

STEM User Manual

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HOLD No	Section	Description	Date
Hold1	2.5	Status bar option to be added when feature is available	18.12.21
Hold2	2	Figure 2: STEM User Interface to update	18.12.21
Hold3	3.4	New project report feature required]	18.12.21
Hold4	3.6	Delete a project function description required	18.12.21
Hold5	3.8	Help page description required	18.12.21
Hold6	3.7	Software version page Window missing	18.12.21
Hold7	4	System page section update required	18.12.21
Hold8	5.3	Description of the online form in the STEM area is required.	18.12.21
Hold9	6.2	Manage System Architecture section missing	18.12.21
Hold10	6.3	Manage Electronic components section missing	18.12.21

HOLD No	Section	Description	Date
Hold11	6.4	Calculator Linkage Matrix section missing	18.12.21
Hold12	9	Fault Tree (FTA) Module section description required	18.12.21
Hold13	10	Event Tree (ETA) Module description required	18.12.21
Hold14	11	Common Cause Factor (CCF) Module description required	18.12.21
Hold15	12	Calculation Management Module description required	18.12.21
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Disclaimer

Topfield Consultancy's makes no warranty, expressed or implied, to users of the SAFETY TRANSPORT ENGINEERING MANAGEMENT (STEM) Software Tool, and accepts no responsibility for its use. Users of STEM assume sole responsibility under UK Law for determining the appropriateness of its use in any particular application; for any conclusions drawn from the results of its use; and for any actions taken or not taken as a result of analysis performed using these tools.

Users are warned that STEM is intended for use only by those competent in the fields of RISK assessment and is intended only to supplement the informed judgment of the qualified user. The software package is a computer model that may or may not have predictive capability when applied to a specific set of factual circumstances.

1 Introduction

Topfield Consultancy's SAFETY TRANSPORT ENGINEERING MANAGEMENT SOFTWARE (STEMS) Tool is an Integrated Software package for the railway industry which models safety and reliability characteristics of railway engineered systems.

This is a desktop-based software tool that provides engineers and managers with cost effective design solutions for performing safety and reliability engineering calculations.

Users will be able to create new or modify their existing calculations that-to support their system designs

This user guide documents version 1 of the STEM software and details how to setup and run the STEM software.

The STEM software uses the following third-party libraries:

- JGraph - <https://github.com/jgraph>
- JasperReports - <https://www.jaspersoft.com/>
- JFreeChart - <https://www.jfree.org/jfreechart/>

1.1 What does STEMS do?

STEM software integrates 8 tools to suit the needs of an engineering project and to save you time. The following software Apps will help you model safety and reliability calculations efficiently:

- Calculator management module (CMM)
- Event Tree Analysis (ETA) module
- Fault Tree Analysis (FTA) module
- Failure Mode Effects Analysis (FMEA)
- Failure Mode Effects Criticality Analysis (FMECA)
- Safety Integrity Level (SIL) module
- Reliability Block diagram (RBD) module
- Common cause failure (CCF) Module

Each calculator can be used separately or in various combinations.

1.2 Pre-requisites for this manual

The hardware and knowledge-based requirements for STEM users are detailed below.

The minimum requirements for using the STEM software.

System requirements

To operate the STEM software, you will need a dual core processor Windows machine with 4 gigabyte (GB) RAM, and an internet connection.

Further system details can be found in section 14.2.

Knowledge base requirements.

- Tip

To use the STEM, it is assumed that you have had experience in the use of safety and reliability tools or have successfully attended the STEM level 1 course. If not, it is recommended that you undertake the Introduction to STEM level 1 course as a minimum.

1.3 STEM Login

The STEM login screen with the empty fields for entering the username and password is shown in Figure 1.

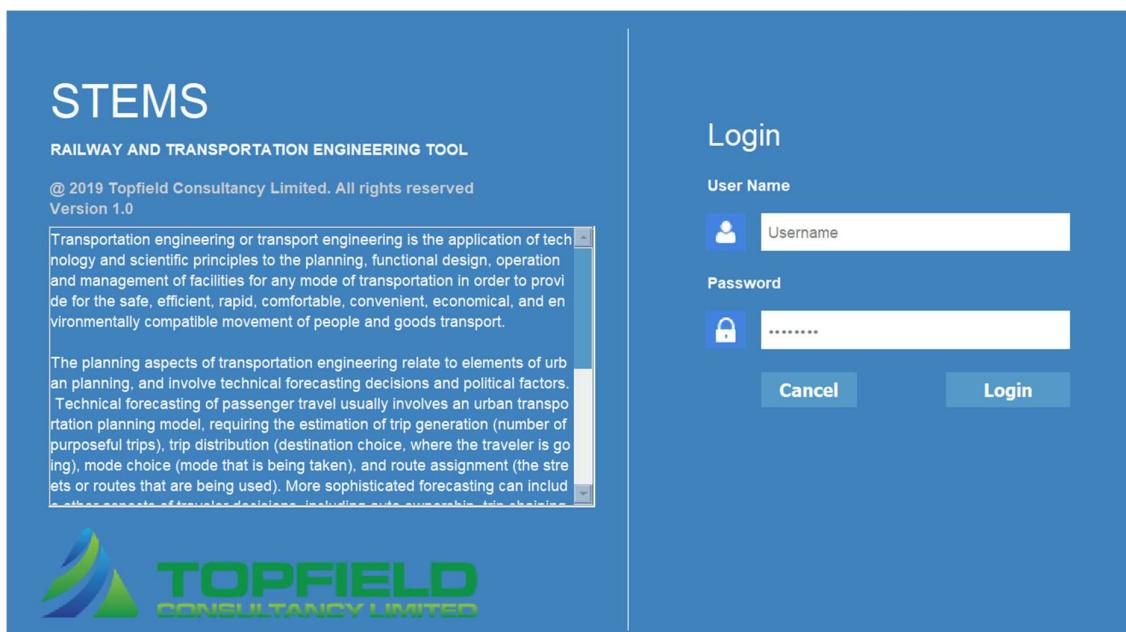


Figure 1: The STEM Login Screen

To log in to the STEM software, the user needs to enter a username and password.

- Tip

Make sure you have the correct username and password details.

2 User Interface

The STEM interface has been designed to provide the designer with a flexible guide to perform safety & reliability engineering calculations and enter, modify, and view data and results in the STEM user interface.

This section describes the menus, toolbox and toolbar functions that you may apply when preparing engineering calculations. The online help provides instructions for specific tasks to support you.

The STEM interface page will appear when you start the STEM software:

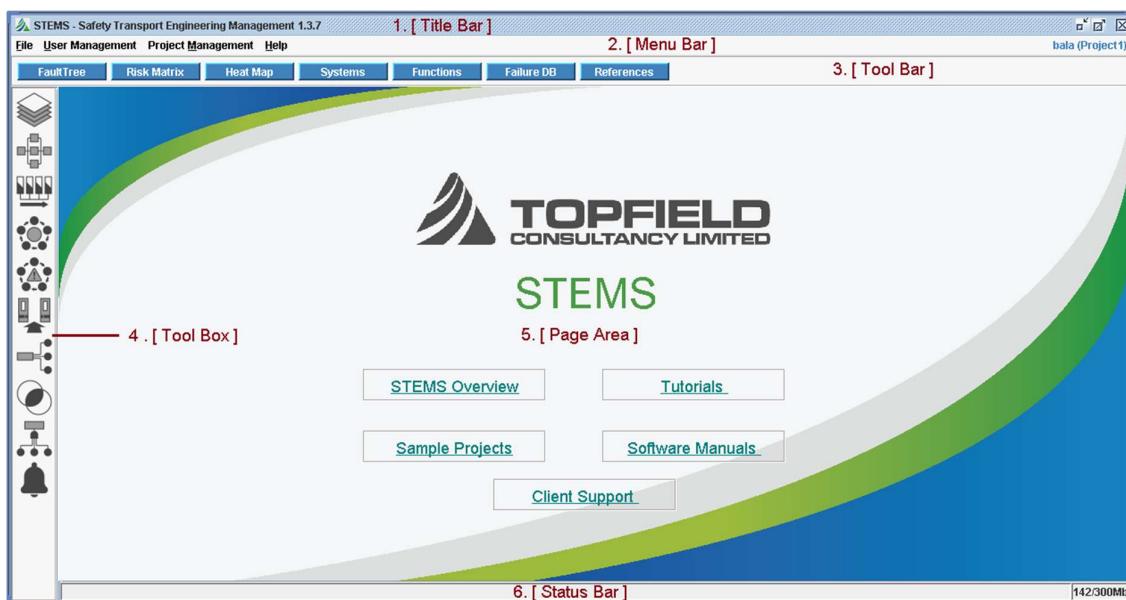


Figure 2: STEM User Interface

The icons associated with the individual Apps and functions in the toolbar shown in the figure are described further in the sections below.

• Tip

You can re-size the view by clicking the maximise icon in the top right-hand corner of the screen or by dragging the edges of the frame.

2.1 Title bar

The title bar contains general information about the software name and version. The right side of the title bar contains the resize icons to minimise, maximise the screen view or to close the software.

2.2 Menu bar

The menu bar allows access to all the STEM features via the main menu and sub-menus. The menu bar contains commands for the main areas of the software's functionality. A list of the menu options and shortcuts are shown below.

Figure 3: STEM Menu Bar

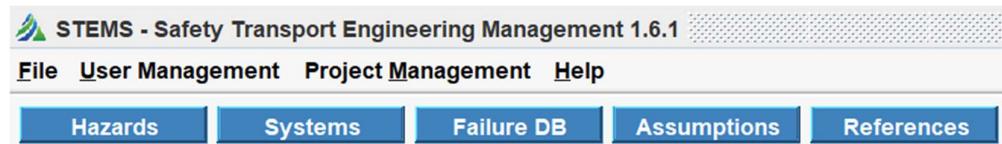


Table 1: STEM File Menu Options

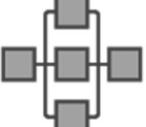
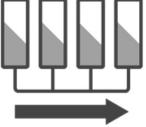
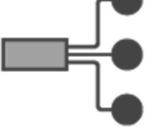
Menu	Description	Shortcut
File	Work with files (New, Open, Save),	
Create New	Creates a new STEM project file	Ctrl + N
Open Project	Opens an existing STEM project file	Ctrl + O
Open Sample Project	Opens a sample STEM project file	Ctrl + J
Export Report	Exports an external report	Ctrl + E
Print	Prints a screen image	Ctrl + P
Screenshot	Creates a screenshot image	Ctrl + S
Exit	Exits STEM	Ctrl + X
User Management	Provides specific STEM information on your usage	
User Profile	User information summary	Ctrl + U
User Package Details	Provides information about the user package	Ctrl + D
Your Comments	Enables user to submit comments or software issues	Ctrl + Z
Layout Settings	General layout settings	Ctrl + L
Project Management	Provides detailed information on the project	
Project Profile	Presents a summary of the project	Ctrl + G
Your Projects	Provides a summary of all the Users projects	Ctrl + O
Manage Systems Architecture	Provides detailed information on the system architecture	Ctrl + H
Manage Electronic Components	Provides a summary of all the electrical / electronic components	Ctrl + B

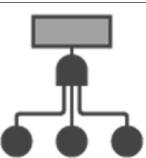
Menu	Description	Shortcut
Calculator Linkage Matrix	Provides information on the calculation modules linked with each App	Ctrl + M
Help	Interactive help menu	
Help Contents	Lists Help contents	Ctrl + K
Online Help	To access online help	Ctrl + W
Report an Issue	To report a software issue	Ctrl + R
About	Summary information about STEM software	Ctrl + A

2.3 Side menu toolbox

The side menu toolbox contains a set of icons which give short-cut access to the calculation modules without the need to navigate through a series of menus and/or sub-menus.

Table 2: STEM Side Menu Toolbar Options

Name	Icon	Description
Calculation management module		Opens the calculation module for the project
Reliability block diagram		Opens the reliability block diagram module
Safety integrity level		Opens the safety integrity calculation module
Failure mode and effects analysis		Opens the failure mode and effects analysis calculation module
Failure mode and effects criticality analysis		Opens the failure mode and effects criticality analysis calculation module
Event tree calculation		Opens the event tree calculation module

Name	Icon	Description
Common cause failure module		Opens the common cause calculation module
Fault tree calculation		Opens the fault tree calculation module
Notification		Provides the current notifications to the user

2.4 Horizontal toolbar

The horizontal toolbar buttons contain short-cut access to utility options.

Figure 4: STEM Horizontal Toolbar



Table 3: STEM Toolbar button options

Name	Description
Hazards	Access the project hazards list
Systems	Access the system summary
Failure DB	Enable access to the failure database
Assumptions	Lists assumptions for the project
References	Lists reference information for the project

2.5 Status bar

The status bar displays the status of the calculation models. The status is displayed in two areas on the user interface screen:

- Region at the top of the interface screen displays the current module status. Once the calculation has been completed the status will be displayed.
- Lower region on the frame displays important information on a specific calculation such as calculation errors.

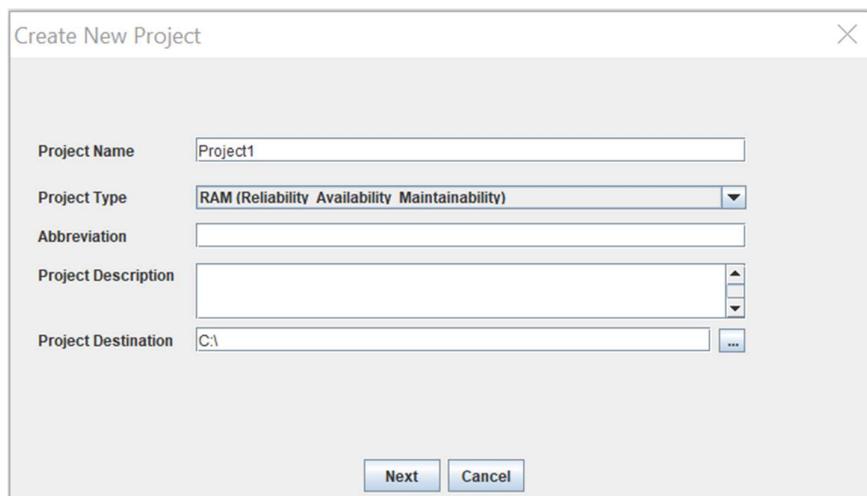
3 Project Setup

The project option enables users to create a project to log all the calculations within a project folder. Users can create a new project or open an existing project to run and /or update as required.

3.1 Creating a new project

To build a new project, click on **File, Create new** from the file menu bar. A new project page view will be displayed.

Figure 5: New Project page



The user then enters the following project data:

- **Project Name:** the title of the project, for example, 'RAILX project',
- **Project Type:** the title of the project, for example, 'new rail transport project',
- **Abbreviation:** the project abbreviation, for example, 'RX100'
- **Project Description:** details the project description. for example, if you are preparing a reliability project for a rail system, enter 'Rail system reliability project', and
- **Project Destination:** the project file destination.

• **Tip**

You can change the project workspace location by clicking on the triple dot icon in the right-hand corner of the project destination field.

3.2 Opening an existing project

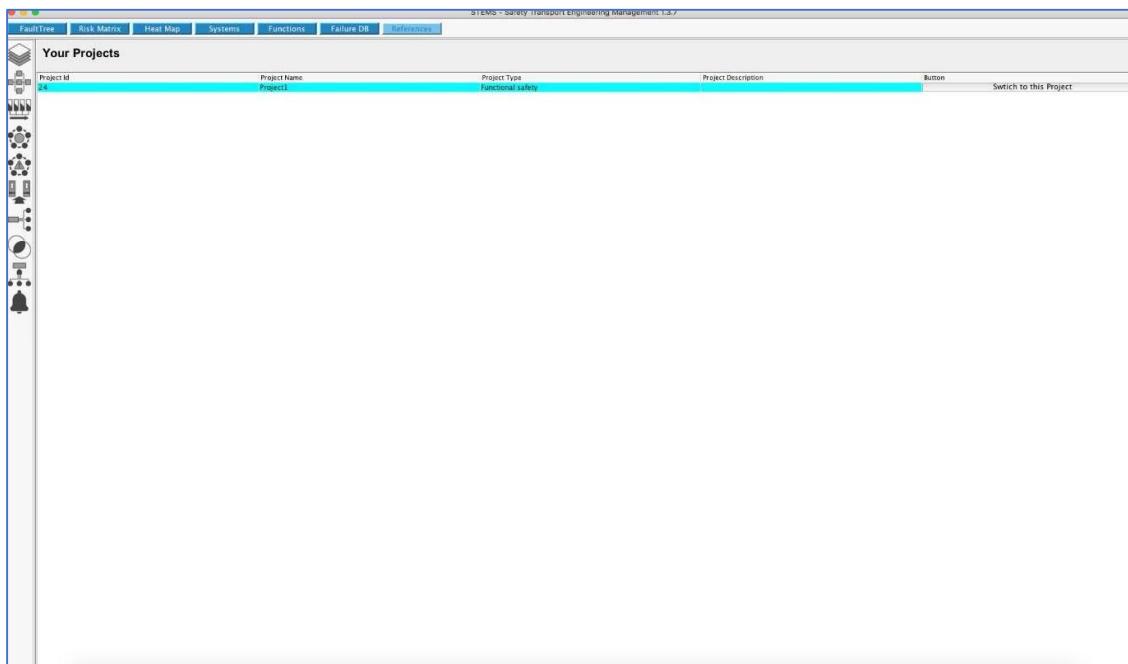
When you open an existing project in STEM, the project details will be displayed in a new screen.

To open an existing project, select one of the following:

- Click on **Open Project** from the file menu bar, or
- Type the shortcut CRTL + O

A project list will be displayed. User can select the project by clicking the required row.

Figure 6: Opening an existing STEM project



The user can switch projects by selecting the “Switch project” button on the right side.

3.3 Saving a project

STEM software is online tool that does not have a specific save feature as the project information is automatically saved to the Cloud. When you save an existing project in STEM, all data associated with your current Apps will be saved in the cloud.

3.4 Export a project report

A project report summary can be generated by the user for their records.

To export the project report, click on **File, Export Report** on the File menu bar or select shortcut CRTL + E. The export message will be displayed in a message box.



3.5 Create a snapshot

To create a snapshot image of the current page, click on **File, Snapshot** on the File menu bar or select shortcut CRTL + S. The message “Snapshot created successfully” with the file path will be displayed in a message box.

3.6 Delete a project

[THIS FUNCTION CURRENTLY DOES NOT EXIST]

To **delete** a project, click on **File, Delete Project** on the File menu bar:

Figure 7: Deleting the STEM project

[HOLD SECTION ---18.12.21]

3.7 License

To obtain information on the Software License, click on **About** on the File menu bar or select shortcut CRTL + A.

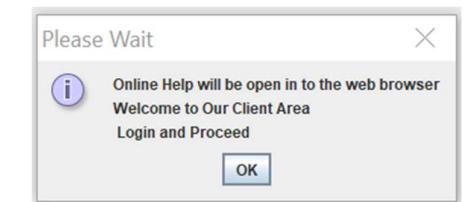
The STEM software License information is displayed.

Figure 8: STEM Software Licence information



3.8 Help

To obtain specific information on the software version, click on **Help**, on the File menu bar and select **About** from the pull-down menu.



