

Aralia Fault Tree Analyzer

User's Guide



V5R20 - BPA FT9 Delivery 8

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Overview

Aralia Fault Tree Analyzer enables safety engineers to perform systems probability risk assessment using Fault Trees or Reliability Block Diagrams.

The *Aralia Fault Tree Analyzer User's Guide* is intended for users who need to become quickly familiar with the Aralia Fault Tree Analyzer product.

Aralia Fault Tree Analyzer in a Nutshell

Aralia Fault Tree Analyzer provides tools to create, organize, manage and assess Fault Trees and Reliability Block Diagrams.

Aralia Fault Tree Analyzer embeds a powerful calculation engine for Boolean risk assessment models Aralia, based on the Binary Decision Diagrams technology.

Aralia Fault Tree Analyzer enables to:

- Design Fault Trees and check their correctness
- Design and assess Reliability Block Diagrams
- Mix Fault Trees and Reliability Block Diagrams in the same study
- Compute minimal cutsets, event probabilities, Importance Factors
- Perform Time Dependent Analysis
- Assess Safety Integrity Level (SIL) to validate system safety requirements (compliant with new IEC 61508 and IEC 61511 standards)
- Organize your model with folders and worksheets
- Import and export Fault Tree models in different formats
- Generate reports
- Export obtained results.

Before Reading this Guide

Before reading this guide, you should be familiar with basic Fault Tree or Reliability Block Diagrams concepts and probability risk assessment.

You may also like to read *Aralia Fault Tree Analyzer mathematical User's Guide*.

Getting the Most Out of this Guide

To get the most out of this guide, we suggest that you start reading and performing the step-by-step user tasks, which cover all product functionality.

The [Interface Description](#) on page 137 section, which describes the commands that are specific to Aralia Fault Tree Analyzer, provides a quick way of accessing information about commands.

Organizing a Model

This section shows you how to organize your Fault Tree model with worksheets and folders.

[About Worksheets and Folders](#) on page 6

[Working with Folders](#) on page 9

[Working with Worksheets](#) on page 11

About Worksheets and Folders

To organize and manage your Fault Tree model and calculation results worksheets and folders can be used. The Fault Tree model organization is displayed in the **Model Explorer**.

The following topics are discussed:

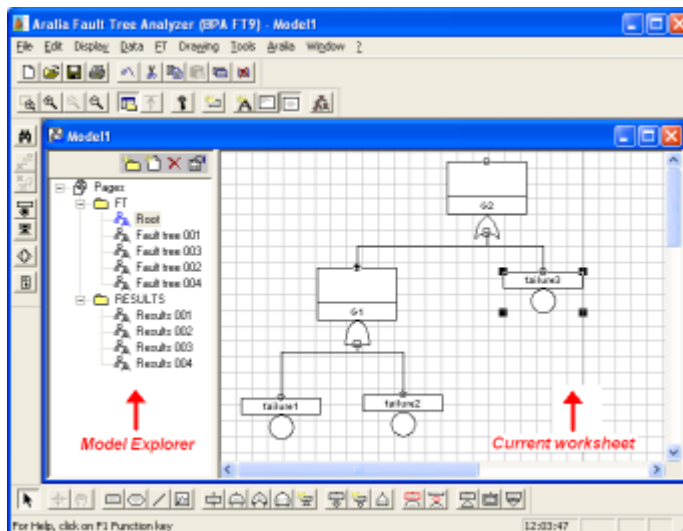
Model Explorer


The model organization is displayed in the **Model Explorer** in the left side of the window.

The **Model Explorer** enables to manage your Fault Tree model:

- Create worksheets and folders
- Delete worksheets and folders
- Edit worksheets and folders properties
- Open worksheets and folders.

 **Note:** To display/hide the **Model Explorer**, select **Display > Model Explorer**.



 **Note:** In the **Model Explorer**, the current worksheet is marked in blue.

Worksheet

A worksheet is a graphical or textual zone.

It can be of three types:

- Fault Tree: Used to create a Fault Tree graphical representation and to display results.
- Reliability Diagram: Used to create Reliability Block Diagrams and to display calculation results.
- Worksheet information: Contains text only.

A worksheet of type Fault Tree or Reliability Block Diagram may contain one or more print pages.

In order to handle very large and complex Fault Trees you can split your Fault Tree model into multiple worksheets. The connexion between subtrees of the Fault Tree represented in the different worksheets is performed using [About Transfer Gates](#) on page 51.

A worksheet can contain:

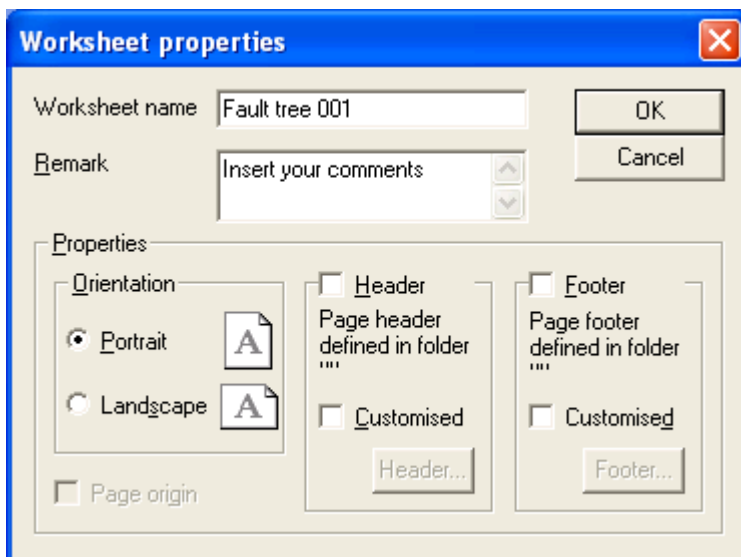
- Fault Tree graphical representation
- Reliability Block Diagram
- Shapes with comments or results
- Charts.

Worksheet Properties

This topic describes the worksheet properties.

In Aralia Fault Tree Analyzer worksheets have the following properties:

- Name
- Remark
- Orientation: portrait or landscape
- Header
- Footer.



Worksheet Property	Definition
Name	Worksheet name can contain maximum 21 character. The default worksheet name is <i>Fault tree i</i> , where <i>i</i> is the number of the worksheet. You can rename the worksheet.
Remark	You can describe the worksheet contents by adding remarks to the worksheet properties.
Orientation	The worksheet has an orientation: portrait or landscape.
Headers and footers	Headers and footers enable to display the same type of information in the same place in all worksheets of the model in order to better manage the model and generated report. You can customize the information displayed in headers and footers of a worksheet.

Folders

A Folder is an element of the **Model Explorer** tree. It enables to group multiple worksheets.

A Folder can contain worksheets and/or other folders.

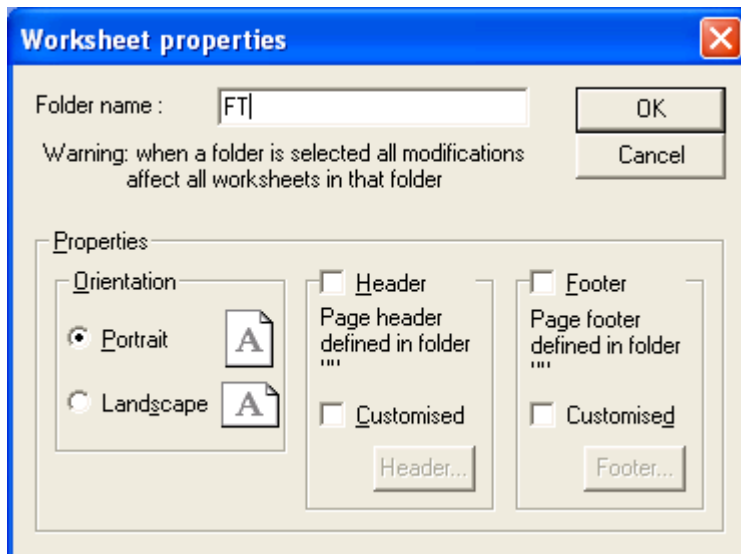
You can use folders to group worksheets by concerned systems.

Folder Properties

This topic describes the folder properties.

In Aralia Fault Tree Analyzer folders have the following properties:

- Name
- Orientation: portrait or landscape
- Header
- Footer.



:

- Folder properties affect the properties of all its worksheets.
- You can customize information displayed in the footers and headers of the worksheets in the folder.

- You can't add remarks to the folders properties.

Working with Folders


You can create, delete and manage folders.

- Launch Aralia Fault Tree Analyzer.
- Open or create a Fault Tree model.
- Open **Model Explorer** from the menu **Display > Model Explorer**.

Create a Folder

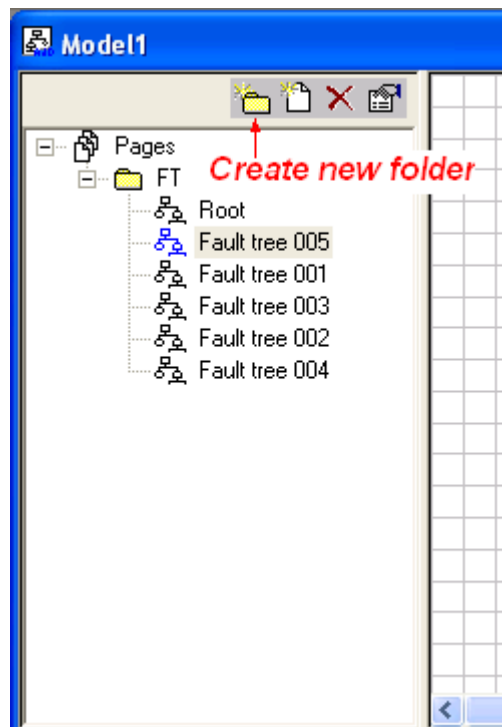
You can create a folder.

1. Select a folder in the **Model Explorer** tree, where you want to create a subfolder or select the root element **Pages**.
The selected element becomes active.

2. Click **New Folder**  in the **Model Explorer** toolbar.

 **Note:** You can also select **Display > Worksheet > New Folder**.

The new folder with a default name appears in the **Model Explorer** tree.




 **Note:** The default folder name is *Folder i*, where *i* is the folder number. You can rename the folder.

You can move worksheets in the created folder using drag-and-drop in the **Model Explorer** or create new worksheets in it.

Delete a Folder

You can delete a folder.

1. Select the folder in the **Model Explorer** to delete.
The folder becomes active.
2. Click **Delete**  in the **Model Explorer** toolbar.


 **Note:** You can also select **Display > Worksheet > Delete**.

The folder is deleted with all contained worksheets.

 **Important:** The folder is deleted without asking confirmation.

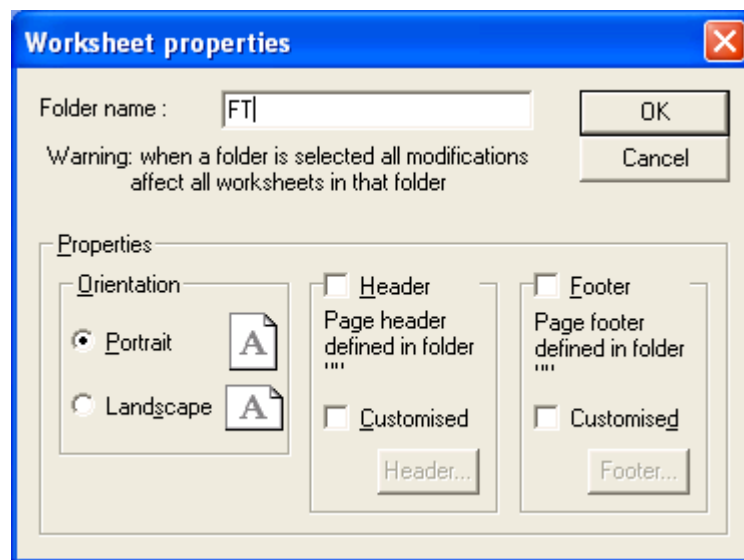
Edit Folder Properties

You can edit folder properties.


1. Select a folder in the **Model Explorer** tree.
The folder becomes active.
2. Click **Properties**  in the **Model Explorer** toolbar.

 **Note:** You can also select **Display > Worksheet > Properties**.

The **Folder properties** dialog box appears.




3. In the **Folder name** box, enter the folder name.
4. In the **Properties** area change the orientation of worksheets if necessary.

 **Note:** This modification will affect all worksheets in the current folder.


5. Select the **Header** check box.

A header and/or a footer is displayed in all worksheets in the current folder. The information displayed in the footer and in the header is the same as defined for the folder father or root element.

 **Note:** To customize the information displayed in the header and in the footer of the worksheets in the current folder, select the **Customised** check box and follow the instructions in [Customize Worksheet Headers and Footers](#) on page 13.

6. Click **OK**.

The properties of the selected folder are changed.

 **Note:** You can rename the folder following the task [Rename a Worksheet](#) on page 14.

Working with Worksheets


You can create, delete and edit worksheets.

- Launch Aralia Fault Tree Analyzer.
- Create a new model.
- Select **Display** > **Model Explorer** to open the **Model Explorer**.

Create a Worksheet

You can create a worksheet.

1. Select a folder where you want to place the new worksheet.

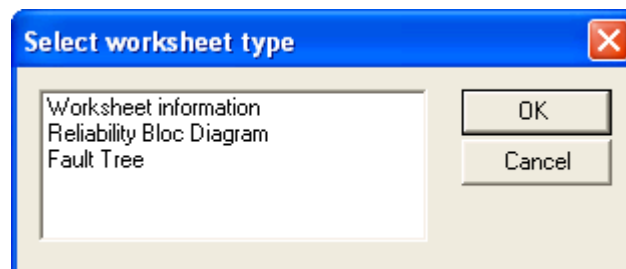
 **Note:** You can also select **Pages** to create the worksheet under the root element in the **Model Explorer** tree in the **Model Explorer**.

The selected element becomes active.

2. Click **New Worksheet**  in the **Model Explorer** toolbar.

 **Note:** You can also select **Display** > **Worksheet** > **New Worksheet**.

The **Select worksheet type** dialog box appears.



-
3. Select the worksheet type and click **OK**.

The new worksheet with the default name appears in the **Model Explorer** tree in the previously selected folder. The created worksheet becomes active.

:


- You can move worksheets in the **Model Explorer** tree using drag-and-drop.
- To rename the worksheet see [Rename a Worksheet](#) on page 14.


You can now create your Fault Tree or Reliability Block Diagram in the created worksheet or simply type text.

Delete a Selected Worksheet

You can delete a worksheet.

1. Select the worksheet to delete in the **Model Explorer**.
The worksheet becomes active.

 **Note:** You cannot select more than one worksheet at the same time.

2. Click **Delete**  in the **Model Explorer** toolbar.


 **Note:** You can also select **Display > Worksheet > Delete**.

 **Important:** The worksheet is deleted without asking confirmation from user.

The worksheet is removed from the model with all its contents and from the **Model Explorer** tree.

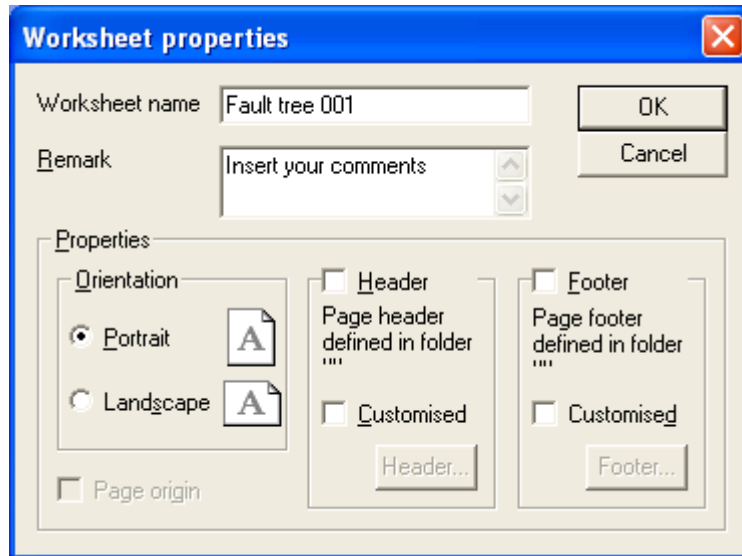
Edit Worksheet Properties

You can edit a worksheet.

1. Select the worksheet in the **Model Explorer** tree.
The worksheet becomes active.
2. Click **Properties**  in the **Model Explorer** toolbar.

 **Note:** You can also select **Display > Worksheet > Properties**.

The **Worksheet properties** dialog box appears.

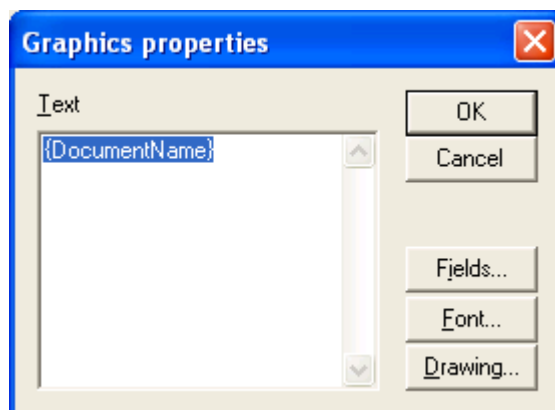


3. In the **Worksheet name** box, enter the new folder name.
4. In the **Remark** box, enter your comments.
5. In the **Properties/Orientation** area, set the worksheet orientation.
6. To insert a header and a footer in the worksheet, select the:
 - **Header** and **Footer** check boxes in the **Properties** area to insert the information defined for the folder of the current selected worksheet.
 - **Customised** check box to insert customized information in the footer and header of the selected worksheet.
7. Click **Ok** to save changes.
The worksheet has new properties.

Customize Worksheet Headers and Footers

You can customize the information displayed in the header and footer of the selected worksheet.

1. Select the **Customised** check box in the **Properties/Header** area in the **Worksheet properties** dialog box
The **Header** button becomes active.
2. Click **Header**.
The **Graphics properties** dialog box appears.



-
3. Click **Fields...** to choose fields to be displayed in the header or in the footer.

See [About Dynamic Fields](#) on page 129 to know more about fields.

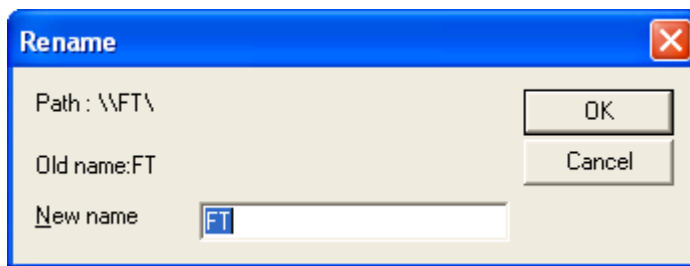
4. Click **Font...** and **Drawing...** to change the text style.

The selected information is displayed in the header and footer of each print page of the worksheet.

Rename a Worksheet

You can rename a worksheet.

1. Select the worksheet to rename in the **Model Explorer**.
In the **Model Explorer** The worksheet becomes active.
2. Select **Display > Worksheet > Rename**.
The **Rename** dialog box appears.



3. In the **New name** box, enter the new worksheet name.
4. Click **OK**.

You can also rename the worksheet using the **Properties**  command in the **Model Explorer** toolbar.

In the **Model Explorer** tree the name of the selected worksheet is changed.

Fault Trees and Reliability Block Diagrams

Describes how to work with Fault Trees and Reliability Block Diagrams.

[About Fault Trees](#) on page 15

[About Reliability Block Diagrams](#) on page 16

[About Fault Trees and Reliability Block Diagrams](#) on page 17

[Creating a Link Between Two Objects](#) on page 21

[Autoconnecting Objects](#) on page 21

[Creating a Fault Tree](#) on page 22

[Creating a Reliability Block Diagram](#) on page 67

[Common Cause Failure](#) on page 75

About Fault Trees

A Fault Tree (FT) is a structure that expresses a particular system failure mode in terms of combinations of component failure modes and operator actions.

The system failure mode to be considered is represented by the Top Event and the Fault Tree is developed in branches below this event, showing its causes. The events represented in the tree are continually redefined in branches to specify the lower causes. The development of the Fault Tree is terminated when component failure events, named Basic Events, are encountered, or when the causes are not developed (events to be developed).

Analysis of the Fault Tree can be carried by providing information on the Basic Event probability distributions.

For a given system, several Fault Trees can be built during the safety assessment of the system. Each Fault Tree considers only one of the many possible system failure modes.

For a system failure mode, the top event leads to the development of a Fault Tree to model causes of this situation. The top event corresponds to the Unexpected Event of the system. It is developed until basic component failures are encountered.

An example of a Fault Tree created with Aralia Fault Tree Analyzer is given below:



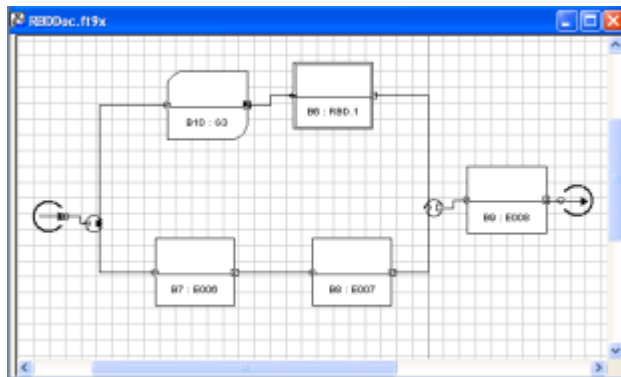
A Fault Tree structure contains two basic elements:

- [About Gates](#) on page 23
- [About Events](#) on page 22


About Reliability Block Diagrams

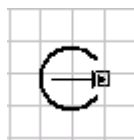
A Reliability Block Diagram (RBD) performs the system reliability and availability analyses on the large and complex systems using block diagrams to show the network relationships.

The structure of the reliability block diagram defines the logical interaction of the failures within a system that are required to sustain system operation.

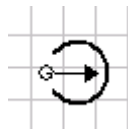


The rational course of a RBD stems from an input node located at the left side of the diagram. The input node flows to arrangements of series or parallel blocks that conclude to the output node at the right side of the diagram. A diagram should only contain one input and one output node.

The worksheet of type Reliability Block Diagram is represented by the icon  in the **Model Explorer**.



Note: The symbol represents the input of the Reliability Block Diagram, and the symbol



represents its output. To be able to perform calculations input and output of the diagram should be connected to other RBD elements.

The RBD system is connected by a parallel or series configuration. A parallel connection is used to show redundancy. A system can contain a series, parallel, or combination of series and parallel connections to make up the network.

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

A Reliability Block Diagrams contains the following elements:

- Input and Output;
- Elementary blocks (see [Creating an Elementary Block](#) on page 67);
- Hierarchical blocks (see [Creating a Hierarchical Block](#) on page 68);
- Not elementary blocks (see [Creating a Not Elementary Block](#) on page 69);
- House event blocks (see [Creating a House Event Block](#) on page 68);
- Connectors (See [Connecting Blocks](#) on page 70).

