToolKit you wish to have exported. If you wish all tables, click the **triple** arrow button. If you want only selected tables, select the table, then click the **double** arrow button to move it to the right. Click **Next** when finished.

Export Wizard !			X
Ele	Tables Input Table: <u>MIL 217 Application Parameters</u> MIL 217 Physical Parameters MIL 217 Pi Factors MIL 217 System	Output Table: MIL 217 Blocks and Components >>> Use this button to select all tables for export.	Step 2 of 4
	Show Preview 🔽	<< <u>B</u> ack <u>N</u> ext >>	<u>C</u> ancel

5. In this step you select the fields from the tables you selected in the previous step that you want to have exported. Select the table, and then use either the double or triple arrow buttons to select the fields. Click **Next** when done.

◆ Export Wizard ! Eile ▼	Fields		X Step 3 of 4	
Export Wizard	Select Table: MIL 217 Blocks and Components	Input Fields:	Output Fields:	
	Show Previe	w 🔽 🛛 << Back	Next >> Cancel	

6. The final step is to confirm the format of the export. Amongst other formats, Excel spreadsheets or Microsoft Access are the most popular. Click **Finish** when ready to start the export.

Export Wizard !					
Eile 🔻					
	Output				Step 4 of 4
	C:\Dc Format Microsoft Excel Delete Existing Append to Exis Delete Unselect	Records ted Fields	na Pake\My Documer Text Export Op Specified Delim	nts\DemoShield\Demoshield \ btions iter I Field Names As f Decimals Places: [	Browse
		ID	System ID	Parent ID	Ci 🔺
X	1 1	1		0	вк
$\sim$	2 2	1		1	CR
	3 3	1		1	CR
	4 4	1		1	RS
	5 5	1		1	RS
	6 309	1		0	BK
Export	7 310	1		309	CR
Export	8 311	1		309	CR 🚽
Wizard	MIL 217 E	Blocks and Components			
		Show Preview 🔽	<< <u>B</u> ack	Einish	Cancel

### 314 Item ToolKit Tutorial

7. The end result of the export, if you chose Excel, is an .xls file with a worksheet for each major table of data within ToolKit.

## CHAPTER 15

## **Library Facilities**

ITEM ToolKit contains several library facilities. The first facility is referred to as "Library Project" and is functionally identical to a regular "Project File", with the addition of another "System Window" labeled "Library System Window". This allows storage, and retrieval of any system, block, or component, including gates, events, or segments (branch) of a fault trees and RBD diagrams. Libraries of this type can be opened as windows on the workspace, or loaded in the background via the Library Lookup Manager.

The second facility, "Failure Model Library" handles storage and retrieval of distribution models. The Failure Model Library also has the capability to store and retrieve from a disk file, allowing the content of the library to be shared with other projects. This is discussed further in the separate Fault Tree User Manual.

This chapter covers:

- 1. Creating a new Library Project
- 2. Adding and Extracting From a Library Project
- 3. Saving and Closing a Library Project
- 4. Loading and Browsing a Library

## 1. Creating a New Library Project

Creating a library project is very similar to creating a regular project file. Select **New Library** from the **File** menu. Alternatively to open an existing library, select **Open Library** from the **File** menu.



Once the command is executed ToolKit will open and display any system in the Library System Window. The layout of the workspace will look like as follows:



## Library Project

A Library Project is identical to ToolKit Project, with the exception that it has an embedded "Library" label. This labeling allows it to be treated slightly differently, such that it can be created, saved, and viewed in parallel to a regular project file. The disk file extension of library files are \*.ITL, which is different from the project files \*.ITP. A Library project file and its contents are also displayed and edited using the same facilities as a project file.

## Library System Window

"Library System Window" is identical in operation and capabilities to the **System Window**, and it embeds the **Library Hierarchy**. The Library System Window is identified by its window title if it is in a floating state, and by the hierarchy header which has "Library" appended to the project name. By default this window is docked on the right side of the System Window.

## Library Hierarchy

The **Library Hierarchy** is identical in operations and capabilities to the System Hierarchy. This hierarchy is embedded in the Library System Window. The Library Hierarchy is identified by the hierarchy header which has (Library) appended to the project name.

## 2. Adding and Extracting from Library Project

Systems, blocks, components, gates and events can be added to a library in the same way as a project. In addition, since the Library Hierarchy is an independent facility from the System Hierarchy Copy/Paste, and Drag/Drop" operations can be carried out between the two hierarchies.