3.9 Software version

To obtain information on the software version, click on **Help**, on the File menu bar and select **About** from the pull-down menu, see Figure 8 above.

4 System Definition

The system option allows the user to specify and develop main system(s), components, and functions from the system database to apply to their calculations.

Users can select the system (s) to be used in the calculation by clicking the specific subsystem groups displayed on the grid in the system architecture tab. Using the pull-down menu to display the generic components for a selected group, users can select or deselect specific components that apply to their calculation. Further information on creating and editing systems are described in section 6.

• **Tip**

Users can select the main product group, subsystems and components for rail systems from this section.

Users can only select the lower subcomponent level within the calculation module.

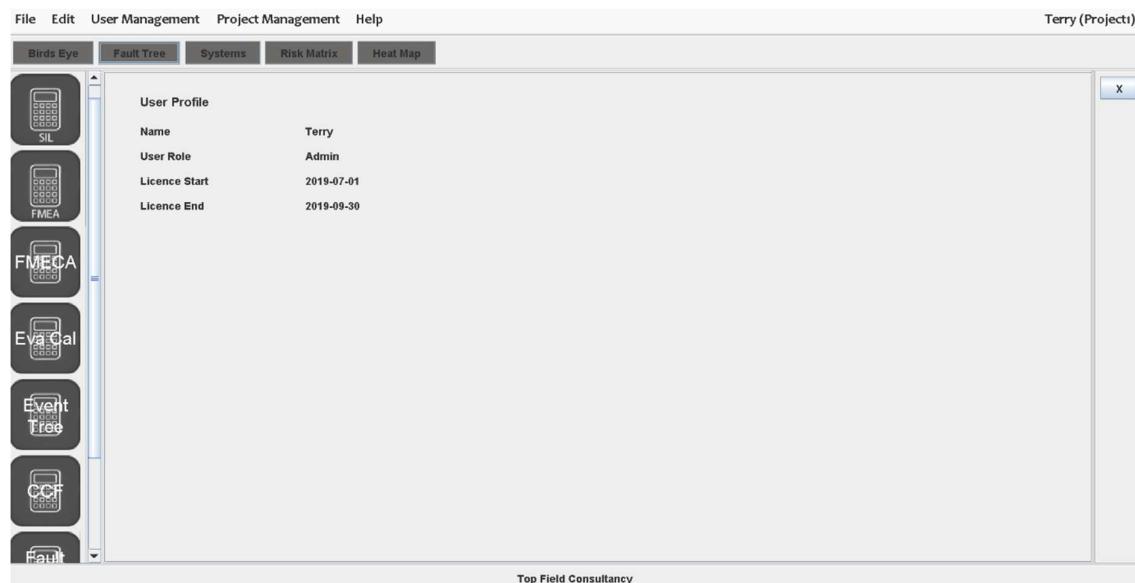
5 User Management

The User management option enables the user to manage their profile, user settings, view the STEM Software package or raise comments on the software.

5.1 User profile

To obtain your user profile information, click on **User Management**, on the File menu bar and select **User Profile** from the pull-down menu or select the shortcut CRTL + U.

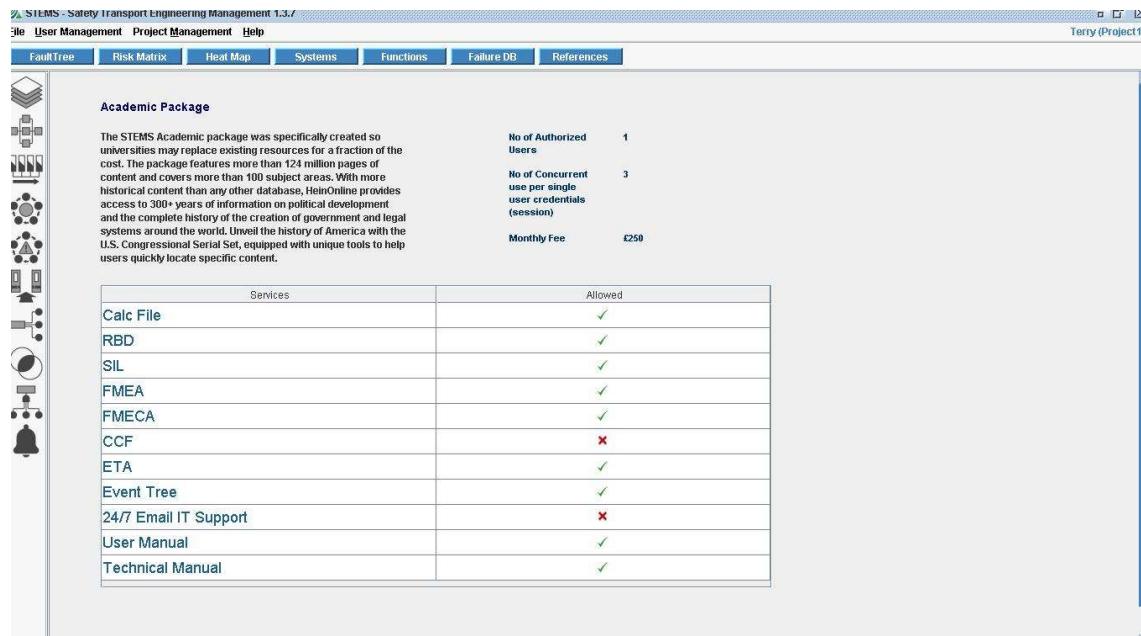
Figure 9: User profile page



5.2 User package details

To add or view the User Package details, click on **User Management**, on the File menu bar and select **User Package** from the pull-down menu or select the shortcut CRTL + U.

Figure 10: User package page



The screenshot shows the STEMS software interface with the title bar "STEMS - Safety Transport Engineering Management 1.3.7". The menu bar includes "File", "User Management", "Project Management", "Help", and a user "Terry (Project 1)". Below the menu is a navigation bar with tabs: "FaultTree", "Risk Matrix", "Heat Map", "Systems", "Functions", "Failure DB", and "References". The main content area is titled "Academic Package". It contains a brief description of the package, specifying it was created for universities and covers over 100 subject areas. It lists the number of authorized users (1), concurrent users per session (3), and monthly fee (£250). A table below details service availability:

Services	Allowed
Calc File	✓
RBD	✓
SIL	✓
FMEA	✓
FMECA	✓
CCF	✗
ETA	✓
Event Tree	✓
24/7 Email IT Support	✗
User Manual	✓
Technical Manual	✓

• Tip

Users looking to update or amend their licence will need to login to the STEM website user area to upgrade the licence package.

5.3 Your Comments

To leave comments, click on ***User Management***, on the File menu bar and select ***Your comments*** from the pull-down menu or select the shortcut CRTL + Z.

This will redirect the user to the client comment online form in the STEM client area:

<https://www.topfieldconsultancy.co.uk/clientArea/login>

• Note.

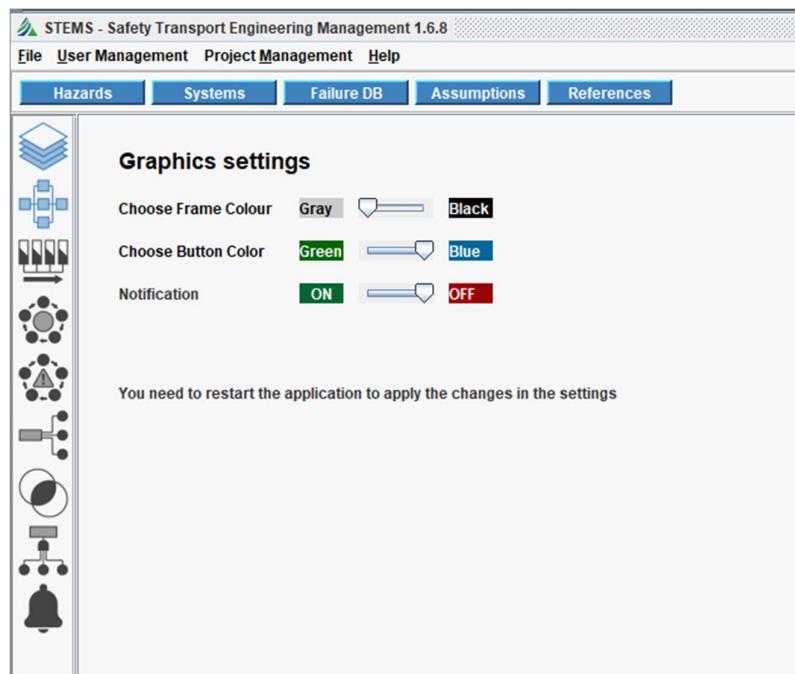
Users will need to enter their user details to enter the Login area.

5.4 Layout settings

To modify the Graphics settings, click on **User Management**, on the File menu bar and select **Layout Settings** from the pull-down menu or select the shortcut CRTL + L.

The graphics layout setting details will be displayed:

Figure 11: Layout settings page



• Note.

Users will need to restart the STEM application to apply the changes.

6 Project Management

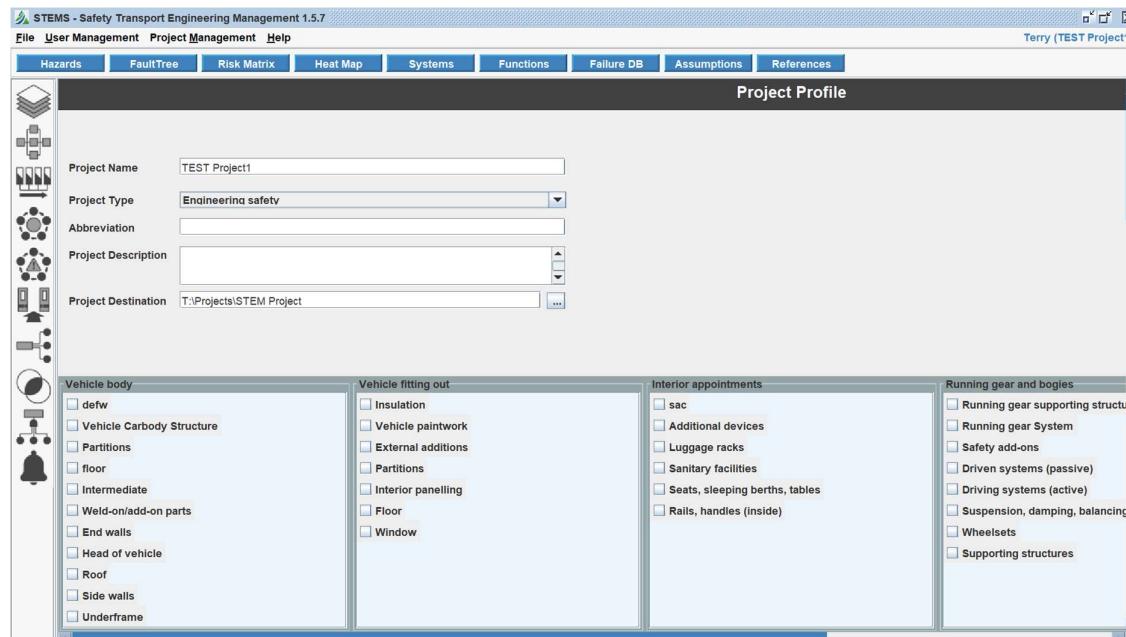
The Project management option enables the user to manage their Projects profile, project settings or update the project details in the STEM Software. Chapter 3 provides details to setup and create a project.

6.1 Project profile

A project can be made up of several subprojects and contain any number of project calculations. In STEM this is referred to as calculation modules.

To obtain your project profile information, click on **Project Management** on the menu bar and select **Project Profile** from the pull-down menu.

Figure 12: Project Profile page



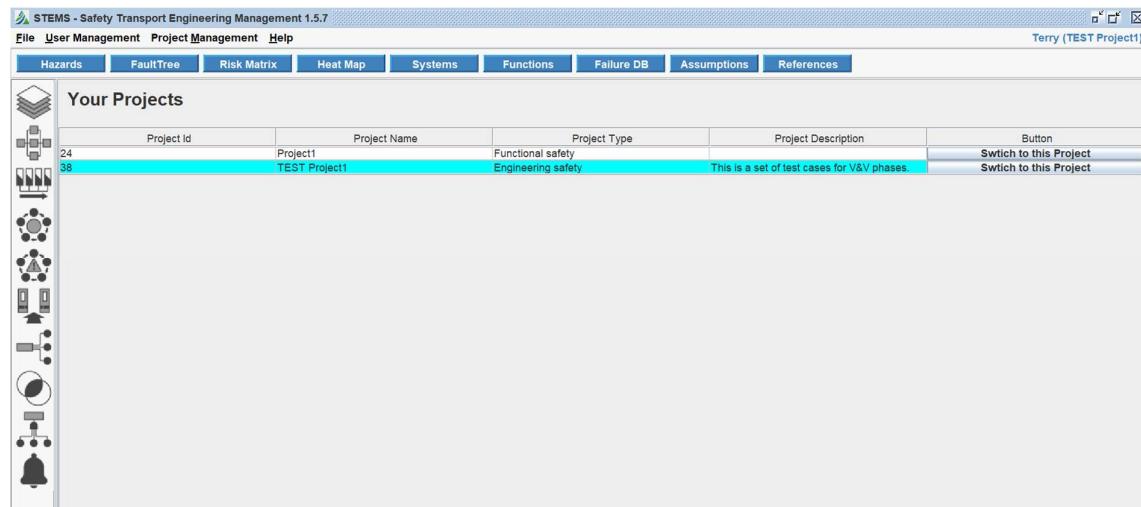
6.2 Your project

To make it easier to manage your project calculations the user can organise them by subprojects.

To obtain information on your project, click on **Project Management**, on the file menu bar and select **Your Projects** from the pull-down menu or select shortcut CRTL + O.

The following screen appears:

Figure 13: Your project profile page



Project Id	Project Name	Project Type	Project Description	Button
24	Project1	Functional safety	This is a set of test cases for V&V phases.	Switch to this Project
38	TEST Project1	Engineering safety	This is a set of test cases for V&V phases.	Switch to this Project

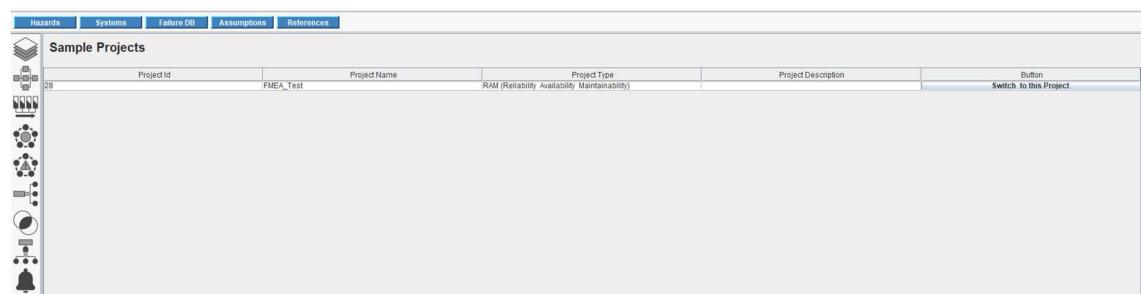
6.3 Sample projects

When you select the sample projects option in STEM, the list of sample projects is displayed in a new screen.

To open the sample projects option, select one of the following:

- Click on **Sample projects** from the Project Management menu bar, or
- Type the shortcut CRTL + J

A project list will be displayed. The user can select the project by clicking the required row.



Project Id	Project Name	Project Type	Project Description	Button
28	FMEA_Test	RAM (Reliability Availability Maintainability)		Switch to this Project

Figure 14: Opening the sample projects page

6.4 Manage system architecture

Users can create and select the main product groups to define their support their project systems and support the projects calculations.

To access this option, users select one of the following:

- Click on **manage system architecture** from the Project Management menu bar, or
- Type the shortcut CRTL + H

6.5 Manage electronic components

STEM's generic database enables users to apply generic electrical and electronic components in their calculations.

To access the electrical and electronic components option, select one of the following:

- Click on **manage electronic components** from the Project Management menu bar, or
- Type the shortcut CRTL + B

The electronic components list will be displayed, see Figure 15. The user can select the project by clicking the required row.

No	ComponentId	Component Type	Component Name	Manufacturer	Failure Rate	
1	3	Sensors	Thermocouple			View Only(Admin)
2	4	Sensors	Level sensor			View Only(Admin)
3	5	Controller	PLC			View Only(Admin)
4	6	Controller	CPU			View Only(Admin)
5	7	Controller	Logic			View Only(Admin)
6	8	Final Element	Contacts			View Only(Admin)
7	9	Final Element	Valve control			View Only(Admin)

Figure 15: Manage electronic components

6.6 Calculator linkage matrix

Users can review the status of the calculation's interactions via the calculator linkage matrix.

The matrix shows which primary App is linked to one or more secondary Apps. Users can select the calculation matrix page by selecting one of the following options:

- Click on **calculation linkage matrix** from the Project Management menu bar, or
- Type the shortcut CRTL + M

Figure 16 shows the calculation matrix page.

		SIL	FMEA	FMECA	EVACUATION	CCF	EVENT TREE	FAULT TREE
		SIL	FMEA	FMECA	EVACUATION	CCF	EVENT TREE	FAULT TREE
	SIL	x	x	x	x	x	x	x
	FMEA	x	x	x	x	x	x	x
	FMECA	x	x	x	x	x	x	x
	EVACUATION	x	x	x	x	x	x	x
	CCF	x	x	x	x	x	x	x
	EVENT TREE	x	x	x	x	x	x	x
	FAULT TREE	x	x	x	x	x	x	x

Figure 16: Calculation Matrix Linkage

7 Failure Modes Effects Analysis (FMEA) Module

To start the FMEA calculator module, click on the FMEA icon on the left side menu bar. This will display a blank FMEA input sheet that the user develops is described in sections below.

7.1 FMEA menu

The FMEA calculator contains information tabs showing the information summary and the FMEA calculation sheet that is illustrated in Figure 17.

Figure 17: STEM FMEA menu buttons

FMEA Summary		FMEA Calculator							
		Add FMEA		Edit FMEA		Remove FMEA		Refresh	
No	Component Id	Function Name	MPG Type	Calcfile Id	Calcfile	Standards	Comments		

The functions of the horizontal menu bar used to manage the input data is detailed in Table 4.

Table 4: FMEA horizontal menu buttons description

Button	Function
Add FMEA	Add a FMEA component to the FMEA summary
Edit CALC	Edit a row in the FMEA summary sheet
Remove FMEA	Remove a FMEA calculation sheet from the FMEA summary
Refresh	Refreshes the FMEA summary sheet

7.2 FMEA summary tab

The FMEA summary tab lists all the inputs for the FMEA calculation. Users can track their FMEA calculations by filename, as shown in Figure 18. Table 13 outlines the fields used in the FMEA input summary tab.