About Fault Trees and Reliability Block Diagrams

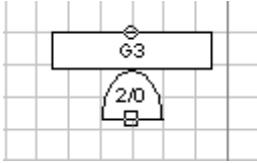
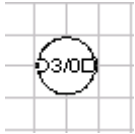
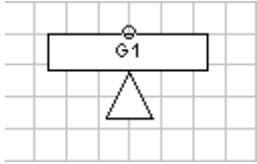
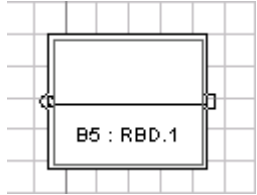
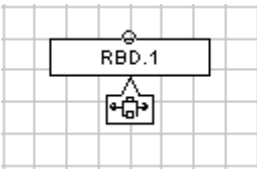
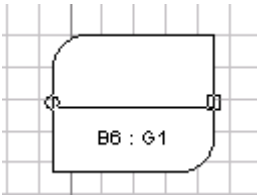
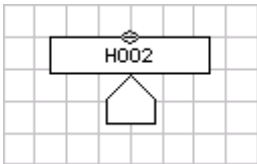
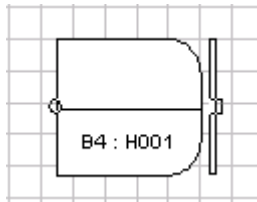
This page describes different elements of Fault Trees and Reliability Block Diagrams and the relation between these two formalisms.

Fault Tree and Reliability Block Diagrams Elements

This topic describes different elements in Fault Trees and Reliability Block Diagrams.

Fault Trees and Reliability Block Diagrams are two common formalism used to perform system safety analysis. Aralia Fault Tree Analyzer allows you to use both formalisms and also to mix them in the same model. The concepts used in the both formalisms are quite similar but have different graphical representations. The summary of these concepts is given in the following table:

Fault Tree concepts	Representation	Reliability Block Diagram concepts	Representation
Basic event		Elementaty block	

Fault Tree concepts	Representation	Reliability Block Diagram concepts	Representation
Gates		Connectors	
Transfer gate		Hierarchical block	
Not elementary event		Not elementary block	
House event		House event block	

About Basic Events and Elementary Blocks

This topic describes basic events and elementary blocks.

In Aralia Fault Tree Analyzer basic events and elementary blocks are managed in the same way but have different graphical representations. See [About Basic Events](#) on page 29 and related topics to know more about elementary blocks.

About Gates and Connectors

This topic describes gates and connectors.

A gate shows the relationship between the events involved in the occurrence of a higher level event. A gate represents a Boolean operator that takes as input the occurrences of several events and returns the occurrence of a higher level event.

A connector links blocks.

For more information, see [About Gates](#) on page 23.

About Transfer Gates and Hierarchical Blocks

This topic describes transfer gates and hierarchical blocks.

Transfer gate is used to indicate a transfer to a sub tree. It enables to split a Fault Tree into several subtrees organized in different worksheets.

In the same way a hierarchical block is used to indicate that the structure of the current block is detailed in the another worksheet.

For more information, see [About Transfer Gates](#) on page 51.

About Not Elementary Events and Blocks

This topic describes not elementary events and blocks.

A not elementary event is a Reliability Block Diagram used as a leaf of a Fault Tree.

A not elementary block is a Fault Tree used as a block in the Reliability Block Diagram.

For more information, see [Creating a Not Elementary Event](#) on page 65 and [Creating a Not Elementary Block](#) on page 69.

About House Event and House Event Blocks

This topic describes house event and house event blocks.

House event is used to model two different states of a Fault Tree model with a specific event which occurs or does not occur. House event has a probability of occurrence equal to one or zero. It provides a very effective means of turning branches of Fault Tree on and off. Hence, a same Fault Tree can be used to model several scenarios.

In the same way the house event block is used as a switch in the Reliability Block Diagram.

For more information, see [About House Event](#) on page 42.

Relation Between Fault Trees and Reliability Block Diagrams

This topic describes relation between fault trees and reliability block diagrams.

Fault Trees and Reliability Blocks Diagrams are two ways to represent system failures. The two approach are equivalent.

Two blocks connected in series in the RBD are equivalent to an OR gate between two basic events. See the following figures:

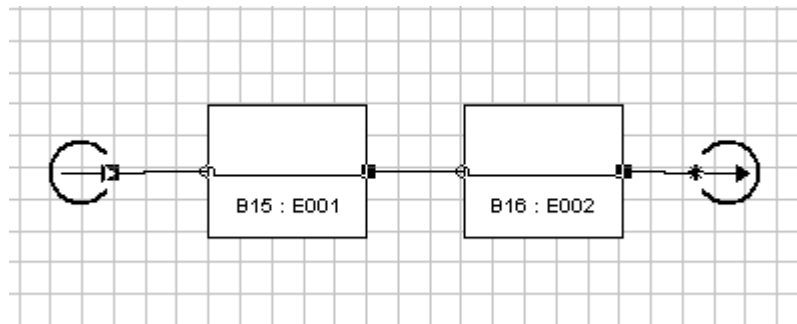


Figure 1: Blocks connected in series

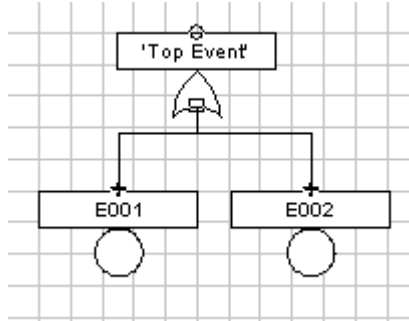


Figure 2: OR gate between two basic events

Two blocks connected in parallel are equivalent to the AND Gate between two basic events in the Fault Tree. See the following figures:

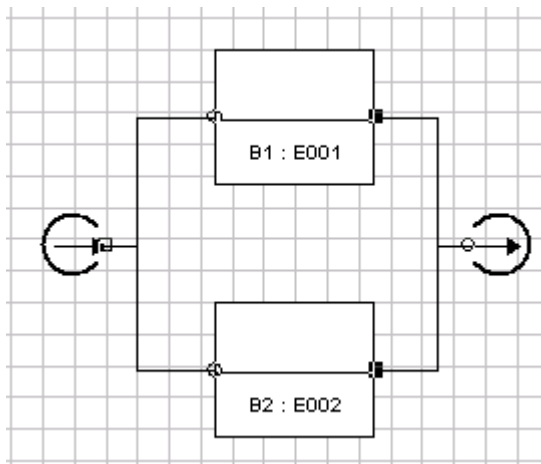


Figure 3: Blocks connected in parallel

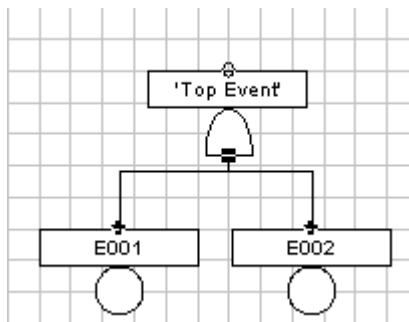


Figure 4: AND Gate between two basic events

It is also possible to combine the two approaches in the same model. To use a Fault Tree as a block in the Reliability Block Diagram or a Reliability Block Diagram as a basic event of a Fault Tree see:

- [Creating a Not Elementary Event](#) on page 65
- [Creating a Not Elementary Block](#) on page 69

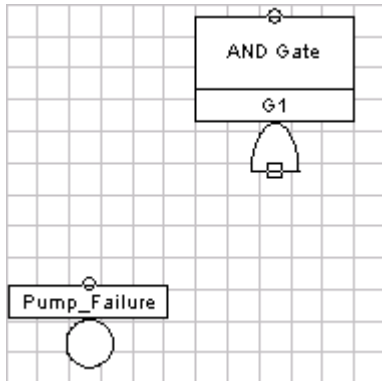
Creating a Link Between Two Objects

You can create a link between two objects.


For example, between two gates or between a basic event and a gate.

- Create a basic event.
- Create an AND gate.

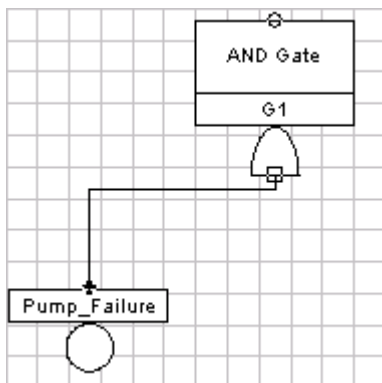
1. Open the model.



2. Click the connection dot of the first object to create a link between two objects.
A line starting from the object appears.
3. Drag the line to the middle of the second object.

 **Note:** You can create single or multiple connexions between objects according to the object type (type of gate or event).


The link is created.



Autoconnecting Objects

You can create objects automatically connected to the selected gate.

- Open a Fault Tree model.
- Create a gate.

1. Select a gate.
2. Click **Autoconnect**  in the **Graphics** toolbar.

 **Note:** You can also select **Drawing** > **Autoconnect** .

3. Create a basic event or another gate.
The created basic event or gate will be automatically connected to the selected gate.

All objects created after will be automatically connected to the selected gate.

Creating a Fault Tree

This section describes how to create a Fault Tree model with Aralia Fault Tree Analyzer.

[About Events](#) on page 22

[Working with Gates](#) on page 23

[Working with Basic Events](#) on page 28

[Working with House Events](#) on page 41

[Working with Intermediate Events](#) on page 48

[Working with Transfer Gates](#) on page 51

[Creating a Not Elementary Event](#) on page 65

About Events

This page describes different types of events used to create Fault Trees.

Event	Definition
Top event	The top event corresponds to the Unexpected Event of the system. It is developed until basic component failures are encountered. See About Top Events on page 49.
Basic event	Basic events are the lowest level events. They indicate the limit of a Fault Tree resolution. See About Basic Events on page 29.
Intermediate event	An intermediate event is an event that depends on several basic events or other intermediate events. The top event is a particular case of an intermediate event. See About Intermediate Events on page 49.
House event	House event is used to model two different 'states' of a Fault Tree model with a specific event which occurs or does not occur. House event has a probability of occurrence equal to 1 or 0. See About House Event on page 42.

Working with Gates

This section describes how to create and edit different types of gates.

[About Gates](#) on page 23

[Creating a Gate](#) on page 26

[Editing a Gate](#) on page 26

About Gates

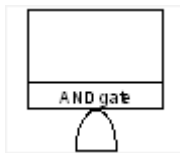
A gate shows the relationship between the events involved in the occurrence of a higher level event.


A gate represents a Boolean operator that takes as input the occurrences of several events and returns the occurrence of a higher level event. This section describes different types of gates available in Aralia Fault Tree Analyzer.

AND Gate

The output event of an AND gate occurs if all input events occur.

An AND gate is represented by the following figure:

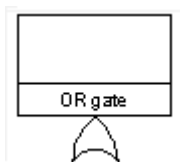



 **Note:** The number of input events of an AND gate should be greater than 2.

OR Gate

The output event of an OR gate occurs if at least one of the input events occurs.

An OR gate is represented by the following figure:

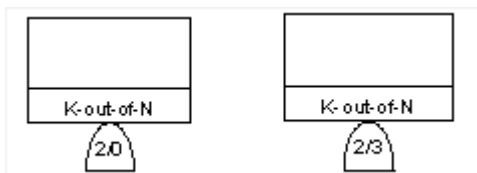


 **Note:** The number of input events of an OR gate should be greater than 2.

K out of N Gate

The output event of a K out of N gate occurs if at least K input events occur. This gate is also known as a Vote gate.

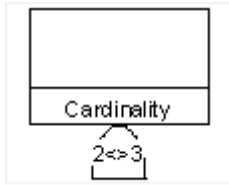
A K out of N gate is represented by the following figure:




Cardinality Gate

The output event of a cardinality gate occurs if at least K input events and at most N input events occur.

A Cardinality gate is represented by the following figure:

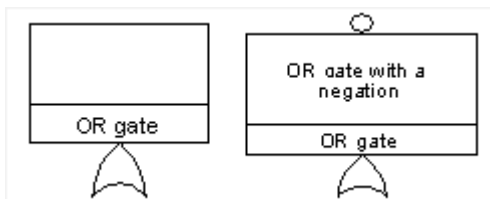



 **Note:** User can define K and N values.

Negation

It is possible to add a negation logical operator on events and gates. An AND gate with a negation becomes a NAND gate. An OR gate with a negation becomes a NOR gate.

A negation on an object is represented by a circle on the top middle of the object. The following example shows the difference between OR and NOR gates:

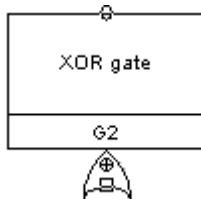



 **Important:** A negation can make a Fault Tree no-coherent!

XOR Gate

The output event of a XOR Gate occurs if only one of two input events occurs.

A XOR gate is represented by the following figure:



 **Important:** A XOR gate can make a Fault Tree no-coherent!

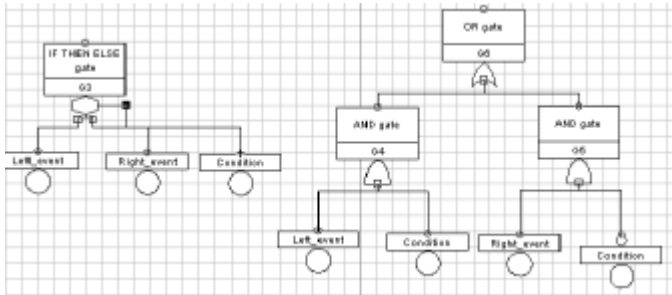
If then Else Gate

The output event of an If Then Else Gate is its left input event if the the event Condition occurs, otherwise the output event is its right input event.

This gate is used to represent the following structure: *if event1 then event2 else event3*. This gate was introduced to represent connectors with two inputs.

Note: The events *event1*, *event2* and *event3* may be sub fault trees.

The If Then Else Gate can be always represented by a combination of AND, OR and NEGATION gates.



ImPLY Gate

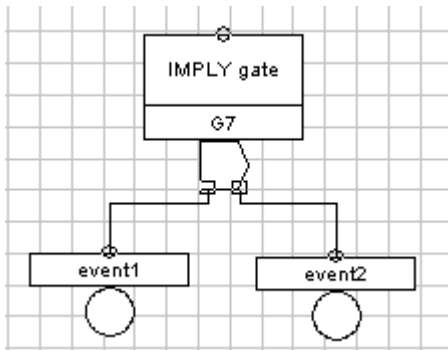
This section describes the imply gate.

An ImPLY gate is used to represent the following structure: event1 implies event2.

The output of this gate is

event1	event2	output event
0	0	1
0	1	1
1	0	0
1	1	1

An ImPLY gate is represented by the following figure:



Note: The order of the input events is very important. It is always the left input event (*event1* on the figure above) that implies the right input event (*event2* on the figure above).

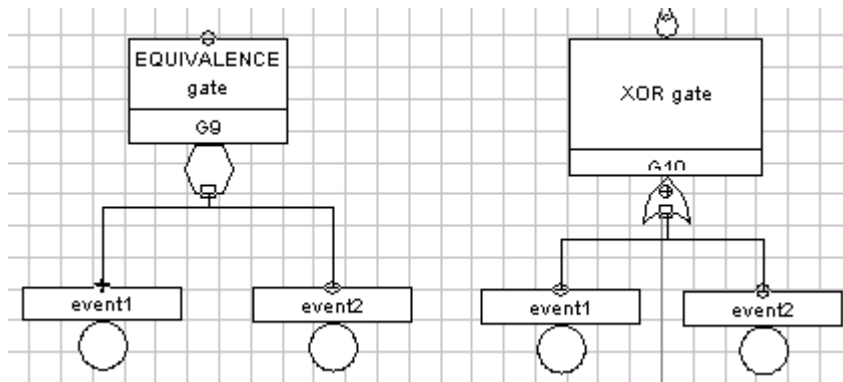
Note: The number of input events should be equal to 2.


Important: An ImPLY gate may make a Fault Tree no-coherent!

Equivalence Gate

The output event of an equivalence gate occurs if both two input events occur or don't occur.

An equivalence gate can be represented by a XOR and a negation gates. See the following figure:




 **Note:** The number of input events should be equal to 2.

Creating a Gate

You can create a gate.

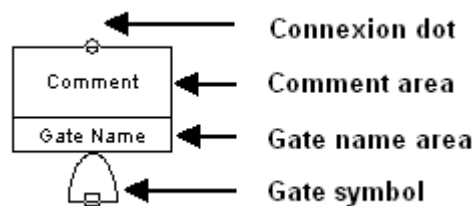
- Launch Aralia Fault Tree Analyzer
- Open an empty model.

1. Select a gate you want to create in the **Graphics** toolbar.

 **Note:** **Graphics** toolbar contains only the most frequently used gates. All types of gates are available from the menu **FT > Fault Tree Logic**

2. Click in the worksheet to place the selected gate.

The default gate name is Gi, where i is a number of the gate. You can change the gate name and add a comment in the comment area. See the figure below:



3. Right-click the **Comment** area to add a comment.
4. Right-click the **Gate name** area to change the gate name.


Editing a Gate

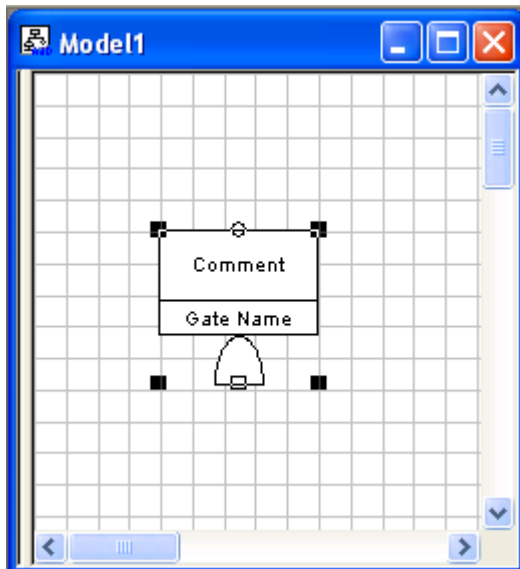
You can edit a gate.

Create a gate.

Select a Gate

You can select a gate.


1. Click **Select**  in the **Graphic** toolbar.
2. Click in the middle of the gate to select it.
Small black squares (handles) appear at the corners of the object indicating the selected object.




Select Multiple Gates

You can select multiple gates.

1. To select multiple gates you can
 - Press and hold **Shift** while selecting the gates.
 - Define a selection area with the mouse.

 **Tip:** To select all objects in the current worksheet select **Edit > Select All** or press **CTRL + A**.

2. Click **Select**  in the **Graphic** toolbar to define a selection area.
3. Drag and drop in the current worksheet to define a square area.
All objects contained in this area are selected.

Move a Gate

You can move a gate.

1. Select a gate or multiple gates.
2. Drag and drop the selected objects in the worksheet.

Resize a Gate

You can resize a gate.

1. Select a gate to resize.
The sizing handles become visible.

-
2. Drag these handles to change the size of the gate.

Delete a Gate

You can delete a gate.

1. Select a gate or multiple gates.
2. Delete the selected objects:
 - Press **Delete**.
 - Select **Edit > Delete**.

The selected objects are deleted from the model.

Duplicate a Gate

You can duplicate a selected object in the same worksheet.

1. Select a gate or multiple gates.
2. Select **Edit > Duplicate**.

The duplicated objects appear in the same worksheet.

Copy / Paste a Gate

You can copy or cut a selected gate and to paste it in the current worksheet or another worksheet of the current model.

1. Select a gate or multiple gates.
2. Select **Edit > Copy**.

 **Note:** You can select **Edit > Cut** to cut the gate.

3. Open another worksheet or stay in the current worksheet.
4. Select **Edit > Paste**.

The gates appear in the worksheet.

Convert Gates

You can transform automatically a gate of one type to a gate of another type.

This function enables to convert:

- AND gate to OR gate and vice versa.
- AND gate to K-out-of-N gate and vice versa.
- K-out-of-N gate to CARDINALITY gate and vice versa.

1. Select a gate in the Fault Tree.
2. Select **FT > Replace > conversion command**.
The selected gate is replaced by another one.

Working with Basic Events

This section describes how to create and edit basic events.

[About Basic Events](#) on page 29

[Creating a Basic Event](#) on page 29

[Creating a Basic Event with Basic Event Manager](#) on page 30

[Editing a Basic Event](#) on page 33

[Inserting Basic Events in the Fault Tree Model](#) on page 37

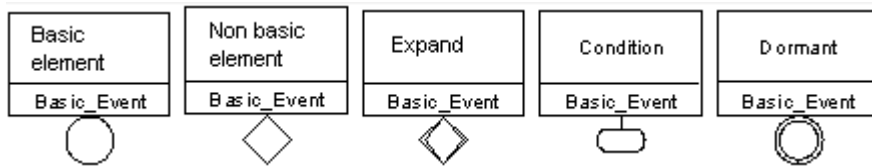
About Basic Events

Basic event is the lowest level event. It indicates the limit of a Fault Tree resolution.

Basic event is characterized by the probability distribution of its occurrence. These probability distributions are used to perform quantitative analysis, i.e. to compute the probability of the unexpected event (top event) or of the intermediate events.

It is unnecessary to develop Fault Tree branches beyond the events for which data are available.

Traditional Fault Trees use different shapes to represent basic events. Unlike gates, however, different basic events in a Fault Tree are not treated differently from an analytical perspective. The event shapes are used to convey additional information visually. The following symbols are used to represent basic events:



The meaning of each symbol is explained in the following table:

Basic event symbols	
Basic element	Event that does not need further development.
Non basic element	Event that cannot be considered as elementary but its causes will not be developed.
Expand	Event that should be developed.
Condition	Event used in the gate IfThenElse as condition event.
Dormant	Event that describes failures of a stanby component that can occur if the main system is under maintenance or failed.

Creating a Basic Event

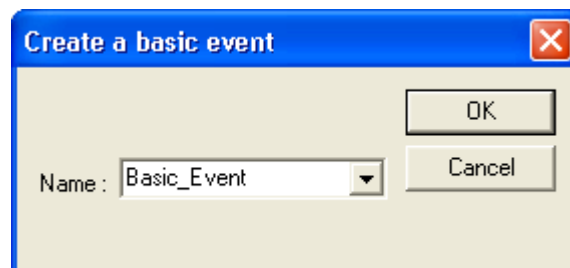
You can create a basic event.

Launch Aralia Fault Tree Analyzer and open a Fault Tree model (possibly empty).


1. Click **New Basic Event**  in the **Graphic** toolbar.

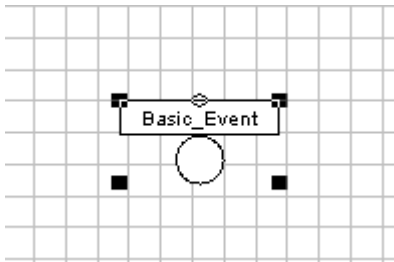
 **Note:** You can press **CTRL+SHIFT+E**.

The **Create a basic event** dialog box appears.



-
2. In the **Name** box, enter a name for the new basic event.
 3. Click **OK**.
 4. Click in the worksheet to insert the basic event in the model.


 **Note:** The new Basic Event is created with default parameters. Open **Basic Event Manager** to edit parameters: distribution, symbol, attributes.