1. Select an element from the System Hierarchy, and use the right mouse menu copy command:



2. Select a target element in the library hierarchy and use the right mouse menu paste command:



## **Extracting from a Library**

An element and all its sub-branches can be copied from a library project, into a regular project.

1. With both project, and library open in ToolKit, select an element in the Library Hierarchy and copy it using the right mouse menu **Copy** command:



2. Select a target element in the System Hierarchy and use the right mouse menu Paste command:


#### 3. Saving and Close a Library Project

Library project files are saved and closed via a set of commands on the File menu that are different from regular project files.

With the Library Project active, note that the **File** menu **Save**, **Save As**, and **Close** are active. The **Save Library** command will save the existing library with the file extension of "\*.ITL". The **Save Library As** command will save the existing library allowing an opportunity to rename the library file. The **Close Library** command will close the active library.

New Library	
Open Library	
Save Library	
Save Library As	
Close Library	
Library Lookup Manager	

#### 4. Loading and Browsing a Library

Using the Library Lookup Manager under the File Menu, any library file can be loaded into memory, eliminating the need to have an extra window open on your workspace.

- 1. Open an existing or create a new project
- 2. Click File Library Lookup Manager

📀 IT Library Manager 📃 🗖 🔀						
Add Delete Loc	ad Selected Librarie	s			[	ок
Path:		Selected	Description:	Notes:	No Systems:	No Block 🔺
1 🔁 🖓 Program Files Vitem \Toolkit \Example	es)DemLib.ITL 🔍	Include			0	0
	<u> </u>		$\rightarrow$			
	Use this but libraries int	tton to loa o memory	id the	Use the library	is button to br files (.ITL)	rowse for

3. Locate the library file(s) you wish to load into memory via the **Path** field.

#### 4. Click Load Selected Libraries, then OK

- 5. Now the selected libraries are in memory and available for browsing via the following locations on the workspace:
  - Right-click a Component in the System window.



• Click the spyglass icon next to the Part Number field on the General tab of a Block or Component.

🖽 General 🔛 Ph	ysical 🛛 🖽 Application 📄		
Capacitor			
Part Number:	<b>•</b>	Oescription:	CAPACITOR, FIXED, CK, 33PF
Name:	10.1	✓ Search System	
Circuit Ref.:		Search Project	
Analyst :		Browse Library	
Category :	Capacitor		
Update Children :	M	LCN : F	F11
	_ Temperature	]	

• Either method opens the Library Browse window.

Library Browse				
– Filters Library File Name:	Part Number	Category	Description	
All loaded library files	1 FC0001	Capacitor		
	2 ECCA3A101JGE	Capacitor	100pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kir
Category	3 ECCA3A121JGE	Capacitor	120pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kir
Capacitor 🗾	4 ECCA3A151JGE	Capacitor	150pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kir
Carriel Object	5 ECCA3A181JGE	Capacitor	180pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kir
- Search Strings	6 ECCA3A221JGE	Capacitor	220pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kir
Part	7 ECCA3A271JGE	Capacitor	270pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kir
	8 ECCA3A331JGE	Capacitor	330pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kir
Description:	9 ECCA3A390KGE	Capacitor	39pF 1000VDC +/-10%, SL/GP,	High Voltage Ceramic Disk, Kir
	10 ECCA3A470KGE	Capacitor	47pF 1000VDC +/-10%, SL/GP,	High Voltage Ceramic Disk, Kir
	IT E Search for	r a compo	nent via the search	ligh Voltage Ceramic Disk, Kir
	12 Eleptions	alaat it fra	m the list then aligh	ligh Voltage Ceramic Disk, Kir
	13 EOptions, S		in the list, then click	ligh Voltage Ceramic Disk, Kir
Const Constitute	14 Ethe Select	button to	add it to your system.	gh Voltage Ceramic Disk, Kinł
Case Sensitive	15 Edunomou	oupdoitor		"gh Voltage Ceramic Disk, Kinl
Starts with	16 ECCA3A180JGE	Capacitor	18pF 1000VDC +/-5%, SL/GP, H	High Voltage Ceramic Disk, Kinł
Contains Update Search	17 ECCA3A220JGE	Capacitor	22pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kin
	18 ECCA3A101KGE	Capacitor	100pF 1000VDC +/-10%, SL/G	P, High Voltage Ceramic Disk, ⊧
Total count:   163	19 ECCA3A471KGE	Capacitor	470pF 1000VDC +/-10%, SL/G	P, High Voltage Ceramic Disk, ⊧
Total count filtered: 40	20 ECCN3A120JGE	Capacitor	12pF 1000VDC +/-5%, SL/GP,	High Voltage Ceramic Disk, Kin
Max. Display Previous				
500 Next	Library lookup manager.			Select Cancel

# CHAPTER 16

# **Grid View Customization**

ITEM ToolKit contains a feature that allows you to create your own grid layouts. The Grid View is available for all ToolKit modules.