FMEA Summary		FMEA Calculator						
		Add FMEA		Edit FMEA		Remove FMEA		Refresh
No	Component Id	Function Name	MPG Type	Calcfile Id	Calcfile	Standards	Comments	
1	25	GKN	RAM	41	RM	MIL-STD1629A	TEST	View Details
2	30	RG	Satty	24	RG	MIL-STD1629A	Test	View Details
3	64	jkmlkjkl	RAM	41	RM	MIL-STD1629A		View Details
4	57	RM	RAM	19	VB 1	MIL-STD1629A		View Details
5	58	FMEA	RAM	41	RM	MIL-STD1629A		View Details
6	63	RG	RAM	24	RG	MIL-STD1629A	New Test 19.07.2021	View Details
7	64	Test	RAM	21	Brake	RPN		View Details
8	65	xzvccb	RAM	19	VB 1	RPN	vbbn1	View Details
9	69	Test More	RAM	19	VB 1	MIL-STD1629A		View Details

Figure 18: FMEA Input Summary page

Table 5: FMEA Input summary description

Parameters	Description
No	Line Number
Component Id	Id reference of the component
Function Name	Function of the component
Main Product Group (MPG) Type	Main product group type
Calcfile Id	Internal calculation file Id used to identify the calculation record for the FMEA
Calcfile Name	Calculation name
Standards	Standard template used for the FMEA
Comments	Commentary section.

7.3 FMEA input summary operation

Users can add, edit, and remove project calculation details in the FMEA input calculator sheet. Users can also copy and paste data from one FMEA or from a text file. There is a refresh function to refresh the FMEA calculator data. To access the menu list right click on the FMEA calculator sheet, which displays the dropdown menu.

7.3.1 Creating a new FMEA summary tab

STEM allows users to create a new FMEA template for developing models. A new FMEA template is created by selecting the ‘Add FMEA’ button in the FMEA summary input sheet, see Figure 19. Basic calculation information, including function name, calculation file, MPG type and template can be entered into the new FMEA options page as illustrated in the figure below.

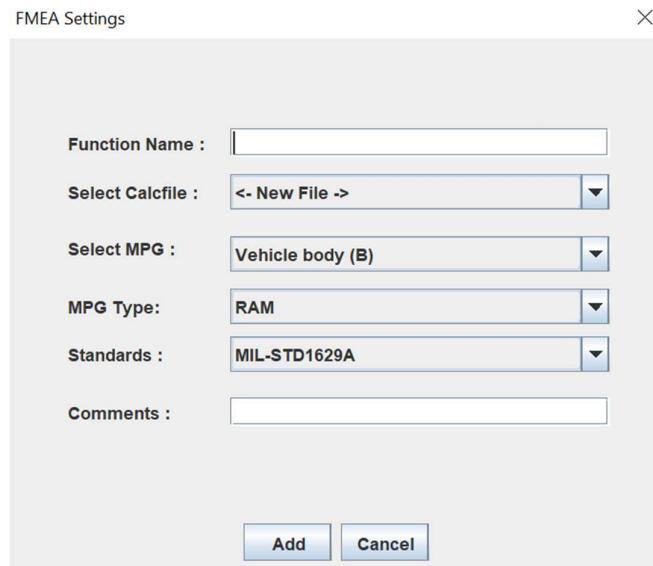


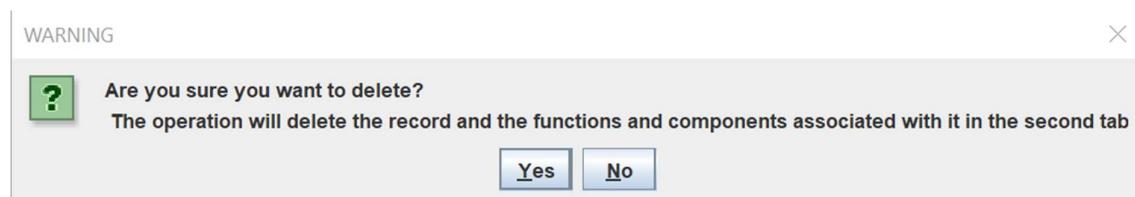
Figure 19: Add FMEA option page

7.3.2 Editing an FMEA summary

To edit an FMEA record from the FMEA record in the row then click the Edit FMEA button in the menu bar, see Figure 17. A warning message will appear when you perform this operation. Select 'Yes' to perform operation or 'No' to stop the deletion, shown below.

7.3.3 Remove an FMEA record

To remove an FMEA record from the FMEA input sheet select the row in the FMEA and then click the Remove FMEA button in the menu bar, see Figure 17. A warning message will appear when you perform this operation. Select 'Yes' to perform operation or 'No' to stop the deletion, shown below.



! Note.

Warning: This operation will delete not only the record but also the functions and components associated with the FMEA. A warning message will appear when you perform this operation. The data deleted cannot be recovered!

7.3.4 View FMEA details

To view the FMEA sheet, click the View Details button on the right side of the summary sheet. This opens the FMEA calculator, which is in the FMEA calculator tab, where the user can build the FMEA models see Figure 18.

The functions of the vertical button used to view the FMEA worksheet is shown in Table 6.

Table 6: FMEA vertical button description

Button	Function
View Details	View the FMEA worksheet

• Tip

The worksheet columns can be adjusted by dragging the edge of the cell.

7.4 FMEA calculator

The FMEA calculator tab allows users to build the FMEA from the input sheet. The features of the FMEA worksheets are shown in the Figure 20. Two calculator templates are available to the user, the qualitative RPN method and quantitative versions of the FMEA.

Further details of the functions and components for both methods are described in s 7.6.1 and s7.6.2.

Failure Mode & Effects Analysis (MIL-STD1629A) - Vehicle body						
Li...	Id	Subsystem Breakdown Code	Failure Identification			Failure
			Subsystem/ Component	Function	Phase	
1	24	RB	RG			
2	7	RG10b	Mode selector DM Mode			
3	441	GC-K33	Train manned			contact steady opened
4	456	GC-K24	Train manned			contact steady opened
5	443	(GC-K27)	RM1 Relay	Test		contact steady opened
5	457	(GC-K28)	RM2 Relay			contact steady opened
7	458	GC-S11	Mode selector key-switch New			Short circuit
8	459	CCF1	Relay			
9	442	GC-K21-1	CM1 Relay			no switching
10	469	GC-K21-2	CM1 Relay			no switching
11	470	GC-K23-1	CM3 Relay			no switching Edited
12	471	GC-K24-1	CM4 Relay			no switching 1
13	8	RG10c	Mode selection RM Mode			
14	460	GC-S18	Mode selector key switch edited			Electrical failure
15	445	GC-K29	DM1 Relay			No switching
16	446	GC-S131	Push Button	UTO Mode,DM Mode,		no switchings
17	461	GC-K30	RM2 Relay			contact steady opened
18	472	GC-K55	BYP ATC Relay 3			contact steady opened
19	473	GC-K56	BYP ATC Relay 4			contact steady opened
20	9	RG10e	Mode Selector UTO Mode			
21	462	GC-S11 New	Mode selector key switch New			Electrical failure New
22	448	GC-K25	ATPM1 Relay			contact steady opened
23	463	GC-K26	ATPM1 Relay			contact steady opened

Figure 20: FMEA Calculator page

7.5 FMEA calculator operations

[ACTION→CHECK THE OPERATIONS AS PER THE LIST]

Users can Add, Edit, delete and save components in the FMEA Calculator. Users can also copy and paste data from one FMEA or from a text file. The Refresh function allows the user to refresh the FMEA data. Users can access the menu list by Right clicking on the FMEA calculator sheet.

7.5.1 Add a single row of data

To add a new component to the FMEA worksheet:

- Select the cell or row on the FMEA worksheet and right click to open the menu list. the component from the list of systems and main product group
- Select Add subcomponent from the list. An input panel will be displayed for the user to enter details, see Figure 22.
- Click the radio button to select the specific component.
- Click on the add button to include the selection to the FMEA input sheet.

The panel enables users to amend any row of data on the FMEA worksheet. The failure identification and failure effects which defined by the user are presented in Table 7. Table 8 describes detection measures.

If you require all subsystems in the analysis:

- Click on the Select All button
- Click on the add button.

Select to insert components

Detection and Recovery Measures

Failure detection	<input type="text"/>	<input type="button" value="▼"/>
Preventive and compensating measures	<input type="text"/>	<input type="button" value="▼"/>
Detection measures	<input type="text"/>	<input type="button" value="▼"/>
Severity (S)	No Relevant Effect (1)	<input type="button" value="▼"/>
Occurrence (O)	Extremely Unlikely (1)	<input type="button" value="▼"/>
Detection (D)	Certain (1)	<input type="button" value="▼"/>
RPN		

Save **Cancel**

Figure 21: Add FMEA components page

Table 7: FMEA components options: tab1

Parameters	Description
Failure identification	
Breakdown code	References id for the main component or subsystem
Component Name	Name of the main component
Component Function	function of the component
Phase	Operational phase
Failure mode	The manner in which a component fails
Failure cause	Likely cause for each failure mode
Failure effects	
Local level	Describes the effects of the failure mode on the system element under consideration

Parameters	Description
Failure identification	
Subsystem level	Describes the effects of the failure mode on the subsystem
System level	Describes the end effects of the possible failure on the highest system level defined and evaluated by the analysis

Table 8: FMEA components options: tab2

Parameters	Description
Detection and recovery measures	
Failure detection	Description of the detection and diagnostic methods used to detect and identify the failure mode.
Preventive and compensating measures	Description of the technical measures of compensatory means to prevent the failure mode.
Detection measures	Describes the way the failure is detected and the means the user is made aware of the failure
Severity (S)	Describes the severity level used to grade the failure mode effect on the item operation, on the item surrounding or on the item operator
Occurrence (O)	Describes the likelihood of occurrence of the failure modes for a pre-determined or a stated time period
Detection (D)	Describes the ease of detection
RPN	Risk Priority Number (RPN) is a measure of criticality in terms of potential risk. The RPN is a product of the severity level, likelihood of occurrence of the failure modes and means of detection and is used for risk prioritisation.

• Tip

Adding a component will update the calculation management database immediately. This bottom-up approach is made when the user is in the FMEA worksheet

FMEA Settings

Function Name :	<input type="text"/>
Select Calcfile :	<input type="button" value="<- New File ->"/>
Select MPG :	<input type="button" value="Vehicle body (B)"/>
MPG Type:	<input type="button" value="RAM"/>
Standards :	<input type="button" value="MIL-STD1629A"/>
Comments :	<input type="text"/>

Figure 22: Add FMEA component page

Select to insert components

<input type="checkbox"/> Vehicle body
<input type="checkbox"/> Vehicle fitting out
<input type="checkbox"/> Interior appointments
<input type="checkbox"/> Running gear and Bogies
<input type="checkbox"/> Power system, drive unit
<input type="checkbox"/> Control apparatus for train operations
<input type="checkbox"/> Auxiliary operating equipment
<input type="checkbox"/> Monitoring and safety equipment
<input type="checkbox"/> Lighting
<input type="checkbox"/> Air conditioning
<input type="checkbox"/> Ancillary operating equipment
<input type="checkbox"/> Doors, entrances
<input type="checkbox"/> Information facilities
<input type="checkbox"/> Pneumatic/hydraulic equipment

Figure 23: Main product group subsystem list

7.5.2 Copy and paste data

Users can select the cell in the worksheet and click on it and hold down the left mouse button. To obtain specific information on the Software, click on **Edit**, on the File menu bar and select **Copy** from the pull-down menu. Alternatively, select Ctrl – C on the keyboard to copy the object.

Selected objects can be pasted within the worksheet by selecting Ctrl – P on the keyboard to paste the object.

7.5.3 Edit a single row of data

To edit a row on the FMEA worksheet:

- Selected the cell or row on the FMEA worksheet and right click to open the menu list and select the edit selected row from the list of systems and main product group, see Figure 23.

You get a Popup to edit the information. The following image show the FMEA add Popup based on the MIL standards.

The popup filled with previously entered information. You can edit the details and click save button to save the changes, see Figure 24.

Select to insert components ***

Failure of Emergency Brake by ATC

Edit CalcFile Data

Failure Identification		Failure Effects	
Breakdown Code	JD-A01	Local System Level	
Component Name	ATC Rack	Train Subsystem Level	
Component Function			
Phase	<input type="checkbox"/> UTO Mode <input type="checkbox"/> DM Mode	<input type="checkbox"/> RM Mode <input type="checkbox"/> ATPM Mode	Train Level
Failure mode	No switching		
Failure Cause			

Save **Cancel**

Figure 24: FMEA popup box

Users can modify the data without using the “Edit Single Row” option by clicking the cell in the FMEA worksheet to edit the information directly.

• Tip

Components information ("Id", "Subsystem Breakdown Code", "Subsystem/ Component" and "Failure mode") can only be modified in the FMEA summary tab section.

Failure Mode & Effects Analysis (MIL-STD1629A) - Vehicle body					
Failure Identification					
Breakdown Code	Subsystem/ Component	Function	Phase	Failure mode	
RG					
Mode selector DM Mode					
Train manned				contact steady opened	
Train manned				contact steady opened	
RM1 Relay	Test			contact steady opened	
RM2 Relay				contact steady opened	Test
Mode selector key-switch New	Changes the train driving mode to manual mode			Short circuit	Electrical
		DM Mode			
Relay				no switching	
CM1 Relay				no switching	
CM1 Relay				no switching Edited	
CM3 Relay				no switching 1	
CM4 Relay					
Mode selection RM Mode					
Mode selector key switch edited				Electrical failure	
DM 1 Relay				No switching	
Push Button		UTO Mode,DM Mode,		no switchings	
RM2 Relay				contact steady opened	
BYP ATC Relay 3				contact steady opened	
BYP ATC Relay 4				contact steady opened	
Mode Selector UTO Mode					
Mode selector key switch New				Electrical failure New	
ATPM1 Relay				contact steady opened	
ATPM1 Relay				contact steady opened	

Figure 25: Cell entry in the FMEA Worksheet

7.5.4 Save the FMEA file

FMEA data files may either be exported using the current case name or under a new name.

To save a file using the current file name, do one of the following:

- Search the system from the list
- Select **Export report** from the **File** menu, or
- Use the key combination Ctrl + E.

To save a file using a new name, enter the following:

- Select **Export report** from the **File** menu, or
- Use the key combination Ctrl + E.

The dialog box will be displayed to save the file name as shown in Figure 26 for the FMEA file where the case file is saved for the first time or with a new name.

The user should clear the filename field, then type the new filename of the case and click the OK button.

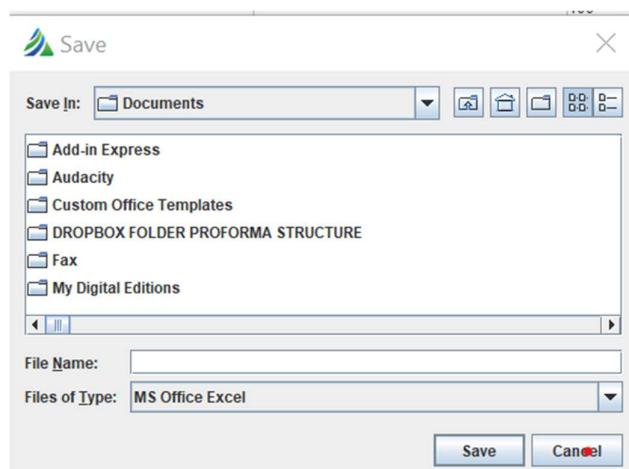


Figure 26: Exporting a data file

• Tip

STEM software will automatically save the file extension, so Users do not need to enter it in the file dialog box.

7.5.5 Delete a component

To delete a component from the FMEA calculator:

- Select the row containing the component in the FMEA calculator.
- Click the **Remove FMEA component** button to delete the component from the FMEA calculator.
- Click the **Refresh** button.

The component in the selected row will be removed in the current FMEA calculator.



! Note.

Warning: This operation will delete the row of data associated with the FMEA. A warning message will appear when you perform this operation. The data deleted cannot be recovered!

7.5.6 Delete a single row

The button allow user to delete a FMEA calculator row. You need select the row in in the table and click Delete Selected Row button to delete a record.

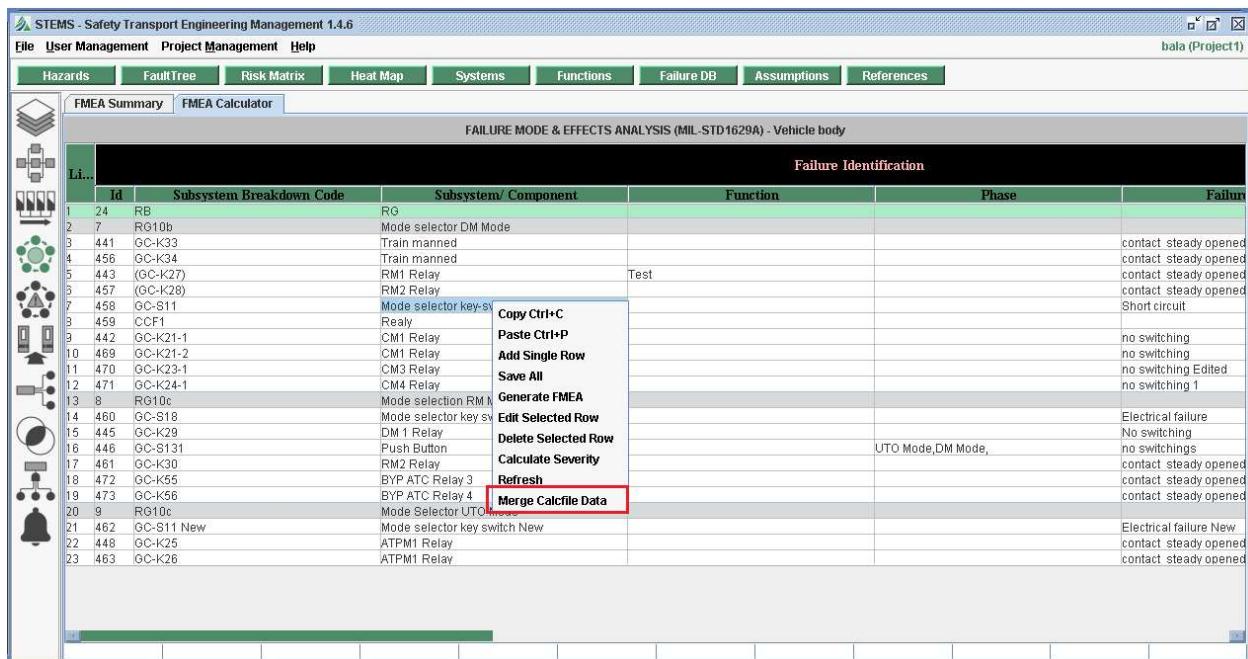
• Tip

The MPG and function cannot be deleted within the calculator sheet by this option. Users will need to delete the MPG and function options in the CMM or in the Calculation input sheet.

7.5.7 Merge calculation data

The option will synchronise the FMEA data in the calculation file at the “local” App level with the data in the CMM. You can use this option to apply the changes to the FMEA.