Creating a Basic Event with Basic Event Manager

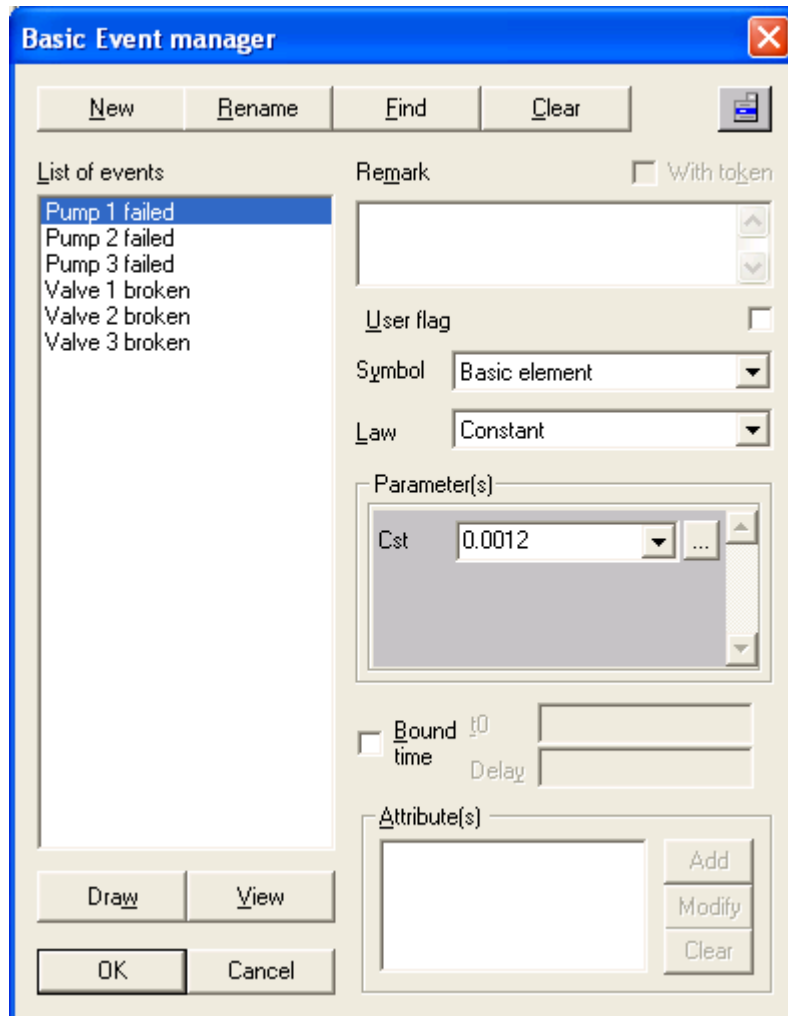
You can create basic events using **Basic Event Manager** dialog window.

- Launch Aralia Fault Tree Analyzer.
- Create or open an existing Fault Tree model.

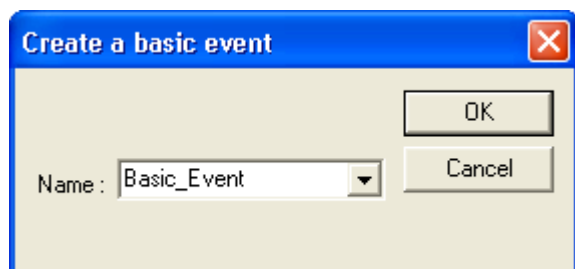
1. Click **Basic Event Manager...**  in the **Graphic** toolbar.

 **Note:** You can select **Data > Basic Event Manager...** or press **CTRL+E**.

The **Basic Event Manager** dialog box appears.



2. Click **New** to create a new basic event.
The **Create a basic event** dialog box appears.



3. In the **Name** box, enter a name of the basic event.
4. Click **OK**.
The new basic event appears in the **List of basic events** dialog box.

Basic Event manager

New Rename Find Clear

List of events

- Basic Event
- Pump 1 failed
- Pump 2 failed
- Pump 3 failed
- Valve 1 broken
- Valve 2 broken
- Valve 3 broken

Remark

☐ With token

User flag ☐

Symbol Basic element

Law Constant

Parameter(s)

Cst 0.01

☐ Bound time

t0

Delay

Attribute(s)

Add

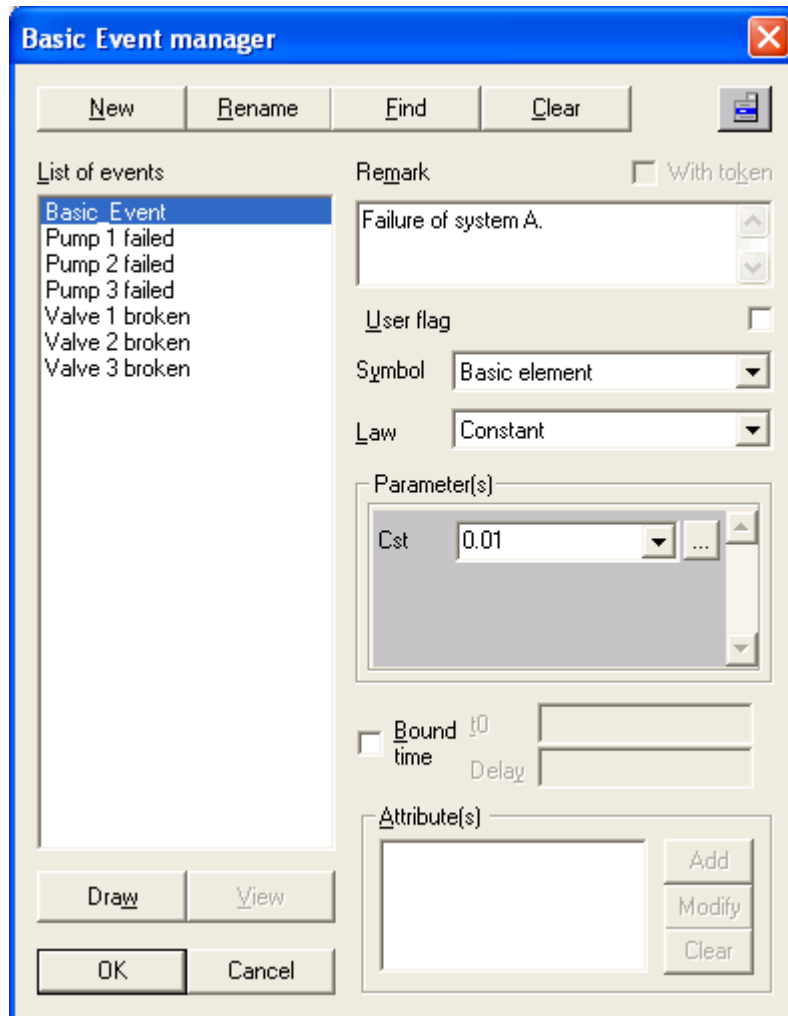
Modify

Clear


Draw View

OK Cancel

5. In the **Remark** area, add comment.



6. In the **Symbol** box, choose the symbol of the basic event.
See [About Basic Events](#) on page 29 to know more about symbols.
7. Associate a probability distribution with a basic event:
 - a) In the **Law** box, select the probability distribution of the basic event from the available list.
 - b) In the **Parameter(s)** area, enter the values of probability distribution parameters.
8. Click **OK**.

 **Note:** You can also add attributes to the basic event if they were previously defined (see [Creating an Attribute](#) on page 91).

The new basic event with its properties has been created.

Editing a Basic Event

You can rename, delete basic events and modify basic events properties.


You can edit basic events in the **Basic Event Manager** dialog box available from the **Data** menu.

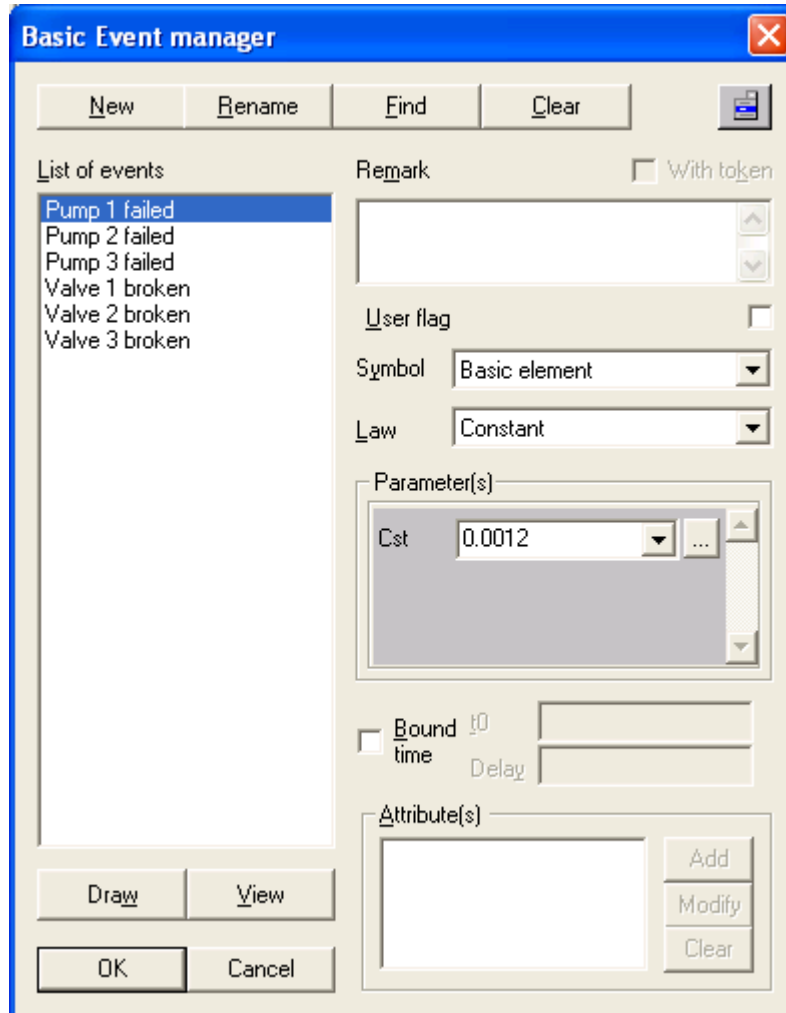
Create a basic event.

Rename a Basic Event

You can rename a basic event.

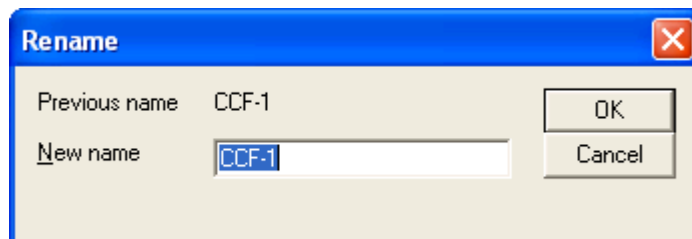
1. Select a basic event in the worksheet and right-click to open **Basic Event Manager** dialog box.

 **Note:** You can open **Basic Event Manager** dialog box and select a basic event in the **List of basic events** dialog box.



The **Basic Event manager** dialog box is shown. It has a title bar with a close button. Below the title bar are buttons for **New**, **Rename**, **Find**, and **Clear**, along with a file icon. The main area is divided into two panes. The left pane, titled **List of events**, contains a list of events: **Pump 1 failed** (selected), **Pump 2 failed**, **Pump 3 failed**, **Valve 1 broken**, **Valve 2 broken**, and **Valve 3 broken**. Below this list are **Draw** and **View** buttons. The right pane, titled **Remark**, has a **With token** checkbox. Below it are fields for **User flag** (checkbox), **Symbol** (dropdown menu showing **Basic element**), and **Law** (dropdown menu showing **Constant**). A **Parameter(s)** section contains a table with one row: **Cst** and **0.0012**. Below this are **Bound time** (checkbox) and **Delay** (text field). At the bottom right is an **Attribute(s)** section with an empty text area and **Add**, **Modify**, and **Clear** buttons. At the bottom left are **OK** and **Cancel** buttons.

2. Click **Rename**.
The **Rename** dialog box appears.



The **Rename** dialog box is shown. It has a title bar with a close button. The main area has two labels: **Previous name** and **New name**. The **Previous name** field contains the text **CCF-1**. The **New name** field contains the text **CCF-1**. To the right of these fields are **OK** and **Cancel** buttons.

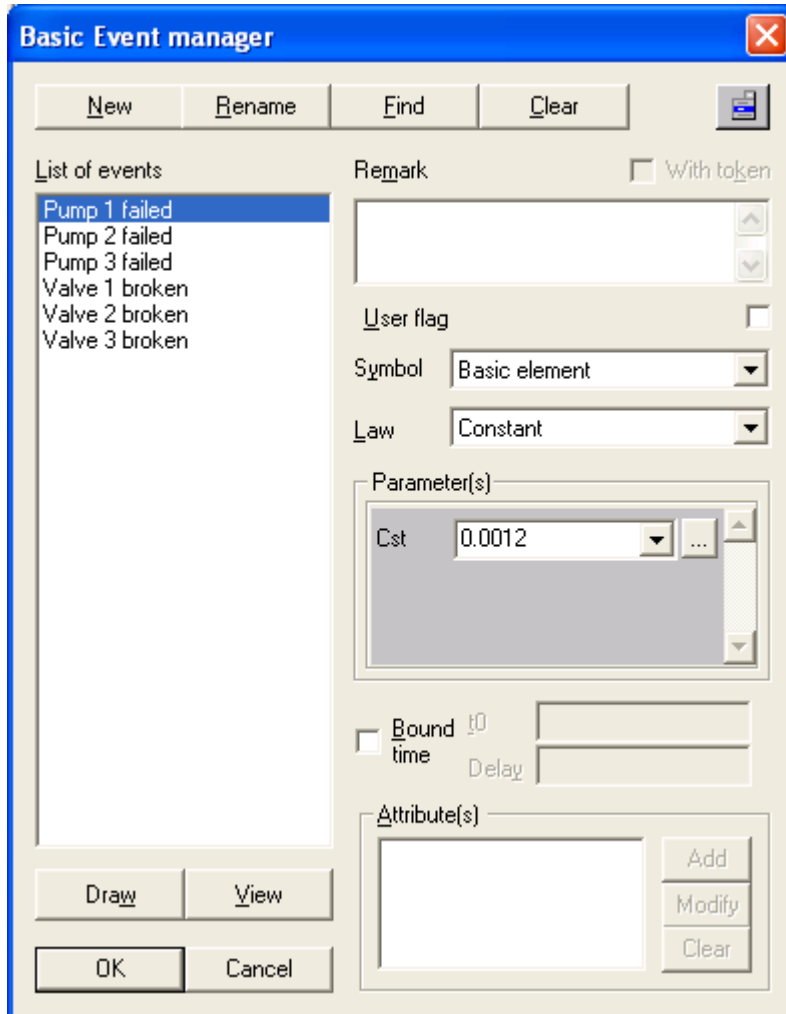
3. In the **New name** box, enter a new name.
4. Click **OK**.
The selected basic event has been renamed.

You can see your modifications in the **List of basic events** box.

Delete Basic Events

You can delete a basic event.

1. Open the **Basic Event Manager** dialog box.



2. Select basic events in the **List of basic events** box.

 **Tip:** Use **CTRL** or **SHIFT** to select several basic events.

The selected basic events are marked in blue.

3. Click **Clear**.
The **Confirmation request** dialog box appears.
4. Click **Yes**.

-
5. Click **OK** to close the **Basic Event Manager** dialog window.

The selected basic events are removed from the **List of basic events** dialog box and from the Fault Tree model.


Delete Instances of a Basic Event

You can only delete an instance of a basic event in the current Fault Tree model without deleting the basic event itself.


1. Select a basic event graphical representation in the current Fault Tree model.

 **Note:** You can select several basic events at the same time.

2. Select **Edit > Delete**.

 **Note:** You can press **Delete**.

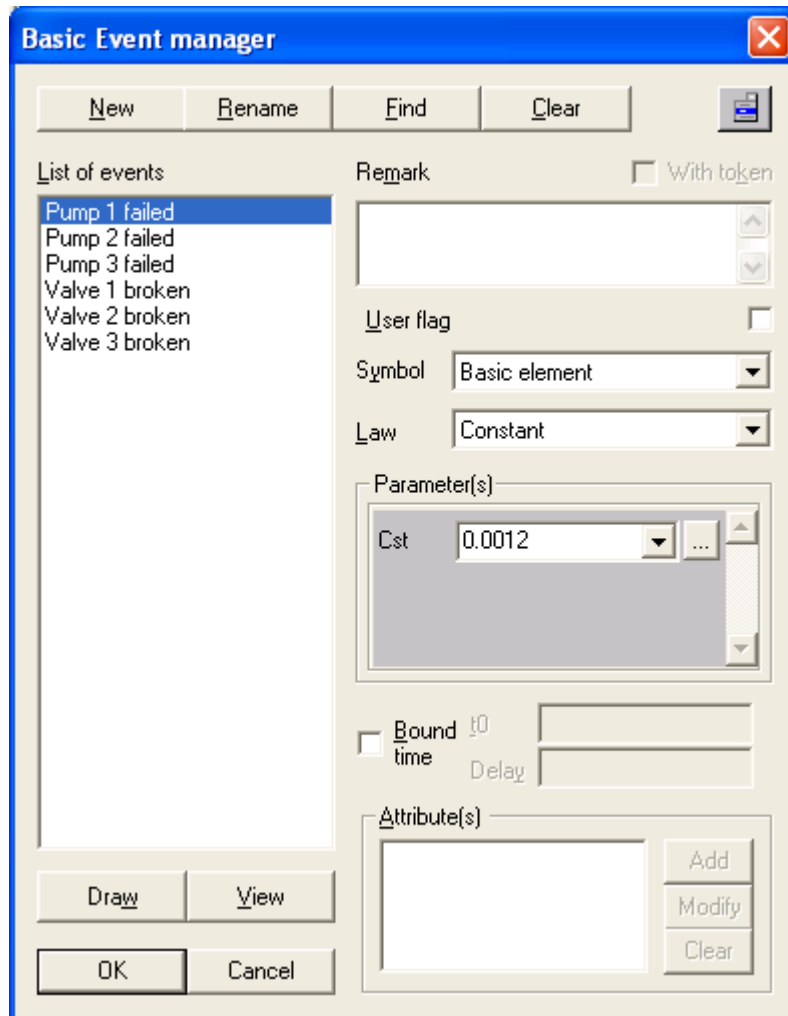
The selected instance of basic event is removed from the Fault Tree model.

 **Note:** The selected basic event is not removed from the **List of basic events** box in the **Basic Event Manager** dialog box. Only its instance is removed from the Fault Tree model.

Modify Basic Event Probability Distribution

You can modify basic events probability distribution.

1. Open the **Basic Event Manager** dialog box.



2. Select a basic event in the **List of basic events** dialog box.
The selected basic event is marked in blue.
3. In the **Law** box, choose another probability distribution.
4. If necessary, change parameters in the **Parameter(s)** area.
5. Click **OK** to save changes and close **Basic Event Manager** dialog box.

The modifications are saved.

Inserting Basic Events in the Fault Tree Model

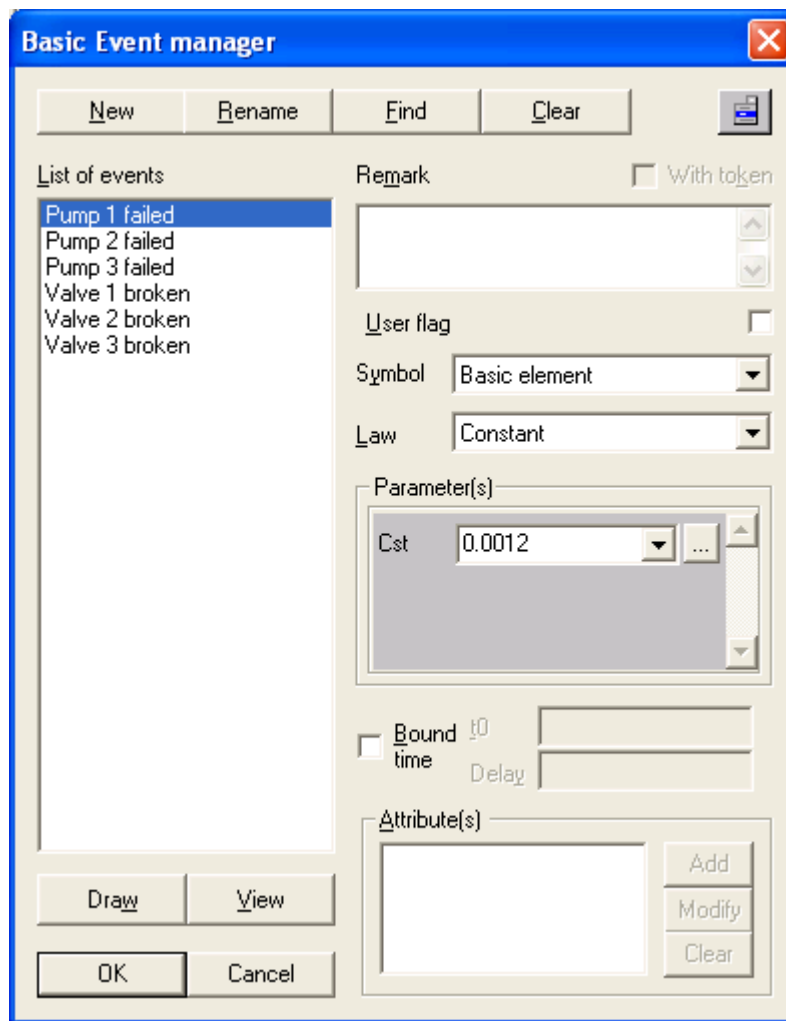
You can insert existing basic events in the current Fault Tree model.

- Create a basic event;
- Create a gate.

1. Click **Basic Event Manager...**  in the **Graphic** toolbar.

 **Note:** You can select **Data > Basic Event Manager...** or press **CTRL+E**.

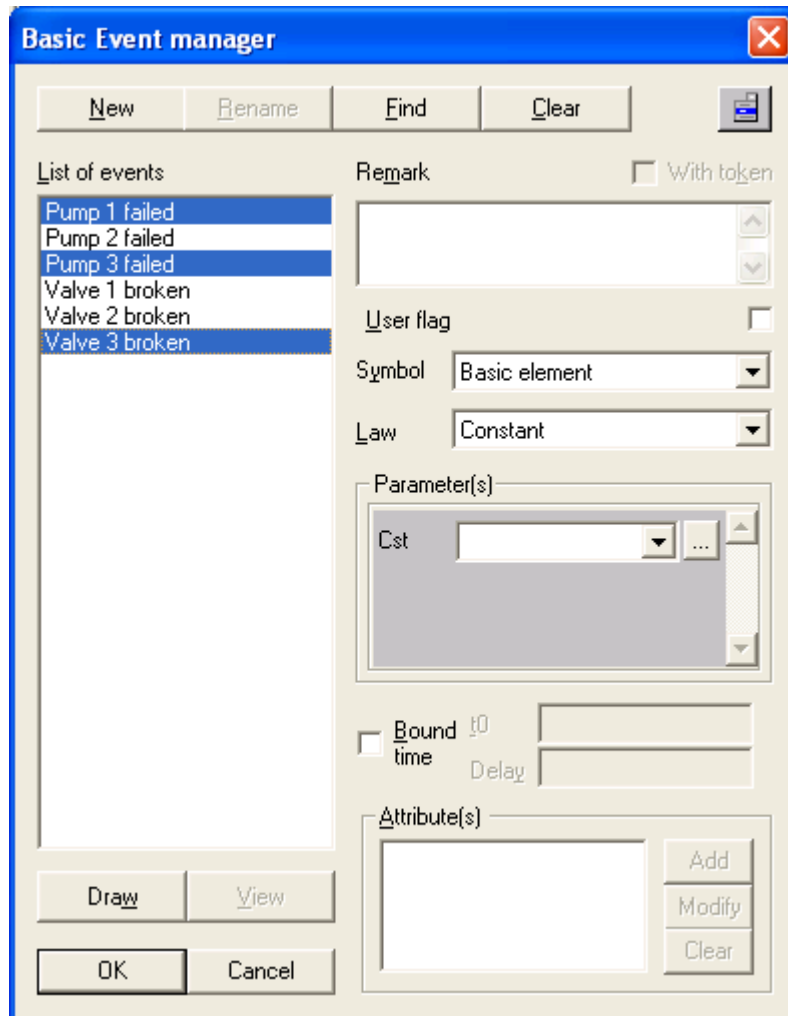
The **Basic Event Manager** dialog box appears.