### 1. Viewing/Creating Grid Templates

If you wish to use a Grid View that is different than the default that comes with ToolKit, use the following steps to create your own.

1. Select Settings – Grid Templates menu to open the Grid Templates window.

•	Grid Templates		<
F	Crid Templates  Crid Template Selection  Cremplate  Cremplates  Cremplates  Cremplates  Cremplates:  Cremplates: C	Template Name:       Default         Filtering(0)       Set up a filter or criteria to look for components matching specific criteria.         Ordering(0)       Select the fields used to sort components.         Image: Selected template as active grid template for selected syster         User Defined Fields(0)       Create, delete, modify user defined fields         Selected Fields       Selected Fields         % Ballast Vol Increase       Symbol         % CO2 Overfill       Name         Activation Energy       Symbol         Activation Energy       Symbol         Activation Factor       C         Application, CN       Application, CN         Application, RA       Application, RA         Application, HB       Up         Application, HB       Up         Application, LB       Down         Each ToolKit module       Down	
		Each ToolKit module has a default Grid template.	

You can edit the default Grid template as you wish, or a better suggestion is to create your own Grid template. Use the File – Add Template menu option to start creating your own.

#### 322 Item ToolKit Tutorial

- 3. Name the template, then choose from the **Available Fields** column. Use the arrow buttons to move the fields to the **Selected Fields** column. You can move the fields up and down the list as desired using the **Up** and **Down** arrows.
- 4. Check the **Set selected template as active grid template for selected system** box to activate your new template. Then click **OK**.
- 5. When you return to the Grid View, the selected default Grid template for the module is used to display the system data.

#### 2. Additional Grid options

There are several options you can utilize within your Grid templates to make the display of data fit your needs.

Filtering – the Grid template can be set to display fields that contain data that meets certain filter criteria. Columns displayed on the Grid that are being used as filters have an \* added to the column name. Filtering is case sensitive.

Ordering - the rows of data displayed in the Grid can be ordered by key fields in ascending or descending order.

**User Defined Fields** – you can define additional fields to enter/display data on the Grid. Additionally, these fields can be imported/exported from ToolKit along with all other parameter fields for the specific module.

Row heights - the display heights of the header and field rows can be adjusted

Styles - the style of the column, header, and fields can also be customized.

File         Sid Template Selection         Image: Templates	Grid Templates		X
Bellcore Templates:     Application.AM     Application.CN     Application.BA     Application.BA     Application.BA     Application.LD     Application.LF     Application.DE     App	Grid Templates File      Grid Template Selection      Templates      PaultTree Templates:      PaultTree Templates:      PaultTree Templates:      Pault Templates:      Pault Templates:      Pault Templates:      Pault Templates:      PaultTemplates:      PaultTemplates:	Template Name:       Default         Filtering(0)       Set up a filter or criteria to look for components matching specific criteria.         Ordering(0)       Select the fields used to sort components.         Image: Set selected template as active grid template for selected syster         User Defined Fields(0)       Create, delete, modify user defined fields         Available Fields       Selected Fields         % Ballast Vol Increase       >>         % C02 Overfill       >>>         Activation Energy       >>>>         Activation Energy       >>>>         Activation Energy       <>>>         Activation Energy       <>>>         Activation Energy       <>>>         Active Optical Surfaces       <	Header Row 31 
ОК	NSWC Templates: Bellcore Templates: China 299B Templa MainTain Template:	Adjustment Factor Application AM Application,CN Application,GA Application,HB Application,HB Application,HD Application,HD Application,LD Application,LD Application,DE Application,OE Application,OE Application,OE Application,OE Application,OE Application,OE Application,OE Application,DE Application,DE Application,OE Application,OE Application,OE	Field Style Font Background Color Field Style Font Background Color

#### 3. Switching to a Different Grid Template

- 1. While in the Grid View, use the Settings Grid Templates menu option to select a different Grid template and Set selected template as active grid template for selected system. Click OK when ready to return to the Grid View.
- 2. The Grid View is changed to match the Grid template you just selected.

## 4. Exporting and Printing the Grid View

Any Grid View can be exported to several different file formats via the **File – Save Grid** menu option. Additionally, the Grid View can be printed directly via the **File – Print – Print Active View** or **File – Print Preview – Print Preview Active View** menu options.