Figure 27: FMEA Calculation Worksheet – RPN method



FAILURE MODE & EFFECTS ANALYSIS (MIL-STD1629A) - Vehicle body						
Failure Identification						
	Id	Subsystem Breakdown Code	Subsystem/ Component	Function	Phase	Failure
1	24	RB	RG			
2	7	RG10b	Mode selector DM Mode			
3	441	GC-K33	Train manned			contact steady opened
4	456	GC-K34	Train manned			contact steady opened
5	443	(GC-K27)	RM1 Relay	Test		contact steady opened
6	457	(GC-K28)	RM2 Relay			contact steady opened
7	458	GC-S11	Mode selector key-s			Short circuit
8	459	CCF1	Relay			
9	442	GC-K21-1	CM1 Relay			no switching
10	469	GC-K21-2	CM1 Relay			no switching
11	470	GC-K23-1	CM3 Relay			no switching Edited
12	471	GC-K24-1	CM4 Relay			no switching 1
13	8	RG10	Mode selection RM			
14	460	GC-S18	Mode selector key s			
15	445	GC-K29	DM1 Relay			Electrical failure
16	446	GC-S131	Push Button			No switching
17	461	GC-K30	RM2 Relay			no switchings
18	472	GC-K55	BYP ATC Relay 3			contact steady opened
19	473	GC-K56	BYP ATC Relay 4			contact steady opened
20	9	RG10	Mode Selector UTO			
21	462	GC-S11 New	Mode selector key switch New			
22	448	GC-K25	ATPM1 Relay			Electrical failure New
23	463	GC-K26	ATPM1 Relay			contact steady opened

7.6 Calculation Options

The two calculation templates are described this section.

7.6.1 Calculate RPN

The Risk Priority Number (RPN) is calculated by multiplying the severity of the effect of failure, the probability of occurrence, and the ability of detection for each failure mode.

• Note.

The RPN does not play an important part in the choice of an action against failure modes but will help in indicating the threshold values used to evaluate critical areas.

Table 9: FMEA worksheet description for the RPN method

Parameters	Description
Line No	Line Number
Failure Identification Section	
Id	Id reference number
System breakdown code	Code according to the product classification process
Subsystem / Component	Name of component or system
Function	Description of the function performed by the component
Phase	Operational phase of the function
Failure mode	Description of the mode of failure, because of the failure cause on the component and associated with the operating conditions.
Failure cause	Description of the cause or circumstance that have led to the failure
Failure Effects Section	
Failure Effects (Local)	Local failure effect based on the worst effect on the failure mode
Failure Effects (Subsystem Level)	Subsystem failure effect based on the worst effect on the failure mode
Failure Effects (System Level)	Failure effect at the overall system level, for example for a Train study this would be the complete train consist, based on the worst effect on the failure mode
Detection and Recovery Measures Section	
Severity	The severity effect of failure
Failure detection	Describes the method of detection and diagnostics used to detect the failure
Prevention and compensating measures	Describes the technical measures or compensation measures to minimise the criticality or reduce / eliminate the effects
Occurrence	Likelihood or probability of failure
Detection measure	Compensating measure to bring the system to a safe state
Detection	The ease of detection.
RPN	Risk priority number (RPN) is a function of the severity of the effect of failure, the probability of occurrence, and the ease of detection for each failure mode.
Comment	Enables user to add comments

7.6.2 Refresh calculation data

The refresh option will synchronise the FMEA data with the database.

STEMS - Safety Transport Engineering Management 1.4.6

bala (Project1)

Hazards FaultTree Risk Matrix Heat Map Systems Functions Failure DB Assumptions References

FMEA Summary FMEA Calculator

FAILURE MODE & EFFECTS ANALYSIS (MIL-STD1629A) - Vehicle body

Failure Identification						
	Id	Subsystem Breakdown Code	Subsystem/ Component	Function	Phase	Failure
1	24	RB	RG			
2	7	RG10b	Mode selector DM Mode			
3	441	GC-K33	Train manned			
4	456	GC-K34	Train manned			
5	443	(GC-K27)	RM1 Relay	Test		
6	457	(GC-K28)	RM2 Relay			
7	458	GC-S11	Mode selector key-switch			
8	459	CCF1	Relay			
9	442	GC-K21-1	CM1 Relay			
10	469	GC-K21-2	CM1 Relay			
11	470	GC-K23-1	CM3 Relay			
12	471	GC-K24-1	CM4 Relay			
13	8	RG10c	Mode selection RM Mode			
14	460	GC-S18	Mode selector key switch			Electrical failure
15	445	GC-K29	DM 1 Relay			No switching
16	446	GC-S131	Push Button			No switchings
17	461	GC-K30	RM2 Relay		UTO Mode,DM Mode,	
18	472	GC-K55	BYP ATC Relay 3			
19	473	GC-K56	BYP ATC Relay 4			
20	9	RG10c	Mode Selector UTO Mode			
21	462	GC-S11 New	Mode selector key switch New			Electrical failure New
22	448	GC-K25	ATPM1 Relay			
23	463	GC-K26	ATPM1 Relay			

Copy Ctrl+C
Paste Ctrl+P
Add Single Row
Save All
Generate FMEA
Edit Selected Row
Delete Selected Row
Calculate Severity
Refresh
Merge Calcfile Data

Li... Failure Identification

	Id	Subsystem Breakdown Code	Subsystem/ Component	Function	Phase
1	24	RB	RG		
2	7	RG10b	Mode selector DM Mode		
3	441	GC-K33	Train manned		
4	456	GC-K34	Train manned		
5	443	(GC-K27)	RM1 Relay	Test	
6	457	(GC-K28)	RM2 Relay		
7	458	GC-S11	Mode selector key-switch New		
8	459	CCF1	Relay		
9	442	GC-K21-1	CM1 Relay		
10	469	GC-K21-2	CM1 Relay		
11	470	GC-K23-1	CM3 Relay		
12	471	GC-K24-1	CM4 Relay		
13	8	RG10c	Mode selection RM Mode		
14	460	GC-S18	Mode selector key switch edited		
15	445	GC-K29	DM 1 Relay		
16	446	GC-S131	Push Button		UTO Mode,DM Mode,
17	461	GC-K30	RM2 Relay		
18	472	GC-K55	BYP ATC Relay 3		
19	473	GC-K56	BYP ATC Relay 4		
20	9	RG10c	Mode Selector UTO Mode		
21	462	GC-S11 New	Mode selector key switch New		
22	448	GC-K25	ATPM1 Relay		
23	463	GC-K26	ATPM1 Relay		

Figure 28: FMEA Calculation Worksheet – RPN method

7.6.3 MIL Std calculation

The MIL Standard FMEA template can be used by the user by choosing the template option in the menu.

Table 10 lists the worksheet parameters generated by the MIL Std FMEA template.

Table 10: FMEA worksheet description for the Mil Std method

Parameters	Description
Line No	Line Number
Failure Identification Section	
System breakdown code	Code according to the product classification process
Main Component Id	Product system code
System / Component	Name of component
Function	Description of the function performed by the component
Phase	
Failure mode	Description of the mode of failure, because of the failure cause on the component and associated with the operating conditions.
Failure cause	Description of the cause or circumstance that have led to the failure
Failure Effects Section	
Failure Effects (Local)	Local failure effect based on the worst effect on the failure mode
Failure Effects (Subsystem Level)	Subsystem failure effect based on the worst effect on the failure mode

Parameters	Description
Failure Effects (System Level)	Failure effect at the overall system level, for example for a Train study this would be the complete train consist, based on the worst effect on the failure mode
Detection and Recovery Measures Section	
Failure detection	Describes the method of detection and diagnostics used to detect the failure
Prevention and compensating measures	Describes the technical measures or compensation measures to minimise the criticality or reduce / eliminate the effects
Severity Class	
Remarks	

7.7 FMEA results

[HOLD SECTION ---18.12.21]

[HOLD: Feature currently unavailable with the current STEM Version]

The FMEA results screen allows the ordering of FMEA data within the project. This can be viewed by clicking the results icon in the navigation bar.

The summary of the FMEA results summary allows the user for the data to be screened as shown in the Table 11.

Table 11: FMEA results worksheet description

Parameters	Description
No	Line number
Main Component Id	References the main product group for the subsystem
Main Component Name	Name of main product group subsystem
Row Count	Number of rows of information listed for the main product group subsystem
Severity	The severity effect of failure
Occurrence	Likelihood or probability of failure
Detection	The ease of detection.
Total RPN	Risk Priority Number result

Figure 29: FMEA Results Table

[HOLD – MISSING FIGURE FMEA Results Table missing]

_Figure 17: FMEA Results Table _

8 Failure Modes Effects Criticality Analysis (FMECA) Module

To start the FMECA Module, click on the FMECA icon on the left side menu bar. A blank FMECA input sheet is displayed allowing the User to develop. This is described in sections below.

8.1 FMECA menu

The FMECA calculator contains information tabs showing the information summary and the FMECA calculation sheet that is illustrated in Figure 30.

Figure 30: STEM FMECA menu Toolbar

FMECA Summary FMECA Calculator							
No	Id	FMECA Name	MFG Type	CMM Id	CMM Name	Standards	Comments

The functions of the horizontal menu bar used to manage the input data is detailed in Table 12.

Table 12: FMECA input worksheet description

Button	Function
Add FMECA	Add a FMECA component to the FMECA summary
Edit FMECA	Edit a row in the FMECA summary sheet
Remove FMECA	Remove a FMECA component from the FMECA summary sheet
Refresh	Refreshes the FMECA summary sheet

8.2 FMECA summary tab

The FMECA summary tab lists all the inputs for the FMECA calculation. Users can track their FMECA calculations by filename, as shown in Figure 31. Table 13 outlines the fields used in the FMECA input summary tab.

FMECA Summary FMECA Calculator							
No	Id	FMECA Name	MFG Type	CMM Id	CMM Name	Standards	Comments
1	132	TEST1	RAM	151	TEST1	MIL-STD1629A	View Details

Figure 31: FMECA Input Summary page

Table 13: FMECA Worksheet description

Parameters	Description
No	Line Number
Component Id	Product System Code
FMECA Name	Name of FMECA
Main Product Group (MPG) Type	Main product group type
CMM id	Internal calculation file Id used to identify the calculation record for the FMECA
CMM Name	Calculation name
Standards	Standard template used for the FMECA
Comments	Commentary section.

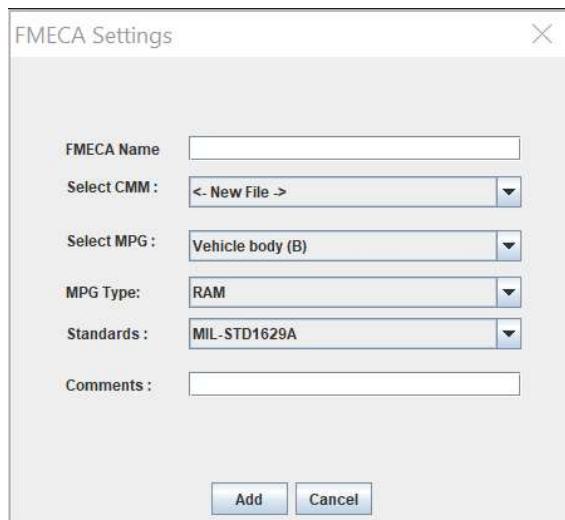
8.3 FMECA input operation

The FMECA input calculator enables users can add, edit, and remove project calculation details in the sheet. Users can also copy and paste data from one FMECA or from a text file. There is a refresh function to refresh the FMECA calculator data. To access the menu list, right click on the FMECA calculator sheet, which displays the dropdown menu.

8.3.1 Building a new FMECA template

Users can develop a new FMECA template by selecting the ‘Add FMECA’ button in the FMECA summary input sheet which opens a new page, see Figure 32. Basic calculation information, including function name, calculation file, MPG type and template can be entered into the new FMECA options page as illustrated in the figure below.

Figure 32: Add FMECA option page



FMECA Settings

FMECA Name:

Select CMM :

Select MPG :

MPG Type:

Standards :

Comments :

Add Cancel

8.3.2 Editing an FMECA template

To edit an FMECA record from the FMECA record in the row then click the Edit FMECA button in the menu bar, see Figure 31.

8.3.3 Remove an FMECA record

To remove an FMECA record from the FMECA input sheet, select the row in the FMECA and then click the Remove FMECA button in the menu bar, see Figure 31. A warning message will appear when you perform this operation. Select 'Yes' to perform operation or 'No' to stop the deletion.

! Note.

Warning: This operation will delete not only the record but also the functions and components associated with the FMECA. A warning message will appear when you perform this operation. The data deleted cannot be recovered!

8.3.4 View FMECA details

To view the FMECA worksheet, click the View Details button on the right side of the summary sheet. This opens the FMECA calculator, which is in the FMECA calculator tab, where the user can build the FMECA models see Figure 18.

The functions of the vertical button used to view the FMECA worksheet is shown in Table 6.

Table 14: FMECA vertical button description

Button	Function
View Details	View the FMECA worksheet

• Tip

The worksheet columns can be adjusted by dragging the edge of the cell.

8.4 FMECA calculator

The FMECA calculator tab allows users to build the FMECA from the input calculator sheet. The features of the FMECA worksheets are shown in the Figure 20. **Two calculator templates are available to the user, the qualitative RPN method and quantitative versions of the FMECA.** Further details of the functions and components for both methods are described in s 7.6.1 and s7.6.2.

Figure 33: FMEA Calculator page

FAILURE MODE EFFECTS AND CRITICALITY ANALYSIS (MIL-STD1629A) - Lighting - 1																
Failure Identification				Failure Effects			Detection and Recovery Measures			Improvement Results						
...	Id	Subsystem Breakd...	Subsystem Co...	Function	Phase	Failure mode	Failure Cause	Severity Class	Failure Rate D...	Failure Effect P...	Failure Mode R...	Failure Rate (x)	Operating Time...	Failure Mode C...	Failure Item Cr...	Remarks
1	16186	TEST1														

Table 15: FMECA options - pt1

Parameters	Description
Failure identification	
Subsystem Breakdown code	References id for the main component or subsystem
Subsystem / Component	Name of the main component
Function	Subsystem / component function
Phase	Operational phase
Failure mode	The manner in which a component fails
Failure cause	Likely cause for each failure mode
Failure effects	

Parameters	Description
Failure identification	
Severity Class	Severity classification
Failure rate data source	The data source of the failure rates used in the calculation
Failure effect probability	The conditional probability that the failure effect will result in the identified criticality classification, given that the failure mode occurs

Table 16: FMECA components options - pt2

Parameters	Description
Detection and recovery measures	
Failure mode ratio	The fraction of the part failure rate based on a specific failure mode under consideration
Failure rate	Part failure rate
Operating time	Time or the number of operating cycles of the item in the mission
Improvement Results	
Failure Item Criticality	Criticality number for the item
Failure mode Criticality	The value of the failure mode criticality. This is a product of the conditional probability of mission loss, failure mode ratio, part failure rate and time or the number of operating cycles of the item in the mission
Remarks	Commentary section

• **Tip**

Adding a component will update the calculation management database immediately. This bottom-up approach is made when the user is in the FMEA worksheet

8.5 FMECA calculator operations

Users can Add, Edit, delete and save components in the FMECA Calculator. Users can also copy and paste data from one FMECA or from a text file. The Refresh function allows the user to refresh the FMECA data. Users can access the menu list by Right clicking on the FMECA calculator sheet.

8.5.1 Add a single row of data

To add a new component to the FMECA input sheet:

-
- Select the cell or row on the FMECA worksheet and right click to open the menu list.
 - the component from the list of systems and main product group
 - Select Add FMECA component button from the list. An input panel will be displayed for the user to enter details, see Figure 22.
 - Click the radio button to select the specific component.
 - Click on the add button to include the selection to the FMECA input calculation sheet.

The panel enables users to amend any row of data on the FMEA worksheet. The failure identification and failure effects which defined by the user are presented in Table 7. Table 8 describes detection measures.

If you require all subsystems in the analysis:

- Click on the Select All button
- Click on the add button.

Figure 34: Add FMECA components page

8.5.2 Copy and paste data

Users can apply the copy and feature in STEM by using the mouse. Users can select the desired cell on the worksheet by clicking on it and then hold down the left mouse button. To obtain specific information, click on **Edit**, on the File menu bar and select **Copy** from the pull-down menu. Alternatively, select Ctrl – C on the keyboard to copy the object.

Selected objects can be pasted within the worksheet by selecting Ctrl – P on the keyboard to paste the object.

8.5.3 Edit a single row of FMECA data

To edit an existing row from the FMECA worksheet:

- Click on the Select the Edit button, or
- Select the row in the sheet

You get a Popup to edit the information. The following image show the FMECA add Popup based on the MIL standards.

The popup filled with previously entered information. You can edit the details and click save button to save the changes, see Figure 24.

Figure 35: FMEA popup box

Users can modify the data without using the “Edit Single Row” option by clicking the cell in the FMECA worksheet to edit the information directly.

• Tip

Components information ("Id", "Subsystem Breakdown Code", "Subsystem/ Component" and "Failure mode") can only be modified in the FMECA summary tab section.

[ADD FIG HERE]

Figure 36: Cell entry in the FMEA Worksheet

8.6 Save FMECA File

FMECA files may either be saved using the current case name or under a new name.

To save a file using the current file name, do one of the following:

- Search the system from the list
- Select **Export report** from the **File** menu, or
- Use the key combination Ctrl + A.

To save a file using a new name, enter the following:

-
- Select **Export report** from the **File** menu, or
 - Use the key combination Ctrl + A.

The dialog box will be displayed to save the file name as shown in **Figure ???** for the FMECA file where the case file is saved for the first time or with a new name.

The user should clear the filename field, then type the new filename of the case and click the **OK** button.

[ADD FIG HERE]

Figure 37: Exporting a data file

• **Tip**

STEM software will automatically save the file extension, so Users do not need to enter it in the file dialog box.

8.7 Delete a component

To delete a component from the FMECA input sheet:

- Select the row containing the component in the FMECA input table.
- Click the **Remove FMECA component** button to delete the component from the FMEA input sheet.
- Click the **Refresh** button.

The component in the selected row will be removed in the current FMECA input sheet.

ADD WARNING DIALOG PG

! Note.

Warning: This operation will delete the row of data associated with the FMEA. A warning message will appear when you perform this operation. The data deleted cannot be recovered!

8.7.1 Import an FMEA template **[HOLD SECTION ---18.12.21]**

[HOLD: This function is currently unavailable with the current STEM Version]. Project sharing feature in the Cloud under review - HOLD]

8.7.2 Merge calculation data

The option will synchronise the FMEA data in the calculation file at the “local” App level with the data in the CMM. You can use this option to apply the changes to the FMEA.

Figure 38: FMEA Calculation Worksheet – RPN method

8.8 Calculation Options

The two calculation templates are described this section.

8.8.1 Calculate RPN

The Risk Priority Number (RPN) is calculated by multiplying the severity of the effect of failure, the probability of occurrence, and the ability of detection for each failure mode.

• **Note.**

The **RPN** does not play an important part in the choice of an action against failure modes but will help in indicating the threshold values used to evaluate critical areas.