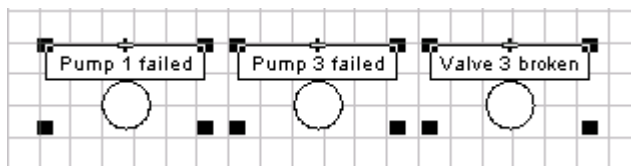
2. Select basic events from the **List of events** box.

 **Tip:** Use **CTRL** or **SHIFT** to select several basic events at the same time.

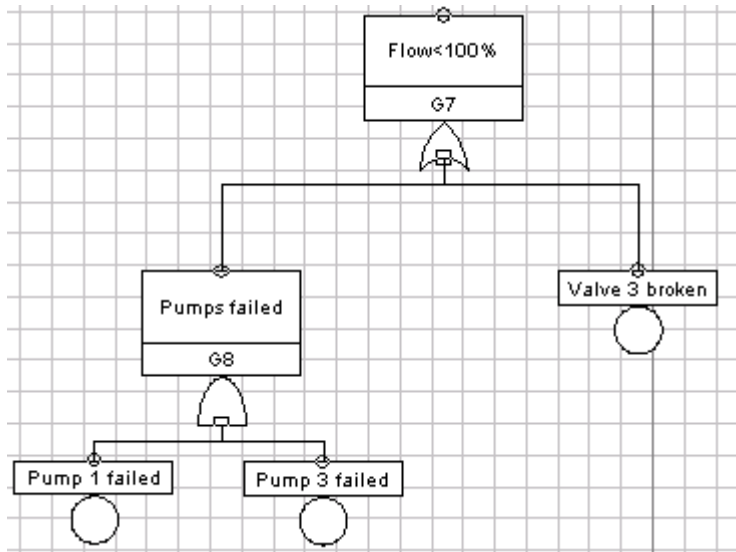
The selected basic events are marked in blue.



3. Click **Draw**.
4. Click **OK**.
The selected basic events appear in the current worksheet.
5. Click in the worksheet to place the selected basic events.



6. Connect basic events to the Fault Tree.



:

- A basic event defined in the **List of events** box of the **Basic Event Manager** dialog box can be inserted several times in the current Fault Tree model (concept of instance).
- You can move and select basic events graphical representations like gates.

Viewing Instances of a Basic Event in the Current Fault Tree Model

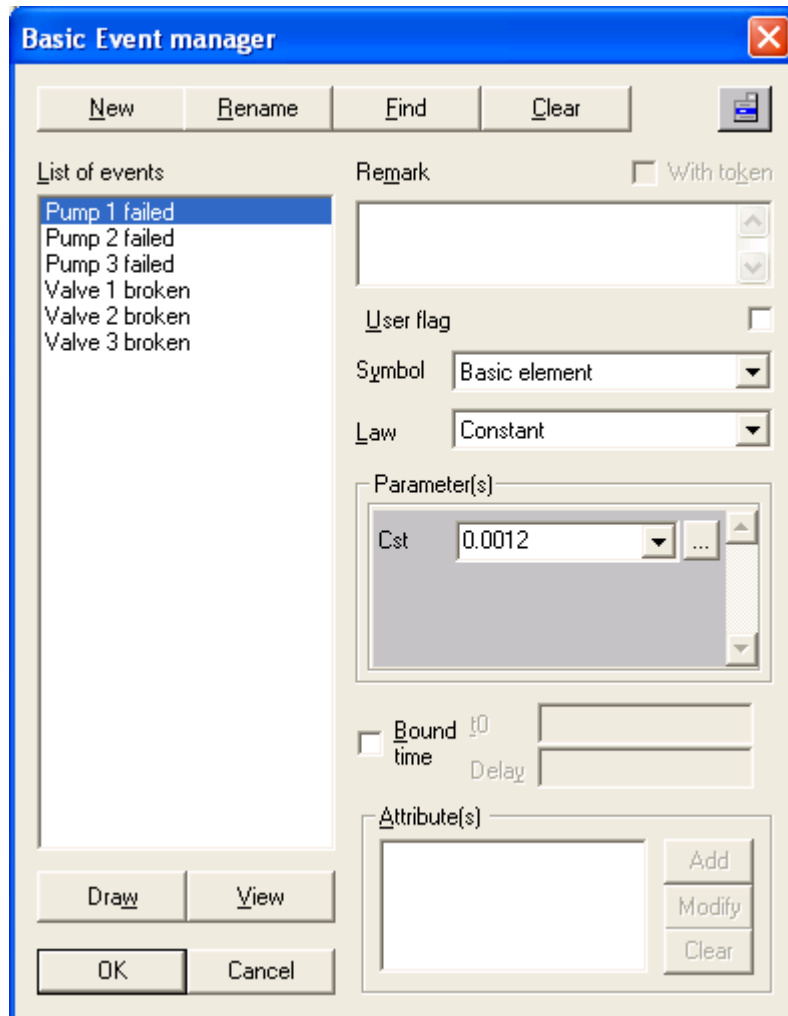
You can view the instances of a basic event in the current Fault Tree model.

- Create basic events.
- Create a Fault Tree using previously created basic events.

1. Click **Basic Event Manager...**  in the **Graphic** toolbar.

 **Note:** You can select **Data > Basic Event Manager...** or press **CTRL+E**.

The **Basic Event Manager** dialog box appears.




2. Select a basic event in the **List of events** box.

 **Note:** To be able to view the instances only one basic event should be selected.

3. Click **View**.

The graphical representation of the selected basic event becomes selected in the current worksheet.

 **Note:** You can click **View** several times to view all worksheets where appears the selected basic event.

You can view all places where the selected basic event is used in the current Fault Tree model.

Working with House Events

This section describes how to use house events in Aralia Fault Tree Analyzer.

[About House Event](#) on page 42

[Creating a House Event](#) on page 42

[Editing a House Event](#) on page 44

[Inserting House Events in the Current Model](#) on page 46

About House Event

House event is used to model two different states of a Fault Tree model with a specific event which occurs or does not occur.

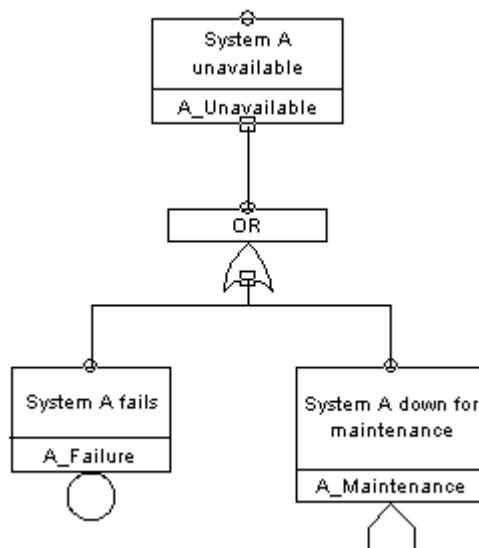
House event has a probability of occurrence equal to one or zero. It provides a very effective means of turning branches of Fault Tree on and off. Hence, a same Fault Tree can be used to model several scenarios.

House Event representation:



The use of House event in the Fault Tree model is illustrated by the following example.

Example of House event use:



The House event **A_Maintenance** represents the occurrence of maintenance action. Hence, the unavailability of the System A can be explained either by the system failure or by the system maintenance. To determine the effect of shutting down System A for maintenance on the whole system, the House Event is then turned on. The same Fault Tree can be used to model different scenarios.

Creating a House Event

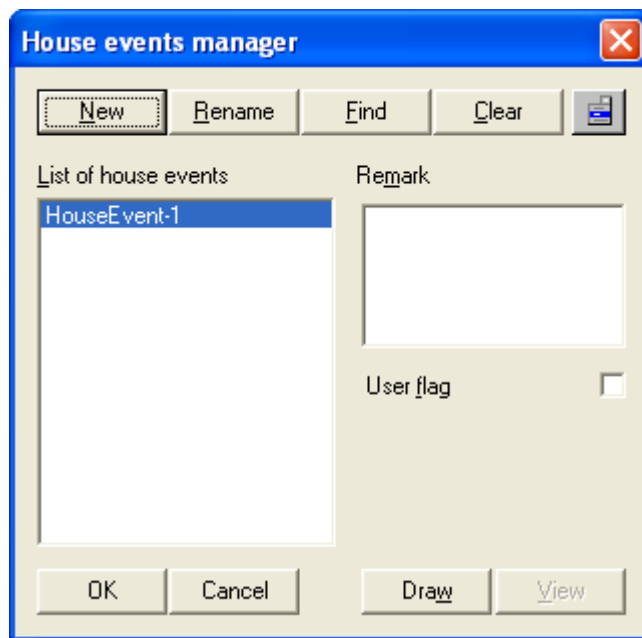
You can create a house event.

- Launch Aralia Fault Tree Analyzer.
- Create or open possibly empty Fault Tree model.

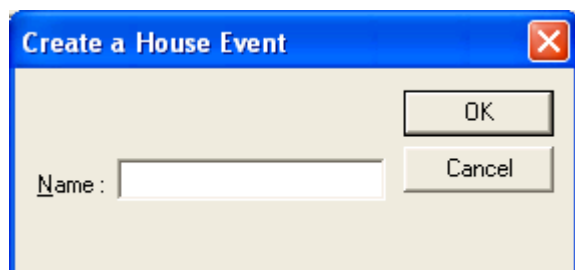
1. Click **House Event Manager...**  in the **Graphic** toolbar.

 **Note:** You can select **Data > House Event Manager...** or press **CTRL+H**.

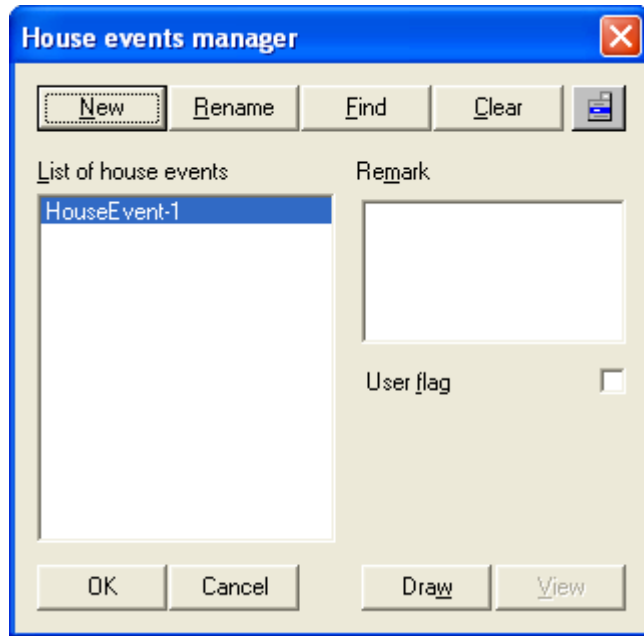
The **House Event Manager** dialog box appears.



2. Click **New** to create a new house event.
The **Create a House Event** dialog box appears.



3. In the **Name** box, enter a house event name.
4. Click **OK**.
The new house event appears in the **List of house events** box.



5. Draw a house event in the current worksheet:
 - a) Select a house event in the **List of house events**.
 - b) Click **Draw**.

The selected house event appears in the current worksheet.

The new house event is created in the **List of house events** and appears in the current worksheet.

:

- You can add comments to the house event in the **Remark** box.
- Use **Find** to search house events by name or comment keywords.

Editing a House Event


You can rename and delete a house event.

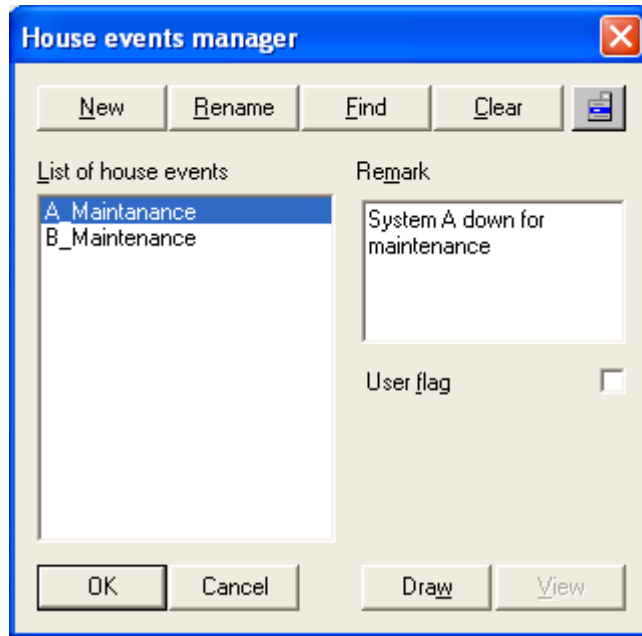
To manage your house events use **House Event Manager** dialog box by selecting **Data > House Event Manager...**

Create a house event.

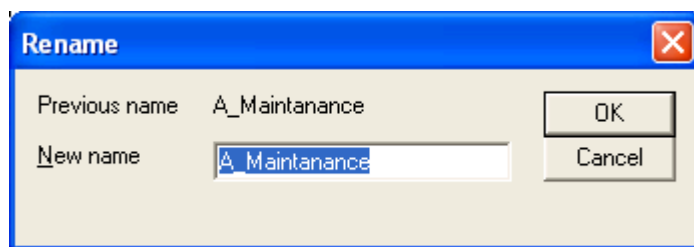
Rename a House Event

You can rename a house event.

1. Click **House Event Manager...**  in the **Graphic** toolbar.
The **House Event Manager** dialog box appears.



2. Select a house event in the **List of house events** box.
3. Click **Rename**.
The **Rename** dialog box appears.




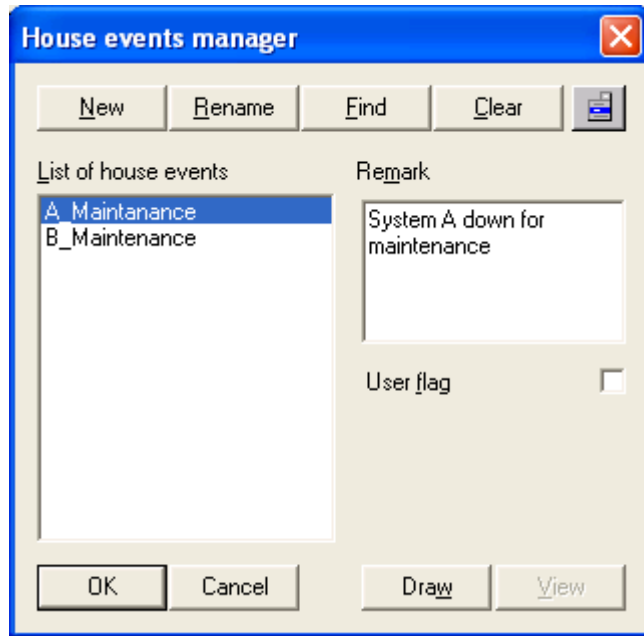
4. In the **New name** box, enter a new name.
5. Click **OK**.
You can see your modification in the **List of house events** box.
6. Click **OK** to save your changes and close **House Event Manager** dialog box.

The selected house event has been renamed.

Delete a House Event

You can delete a house event.

1. Click **House Event Manager...**  in the **Graphic** toolbar.
The **House Event Manager** dialog box appears.



2. Select house events from the **List of house events** dialog box.

 **Tip:** Use **CTRL** or **SHIFT** to select several house events

The selected house events are marked in blue.


3. Click **Clear**.
A **Confirmation request** dialog box appears.
4. Click **Yes** to confirm.

The selected house events are removed from the list and from the Fault Tree model.

Inserting House Events in the Current Model

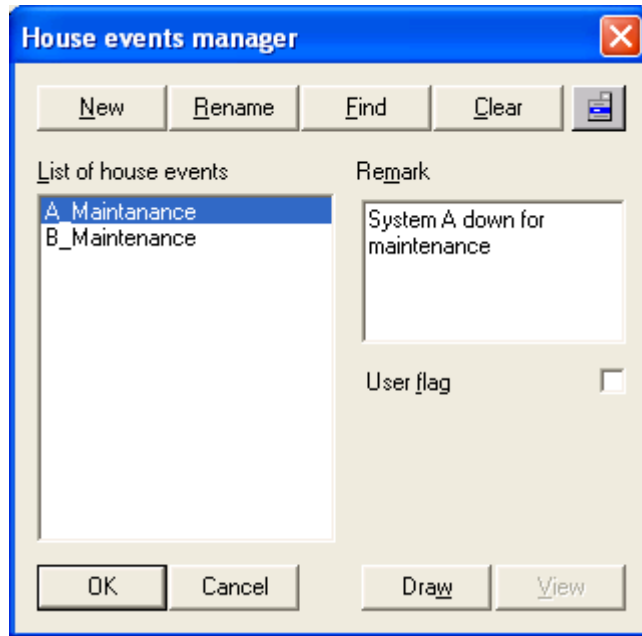
You can insert house events in the current model.

Create a house event.


1. Click **House Event Manager...**  in the **Graphic** toolbar.

 **Note:** You can select **Data > House Event Manager...** or Press **CTRL+H**.

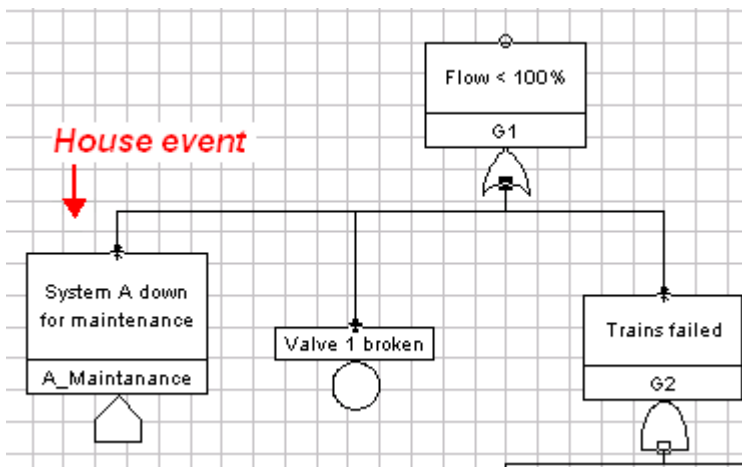
The **House Event Manager** dialog box appears.




2. Select house events in the **List of house events** box.

 **Tip:** Use **CTRL** or **SHIFT** to select several house events in the list.

3. Click **Draw**.
4. Click **OK**.
The selected house events appear in the current worksheet.
5. Click in the current worksheet to place house events.
6. Connect house events to the Fault Tree.



 **Note:** A house event defined in the **List of house events** box in the **House Event Manager** dialog box can be inserted several times in the current Fault Tree model (concept of instance).

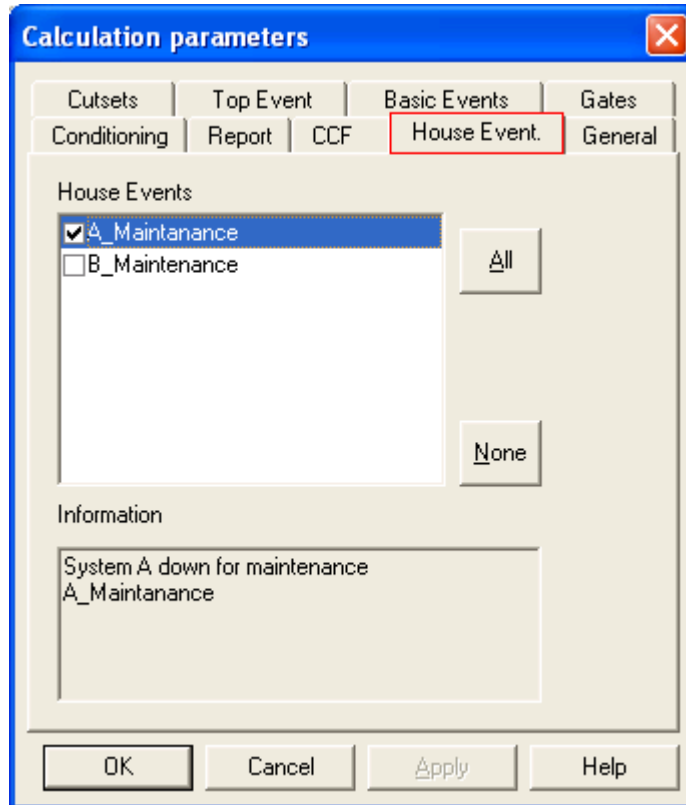
Performing Fault Tree Analysis with House Events

You can enable house events in the Fault Tree assessment.


By default all house events are disabled.

Create a house event and insert it in the current Fault Tree model.

1. Select **Aralia > Set up > Aralia...**
The **Calculation parameters** dialog box appears.
2. Select the **House event** tab.



3. Select house events to be turned on in the **House events** box.

 **Note:** You can use **All** to select all house events in the list or **None** to cancel your selection.

4. Click **OK**.

The selected house events will be taken into account in the Fault Tree assessment.

 **Note:** To desable house events in the Fault Tree assessment follow the same procedure.

Working with Intermediate Events

This section describes how to create and edit intermediate events.

[About Intermediate Events](#) on page 49

[About Top Events](#) on page 49

[Creating an Intermediate Event](#) on page 50

[Editing an Intermediate Event](#) on page 50

About Intermediate Events

An intermediate event is an event that depends on several basic events or other intermediate events. The top event is a particular case of an intermediate event.

In Aralia Fault Tree Analyzer the intermediate event is represented by the following graphical object:



The intermediate event is used to insert a Top Event or an intermediate event description box in the Fault Tree model. These events are followed by a logic gate. They can be seen as a label box or a comment gate.

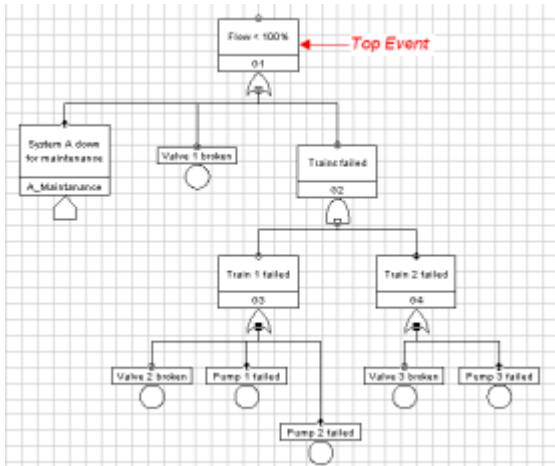
:

- A Fault Tree model can be created without using intermediate events.
- An intermediate event is a graphical object like a gate. You can manipulate it like a gate.

About Top Events

The top event corresponds to the Unexpected Event of the system and represents a particular system failure mode. It is developed until basic component failures are encountered.

The Top event is a root element of the Fault Tree model.



You can have only one top event per Fault Tree model.

 **Note:** The top event can be represented graphically by an intermediate event or by a gate.

Creating an Intermediate Event

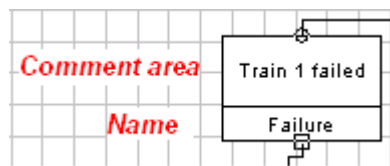
You can create an intermediate event.

Create or open an existing Fault Tree model.

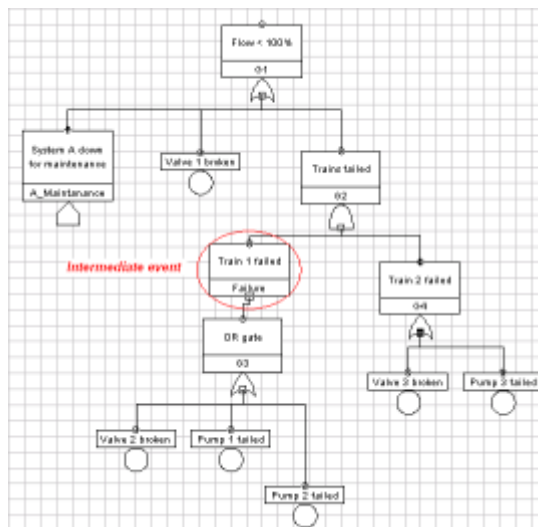
1. Click **Intermediate event**  in the **Graphic** toolbar.

 **Note:** You can select **FT > Fault Tree Logic > Intermediate event**

2. Click in the worksheet to place the object.
3. Right-click in the **Comment** area and enter a comment.
4. Right-click in the **Name** area to change the name.



5. Connect the intermediate event to the Fault Tree model.



Editing an Intermediate Event

You can edit an intermediate event.

Intermediate events are graphical objects like gates. To edit intermediate events you should use the same procedures like for gates.

Create an intermediate event.

To edit an intermediate event see [Editing a Gate](#) on page 26.

Working with Transfer Gates

This section describes how to use transfer gates.

[About Transfer Gates](#) on page 51

[Creating a Transfer Gate](#) on page 52

[Switching between Transfers](#) on page 54

[Transferring a sub-tree in the Current Worksheet](#) on page 55

[Transferring a sub-tree to a New Worksheet](#) on page 55

[Removing a Transfer](#) on page 57

[Working with Clone Transfer Gates](#) on page 58

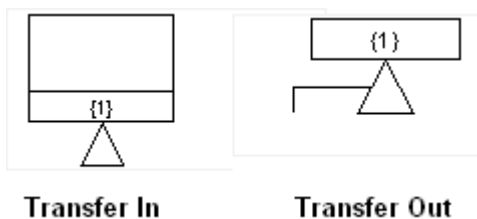
About Transfer Gates

Transfer gate is used to indicate a transfer to a sub tree. It enables to split a Fault Tree into several subtrees organized in different worksheets.

There are three types of Transfer gates:

- Transfer In gate
- Transfer Out gate
- Clone transfer gate.

They are represented by the following figure:

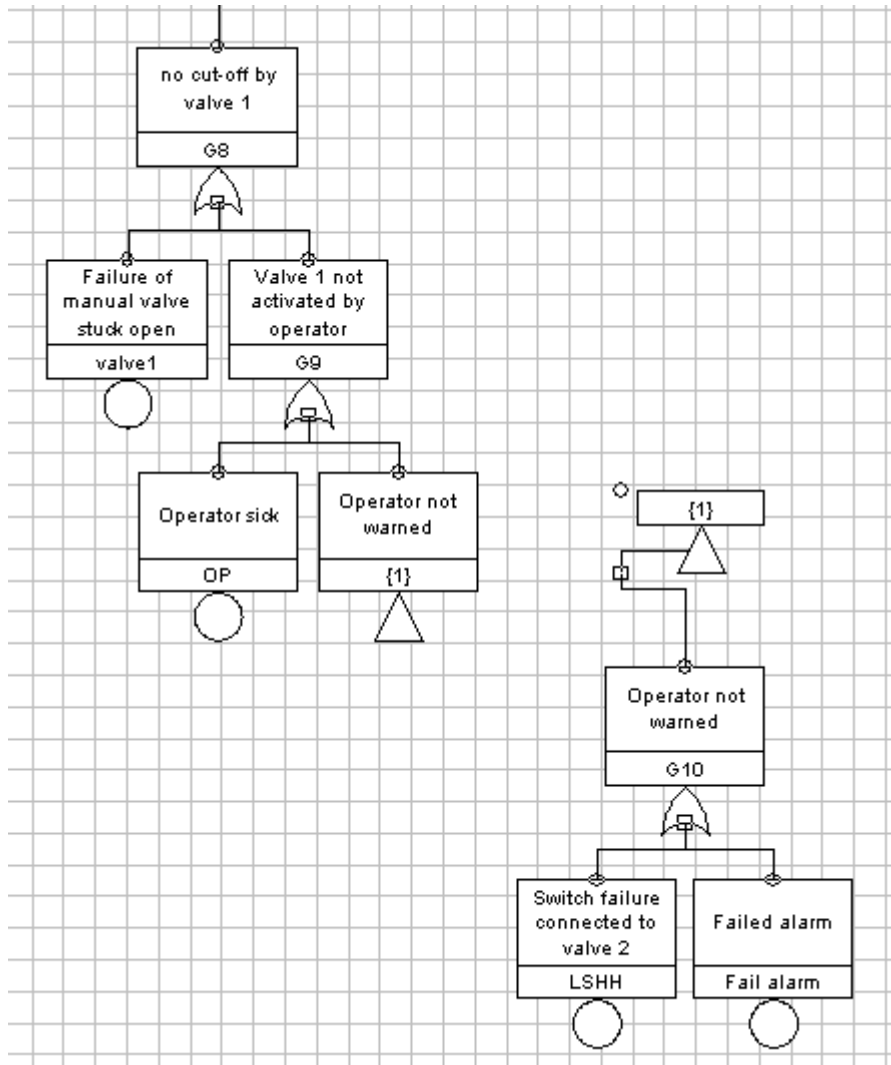


Transfer In Gate is used to indicate that a subtree of a Fault Tree is transferred to another place in the same worksheet or to a separate worksheet. Each Transfer In gate has a corresponding Transfer Out gate.

Transfer Out Gate is used to indicate that the subtree must be attached to another subtree or to a Fault Tree at the corresponding Transfer In Gate.

The use of Transfer gates is illustrated by the following example.

The Transfer gate Operator not warned is developed into another sub-tree (in the same worksheet).



A clone is a special transfer gate. It allows to create a duplication of a part of the tree. In the new sub-tree, each event can be duplicated (new events).

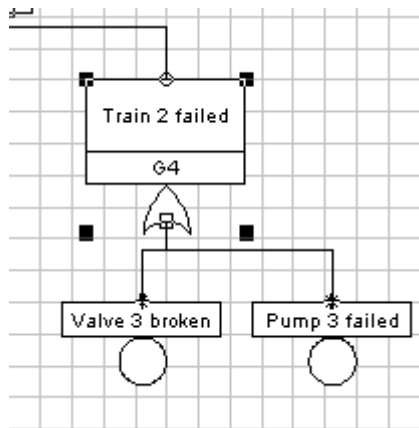
This is very useful when you want to create redundancy of a part of the tree. For example if you have an event failure engine in a part of the tree, you can create a clone of this sub tree including failure engine. Then you have a command expand clone which allows you to specify a new event failure engine 2 from the initial one.

Creating a Transfer Gate

You can create a transfer gate.

Create or open an existing Fault Tree model.

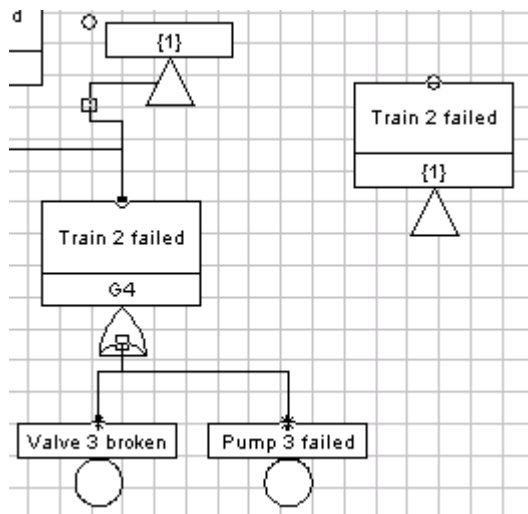
1. In the current worksheet select a gate.
The selected gate will be associated with the transfer gate.




2. Click **Create transfer**  in the **Graphic** toolbar.

 **Note:** You can select **FT > Create transfer** or press **CTRL+I**.

Transfer In gate and Transfer Out gate are created. The Transfer Out gate is associated to the selected gate and is created beside the gate.

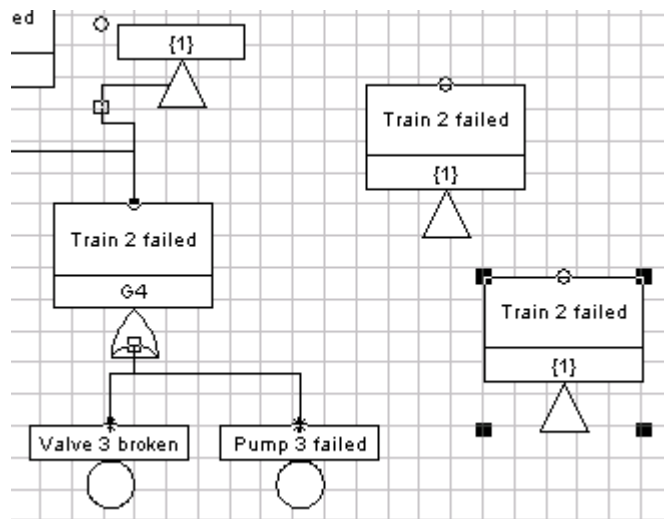


:

- A default number is associated to each new transfer gate.
 - Transfer gate allows reusing and connecting an existing sub-tree on several gates of the Fault Tree.
3. Connect the created Transfer In gate to the sub-tree you want to reuse.
 4. Create additional Transfer In gate:
 - a) Select the existing Transfer In or Transfer Out gates;
 - b) Click **Create transfer**  in the **Graphic** toolbar.

 **Note:** You can select **FT > Create transfer** or press **CTRL+I**.

The additional Transfer In gate appears in the current worksheet.

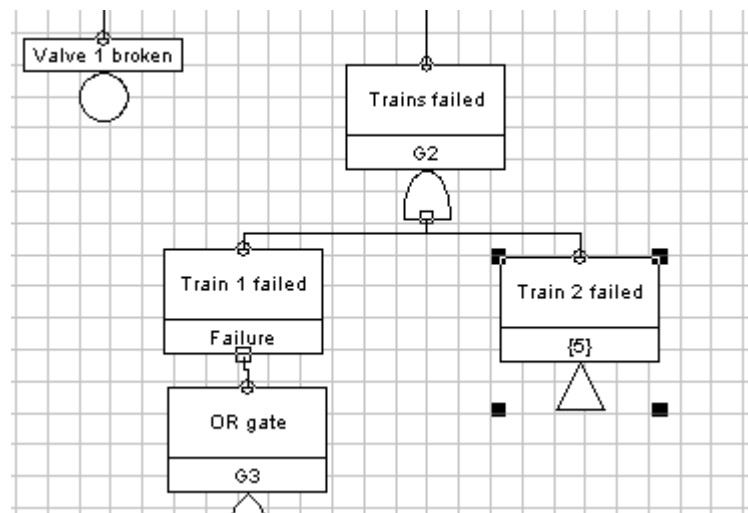



Switching between Transfers


You can switch from Transfer In gate to Transfer Out gate and vice-versa.

Create a transfer gate.

1. Select the Transfert Out gate (Transfer In gate).



2. Click the icon .

 **Note:** You can press **Shift** and right-click on the selected gate. Also you can click the gate symbol of the selected gate.

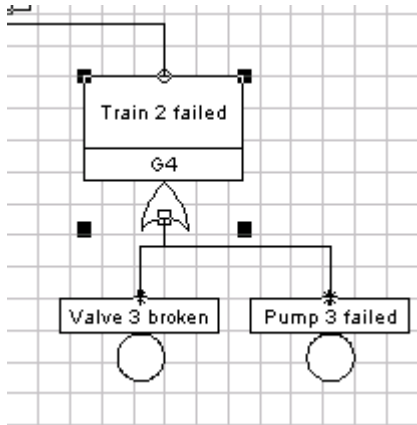
The worksheet with the corresponding Transfer In gate (Transfer Out gate) opens.

Transferring a sub-tree in the Current Worksheet

You can transfer a sub-tree in the current worksheet.

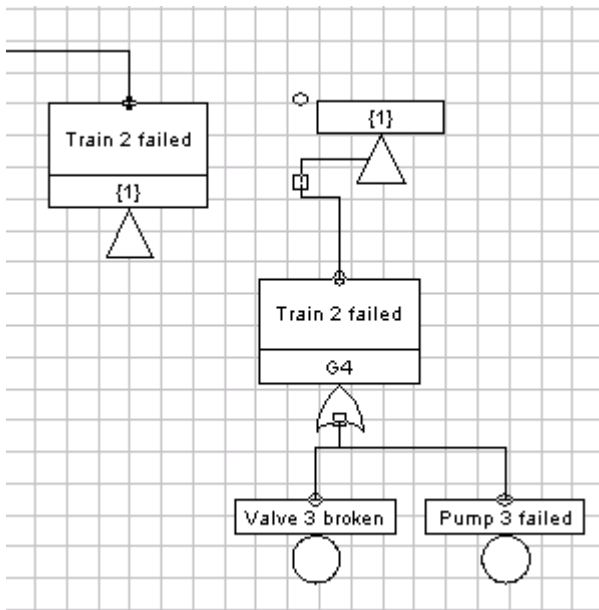
Create or open an existing Fault Tree model.

1. Select the top gate of the sub-tree to be transferred.



2. Select **FT > Detach and transfer into the same worksheet.**

Transfer In and Transfer Out gates are created and the sub-tree is transferred beside the selected top gate.

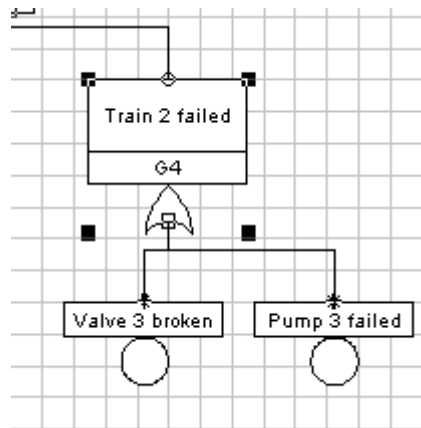


Transferring a sub-tree to a New Worksheet

You can transfer a sub-tree to a new worksheet.

Create or open an existing Fault Tree model.

1. Select the top gate of the sub-tree to be transferred.

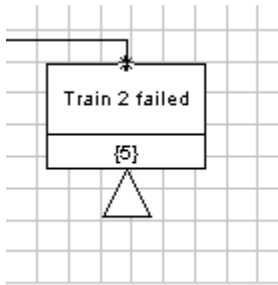


2. Select **FT > Detach and transfer into a new worksheet**.
The **Select worksheet** dialog box appears.

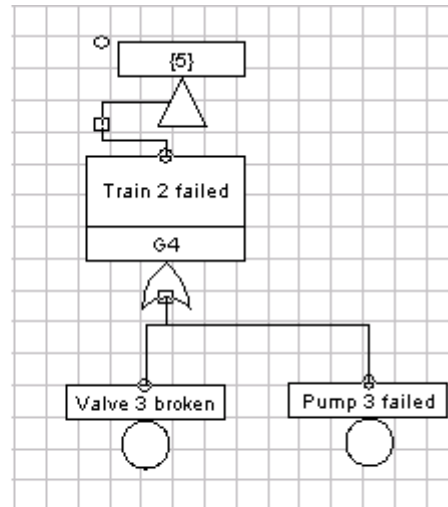


3. Select the worksheet to transfer the sub-tree in this worksheet.
4. Click **Close**.

The sub-tree is transferred to the selected worksheet.



**Current
worksheet**



**New
worksheet**

:

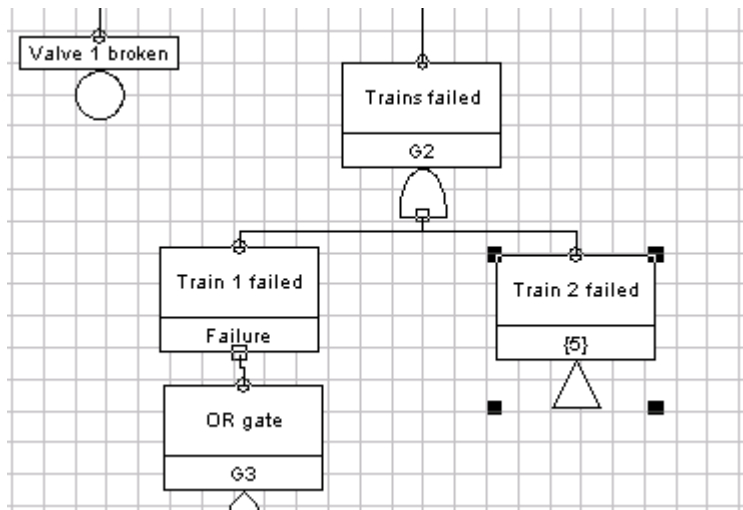
- If you select **Pages** in the **Select worksheet** dialog box a new worksheet will be created containing the transferred sub-tree.
- If you select a folder in the **Select worksheet** dialog box, a new worksheet containing the transferred sub-tree will be created in the selected folder.

Removing a Transfer

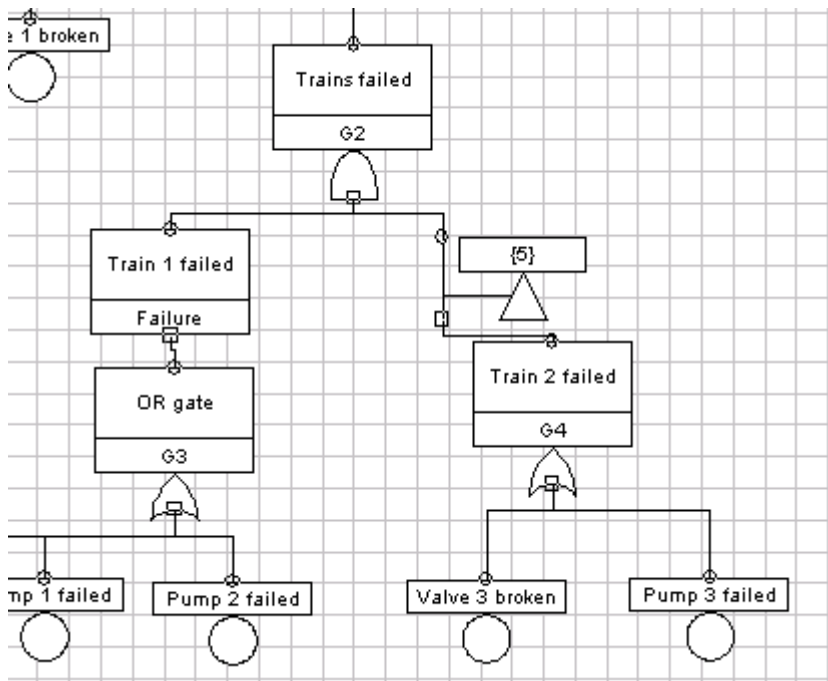
You can bring back a transferred sub-tree to the corresponding Transfer In gate.


Create a transfer gate.

1. Select the Transfer In gate.



2. Select **FT > Expand transfer here.**
This command brings back the sub-tree under the selected Transfer In gate.



 **Note:** The Transfer Out gate is not removed because some other Transfer In gates corresponding to this Transfer Out gate can exist in the model. Before removing it manually, right-click on this gate to ensure it is orphan.

Working with Clone Transfer Gates

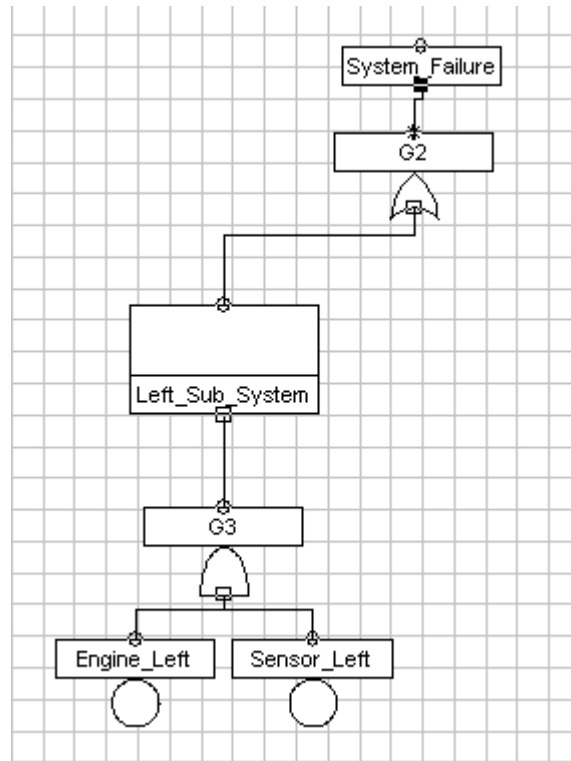
You can create clone transfer gates to duplicate a part of the fault tree. It is very useful to create redundancy.


Create or open an existing Fault Tree model.


Create a Clone Transfer Gate

You can create a clone transfer gate.

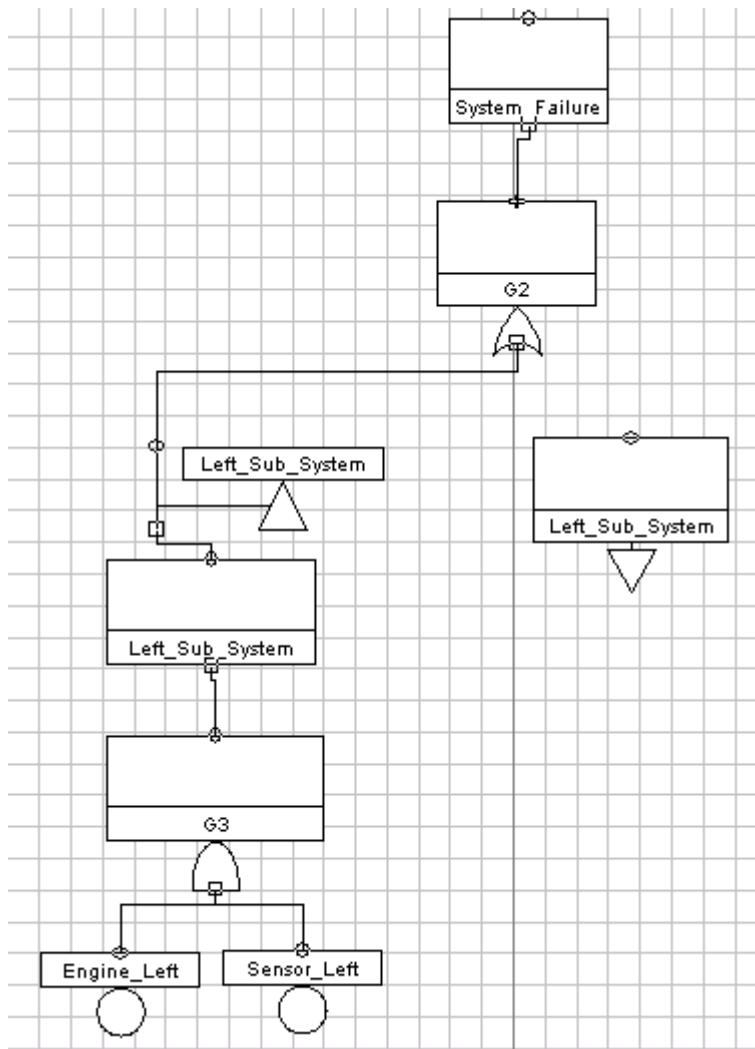
1. Create a system composed with a sub-system "left" like in the example below.




2. Duplicate "Left_Sub_System" to create a "Right_Sub_System" with new basic events: Engine_Right and Sensor_Right. .
3. Select "Left_Sub_System"
4. Click **Create Unexpanded Clone**  in the **Graphic** toolbar.

 **Note:** You can select **FT > Create Unexpanded Clone**.

The cloned gate appears.