Table 17: FMECA worksheet description for the RPN method

Parameters	Description
No	Line number
Component Id	References id the main product group for the subsystem
Component Name	Name of main product group subsystem
Criticality	Risk criticality result

Table 18: FMECA Worksheet description

Parameters	Description
Line No	Line Number
Failure Identification Section	
id	Id reference number
System breakdown code	Code according to the product classification process
Subsystem / Component	Name of component or system
Function	Description of the function performed by the component
Phase	Operational phase of the function
Failure mode	Description of the mode of failure, because of the failure cause on the component and associated with the operating conditions.
Failure cause	Description of the cause or circumstance that have led to the failure
Failure Effects Section	
Failure Effects (Local)	Local failure effect based on the worst effect on the failure mode
Failure Effects (Subsystem Level)	Subsystem failure effect based on the worst effect on the failure mode
Failure Effects (System Level)	Failure effect at the overall system level, for example for a Train study this would be the complete train consist, based on the worst effect on the failure mode
Detection and Recovery Measures Section	
Severity	The severity effect of failure
Failure detection	Describes the method of detection and diagnostics used to detect the failure
Prevention and compensating measures	Describes the technical measures or compensation measures to minimise the criticality or reduce / eliminate the effects
Occurrence	Likelihood or probability of failure
Detection measure	Compensating measure to bring the system to a safe state
Detection	The ease of detection.
RPN	Risk priority number (RPN) is a function of the severity of the effect of failure, the probability of occurrence, and the ease of detection for each failure mode.
Comment	Enables user to add comments

8.8.2 Refresh calculation data

The STEM software will synchronise the FMECA data with the database.

[ADD FIG HERE]

Figure 39: FMEA Calculation Worksheet – RPN method

8.8.3 MIL Std calculation

The MIL Standard FMECA template can be used by the user by choosing the template option in the menu.

Table 10 lists the worksheet parameters generated by the MIL Std FMECA template.

Table 19: FMECA worksheet description for the Mil Std method

[To add table here]

8.9 FMECA Results

[HOLD SECTION ---08.01.22]

[HOLD: Feature currently unavailable with the current STEM Version]

The FMECA results screen allows the ordering of FMECA data within the project. This can be viewed by clicking the results icon in the navigation bar.

The summary of the FMECA results summary allows the user for the data to be screened as shown in the Table 11.

The tabulated FMECA results can be viewed by clicking the View icon in the navigation bar, refer to Figure ???.

Table 20: FMECA results worksheet description

Parameters	Description
No	Line number

Parameters	Description
Main Component Id	References the main product group for the subsystem
Main Component Name	Name of main product group subsystem
Row Count	Number of rows of information listed for the main product group subsystem
Severity	The severity effect of failure
Occurrence	Likelihood or probability of failure
Detection	The ease of detection.
Total RPN	Risk Priority Number result

Figure 40: FMECA Results Table

[HOLD – MISSING FIGURE FMECA Results Table missing]

Figure 41: FMECA results worksheet description

[HOLD – MISSING FIGURE FMECA Results Table missing]

_Figure 19: FMECA Results Table _

Parameters	Description
No	Line Number
Main Component Id	Product System Code
Main Component Name	Name of Component
Row Count	Description of the Subsystem or Component function
Total RPZe	Operating condition
Failure Effects (Local)	Local failure effect based on the worst effect on the failure mode
Failure Effects (System Level)	System failure effect based on the worst effect on the failure mode
Importance	HOLD
Failure detection	Describes the method of detection and diagnostics used to detect the failure

Parameters	Description
Prevention / Compensating Measures	Describes the technical measures or compensation measures to minimise the criticality or reduce / eliminate the effects
Occurrence	
Detection measure	Compensating measure to bring the system to a safe state
Detection	
RPN	Risk priority number (RPN) is a function of the severity of the effect of failure, the probability of occurrence, and the ease of detection for each failure mode.
Improvement measures	
Responsible / Date	Responsible person / Date
Measures undertaken	
Importance (Post)	
Occurrence (Post)	
Detection (Post)	
RPZ (Post)	
Main Components id	Creates a New Project File
Component Name	
Row Count	
RPZ	

9 Fault Tree Analysis (FTA) Module

To start the Fault Tree Analysis (FTA) Module, click on the FTA ICON on the left side toolbox.

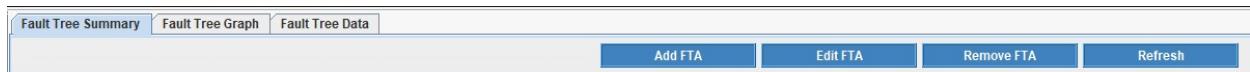
The FTA summary screen will be displayed to develop the input data sheet for the FTA model.

The blank FTA summary sheet can be developed as described in sections below.

9.1 FTA Component Inputs Menu

The Fault Tree summary tab contains information tabs showing the information summary and the FTA calculation sheet that is illustrated in Figure 42.

Figure 42: STEM FTA menu buttons



The functions of the FTA horizontal buttons used to manage the input data is detailed in Table 21.

Table 21: FTA horizontal menu buttons description

Button	Function
Add FTA	Add an FT calculation sheet to the FTA summary
Edit FTA	Edit a row in the FTA summary sheet
Remove FTA	Remove an FT calculation sheet from the FTA summary
Refresh	Refreshes the FT summary sheet

9.2 Fault Tree summary tab

The Fault Tree summary tab setups the calculation inputs for the FTA calculation. The FTA calculations can be tracked by filename, as shown in Figure 42. Table 22 outlines the fields used in the FTA input summary tab.

Fault Tree Summary							
No	Id	FTA Name	CMM	Function Name	Standards	Comments	Created Date
1	42	HIPPS TEST CASE 1 - RBD	Test.1	Battery Loss	IEC 61025	HIPPS TEST CASE 1 - RBD	2021-04-15 23:58:11.0
2	43	SP OPS TEST CASE 4	Test.3	Brake Failure with ED Blending	IEC 61025	0.0	2021-04-20 12:20:48.0
3	76	FT-TestA	FT-TestA	FT-TestA	IEC 61025		2021-10-01 17:07:53.0

Figure 43: FTA Input Summary page

Table 22: FTA Input summary description

Parameters	Description
No	Line Number
Id	Id reference of the component file Id used to identify the calculation record (for internal use)
FTA Name	FTA Top event name
CMM	Calculation management model reference
Function Name	Function heading
Standards	Standard reference template for the FTA
Comments	Commentary section.

9.3 FTA Input summary operation

Fault Tree summary tab enables users to add, edit, and remove the FTA summary details for the FT calculator. Users can also copy and paste data from one FTA or from a text file into the popup panel when the ‘Edit FTA’ button is selected

• Note

Users can copy and paste data through the popup option to enable the features, Ctrl + C to copy and Ctrl + V to paste.

9.3.1 Creating a new FTA project summary

A new FTA project summary (template) is created when users select the ‘Add FTA’ button in the summary input sheet, see Figure 43 and Figure 44. Basic calculation information, including function name, CMM file, MPG type and comments can be entered into the popup FTA options page as illustrated in the figure below.



Figure 44: Add FTA option page

9.3.2 Editing an FTA project summary

To edit an FTA project summary record in the FTA Input summary tab, select the row then click the 'Edit FTA' button in the menu bar, see Figure 43.

9.3.3 Remove an FTA project summary record

To remove an FTA project summary record, select the row in the FTA input sheet and then click the 'Remove FTA' button in the menu bar, see Figure 43. A warning message will appear when you perform this operation. Select 'Yes' to perform the operation or 'No' to stop the deletion, as shown below.



Figure 45: FTA deletion warning message

! Note.

Warning: This operation will delete the row of data associated with the FTA. Check that you intend to delete the data, as this operation will delete the data permanently.

9.3.4 View FTA details

To view the FTA model, click the ‘View Details’ button on the right side of the summary sheet. This opens the FTA calculator, which is shown by the Fault Tree Model tab, where the user can build the FTA models, see Figure 43.

The functions of the vertical button used to view the FTA worksheet is shown in Table 23.

Table 23: FTA vertical button description

Button	Function
View Details	View the FTA worksheet

9.4 FTA Model

The Fault Tree (FT) model tab allows users to enter the build the Fault Tree model. The following sections describe the features available in the STEM FTA App to build a Fault Tree model.

9.5 FT Horizontal toolbar

The horizontal toolbar buttons contain a set of icons that gives short-cut access to the FT calculation utility options, as shown in Figure 46. Table 24 presents a list of the FT menu options and shortcuts.



Figure 46: FT Horizontal Toolbar

Table 24: FT Toolbar Tab Options

Parameters	Icon	Description
Insert event*		Inserts an event
Insert basic*		Inserts a basic event
Edit cell*		Edits the selected cell
Delete*		Delete an event or a basic event
Refresh		Refreshes the model
Merge		Merge with CMM
Calculate		Calculates the model
Zoom In		Zooms into the model
Zoom Out		Zooms out of the model
Save All		Saves all data in the model

• Note*.

To insert, edit or delete an FT object, the user will need to select the object in the FT model to enable the buttons.

• Note.

The names of the FT icons are revealed when the user places the cursor over the icon.

9.6 FT Model operations

Users can Add, Edit, delete and save components or generate the model calculation in the FT Model clicking on the ICONs in the menu or by right clicking or double clicking on the object in the model. The event options menu will be displayed, as shown in Figure 46.

Users can enter event id, type, link to a document reference or a value. Comments can also be added. The update button allows the user to refresh the FTA data.

9.6.1 Insert gate event

To add a new gate event in the FT model, select the model tab and select the Top Event or Gate Event box then right click or double click on the object in the model. This will open the pull-down menu, see Figure 48. Basic gate event information, including event id, event name, Gate (type), Proof test interval (PTI) and reference can be entered into the new FT gate event options page as illustrated in the figure below.

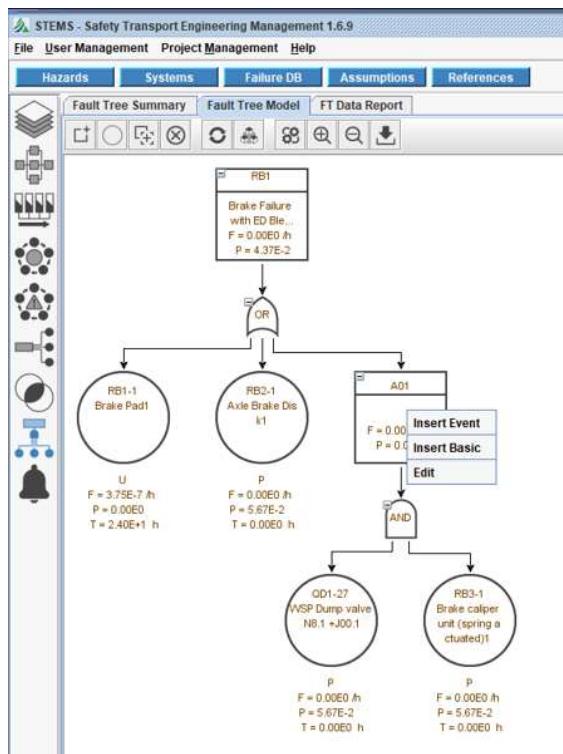


Figure 47: FT Insert Options

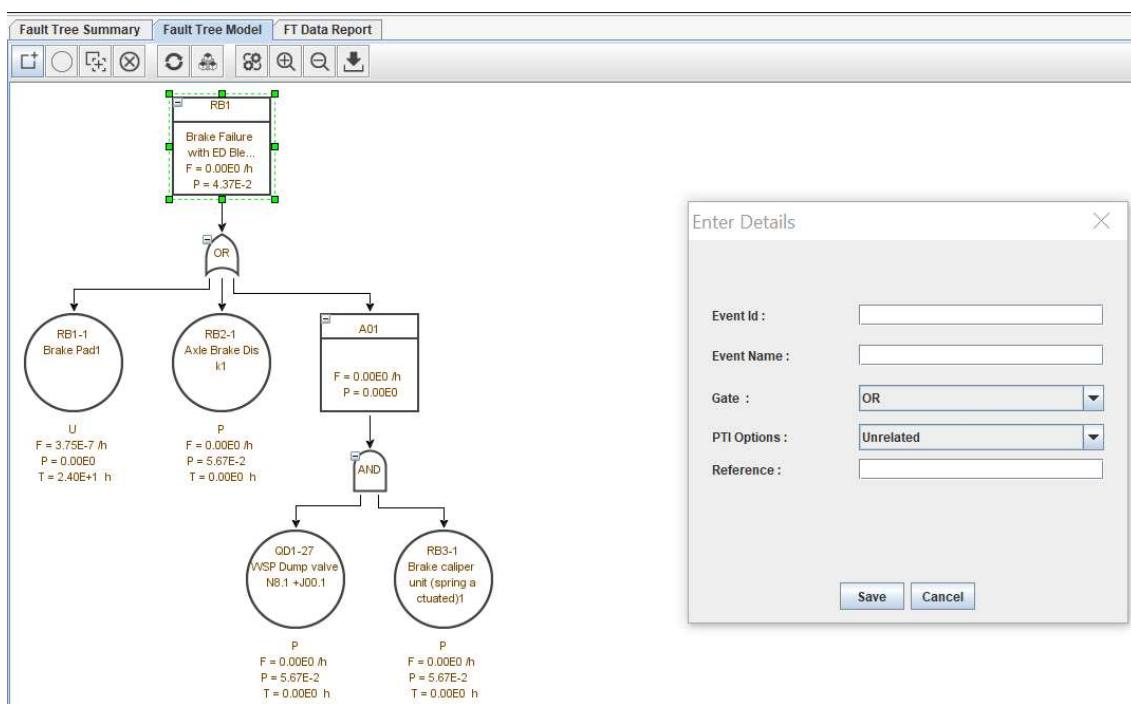


Figure 48: FT Gate event options page

9.6.2 Insert base event

To add a new base component to the FTA model, select the model tab and select the Top Event or Gate Event box then right click or double click on the object in the model. This will open the pull-down menu, see Figure 49. Base event information, including component, data type, component id, component name, reference and probability can be entered into the new FT base event options page as illustrated in the figure below.

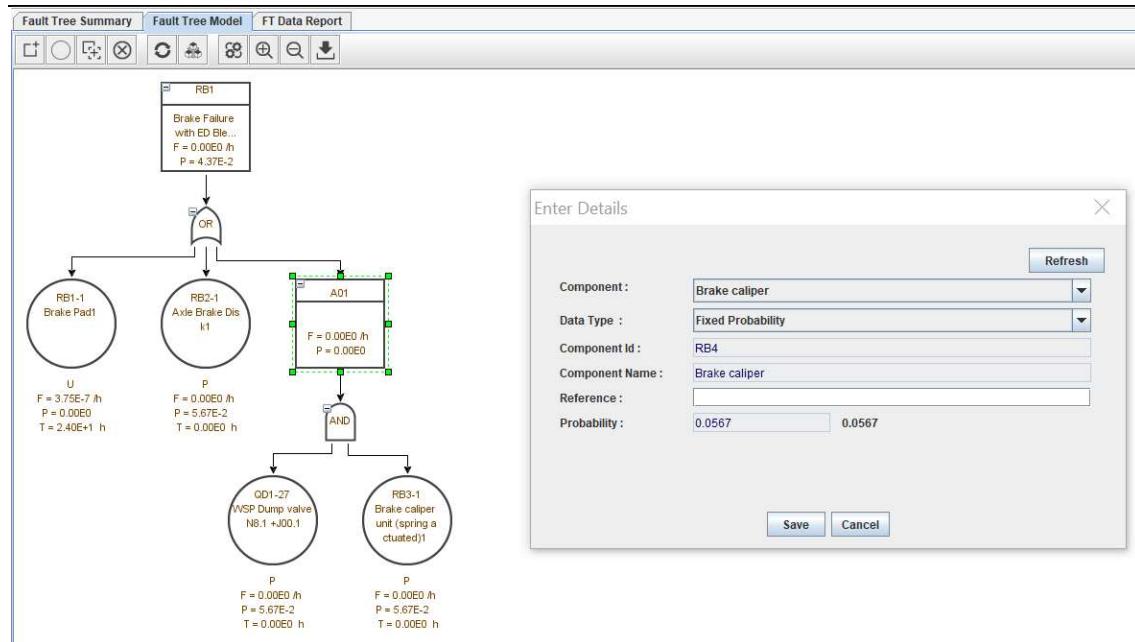


Figure 49: FT base event options page

9.6.3 Edit cell

To edit an FTA record from the FTA record in the row then click the Edit FTA button in the menu bar or select the model tab and select the Top Event or Gate Event box then right click or double click on the object in the model. This will open the pull-down menu, see Figure 48 and Figure 50. Basic gate event information, including event id, event name, Gate (type), Proof test interval (PTI) and reference can be entered into the new FT gate event options page as illustrated in the figure below.

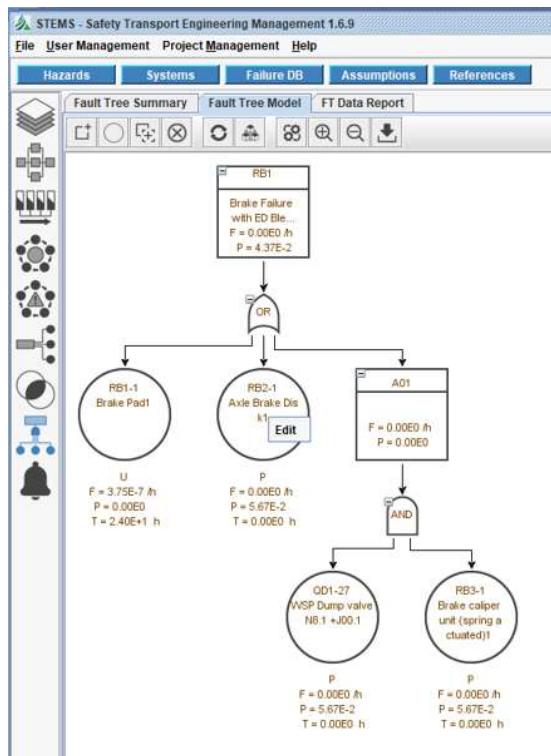


Figure 50: FT Edit Option

9.6.4 Delete

To delete an FTA component from the FTA model:

- Select the delete ICON in the toolbar, see Table 24, or by right clicking on the FT sheet in the model to activate the pull-down menu and select the delete option

The component will be removed in the FTA model.

9.6.5 Refresh

To refresh the FT model:

- Select the refresh ICON button in the toolbar, see Table 24, or by right clicking on the FT sheet in the model to activate the pull-down menu and select the refresh option.

The FT Top event result will be updated.

9.6.6 Merge

This option will synchronise the FTA data in the calculation tab at the “local” App level with the data in the CMM. You can use this option to apply the changes to the FTA gate data pulled from CMM.

9.6.7 Calculate

This option recalculates the FTA Top and all base event results in the FT model.

9.6.8 Zoom in

To Zoom into the model and increase magnification, click of the Zoom in button in the menu bar.

9.6.9 Zoom out

To Zoom out of the model to decrease magnification, click of the Zoom out button in the menu bar.

9.6.10 Save All

To save data in the FTA model:

- Select the save all button in the toolbar, see Table 24, or by right clicking on the FT event in the model to activate the pull-down menu and select the save option.
- The saved data will bed indicated by the document save message in the status bar, see Figure 51.

The FT data will be saved.

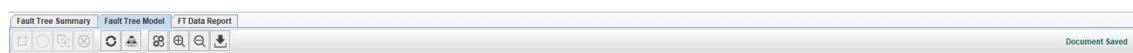


Figure 51: FT Save all option

9.6.11 Creating a new FTA model

STEM allows users to create a new FTA model for design. A new FTA model is created by selecting the ‘Add FTA’ button in the FTA summary input sheet, see Table 4. Basic calculation

information, including function name, calculation file, MPG type and template can be entered into the new FTA options page as illustrated in the figure below.