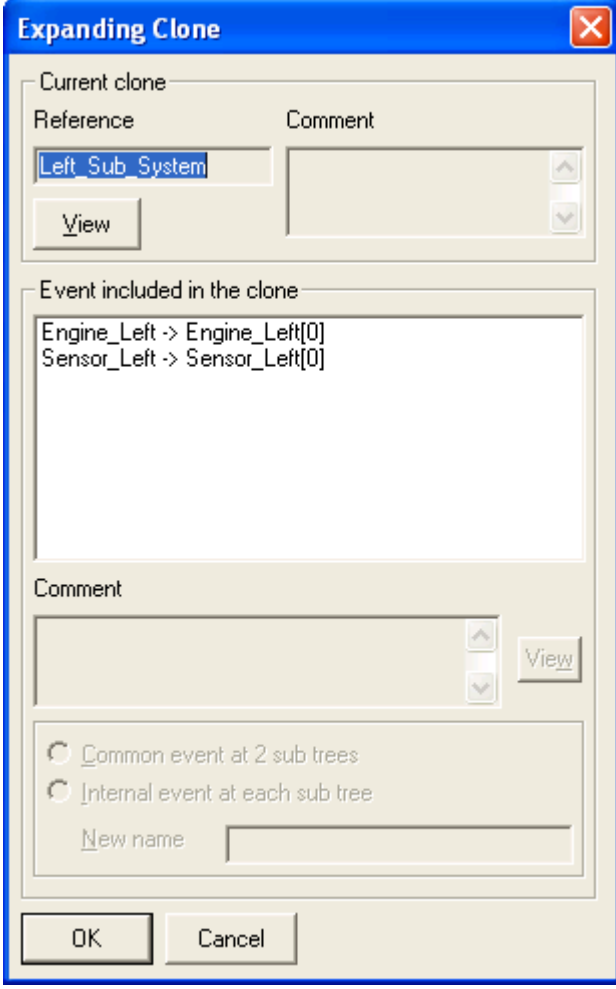


 **Note:** To finish the system you have to develop the new gate.

Expand a Clone Transfer Gate

You can develop a cloned transfer gate.

1. Select **FT > Expand clone**.
The **Expanding clone** dialog box appears.



The 'Expanding Clone' dialog box is shown with a blue title bar and a close button. It contains several sections: 'Current clone' with a 'Reference' field containing 'Left_Sub_System' and a 'View' button; 'Event included in the clone' with a text area containing 'Engine_Left -> Engine_Left[0]' and 'Sensor_Left -> Sensor_Left[0]'; a 'Comment' field with a 'View' button; two radio buttons for 'Common event at 2 sub trees' and 'Internal event at each sub tree'; and a 'New name' field. At the bottom are 'OK' and 'Cancel' buttons.

Current clone	
Reference	Comment
Left_Sub_System	
<u>V</u> iew	

Event included in the clone


Engine_Left -> Engine_Left[0]
Sensor_Left -> Sensor_Left[0]

Comment

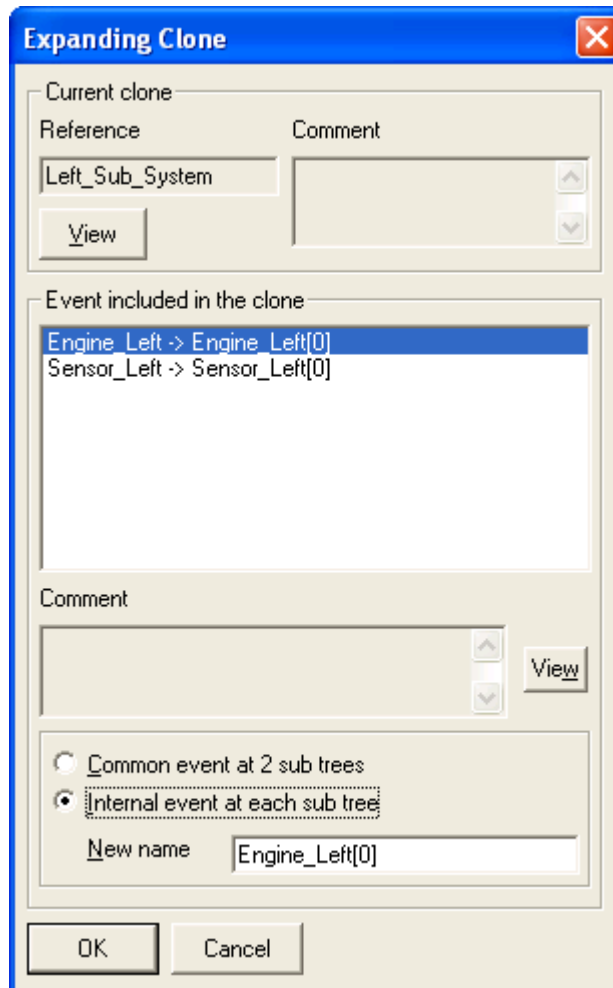
☐ Common event at 2 sub trees
☐ Internal event at each sub tree

New name

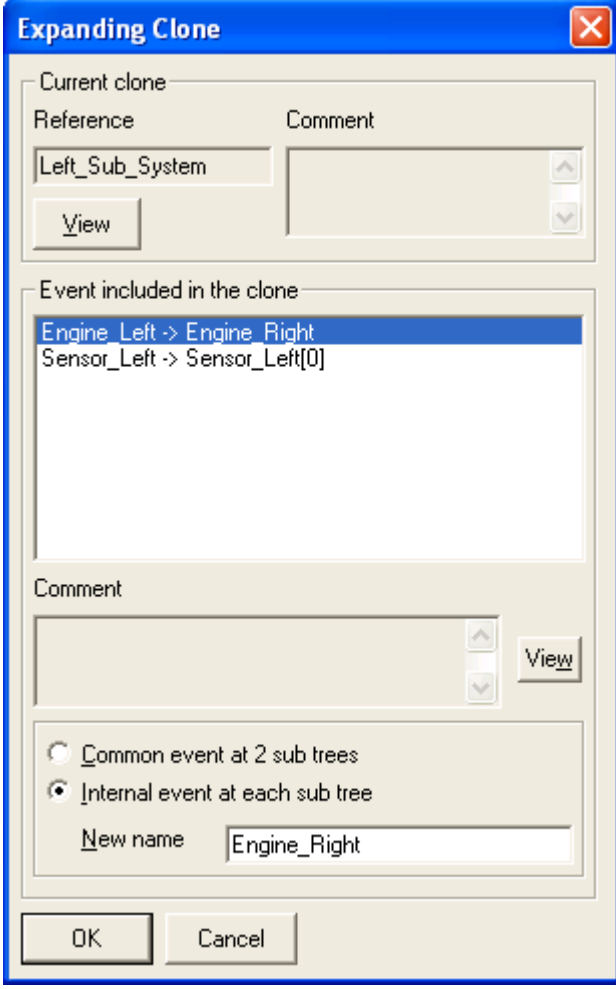
OK Cancel

 **Note:** For each event you can reuse the initial event or create a new event (duplication).

2. Select the event in the **Event included in the clone** area.



3. Choose **Common event at 2 subtrees** if you want to reuse the initial basic event or **Internal event at each sub tree** to create a new basic event and enter its name in the **New name** area.



The image shows a Windows-style dialog box titled "Expanding Clone" with a red close button in the top right corner. The dialog is divided into several sections. The first section, "Current clone", contains a "Reference" text box with the value "Left_Sub_System", a "Comment" text box, and a "View" button. The second section, "Event included in the clone", contains a list box with two items: "Engine_Left -> Engine_Right" (which is selected) and "Sensor_Left -> Sensor_Left[0]". Below this list is a "Comment" text box and a "View" button. The third section contains two radio buttons: "Common event at 2 sub trees" (which is unselected) and "Internal event at each sub tree" (which is selected). Below the radio buttons is a "New name" text box with the value "Engine_Right". At the bottom of the dialog are "OK" and "Cancel" buttons.

Reference	Comment
Left_Sub_System	

View

Event included in the clone

- Engine_Left -> Engine_Right
- Sensor_Left -> Sensor_Left[0]

Comment

View

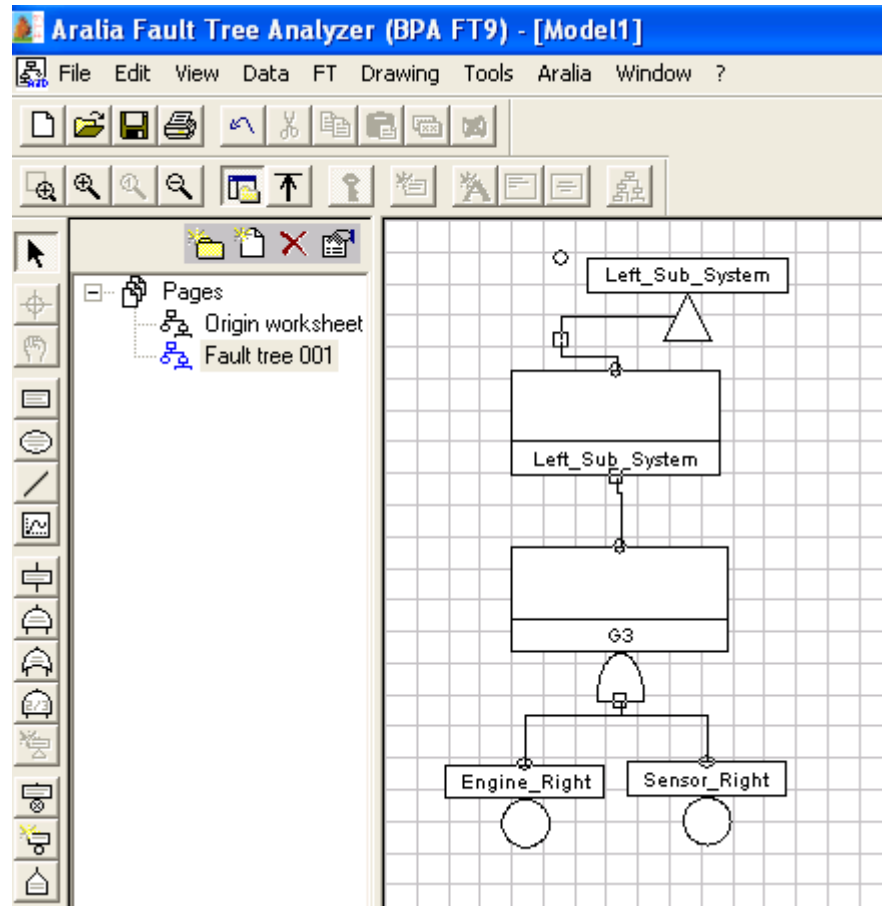
☐ Common event at 2 sub trees

☒ Internal event at each sub tree

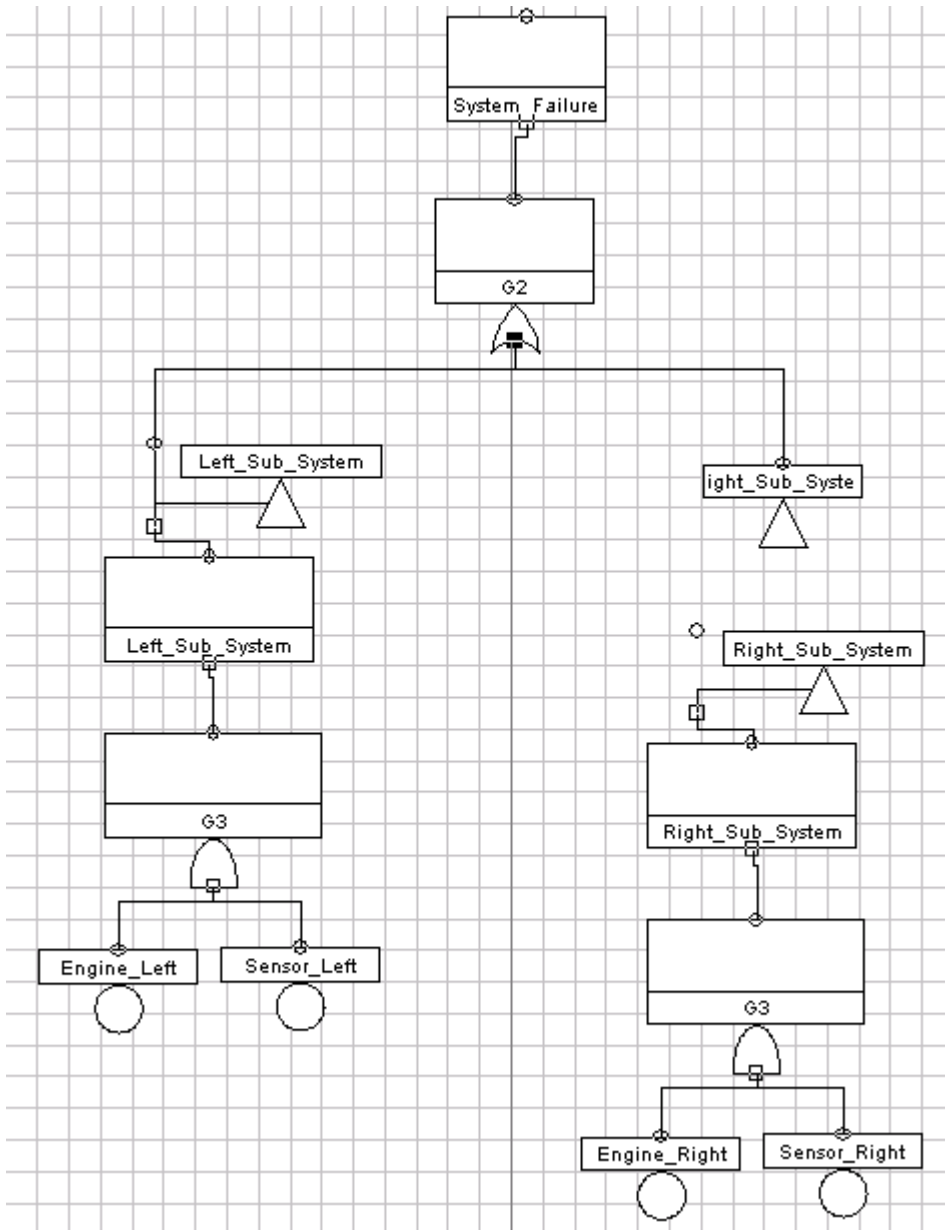
New name: Engine_Right

OK Cancel

4. Do the same for all basic events in the list and click **OK**.
The new sub tree (duplication/clone) is created (in a new page).



5. Rename intermediate gates with "Right" prefix.




- Note:** Structurally, left and right sub trees are the same. But the events are now different, because components (sensor, engine) are different (redundancy).

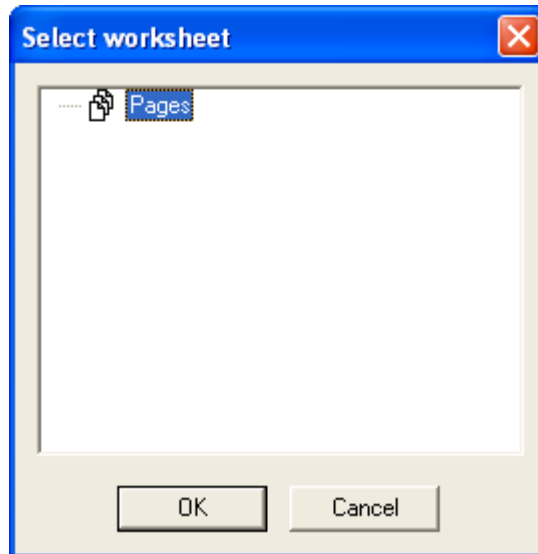
Creating a Not Elementary Event

You can create a not elementary event of your Fault Tree.

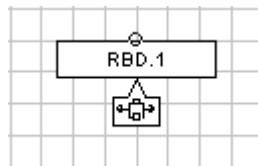
Instead of basic events you can use a Reliability Block Diagram as a leaf of your Fault Tree.


- Create or open a study;
- Create a Reliability Block Diagram;
- Open a Fault Tree worksheet.

1. Click **Create a not elementary event**  in the **Graphic** toolbar.
2. Click in the worksheet.
The **Select worksheet** dialog box appears.

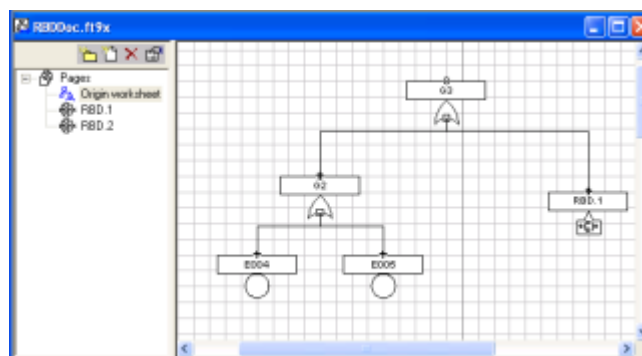


3. Select the RBD worksheet to use an already created Reliability Block Diagram or Pages to create a new RBD worksheet.
4. Click **OK**.
A new not elementary event appears in the worksheet.



 **Note:** If **Pages** was selected, a new RBD worksheet is also created and appears in the **Model Explorer**.

5. Connect the created not elementary event to the Fault Tree as a basic event.



Creating a Reliability Block Diagram

These tasks show you how to create different elements of a Reliability Block Diagram.

[Creating an Elementary Block](#) on page 67

[Creating a House Event Block](#) on page 68

[Creating a Hierarchical Block](#) on page 68

[Creating a Not Elementary Block](#) on page 69

[Connecting Blocks](#) on page 70

Creating an Elementary Block

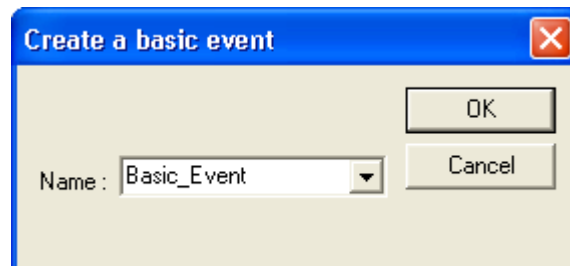
You can create elementary blocks.

Create or open a Reliability Block Diagram worksheet.

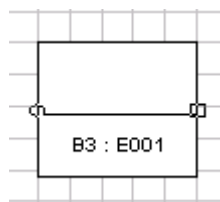
1. Click **Elementary block**  in the **Reliability Block Diagrams Graphic** toolbar.


 **Note:** You can also select **RBD > Block > Elementary block**.

2. Click in the worksheet
The **Create new basic event** dialog box appears.



3. In the **Name** box, enter the name.
4. Click **OK**.
New elementary block appears in the current worksheet:



 **Note:** Elementary blocks are managed in the same way as basic events. For more information about elementary blocks refer to basic event section.

Creating a House Event Block

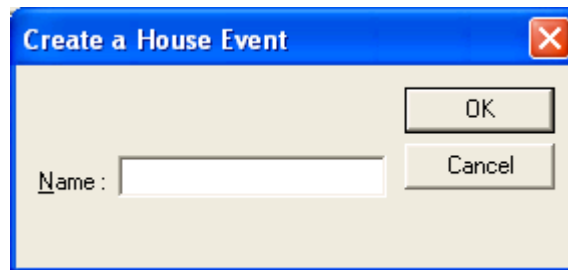
You can create house event blocks.

Create or open a Reliability Block Diagram Worksheet.

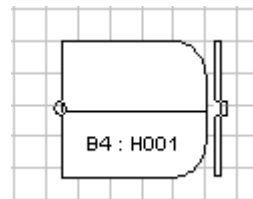
1. Click **House event block**  in the **Reliability Block Diagrams Graphic** toolbar.


 **Note:** You can also select **RBD > Block > House event block**.

2. Click in the current worksheet.
The **Create a House Event** dialog box appears.



3. In the **Name** box, enter the house event block name.
4. Click **OK**.
New house event block appears in the current worksheet.



 **Note:** House event blocks are used as switches and are similar to house events. For more information please refer to Working with house events section.

Creating a Hierarchical Block

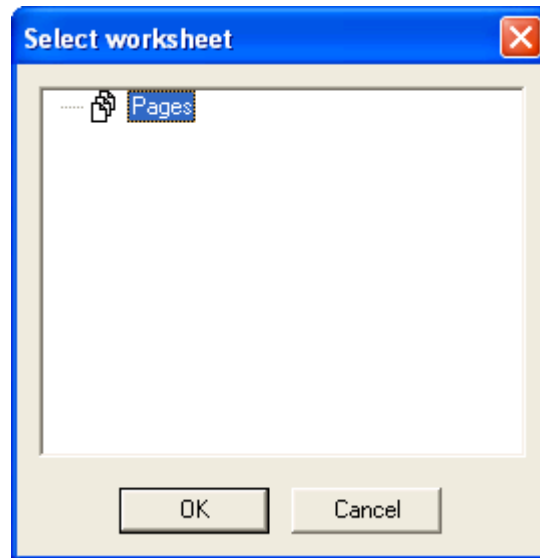
You can create a hierarchical block.

Open or create a Reliability Block Diagram worksheet.

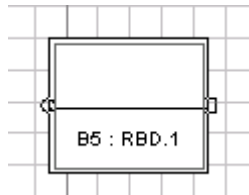
1. Click **Hierarchical block**  in the **Reliability Block Diagrams Graphic** toolbar.

 **Note:** You can also select **RBD > Block > Hierarchical block**.


2. Click in the current worksheet.
The **Select worksheet** dialog box appears.



3. Select a Reliability Block Diagram worksheet from the list or select **Pages** to create a new Reliability Block Diagram worksheet.
4. Click **OK**.
A new hierarchical block and a new RBD worksheet are created.




5. You can open the created worksheet and create a reliability block diagram in it.

 **Note:** Use **Shift + Ctrl + Right Click** to navigate between the hierarchical block and the worksheet it references to.

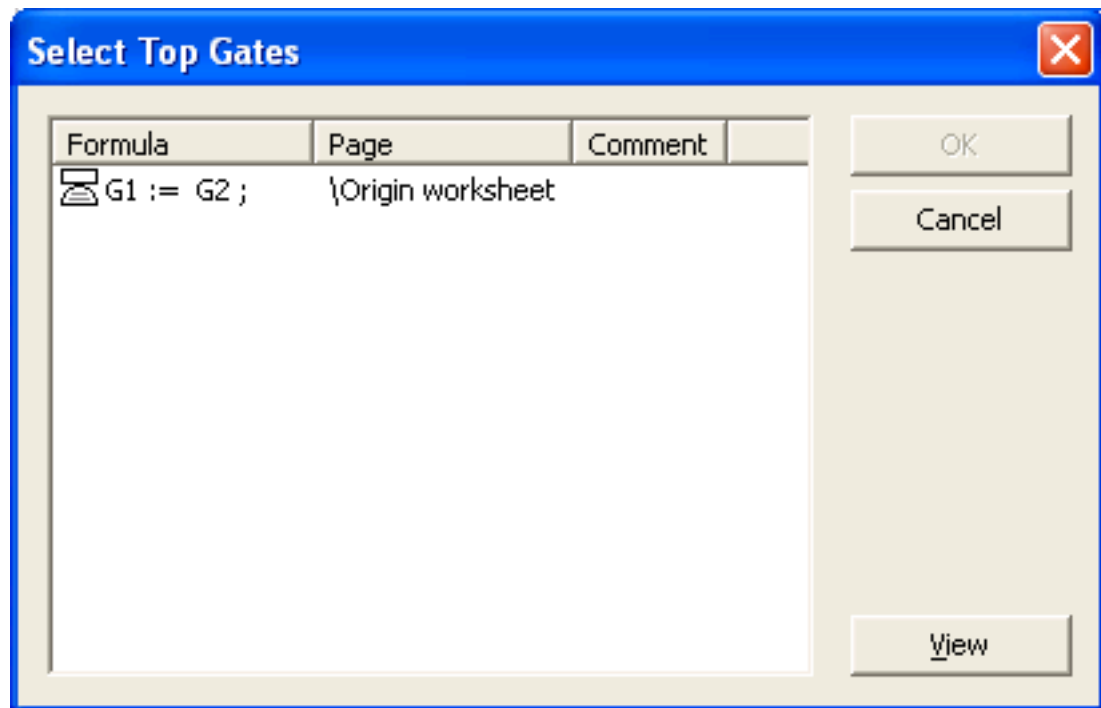
Creating a Not Elementary Block

You can create not elementary blocks.

- Create a Fault Tree in a Fault Tree worksheet.
 - Create a Reliability Block Diagram worksheet.
1. Choose the Reliability Block Diagram worksheet as a current worksheet.
 2. Click **Not elementary block**  in the **Reliability Block Diagrams Graphic** toolbar.

 **Note:** You can also select **RBD > Block > Not elementary block**.

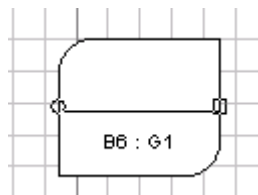
3. Click in the current worksheet.
The **Select Top Gates** dialog box appears.



4. Select the top gate.

5. Click **OK**.

A new not elementary block appears in the current worksheet.



:

- You can use the button **View** to view the top event in the study.
- The field **Page** indicates the name of the page where is situated the Fault Tree.
- This block can be used as an elementary block in the RBD. It can be connected in series or in parallel with other blocks.

Connecting Blocks

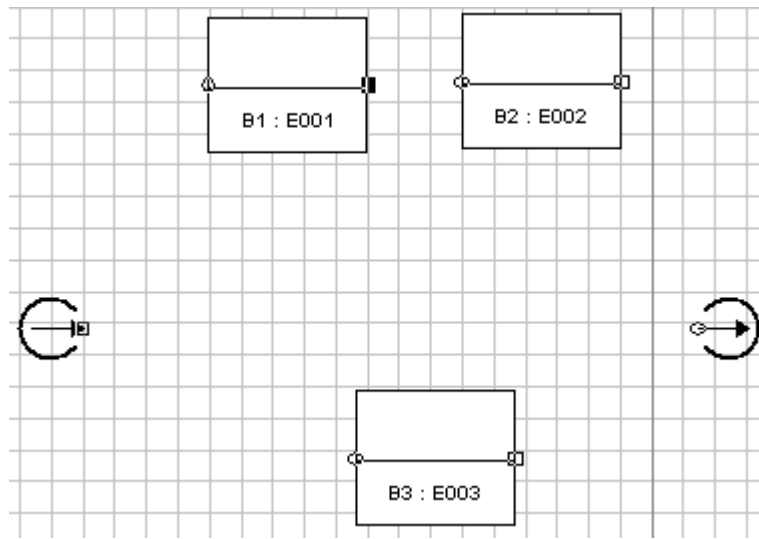
You can connect different blocks.

- Create or open a Reliability Block Diagram worksheet.
- Create three elementary blocks.


Connect using Simple Connector

You can connect blocks using simple connector.

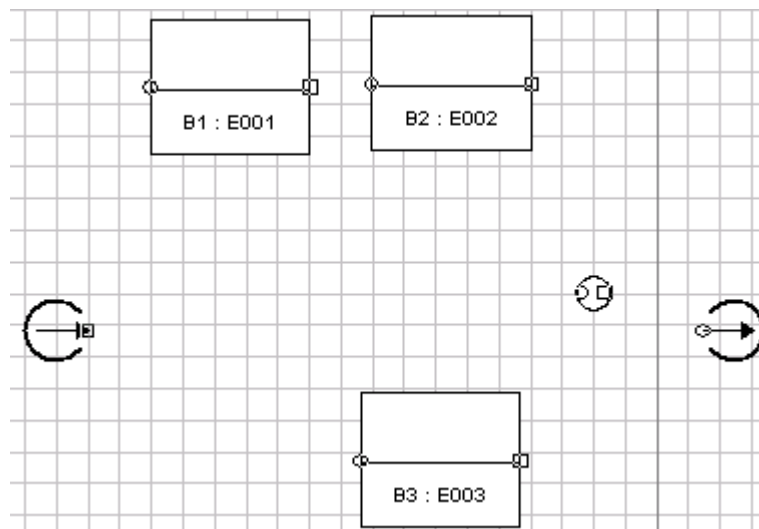
1. Open the model.



2. Click **Connector**  in the **Reliability Block Diagrams Graphic** toolbar.

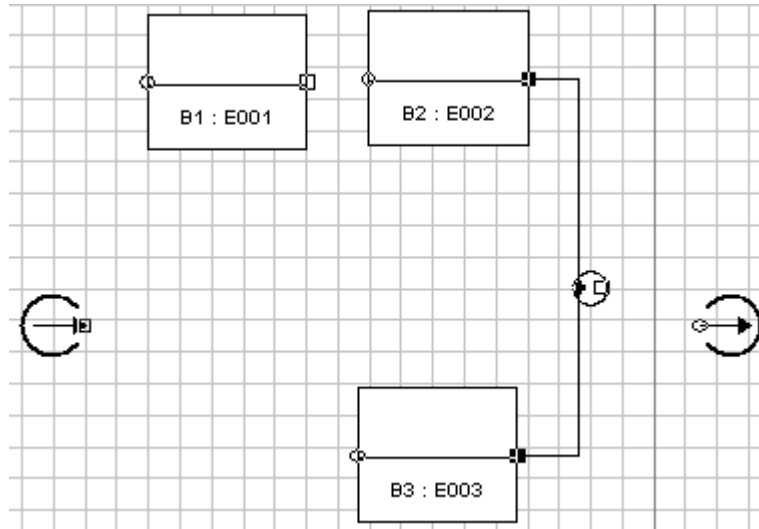
 **Note:** You can also select **RBD > Block > Connector**.

3. Click in the current worksheet.
The connector appears in the current worksheet.



:

- A connector is used to connect blocks in parallel.
 - The system is working if at least one block is not failed.
4. Connect "B2: E002" and "B3: E003" to the created connector.



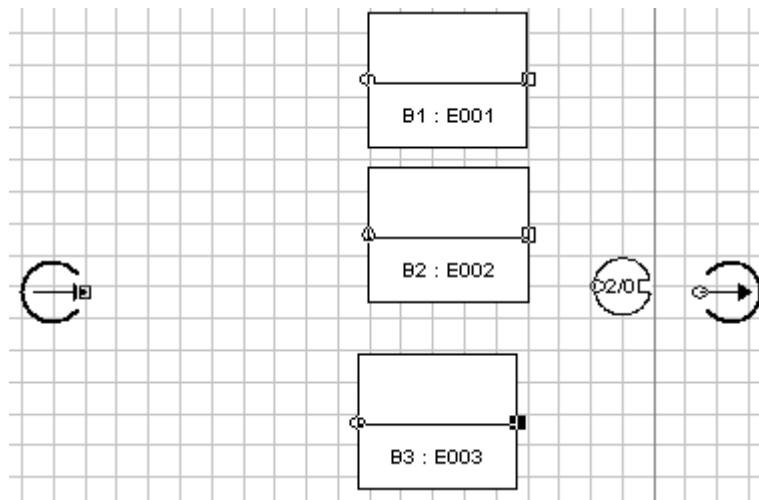
Connect using K-out-of-N Connector

You can connect blocks using K-out-of-N connector.

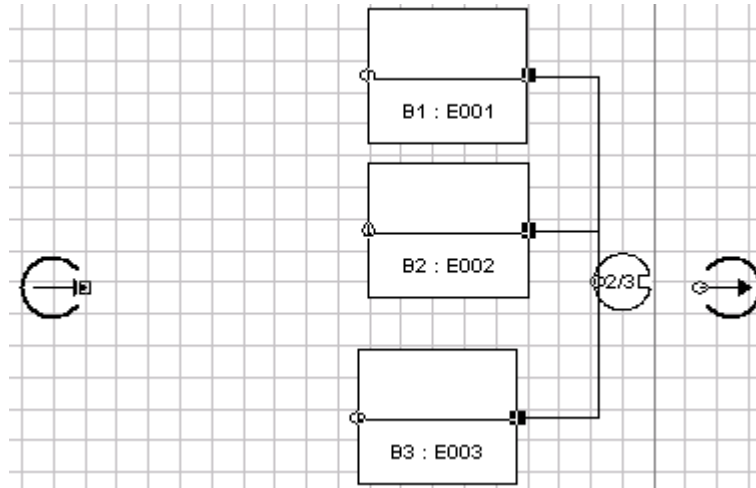
1. Click **k/n connector**  in the **Reliability Block Diagrams Graphic** toolbar.


 **Note:** You can also select **RBD > Block > k/n connector**.

2. Click in the current worksheet.
The 2/0 connector appears in the current worksheet.

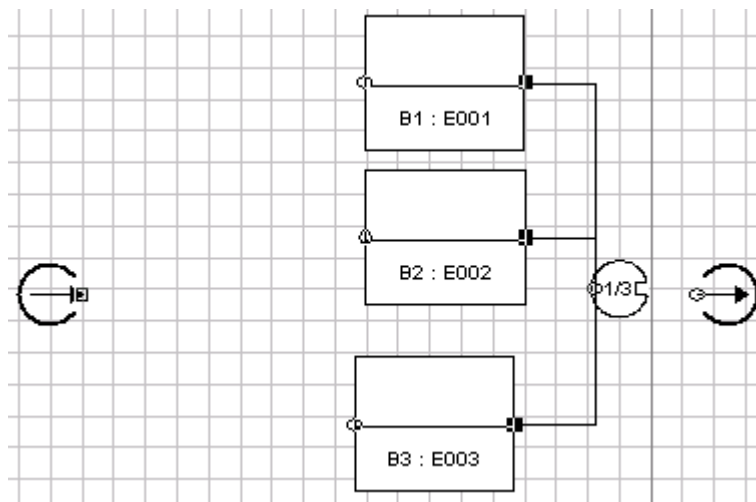


3. Connect blocks "B1: E001", "B2: E002", "B3: E003" to the created connector.
The value of the connector changes to "2/3".



 **Note:** The system is working if 2 of 3 blocks are not failed.

4. Right-click the "2/3" connector and enter a new value.
For example 1.



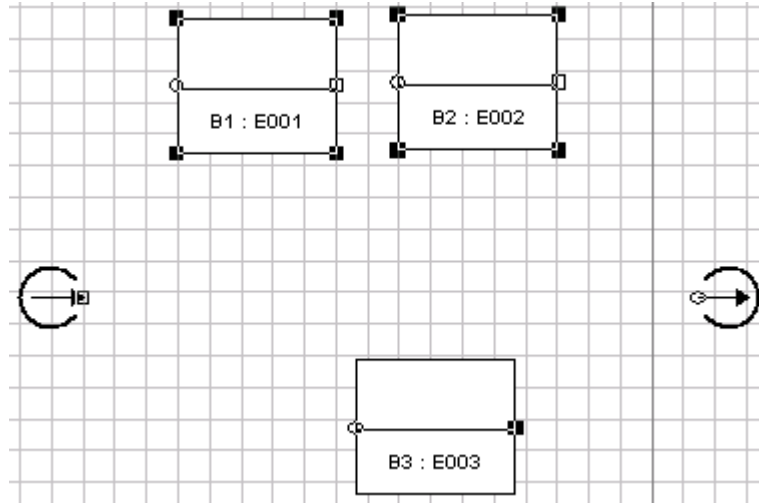
:

- If $K = 1$ the K/N connector is the same as simple connector. If $K = 3$, the K/N connector corresponds to the connecting of 3 blocks in series.
- The value of N depends of the number of the blocks connected to the connector. The value of K should be positive and not greater than N .

Connect Blocks in Series

You can connect two blocks in series.

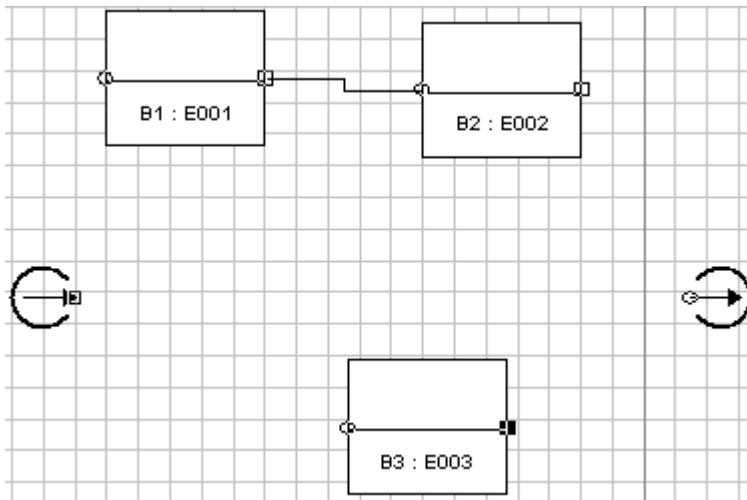
1. Select two blocks "B1:E001" and "B2: E002" in the current worksheet.



2. Click **Connect blocks in series**  in the **Reliability Block Diagrams Graphic** toolbar.

 **Note:** You can also select **RBD > Connect blocks in series**.

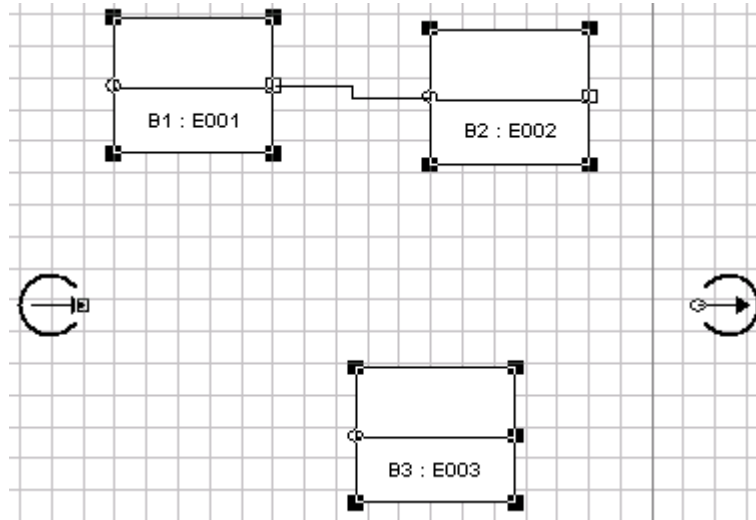
A connection between the blocks appears.




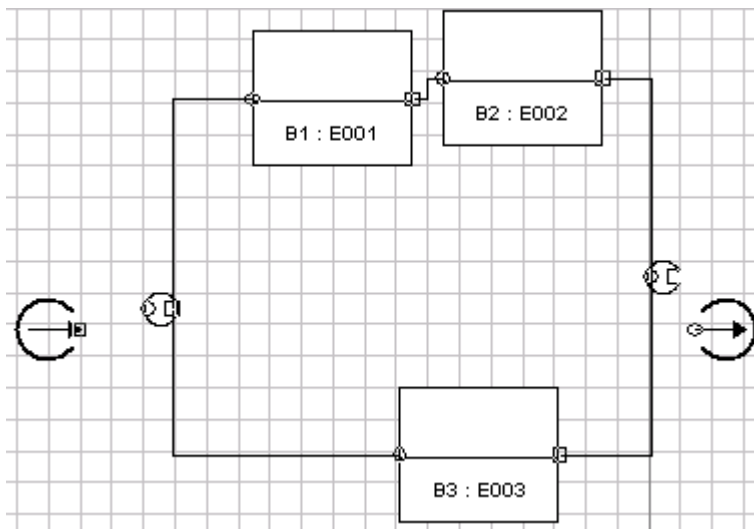
Connect Blocks in Parallel

You can connect blocks in parallel.

1. Select blocks "B1: E001", "B2: E002", "B3: E003".



2. Click **Connect two blocks in parallel**  in the **Reliability Block Diagram** graphic toolbar. Connections and connectors appear in the worksheet.



Common Cause Failure

This section describes how to work with Common Cause Failure (CCF) groups.

[About Common Cause Failure \(CCF\)](#) on page 76

[Creating a Common Cause Failure Group](#) on page 76

[Editing a Common Cause Failure Group](#) on page 78

[Performing Fault Tree analysis with Common Cause Failure](#) on page 81

About Common Cause Failure (CCF)

A Common Cause Failure is an event that because of dependencies causes a coincidence of failures of several components.

A Common Cause Failure occurs when events are not statistically independent. One event causes multiple elements to fail.

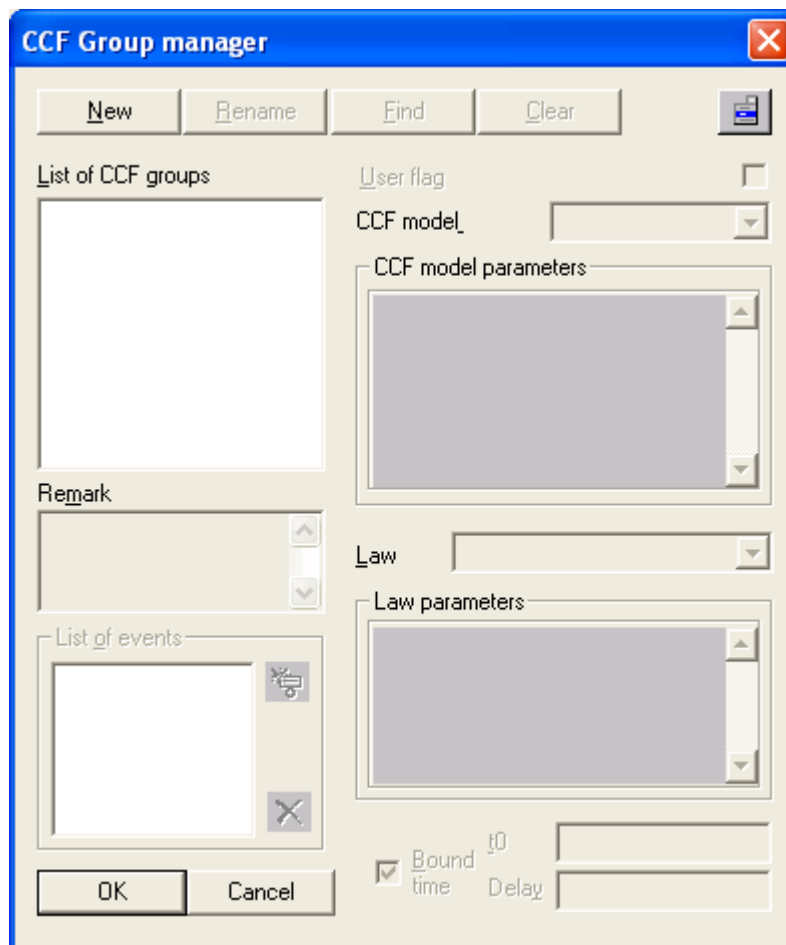
For example, if multiple pumps are connected to the same power supply, the failure of this power supply will cause the unavailability of all pumps.

Creating a Common Cause Failure Group

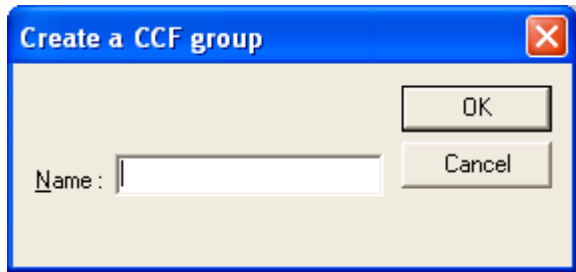
You can create a Common Cause Failure Group.


Create or open an existing Fault Tree model.


1. Select **Data > CCF Group Manager...**
The **CCF Group Manager** dialog box appears.



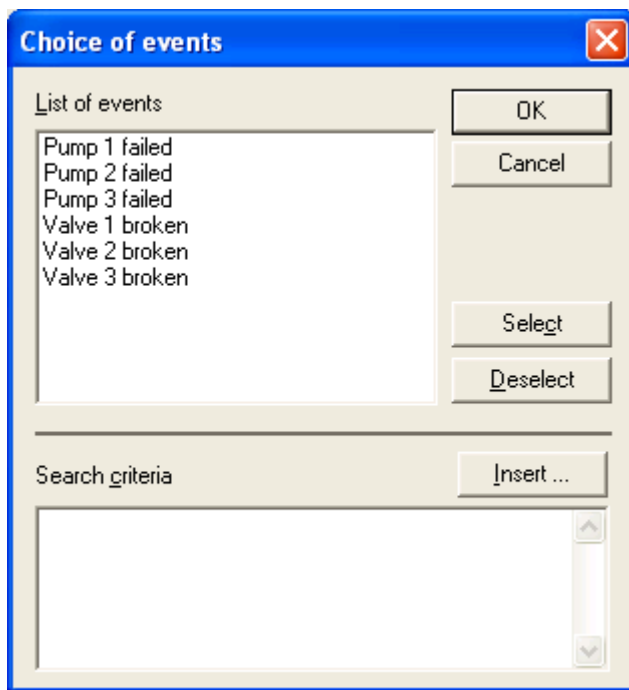
2. Click **New** to create a new Common Cause Failure group.
The **Create a CCF group** dialog box appears.





3. In the Name box, enter a Common Cause Failure group name.
4. Click **OK**.
The new Common Cause Failure Group appears in the list of the CCF groups.
5. In the **List of events** area, click  to insert basic events.

 **Note:** A Common Cause Failure group should be selected to be able to add basic events to this group.

The **Choice of events** dialog box appears.



6. Select basic events from the list of available basic events.
 **Note:** You can use **CTRL** or **SHIFT** to select several basic events.
7. Click **Ok**.
The selected basic events appear in the list.
8. Select the basic event and click  to delete a basic event from the list.
9. CCF model:

- a) In the **CCF model** box, select the type of CCF model.
 - b) In the **CCF model parameters** area, enter the values of model parameters.
10. Probability distribution:
 - a) In the **Law** box, select the probability distribution of the CCF.
 - b) In the **Law parameters** area, enter values of probability distribution parameters.
11. Click **OK**.

 **Note:** You can add comments in the **Remark** area.

Editing a Common Cause Failure Group

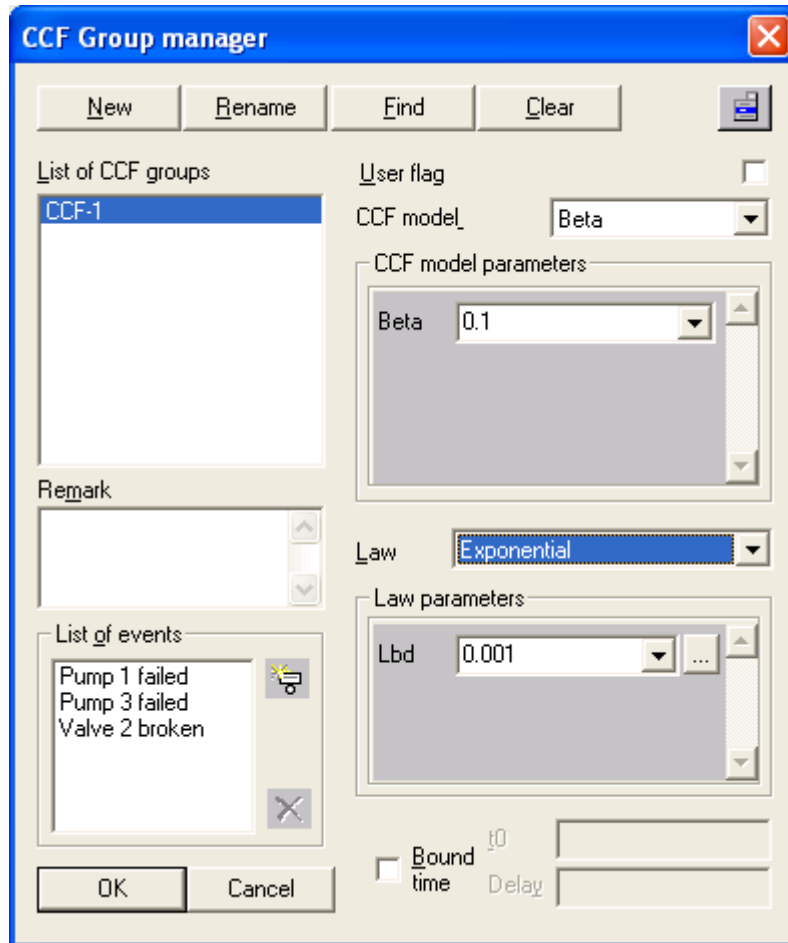
You can edit a Common Cause Failure Group using **CCF Group Manager** available from the menu **Data**.