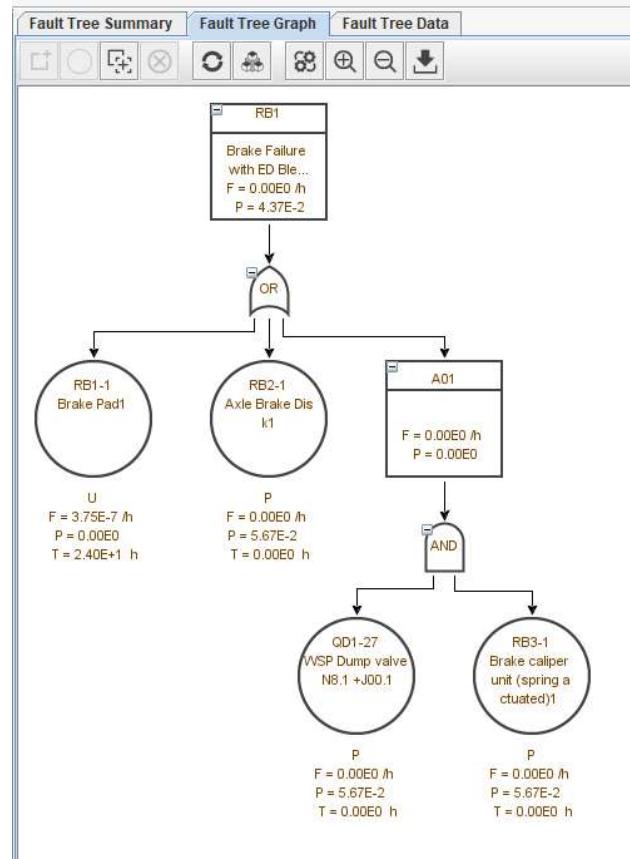


Figure 52: FT Model Example

9.7 Calculation Options

The FT calculation results are described this section.

9.7.1 Calculate FT Model

To generate the FT model, select the calculate option button in the menu bar to recalculate the FTA Top event result in the FT model.

9.7.2 Generate FT Model

Users can generate the Fault Tree Top event result by clicking the Calculate Icon in the Toolbar or activating the pull-down menu by selecting the Top event and then right clicking the mouse. To export the Fault Tree model, click on **File, Export Report** on the File menu bar or select shortcut CRTL + E. The export message will be displayed in a message box with the option to generate a FT graph in a PDF or PNG format.

9.7.3 Generate FT Model data

You can export an FT data file as a table by selecting the calculate option button in the menu bar to download the data file as excel or MS access file, see Figure 54 and Figure 55.

• **Tip**

STEM users will not be able to amend the data in the FT data tab. Data adjustments can be made in the FT model.

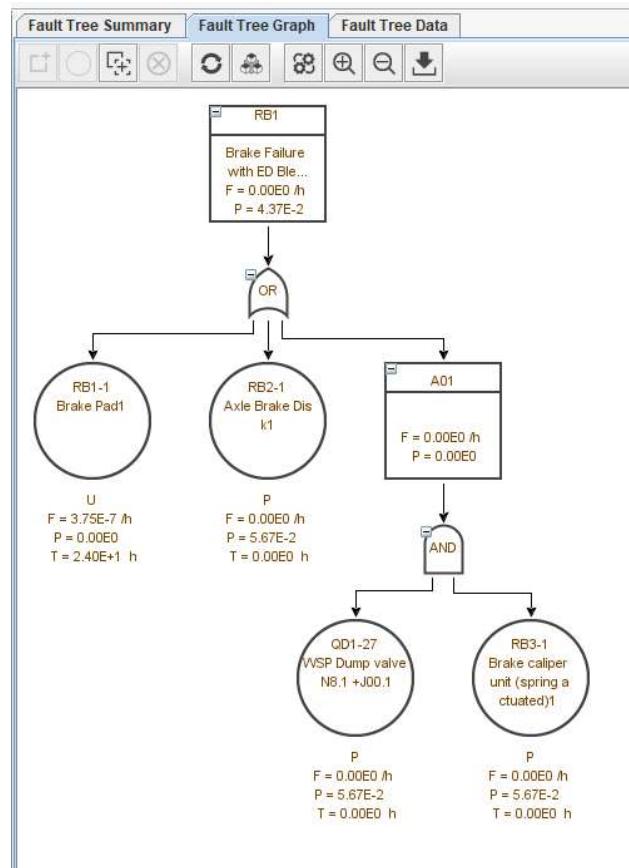


Figure 53: FT Model



Figure 54: FTA data export option

FAULT TREE ANALYSIS											
Id	No	Type	Node	Name	Description	FailureRate (/h)	Possibility	PTI-RepairTime (h)	Category	Date	References
530	1	Event	RB1	Brake Failure with ED Bleed	0.0	0.043680027611012846	0.0		Head Event	OR	
531	2	Basic	RB1-1	Brake Pad1	3.75E-7	0.0	24.0		Unrevealed Failure		
532	3	Basic	RB2-1	Axe Brake Disk1	0.0	0.0567	0.0		Fixed Probability	OR	
764	4	Event	A01		0.0	0.0	0.0		Event	AND	
765	5	Basic	QD1-27	WSP Dump valve N8.1 +J00.1	0.0	0.0567	0.0		Fixed Probability		
766	6	Basic	RB3-1	Brake caliper unit (spring actuated)1	0.0	0.0567	0.0		Pass Probability		

Figure 55: FTA data report

10 Event Tree (ETA) Module

The Event Tree Analysis (ETA) module allows the development of an Event tree (ET) model. To start the ETA module, click on the ET ICON on the left side menu bar. This will display the ETA input screen to develop the input data sheet for the ETA model. The blank ET input sheet can be developed that can be developed as described in the sections below.

10.1 ETA Component inputs menu

The Event tree (ET) Summary tab is a calculation input tab that shows the key summary information supporting the ET model. The summary tab menu is illustrated in Figure 56.

Figure 56: STEM ETA menu Toolbar



The ET functions in the horizontal menu bar used to manage the input data is detailed in Table 25.

Table 25: ETA horizontal menu buttons description

Button	Function
Add Event	Add an ETA calculation sheet to the ETA summary
Edit Event	Edit a row in the ETA summary sheet
Remove Event	Remove an ETA calculation sheet from the ETA summary sheet
Refresh	Refreshes the ETA summary sheet

10.2 Event Tree summary tab

The Event Tree summary tab setups the calculation inputs for the ET calculation. Users can track their ET calculations by filename, as shown in Figure 57. Table 26 outlines the fields used in the ET input summary tab.

EventTree Summary									
Add Event Edit Event Remove Event Refresh									
No	Id	Event Name	Event type	Reference Type	Initiating Event	Initial Value	Unit	Hazard	
1	10	C1444 Pass Door Opens V>5...	Safety	Internal FTA	GK12	1.0E-5	hour	Failure to control the train	View Event Tree
2	14	Test1	Reliability	Internal FTA	HIPPS TEST CASE 1 - RBD	0.00201	/hr	Failure to control the train	View Event Tree
3	17	External door failure	Safety	External FTA	NO REF	3.6E-5	/hr	Danger during the entering or...	View Event Tree
4	18	Unwanted Train uncoupling f...	Safety	External FTA	NO REF	5.23E-5	/hr	Loss of Train integrity	View Event Tree

Figure 57: ET Input Summary page

Table 26: ET Input summary description

Parameters	Description
No	Line Number
Calculation Id	Internal calculation file Id used to identify the calculation record (for internal use)
Event Name	Event tree name
Event Type	Type of event tree (e.g. safety, reliability)
Reference Type	Reference calculation description
Initiating event	Initiating event name
Initiating value	Initiating event value
Unit	Unit of the initiating event value
Hazard	Hazard reference

10.3 ET input summary operation

The Event Tree summary tab enables users to add, edit, and remove the ET project summary details for the ETA calculator.

Users can also copy and paste data from one ETA or from a text file into the popup panel when the ‘Edit ETA’ button is selected

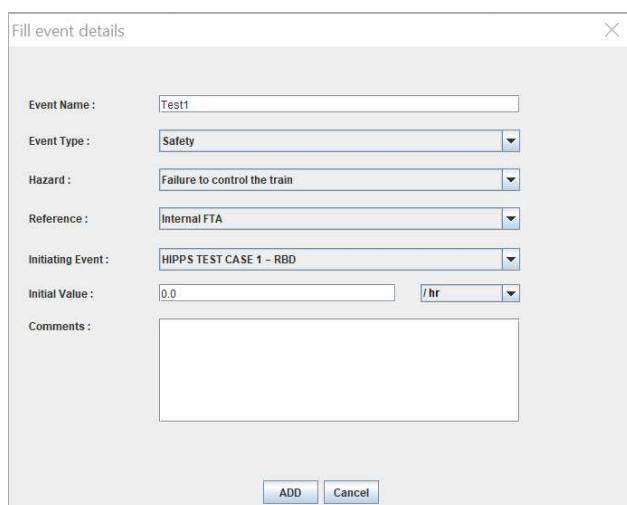
• **Note**

Users can copy and paste data only through the popup option in Edit Event button to enable these features.

10.3.1 Creating a new ETA template

STEM enables users to create a new ETA template for developing models. A new ETA template is created by selecting the ‘Add ETA’ button in the ETA summary input sheet, see Figure 56. Basic ET calculation information, including event name, event type, hazard, reference to other calculation files, initiating event, initial value of the initiating event and comments can be entered into the new ET options page as illustrated in the figure below.

Users can create their own event or link the initiating event to an existing calculation, such as an FTA. This is described further in section 12.



The dialog box is titled 'Fill event details'. It contains the following fields:

- Event Name : Test1
- Event Type : Safety
- Hazard : Failure to control the train
- Reference : Internal FTA
- Initiating Event : HIPPS TEST CASE 1 - RBD
- Initial Value : 0.0 /hr
- Comments :

At the bottom are 'ADD' and 'Cancel' buttons.

Figure 58: Add ET option page

10.3.2 Editing an ET project summary

To edit an ET record from the ET input summary page, select the row then click the ‘Edit ETA’ button in the menu bar, see Figure 57.

10.3.3 Remove an ETA project summary record

To remove an ET project summary record from the ET input sheet select the row in the ETA input sheet and then click the ‘Remove ETA’ button in the menu bar, see Figure 57. A warning message will appear when you perform this operation. Select ‘Yes’ to perform the operation or ‘No’ to stop the deletion, as shown below.

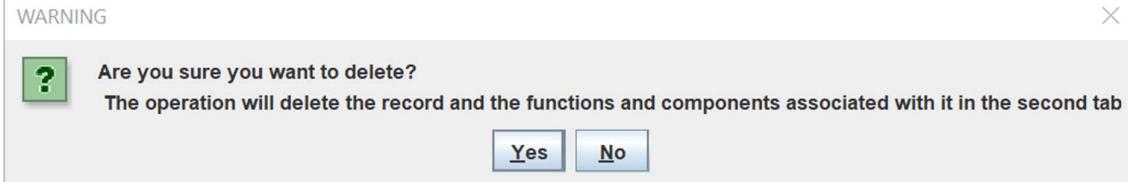


Figure 59: ETA deletion warning message

! Note.

Warning: This operation will delete the row of data associated with the ETA. Check that you intend to delete the data, as this operation will delete the data permanently.

10.4 View ETA details

To view the event tree model, click the 'View Details' button on the right side of the summary sheet. This opens the ET calculator, which is shown by the event tree model tab, where the user can build the ET models, see Figure 57.

The functions of the vertical button used to view the ETA worksheet is shown in Table 27.

Table 27: ETA vertical button description

Button	Function
View Details	View the ETA worksheet

10.5 ETA Model

The Event Tree (ET) model tab allows users to enter the build the event tree model. The following sections describe the features available in the STEM FTA App to build an event tree model.

10.6 ET Horizontal Toolbar

The horizontal toolbar buttons contain a set of icons that gives short-cut access to the ET calculation utility options, as shown in Figure 60. Table 28 presents a list of the ET menu options and shortcuts.



Figure 60: ET Horizontal Toolbar

Table 28: ET Toolbar Tab Options

Parameters	Icon	Description
Insert event*		Inserts node
Edit caption*		Edit heading captions
Edit cell*		Edits the selected cell
Delete*		Delete a node
Delete*		Delete a caption
Calculate		Calculates the model
Zoom In		Zooms into the model
Zoom Out		Zooms out of the model
Save All		Saves all data in the model

• Note.

The names of the ET icons are revealed when the user places the cursor over the icon.

10.7 ET Model Operations

Users can Add, Edit and save components or generate the calculation in the event tree model clicking on the ICONs in the menu. The event options menu will be displayed, as shown in Figure 60.

10.7.1 Insert node

To add a new node in the ET model, select the Insert node ICON in the toolbar or by right clicking on the node in the model. This will open the pull-down menu, see Figure 61. Basic node information, including barrier or control heading name, node value and end label tag names can be entered into the new ET node options page as illustrated in the figure below.

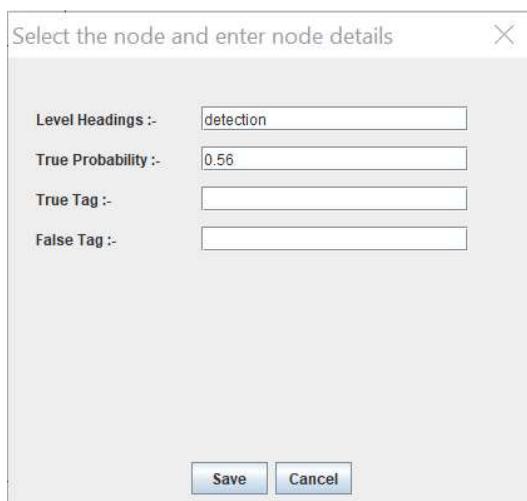


Figure 61: ET Node options page

10.7.2 Insert / edit caption

To add a new caption to the ET model, select the Insert node ICON in the menu bar as described in 10.7.1. This will open the pull-down menu, see Figure 61.

Caption headings can be edited by selecting the edit caption ICON in the Toobar. The user can amend the barrier or control heading name information for all headings, see the figure below.

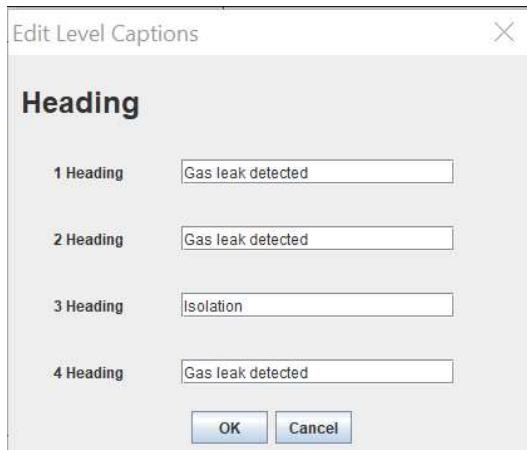


Figure 62: ET Insert Caption options page

10.7.3 Delete a node

To delete a node from the ET model:

- Select the delete ICON in the toolbar, see Table 28, or by specific node on the ET model and right clicking the mouse to activate the pull-down menu and select the delete option

The component will be removed in the ET model.

10.7.4 Delete a caption

To delete a caption from the ET model:

- Select the delete ICON in the toolbar, see Table 28, or by specific node on the ET model and right clicking the mouse to activate the pull-down menu and select the delete option

The component will be removed in the ET model.

10.7.5 Calculate

This option recalculates the ET data and all base event results in the ET model.

10.7.6 Zoom in

To Zoom into the model and increase magnification, click of the Zoom in button in the menu bar.

10.7.7 Zoom out

To Zoom out of the model to decrease magnification, click of the Zoom out button in the menu bar.

10.7.8 Save All

To save data in the ET model:

- Select the save all button in the toolbar, see Table 24, or by right clicking on the ET event in the model to activate the pull-down menu and select the save option.
- The saved data will be indicated by the document save message in the status bar, see Figure 51.

The ET data will be saved.

10.8 Calculation Options

The ET calculation results are described this section.

10.8.1 Calculate ET Model

To generate the ET model, select the calculate option button in the menu bar to recalculate the ET data result in the ET model, see the result table in Figure 63.

10.8.2 Generate ET File

Users can generate the event tree result by clicking the Calculate Icon in the Toolbar.

To export the event tree model, click on **File, Export Report** on the File menu bar or select shortcut CRTL + E. The export message will be displayed in a message box with the option to generate an ET model in a PDF or PNG format.

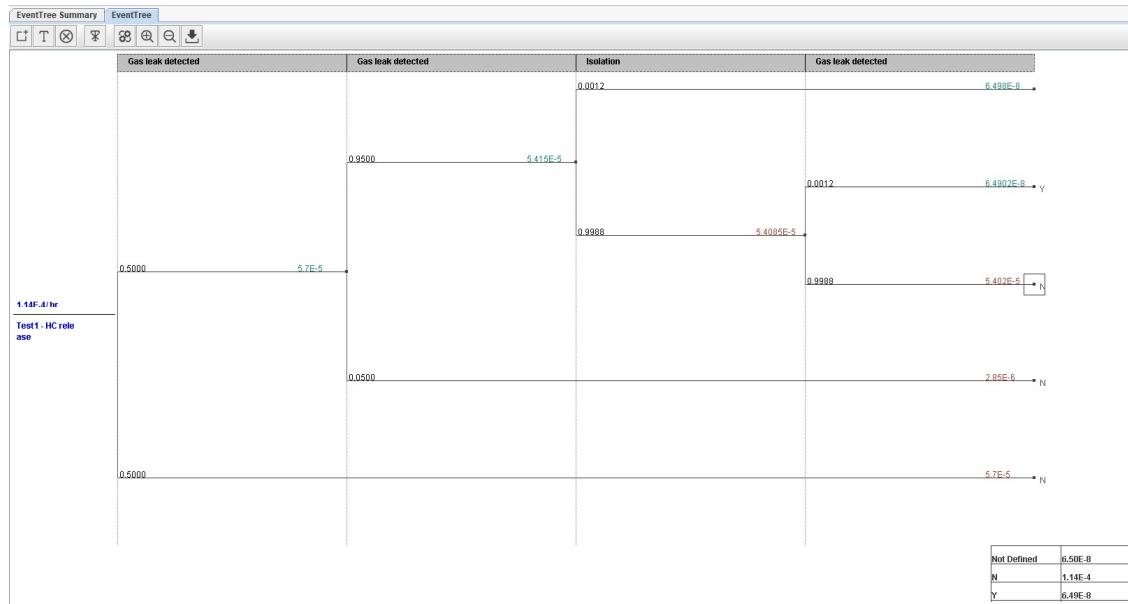


Figure 63: Sample ETA Model

10.9 Linking ETA and FTA Models

The initiating event in the Event tree model can be linked to a fault tree model using the Calculation Management Module Linking Option, see section 12 for further details.

• Tip

You will need to have created a fault tree model before it can be successfully link to an event tree model.

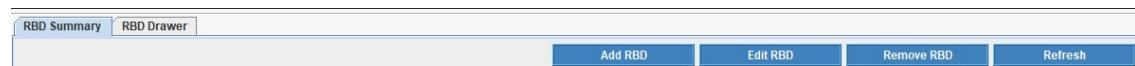
11 Reliability Block Diagram (RBD) Module

To start the Reliability Block Diagram (RBD) Module, click on the RBD ICON on the left side toolbox. The RBD summary screen will be displayed to develop the input data sheet for the RBD model. The blank RBD summary sheet can be developed as described in sections below.

11.1 RBD Input Menu

The Reliability Block Diagram (RBD) Menu contains the RBD information summary and the RBD drawer tab that is illustrated in Figure 64.

Figure 64: STEM FTA menu buttons



The functions of the RBD horizontal buttons used to manage the input data is detailed in Table 21.

Table 29: RBD horizontal menu buttons description

Button	Function
Add RBD	Add an RBD calculation sheet to the RBD graph
Edit RBD	Edit a row in the RBD graph
Remove RBD	Remove an RBD calculation sheet to the RBD graph
Refresh	Refreshes the RBD summary sheet

11.2 RBD summary tab

The RBD summary tab setups the calculation inputs for the RBD graph. The RBD graphs can be tracked by filename, as shown in Figure 65. Table 30 outlines the fields used in the RBD summary tab.

RBD Summary		RBD Drawer		Add RBD	Edit RBD	Remove RBD	Refresh			
No	Id	RBD Name	Function Name	CMM	Battery Log	Standards	Comments	Created Date		View Details
1	91	Battery	Test1	CMM	Battery Log	RBD Normal		2021-10-21 10:51:19.0		

Figure 65: RBD Input Summary page

Table 30: RBD Input summary description

Parameters	Description
Function Name	Function name
CMM	Calculation management model reference
Function Name	Function name
Standards	Standard reference template for the RBD
Comments	Commentary section.

11.3 RBD Input summary operation

RBD summary tab enables users to add, edit, and remove the RBD summary details for the RBD graph. Users can also copy and paste data from one RBD or from a text file into the popup panel when the 'Edit RBD' button is selected

• Note

Users can copy and paste data through the popup option to enable the features, Ctrl + C to copy and Ctrl + V to paste.

11.3.1 Creating a new RBD project summary

A new RBD project summary (template) is created when users select the 'Add RBD' button in the summary input sheet, see Figure 65. Basic calculation information, including function name, CMM file, MPG type and comments can be entered into the popup RBD options page as illustrated in the figure below.

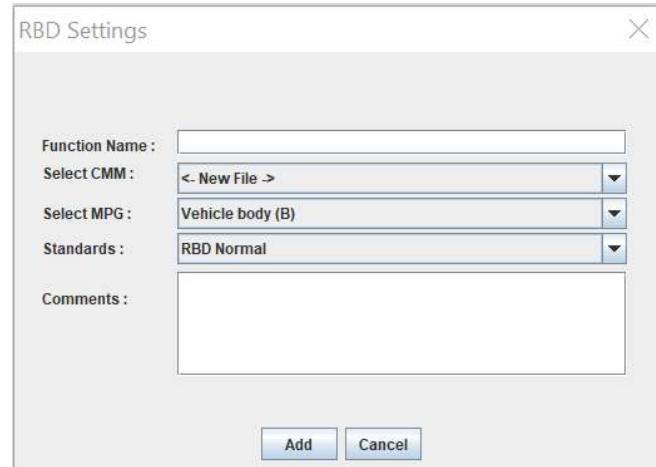


Figure 66: Add RBD option page

11.3.2 Editing an RBD project summary

To edit an RBD project summary record in the RBD Input summary tab, select the row then click the 'Edit RBD' button in the menu bar, see Figure 67.



Figure 67: Edit RBD settings page

11.3.3 Remove an RBD project summary record

To remove an RBD project summary record, select the row in the RBD input sheet and then click the ‘Remove RBD’ button in the menu bar, see Figure 43. A warning message will appear when you perform this operation. Select ‘Yes’ to perform the operation or ‘No’ to stop the deletion, as shown below.



Figure 68: FTA deletion warning message

! Note.

Warning: This operation will delete the row of data associated with the RBD. Check that you intend to delete the data, as this operation will delete the data permanently.

11.3.4 View RBD details

To view the RBD model, click the ‘View Details’ button on the right side of the summary sheet. This opens the RBD graph calculator, which is shown by the RBD Model tab, where the user can build the FTA models, see Figure 43.

The functions of the vertical button used to view the FTA worksheet is shown in Table 23.

Table 31: FTA vertical button description

Button	Function
View Details	View the FTA worksheet

11.4 RBD Model

The RBD model tab allows users to enter the build the Fault Tree model. The following sections describe the features available in the STEM RBD App to build a Fault Tree model.

11.5 RBD Horizontal toolbar

The horizontal toolbar buttons contain a set of icons that gives short-cut access to the RBD calculation utility options, as shown in Figure 46. Table 32 presents a list of the RBD menu options and shortcuts.

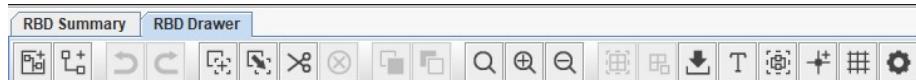


Figure 69: RBD Horizontal Toolbar

Table 32: RBD Toolbar Tab Options

Parameters	Icon	Description
RBD Node		Inserts an RBD node
Line connector		Inserts a line connector
Undo		Undo an event
Redo		Redo an event
Copy		Copy a node
Paste		Paste a node
Cut		Cut a node
Delete*		Delete a node or a block
Bring front		Move the block to the front
Send back		Move the block to the back
Zoom		Zoom
Zoom In		Zooms into the model
Zoom Out		Zooms out of the model
Group		Groups the blocks
Ungroup		Ungroups the blocks
Save All		Saves all data in the model
Insert Caption		Adds a caption
RBD Subsystem Outline		Adds a caption frame

Parameters	Icon	Description
RBD Internal connector		Add an internal connection point
Set grid		Sets a grid frame
Settings		Opens settings

• **Note***.

To insert, edit or delete an RBD object, the user will need to select the object in the RBD model to enable the buttons.

• **Note.**

The names of the RBD icons are revealed when the user places the cursor over the icon.

11.6 RBD Model operations

Users can Add, Edit, delete and save RBD block elements and connectors or amend the RBD Model clicking on the ICONs in the menu or by right clicking or double clicking on the object in the model. The event options menu will be displayed, as shown in Figure 46.

Users can enter labels, such as event id, to the block elements or a value. Comments and captions can also be added. The set grid icon allows the user to apply a grid to the RBD.

11.6.1 Insert an RBD node

To add a new RBD node in the RBD model, select the model tab and select the RBD Node icon in the menu bar to insert a new block object in the model.

11.6.2 Insert line connector

To add a new line connector to the RBD model, select the line connector icon in the menu bar to insert a new line connector object in the model.

11.6.3 Undo a block or line object

Users can undo any block objects inserted by selecting the undo ICON in the menu bar to undo a block or line element in the model.

11.6.4 Redo a block or line object

Users can redo any block objects inserted by selecting the redo ICON in the menu bar to undo a block or line element in the model.

11.6.5 Copy

Block objects in the RBD model can be copied. Users can select the desired object in the model by clicking on it and then hold down the left mouse button. To obtain a copy of the object, click on the copy ICON in the menu bar to copy a block or line element in the model in the File menu bar, as shown in Table 32.

11.6.6 Paste

To paste an object(s) in the model, that has already been selected, click on the paste ICON in the menu bar to copy a block or line element in the model in the File menu bar, as shown in Table 32.

11.6.7 Cut

To cut an object in the model, that has already been selected, click on the cut ICON in the menu bar, as shown in Table 32. This will temporarily store the data in memory location and can be reused when you select the paste option.

! Note.

The conventional Ctrl + C, Ctrl + V or Ctrl + X short cuts will not work in the RBD App.

11.6.8 Delete

To delete an RBD component from the RBD model:

- Select the delete ICON in the toolbar, see Table 24, or by right clicking on the RBD model to activate the pull-down menu and select the delete option

The component will be removed in the RBD model.

11.6.9 Bring object to the front

The bring front option allows users to push the selected object to the front of the frame by selecting the block object in the model and then by selecting the bring front ICON in the menu bar, see Table 32.

11.6.10 Send object to the back

The send back option allows users to push the selected object to the back of the frame, see Table 32.

11.6.11 Group

Users can group any selected objects in the model to arrange or move the objects. To group the object, first select objects in the model then click on the group ICON in the menu bar. If you move the objects, they will move as one in the model.

11.6.12 Ungroup

To ungroup a group of objects, select the objects' group in the model then click on the ungroup ICON in the menu bar. The object will then become ungrouped, and each object will be able to move separately around the model.

11.6.13 Zoom

The feature the user to resize the model to the original size.

11.6.14 [Zoom in](#)

To Zoom into the model and increase magnification, click of the Zoom in button in the menu bar.

11.6.15 [Zoom out](#)

To Zoom out of the model to decrease magnification, click of the Zoom out button in the menu bar.

11.6.16 [Save All](#)

To save data in the RBD model:

- Select the save all button in the toolbar, see Table 24, or by right clicking on the RBD model to activate the pull-down menu and select the save option.
- The saved data will be indicated by the document save message in the status bar.

The RBD model will be saved.

11.6.17 [Insert Caption](#)

This allows the user to insert a line boundary or caption for the RBD model. To add a new text caption to the RBD model, select the Insert Caption ICON in the menu bar, see Table 32.

11.6.18 [RBD Subsystem Outline](#)

The subsystem outline feature allows users to place a boundary line around objects. Click on the subsystem outline ICON in the menu bar to add a text caption to the RBD model, see Table 32.

11.6.19 [RBD Internal connector](#)

Users can insert a connection point between a line to add multiple connections at that point. To insert a connection point, first select the line object in the model then click on the internal connector ICON in the menu bar, see Table 32. If you move the line object, this will move in the model. You can add a line from an object to the internal connector point or vice versa.

11.6.20 Sets a grid frame

The grid features enable users to snap objects within a grid frame. To activate the grid frame feature to the RBD model, select the grid ICON in the menu bar, as shown in Table 32.

11.6.21 RBD Settings

Users can adjust the colour, caption fonts and sizes, line size or line arrow colour or style settings. To modify the RBD Graphics settings, click on the Settings ICON in the menu bar, see Table 32. The graphics layout setting details will be displayed, as shown below.

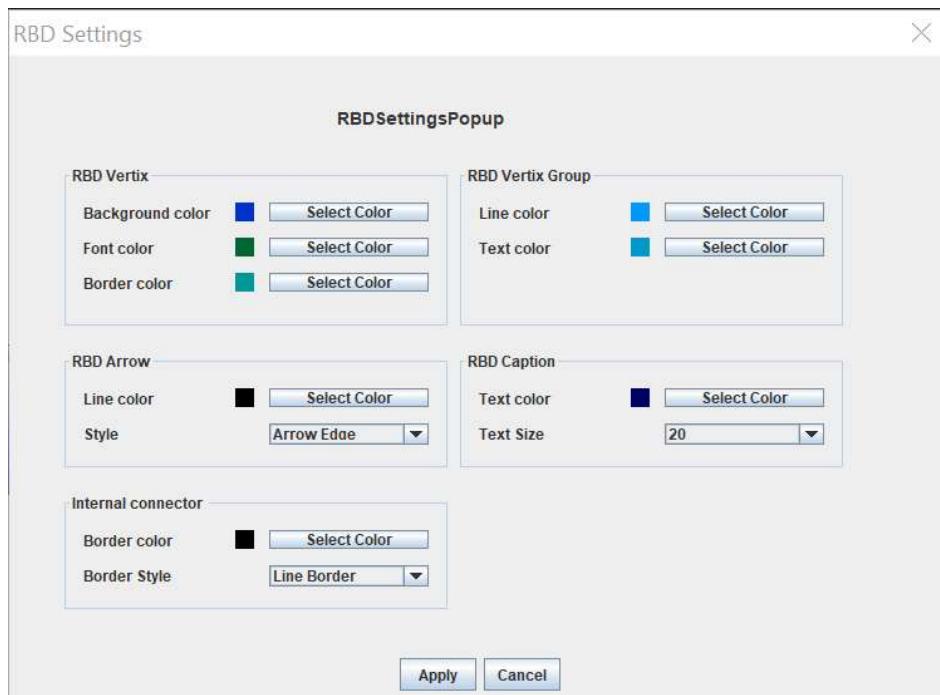


Figure 70: RBD Settings page

12 Common Cause Factor (CCF) Module

The Common Cause Factor (CCF) module allows users to consider system dependency failures which are considered to have the potential for simultaneous occurrence due to shared cause. The CCF module allows the user to define their system and the scope of the project to estimate the impact of system dependency failures.

To initiate the CCF App, click on the CCF icon on the left side menu bar. A blank CCF input sheet will display which is described in sections below.

12.1 CCF Calculator Inputs Menu

The Common Cause Factor (CCF) summary tab contains summary information supporting the CCF model. The summary tab menu is illustrated in Figure 71.

Figure 71: STEM CCF menu Toolbar



The CCF functions in the horizontal menu bar used to manage the input data is detailed in Table 33.

Table 33: CCF horizontal menu buttons description

Button	Function
Add CCF	Add an CCF calculation to the CCF summary
Edit CCF	Edit a row in the CCF summary sheet
Remove CCF	Remove an CCF calculation from the CCF summary sheet
Refresh	Refreshes the CCF summary sheet

12.2 CCF summary tab

The CCF summary tab setups the calculation inputs for the CCF calculation. The CCF calculations can be tracked by filename, as shown in Figure 72. Table 34 outlines the fields used in the CCF input summary tab.

CCF Summary		Calculator		Add CCF	Edit CCF	Remove CCF	Refresh
No	Id	CCF Name	CMM	Function Name	Standards	Comments	Created Date
1	104	Brake System	Brake System	Brake System	NonProgramable		2022-01-15 17:20:06.0

Figure 72:CCF Input Summary page

Table 34: CCF Input summary description

Parameters	Description
No	Line Number
id	Calculation id
CCF Name	CFF name
CMM	Calculation management model reference
Function Name	Function name
Standards	Standard reference template for the CCF
Comments	Commentary section.

12.3 CCF Input summary operation

CCF summary tab enables users to add, edit, and remove the CCF summary details for the CCF graph. Users can also copy and paste data from one CCF or from a text file into the popup panel when the ‘Edit CCF’ button is selected

• **Note**

Users can copy and paste data through the popup option to enable the features, Ctrl + C to copy and Ctrl + V to paste.

12.3.1 Creating a new CCF calculation

A new CCF calculation is created when users select the ‘Add CCF’ button in the summary input sheet, see Figure 73. Basic calculation information, including function name, CMM file, MPG type and comments can be entered into the popup options page as illustrated in the figure below.

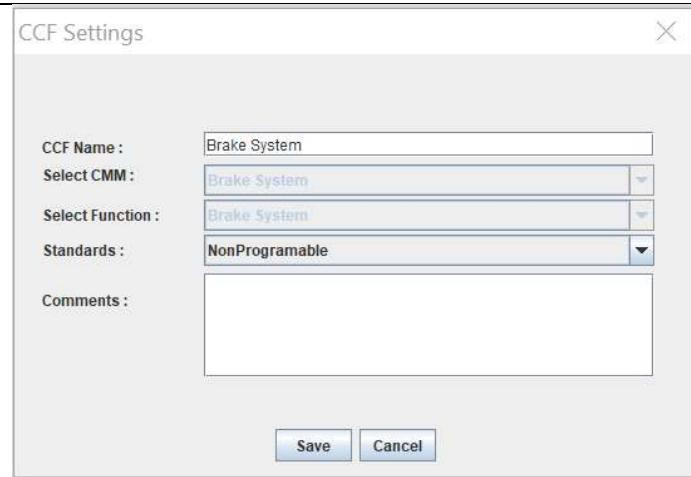


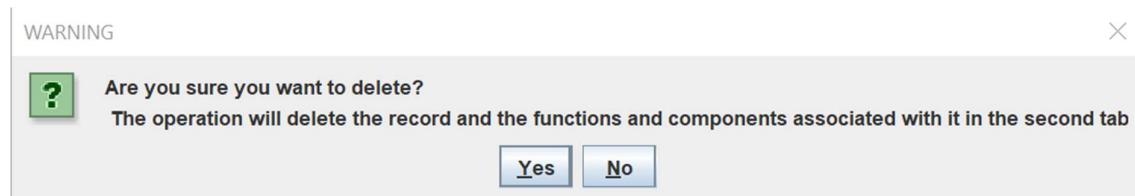
Figure 73: Add CCF option page

12.3.2 Editing an CCF project summary

To edit an CCF calculation record in the CCF Input summary tab, select the row then click the 'Edit CCF' button in the menu bar, see Figure 71.

12.3.3 Remove an CCF project summary record

To remove an CCF calculation record, select the row in the CCF input sheet and then click the 'Remove CCF' button in the menu bar, see Figure 71. A warning message will appear when you perform this operation. Select 'Yes' to perform the operation or 'No' to stop the deletion, as shown below.



12.4 CCF Model

The CCF calculator tab allows users to common cause factor model. The following sections describe the features available in the STEM CCF App to build a CCF model.

To view the CCF calculator model, click the ‘View Details’ button on the right side of the summary sheet which opens the CCF calculator, see Figure 43.

The functions of the vertical button used to view the FTA worksheet is shown in Table 23.

12.5 CCF Horizontal toolbar

The horizontal toolbar buttons contain a set of icons that gives short-cut access to the CCF calculation utility options, as shown in Figure 74. Table 35 presents a list of the CCF menu options and shortcuts.

Figure 74: CCF Horizontal Toolbar

Table 35: CCF Options

Parameters	Description
No	Line Number
Main Component Id	Product System Code
Main Component Name	Name of Component
Row Count	Description of the Subsystem or Component function
Total RPZe	Operating condition
Failure Effects (Local)	Local failure effect based on the worst effect on the failure mode
Failure Effects (System Level)	System failure effect based on the worst effect on the failure mode
Importance	HOLD
Failure detection	Describes the method of detection and diagnostics used to detect the failure
Prevention / Compensating Measures	Describes the technical measures or compensation measures to minimise the criticality or reduce / eliminate the effects
Occurrence	
Detection measure	Compensating measure to bring the system to a safe state
Detection	
RPN	Risk priority number (RPN) is a function of the severity of the effect of failure, the probability of occurrence, and the ease of detection for each failure mode.

Parameters	Description
Improvement measures	
Responsible / Date	Responsible person / Date
Measures undertaken	
Importance (Post)	
Occurrence (Post)	
Detection (Post)	
RPZ (Post)	
Main Components id	Creates a New Project File
Component Name	
Row Count	
RPZ	

Parameters	Icon	Description
RBD Node		Inserts an RBD node
Line connector		Inserts a line connector
Undo		Undo an event
Redo		Redo an event
Copy		Copy a node
Paste		Paste a node
Cut		Cut a node
Delete*		Delete a node or a block
Bring front		Move the block to the front
Send back		Move the block to the back
Zoom		Zoom
Zoom In		Zooms into the model
Zoom Out		Zooms out of the model
Group		Groups the blocks
Ungroup		Ungroups the blocks
Save All		Saves all data in the model

Parameters	Icon	Description
Insert Caption		Adds a caption
RBD Subsystem Outline		Adds a caption frame
RBD Internal connector		Add an internal connection point
Set grid		Sets a grid frame
Settings		Opens settings

• **Note*.**

To insert, edit or delete an RBD object, the user will need to select the object in the RBD model to enable the buttons.

• **Note.**

The names of the RBD icons are revealed when the user places the cursor over the icon.

12.6 CCF calculator operations

Users can Add, Edit, delete and save information in the CCF calculator by clicking on the view ICONs in the menu or **by right clicking or double clicking on the object in the model. The event options menu will be displayed, as shown in Figure 46.**

Users can enter event id, type, link to a document reference or a value. Comments can also be added. The update button allows the user to refresh the RBD data.

12.6.1 Insert an RBD node

To add a new RBD node in the RBD model, select the model tab and select the **RBD Node** icon in the menu bar to insert a new block object in the model.

12.6.2 Insert line connector

To add a new line connector to the RBD model, select the line connector icon in the menu bar to insert a new line connector object in the model.

12.6.3 Undo a block or line object

Users can undo any objects inserted by selecting the undo ICON in the menu bar to undo a block or line element in the model.

12.6.4 Redo a block or line object

Users can redo any objects inserted by selecting the redo ICON in the menu bar to undo a block or line element in the model.

12.6.5 Copy

Users can copy any objects in the RBD model by using the mouse. Users can select the desired object in the model by clicking on it and then hold down the left mouse button. To obtain a copy of the object, click on the copy ICON in the menu bar to copy a block or line element in the model in the File menu bar, as shown in Table 32 .

12.6.6 Paste

To paste an object(s) in the model, that has already been selected, click on the paste ICON in the menu bar to copy a block or line element in the model in the File menu bar, as shown in Table 32.

12.6.7 Cut

To cut an object in the model, that has already been selected, click on the cut ICON in the menu bar, as shown in Table 32. This will temporarily store the data in memory location and can be reused when you select the paste option.

! Note.

Warning: The conventional Ctrl + C, Ctrl + V or Ctrl + X operations will not work in the RBD App.

12.7 Linking Calculation Modules

The linking page connects calculation modules to evaluate complex calculations.

This involves linking the external references from one calculation to the other calculation module.

To link a calculation module, select the calculation module button.

This will display the **module linking** form.

The following calculation links can be made:

13 Calculation Management Module

The Calculation management module (CMM) is a central location for all the STEM calculations that is used for the project. The CMM file forms the master data file for project calculations. Users can define the scope, system, subsystem, functions and the components within the systems and subsystems for the project. The data defined is accessible to all calculator Apps.

To initiate the CMM App, click on the CMM icon on the left side menu bar. A blank CMM input sheet will be displayed which is described in sections below.

13.1 CMM menu

The Calculation management summary tab contains information tabs showing the Calculation summary, as shown in the CMM calculation sheet in Figure 42.

Figure 75: STEM CMM menu Toolbar

CMM Summary		Calculator Management Module		Calcfile Linkage Report		Add CMM	Edit CMM	Remove CMM	Refresh	Usage
No	Group/Function Id	Group/Function Name	Module	MPG						

The functions of the horizontal menu used to manage the input data is detailed in Table 36.

Table 36: CMM input worksheet description

Button	Function
Add CMM	Add a CMM component to the FMEA summary
Edit CMM	Edit a row in the CMM summary sheet
Remove CMM	Remove a CMM component from the FMEA summary sheet
Refresh	Refreshes the CMM summary sheet
Usage	Indicates which calculations and Apps the CMM components are used

13.2 CMM summary tab

The CMM summary tab lists all the inputs required for the CMM calculation. Users can track their CMM calculations by CMM group or function name or by id, as shown in Figure 18. Table 37 outlines the fields used in the CMM input summary tab.

CMM Summary		Calculator Management Module		Calcfile Linkage Report					
No	GroupFunction Id	GroupFunction Name	Module	Refresh	Usage				
1	44	Test 1	RAM	General					
2	46	Test 2	RAM	Running gear and bogies					
3	47	Test 3	RAM	Brake	SP Test Case 4				

Figure 76: CMM Input Summary page

Table 37: CMM Input summary description

Parameters	Description
No	Line Number
Group Function Id	Internal calculation file Id used to identify the calculation summary record for the CMM
Group Function Name	Function of the component
Module	Represents the specific App calculator used in the top-down calculation, e.g. FMEA, FTA, RBD.
Main Product Group (MPG) Type	Main product group type
Comments	Commentary section.

13.3 CMM input summary operation

Users can add, edit, and remove project calculation details in the CMM input calculator sheet. Users can also copy and paste data from the popup panel. There is a refresh function to refresh the CMM calculator data. To access the menu list right click on the CMM calculator sheet, which displays the dropdown menu.

13.3.1 Creating a new CMM summary tab

STEM allows users to create a new calculation record in the CMM tab for developing models. A new record is created by selecting the ‘Add CMM’ button in the CMM summary sheet, see Table 36. This will open the CMM settings popup form, as shown in figure below. Basic calculation information, including function name, calculation file, MPG type and template can be entered into the new CMM options page. Once filled the user clicks the ‘add button’ to insert a record into the CMM summary tab.

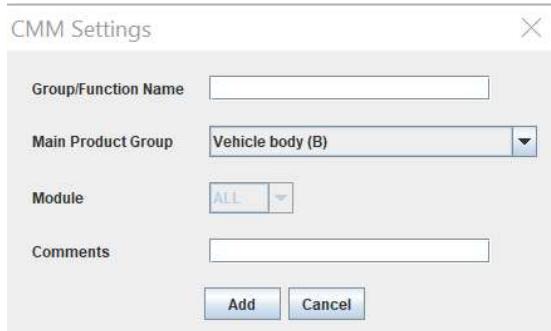


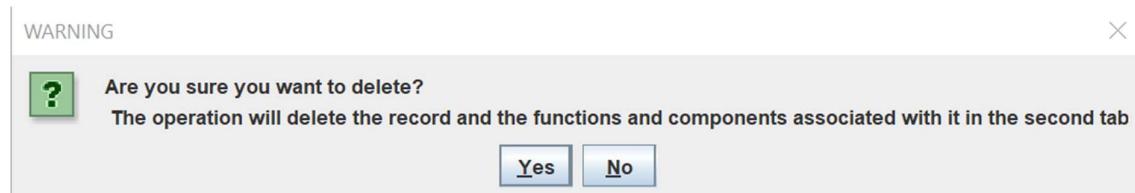
Figure 77: Add CMM settings page

13.3.2 Editing an CMM summary

To edit a calculation record in the CMM tab select the row in the CMM sheet then click the 'Edit CMM button' in the menu bar, see Table 36. The CMM settings popup form will be generated, as shown in Figure 77.

13.3.3 Remove an CMM record

To remove an CMM record from the CMM summary sheet select the row in the CMM and then click the 'Remove' CMM button in the menu bar, see Table 36. A warning message will appear when you perform this operation. Select 'Yes' to perform operation or 'No' to stop the deletion, shown below.



! Note.

Warning: This operation will delete not only the record but also the functions and components associated with the CMM. A warning message will appear when you perform this operation. The data deleted cannot be recovered!

13.3.4 Refresh a CMM record

To refresh a CMM record from the CMM summary sheet select the row in the CMM and then click the ‘Refresh’ button in the menu bar, see Table 36.

13.3.5 CMM Usage

The usage button enables users to view the location of the calculation data. To view the CMM usage records in the CMM summary sheet click the ‘Usage’ button in the menu bar, see Table 36. In this example, the CMM record are being used in three FMEA calculations and a FTA calculation respectively. Each calculation is referenced by the CMM Id and description.

Select to insert components				
APP Name	Module Id	Module Name	CMM ID	CMM Description
FMEA	67	Brake wheelside function	47	Test 3
FMEA	68		47	Test 3
FMEA	129	TEST3	47	Test 3
FTA	43	SP OPS TEST CASE 4	19	Brake Failure with ED Blen...

Figure 78: CMM Usage settings page

13.3.6 View CMM details

To view the CMM sheet, click the View Details button on the right side of the summary sheet. This opens the CMM calculator, which is in the CMM calculator tab, where the user can build the CMM models see Figure 79.

The functions of the vertical button used to view the CMM worksheet is shown in Table 38.

Table 38: CMM vertical button description

Button	Function
View Details	View the FMEA worksheet

• Tip

The worksheet columns can be adjusted by dragging the edge of the header.

13.4 CMM Calculator

The CMM calculator tab allows users to build functions and components related to the systems and subsystems defined from the input sheet MPG and component elements. The features of the CMM worksheet are shown in Figure 79.

Further details of the functions and components for both methods are described in Table 39.

Calculator Management Module - FT-TestA (119)												
Id	No	Subsystem Code	Subsystem/ Compo...	Failure mode	Failure Rate(FITS)	Failure Rate...	Probability	Failure Mode Ratio	Unrevealed Fail...	Unrevealed Fail...	Reference	Remarks
89	1	FUN 1	FT-TestA		0.0	0E0	8E-2	0.0	0.0		SIL 0 NO REF	Generated Generated
278	1.1	GK1	Relay 1									

Figure 79: CMM Calculator page

Table 39: CMM Calculator description

Parameters	Description
No	Line Number
Subsystem code	Subsystem id reference
Subsystem / Component	Name of the main subsystem / component
Failure mode	Component failure mode used in calculations
Failure rate (Fits)	Failure rate in fits used in calculations
Failure rate (/hr)	Failure rate in (per hr) unit used in calculations
Probability	Failure probability used in calculations
Failure mode ratio	Failure probability between 0 and 1
Unrevealed failure ratio	Unrevealed failure rate ratio estimate
Unrevealed failure rate (/hr)	Unrevealed failure rate estimate
Reference	Reference
Remarks	Commentary section.

13.5 CMM calculator operations

Users can Add, Edit, delete and save functions or components in the CMM Calculator by right clicking the row. Users can also copy and paste data from one CMM or from a text file. Users can also copy and paste data from the CMM file to other text editors or the reverse. The refresh function allows the user to refresh the CMM data. Users can access the menu list by right clicking on the CMM calculator sheet.

13.6 Add function

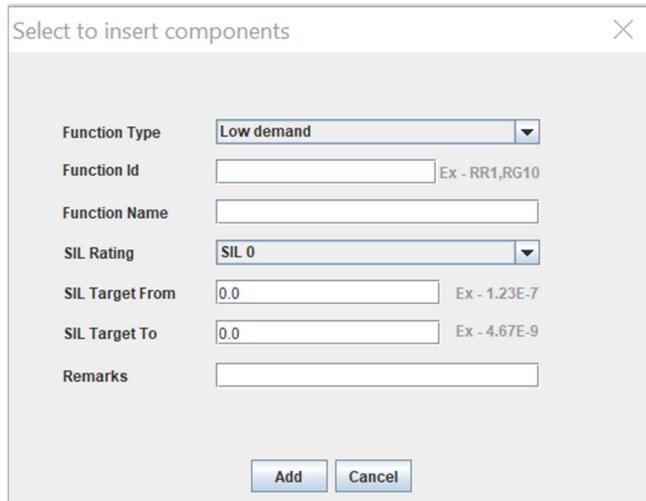
To add a new component to the CMM worksheet:

- Select the cell or row on the CMM worksheet and right click to open the menu list. The component from the list of systems and main product group
- Click on the add button to include the selection to the CMM input sheet.

The panel enables users to amend any row of data on the CMM worksheet. The failure identification and failure effects which defined by the user are presented in Table 7. Table 8 describes detection measures.

• **Tip**

A description of the column heading's can be found when the user hovers the cursor over the headings in the CMM table.



Select to insert components

Function Type	Low demand
Function Id	Ex - RR1, RG10
Function Name	
SIL Rating	SIL 0
SIL Target From	0.0 Ex - 1.23E-7
SIL Target To	0.0 Ex - 4.67E-9
Remarks	

Add Cancel

Figure 80: CMM function page

Table 40: CMM components options

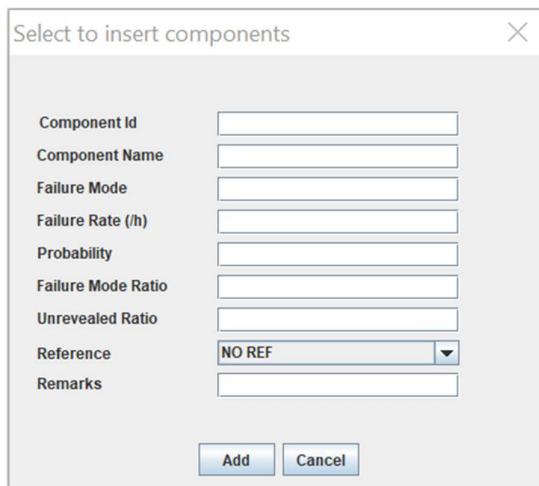
Parameters	Description
Function type	References id for the main component or subsystem
Function id	Name of the main component
Function Name	function of the component
SIL Rating	SIL target estimate
SIL Target From	Lower SIL Level
SIL Target To	Higher SIL Level
Remarks	comments

13.7 Add subfunction

To add a new subcomponent to the CMM worksheet:

- Select the cell or row on the CMM worksheet and right click to open the menu list. The component from the list of systems and main product group
- Click on the add button to include the selection to the CMM input sheet.

The panel enables users to amend any row of data on the CMM worksheet. Figure 81 below presents the subcomponents page. See Table 39 for a description of the features.



The dialog box is titled "Select to insert components". It contains the following fields:

- Component Id: Text input field
- Component Name: Text input field
- Failure Mode: Text input field
- Failure Rate (/h): Text input field
- Probability: Text input field
- Failure Mode Ratio: Text input field
- Unrevealed Ratio: Text input field
- Reference: A dropdown menu currently showing "NO REF".
- Remarks: Text input field

At the bottom of the dialog are two buttons: "Add" and "Cancel".

Figure 81: CMM subcomponent page

13.7.1 Copy and paste data

Users can select the cell in the CMM worksheet by clicking on it and holding down the left mouse button. To obtain specific information on the Software, click on **Edit**, on the File menu bar and select **Copy** from the pull-down menu. Alternatively, select Ctrl – C on the keyboard to copy the object.

Selected objects can be pasted within the worksheet by selecting Ctrl – P on the keyboard to paste the object.

13.7.2 Edit a single row of data

To edit a row on the FMEA worksheet:

- Selected the cell or row on the FMEA worksheet and right click to open the menu list and select the edit selected row from the list of systems and main product group, see Figure 23.

You will get a Popup to edit the information. The following image show the FMEA add Popup based on the MIL standards.

The popup filled with previously entered information. You can edit the details and click save button to save the changes, see Figure 24.

13.8 Delete Row

14 General Information

14.1 Copyright

Version number: 2021.1

Nov 2021

14.2 System Requirements

The minimum system requirements for running the STEM software on a Windows machine and Apple Operating Systems are shown in Table 41 and Table 42.

Table 41: Windows Minimum System Requirements

Processor	1 gigahertz (GHz) or faster with 2 or more cores on a compatible 64-bit processor
RAM	4 gigabyte (GB)
Display	High definition (xxp) display that is greater than (9") diagonally, 8 bits per colour channel
Internet connection	For all STEM software versions, internet access is required to perform calculation, updates and to download and take advantage of the features. A STEM account is required for all features the software.

Table 42: Apple OS Minimum System Requirements

[TO BE REVIEWED – OSX testing requirements – check Apple dev community]

Processor	1 gigahertz (GHz) or faster with 2 or more cores on a compatible 64-bit processor
RAM	4 gigabyte (GB)
Display	High definition (xxp) display that is greater than (9") diagonally, 8 bits per colour channel
Internet connection	For all STEM software versions, internet access is required to perform calculation, updates and to download and take advantage of the features. A STEM account is required for all features the software.

15 Technical Support

15.1 Online Technical Support

STEM customers with a valid licence and software maintenance agreement can register to access the Online Technical Support in the STEM client area:

<https://topfieldconsultancy.co.uk/clientArea/login>

[https://STEMsupport@Topfield.co.uk.](mailto:https://STEMsupport@Topfield.co.uk)

You can use the Online Technical STEM support to:

- Access current STEM product documentation.
- Search on frequently asked questions (FAQs), technical tips and solutions.
- Search for application examples.
- Search for software limitations.
- Send reviews or suggestions.
- Submit and track technical issues.

Registered STEM users can also subscribe to our technical support e-Bulletins which will alert you to important technical support information on:

Technical advisories – [additional]

Announcements with service packs or patches.

Product Updates

Product release announcements

16 References

[1] STEM Technical Manual, Version 1.0, Topfield Consultancy Ltd, 2022.

16.1 Abbreviations

Table 43: List of Abbreviations

Abbreviation	Definition
CCF	Common Cause Failure
EN	European Norm
ETA	Event Tree Analysis
<td>Failure In Time (Failures per 10^9 hours)</td>	Failure In Time (Failures per 10^9 hours)
FMEA	Failure Mode, Effects Analysis
FMECA	Failure Mode, Effects and Criticality Analysis
FTA	Fault Tree Analysis
LRU	Lowest Replaceable Unit
LLRU	Lowest Level Replacement Unit
RAM	Reliability Availability Maintainability
STEM	SAFETY TRANSPORT ENGINEERING MANAGEMENT

16.2 Terminology

Table 44: List of Terms

Term	Definition
Common Cause Failure	A common cause (dependent) failure occurs when several failures have the same origin. Common cause failures are common event failures where the cause is the same single external event, where two systems fail in the same way for the same reason. The use of common cause failures (CCFs) in fault tree analysis takes account of external factors that affect the same or similar equipment in the same way. These external factors could be related to the environment such as high ambient temperatures, vibration or sand, but could also be related to maintenance procedures that are carried out by the same person, who may make the same error on all the equipment types. CCFs can be significant as they can result in single event failures leading to the occurrence of the top event.

Term	Definition
Fault	A fault is a random cessation of the ability of a piece of equipment to perform its function and which requires immediate or deferred attention by maintenance staff.
Icon	Icons are pictorial representations displayed to assist the user navigate the STEM software. The Icon is a symbol of the software calculation module similar to buttons.
Input Field	These are alphanumeric Data items that are entered into an input field. All data that is entered in a field is checked for validity before the User can continue.
Item	A unique functional entity that, depending on the indenture level could be a subsystem, assembly, component, LRU etc.
Lowest Replaceable Unit	Replacement Unit that the Operations and Maintenance staff can replace in the field to restore or preserve the full availability of the system.
Lowest Level Replacement Unit	Replacement Unit that the Operations and Maintenance staff cannot split into lower-level parts according to the delivered maintenance resources.
Menu Bar	The Menu Bar displays all the program functions, which can be accessed by the User by clicking on the appropriate menu item. This is described in more detail later in the chapter.
Status Bar	This displays the current model status
System	Set of elements which interact according to a design, where an element of a system can be another system, called a subsystem and may include hardware, software and human interaction. A system can comprise components, control, software, operators, instructions, etc.
Sub-system	Functional part of a complete system.
Toolbar	The Toolbar contains a number of controls (icons/buttons) which give short-cut access to the most commonly used program functions. This is described in more detail later in this chapter.