- Launch Aralia Fault Tree Analyzer
- Create or open an existing Fault Tree model
- Create a Common Cause Failure group.

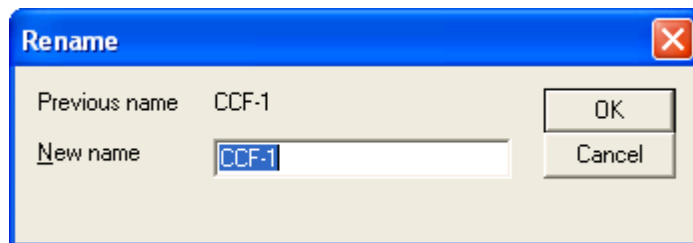
Rename a Common Cause Failure Group

You can rename a Common Cause Failure Group.

1. Select **Data > CCF Group Manager...**
The **CCF Group Manager** dialog box appears.



2. In the **List of CCF groups**, select a Common Cause Failure Group.
3. Click **Rename**.
The **Rename** dialog box appears.



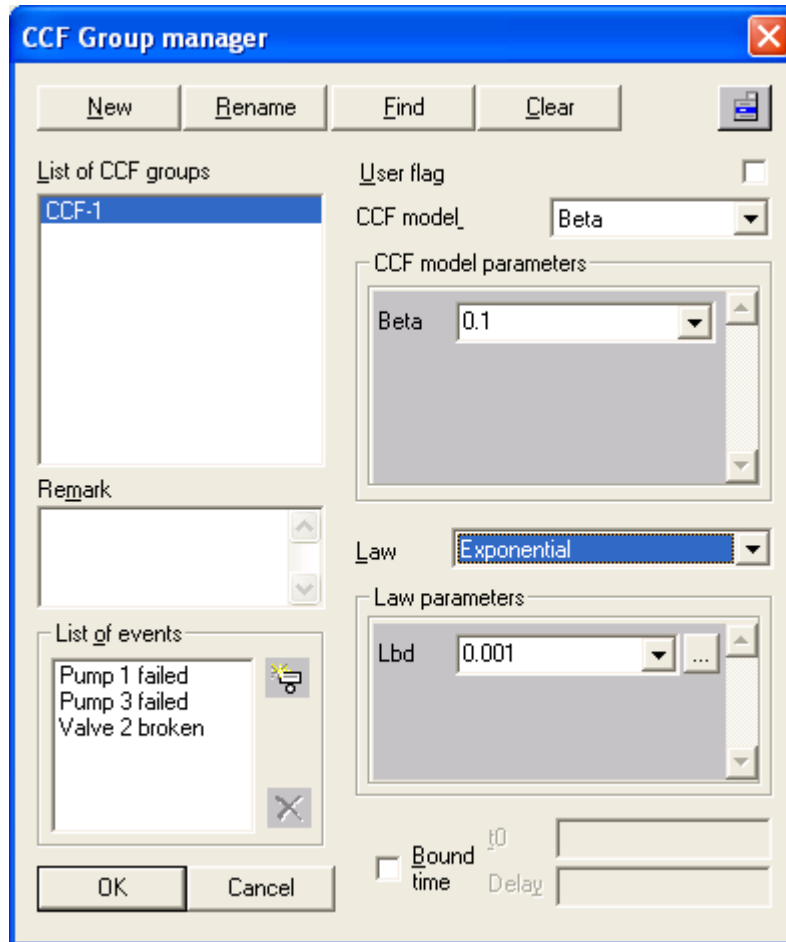
4. In the **New name** box, enter a new name.
5. Click **OK**.
The Common Cause Failure group has been renamed.

You can see the result in the **List of CCF groups**.

Delete a CCF Group

You can delete a Common Cause Failure Group.

1. Select **Data > CCF Group Manager...**
The **CCF Group Manager** dialog box appears.



2. In the **List of CCF Groups** box, select the CCF groups to delete.

 **Tip:** Use **CTRL** or **SHIFT** to select several CCF groups in the same time.

The selected CCF groups are marked in blue.

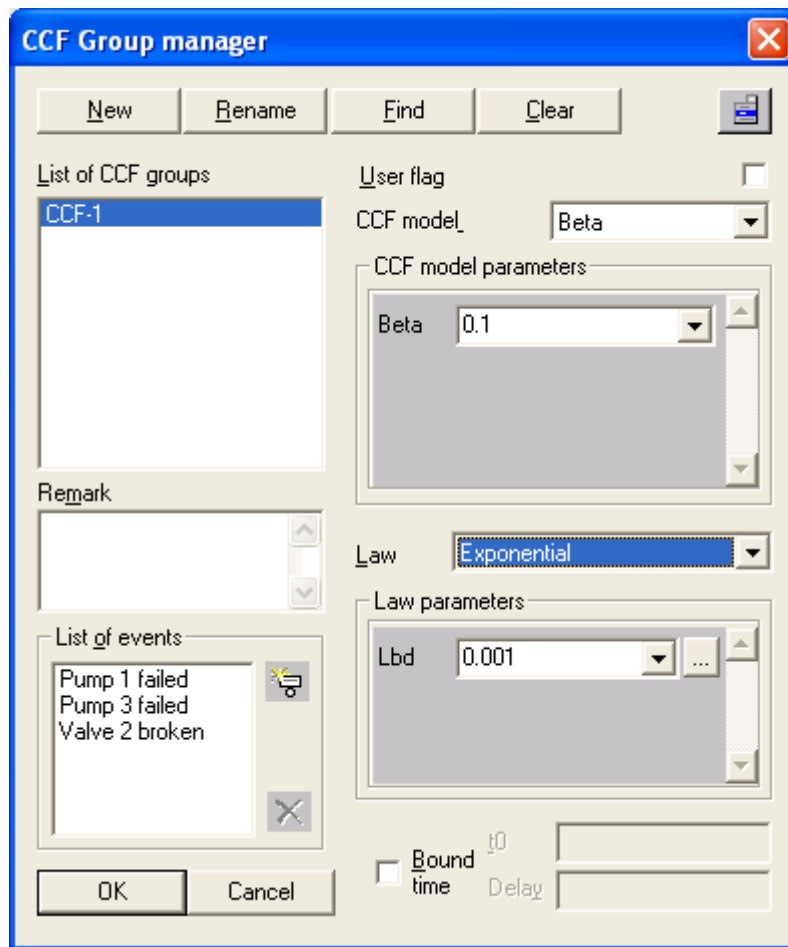
3. Click **Clear**.
A **Confirmation request** dialog box appears.
4. Click **Yes** to delete the selected objects.

The selected CCF groups are removed from the **List of CCF groups**.

Modify Probability Distribution of a CCF Group

You can modify probability distribution of a Common Cause Failure Group.

1. Select **Data > CCF Group Manager...**
The **CCF Group Manager** dialog box appears.



2. In the **List of CCF groups** dialog box, select the CCF group.
3. In the **CCF model** box, choose another model and change its parameters in the **CCF model parameters** area.
4. In the **Law** box, choose another probability distribution and change its parameters in the **Law parameters** area.
5. Click **OK** to save changes.

The CCF model and probability distribution have been changed.

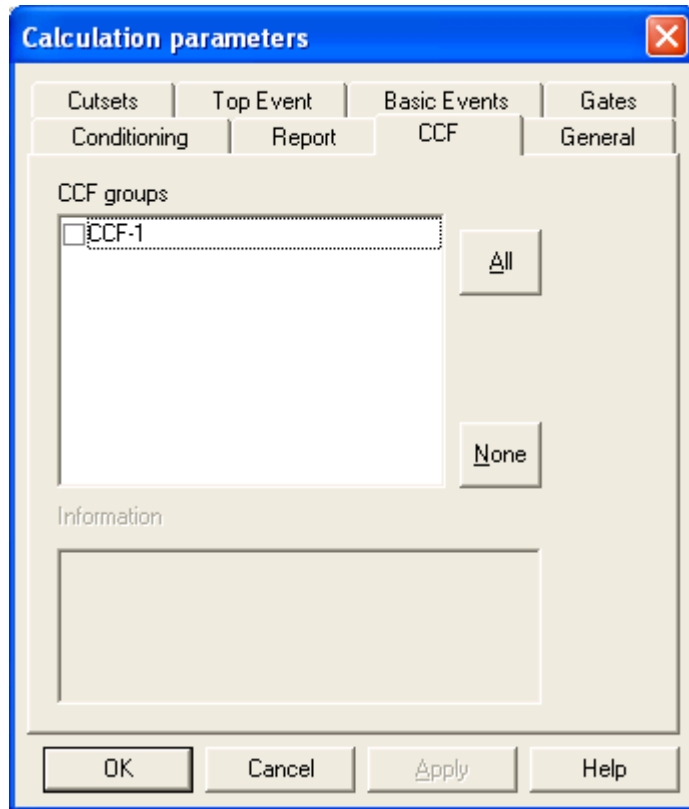
Performing Fault Tree analysis with Common Cause Failure

You can perform a Fault Tree analysis taking into account Common Cause Failures.

By default Common Cause Failures are disabled.

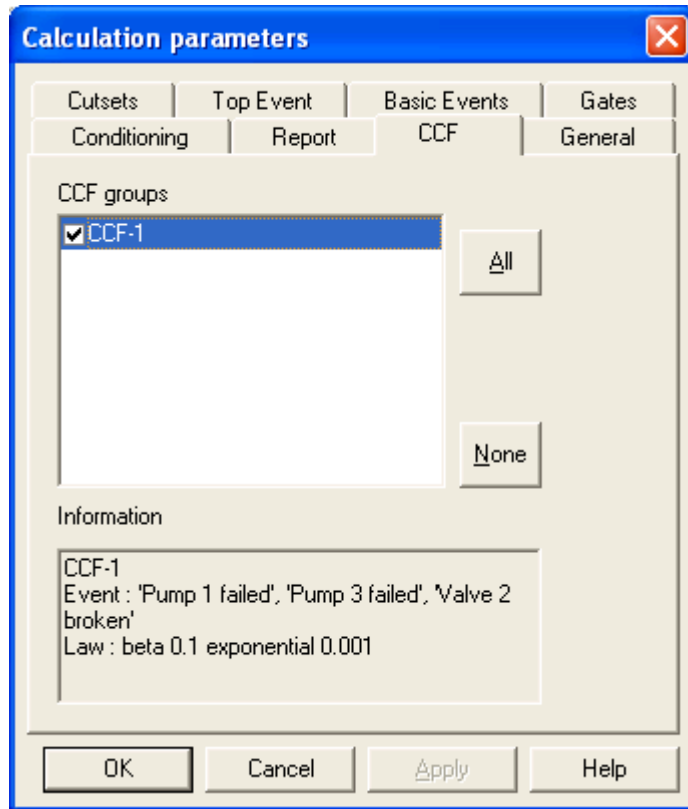
- Launch Aralia Fault Tree Analyzer
- Create or open an existing Fault Tree model;
- Create a Common Cause Failure group.

1. Select **Aralia > Set up > Aralia...**
2. Select the **CCF** tab.




3. In the **CCF groups** box, select Common Cause Failure groups to be integrated in the Fault Tree assessment.

 **Note:** Use **All** or **None** to select all CCF groups in the list or to deselect all.



4. Click **OK**.

 **Note:** When a quantitative assessment is performed with CCF, the probability distribution of the CCF is defined in **CCF Group Manager**. The probability distributions associated with basic events are not considered in CCF distributions.

Managing Data

This section describes how to import and export Fault Tree models with Aralia Fault Tree Analyzer.

[About Named Parameters and Attributes](#) on page 84

[Creating a Named Parameter](#) on page 85

[Editing a Named Parameter](#) on page 86

[Associating a Named Parameter to a Probability Distribution](#) on page 88

[Creating an Attribute](#) on page 91

[Editing an Attribute](#) on page 94

[Assigning an Attribute to a Basic Event](#) on page 96

[Importing data](#) on page 100

[Exporting Data](#) on page 100

About Named Parameters and Attributes

This topic describes named parameters and attributes.

To make easier the management of events, Aralia Fault Tree Analyzer provides you with two concepts to enhance these objects with additional information:

Named Parameters

Named parameter is a typed variable having a numerical value.

The possible types of a named parameter are:

- Rate
- Probability
- Duration
- Factor
- Distribution
- Others.

Named parameter can be used to fill numerical values. For example, when a user has to fill probability distribution of basic events with parameters, instead of filling in a numerical value, user can select a defined named parameter.

Several field values can use the same named parameter.

Named parameters are very useful to modify simultaneously several parameters values of components in the model.

Attributes

An Attribute is an additional feature which can be assigned to one or several Basic Events. It allows selecting several Basic events simultaneously.

Attributes can have the following types:

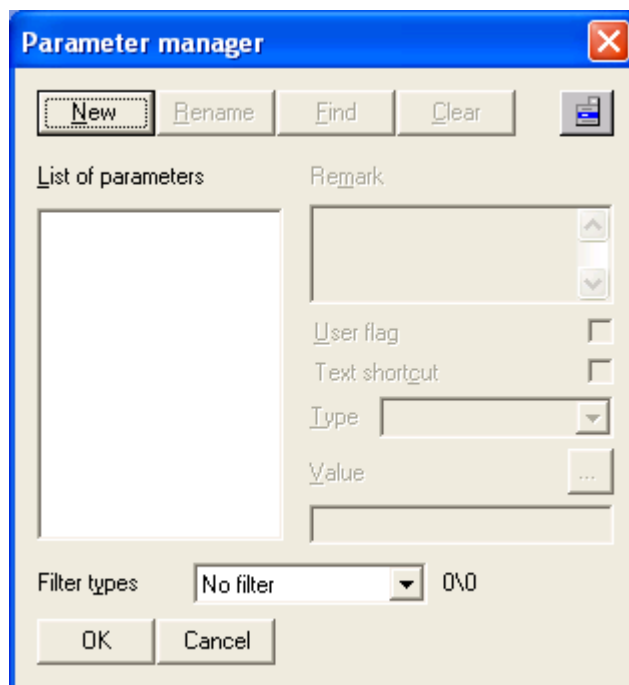
- Real

- String
- Enumeration
- No value.

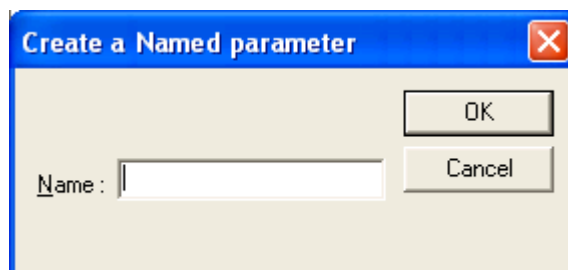
Creating a Named Parameter

You can create a named parameter.

- Launch Aralia Fault Tree Analyzer.
 - Open a Fault Tree model (possibly empty).
1. Select **Data > Parameter Manager...** .
The **Parameter Manager** dialog box appears.

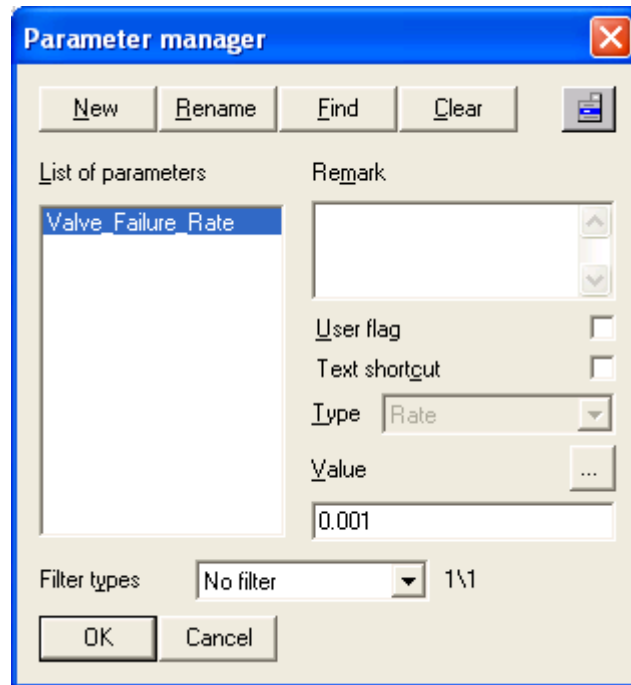


2. Click **New**.
The **Create a Named parameter** dialog box appears.




3. In the Name box, enter a parameter name.
4. Click **Ok**.

The new parameter appears in the **List of parameters** box.



5. In the **Type** box, select the type of the named parameter.

6. In the **Value** box, enter the parameter value.

 **Note:** Named parameter may be a random variable. In that case you can assign a probability distribution (Lognormal or Uniform) to this parameter.

7. Click **Ok** to save the parameter and close the **Parameter Manager** dialog box.

The new named parameter is created.

Editing a Named Parameter

You can rename and delete named parameters.

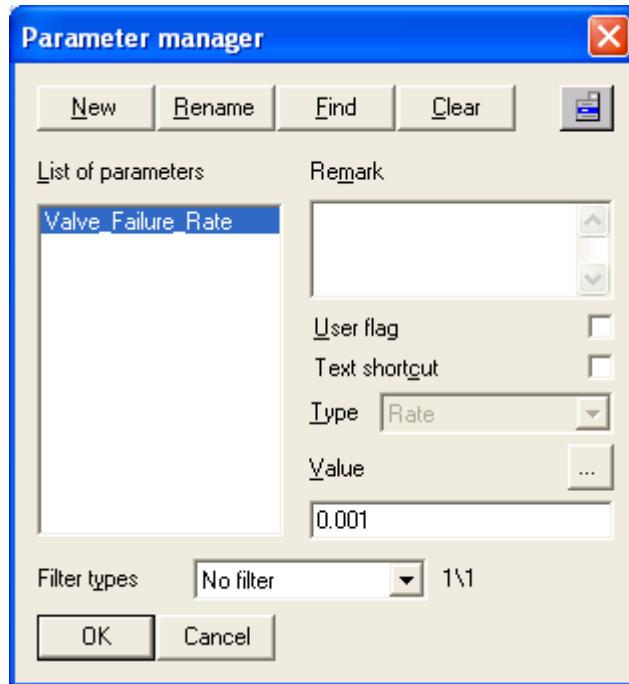
To edit a named parameter open the **Parameter Manager** dialog box.

Create a named parameter.

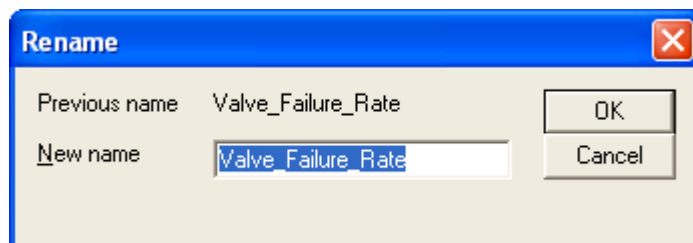
Rename a Named Parameter

You can rename a named parameter.

1. Select **Data > Parameter Manager...**
The **Parameter manager** dialog box appears.




2. In the **List of parameters** box, select a named parameter.
3. Click **Rename**.
The **Rename** dialog box appears.



4. In the **New name** box, enter a new name for the selected parameter.
5. Click **OK**.

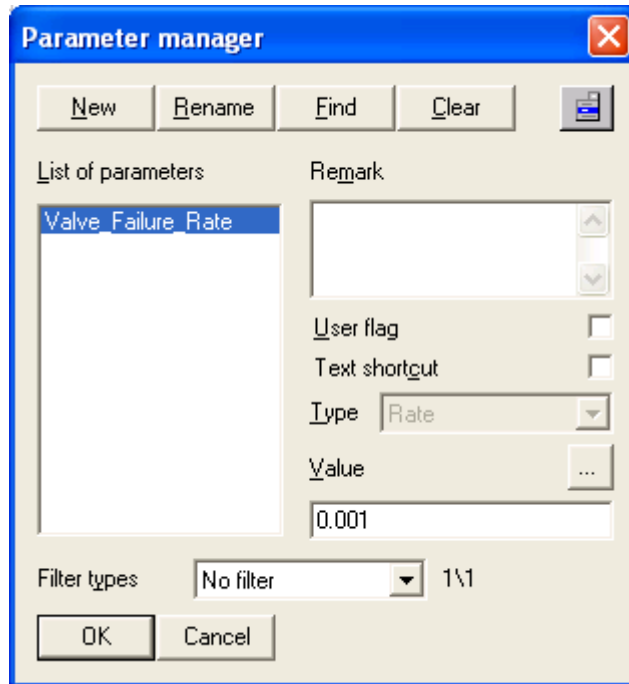
The selected parameter is renamed.

 **Note:** You can also change the type and the value of the selected parameter in the **Parameter Manager** dialog box.

Delete a Named Parameter

You can delete a named parameter.

1. Select **Data > Parameter Manager...**
The **Parameter manager** dialog box appears.



2. In the **List of parameters** box, select a named parameter.

 **Tip:** Use **CTRL** or **SHIFT** to select several parameters.

3. Click **Clear**.
The **Confirmation request** dialog box appears.
4. Click **Yes**.

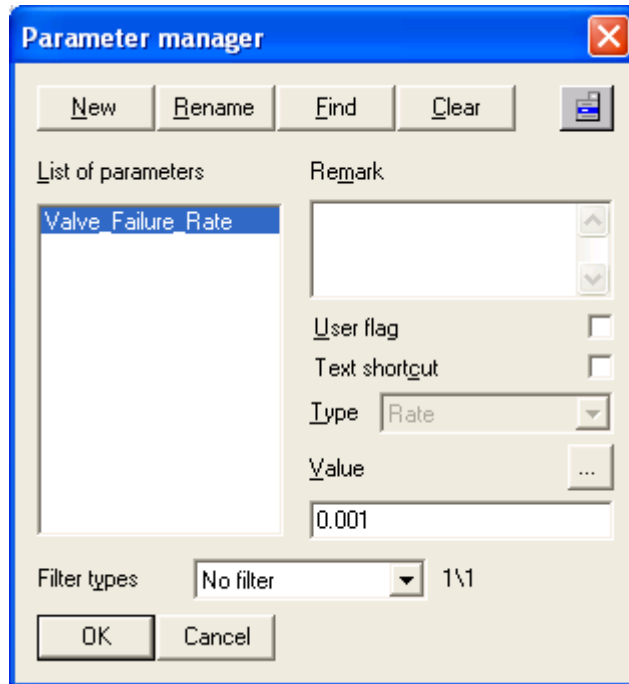
The selected named parameters are removed from the **List of parameters** box.

Associating a Named Parameter to a Probability Distribution

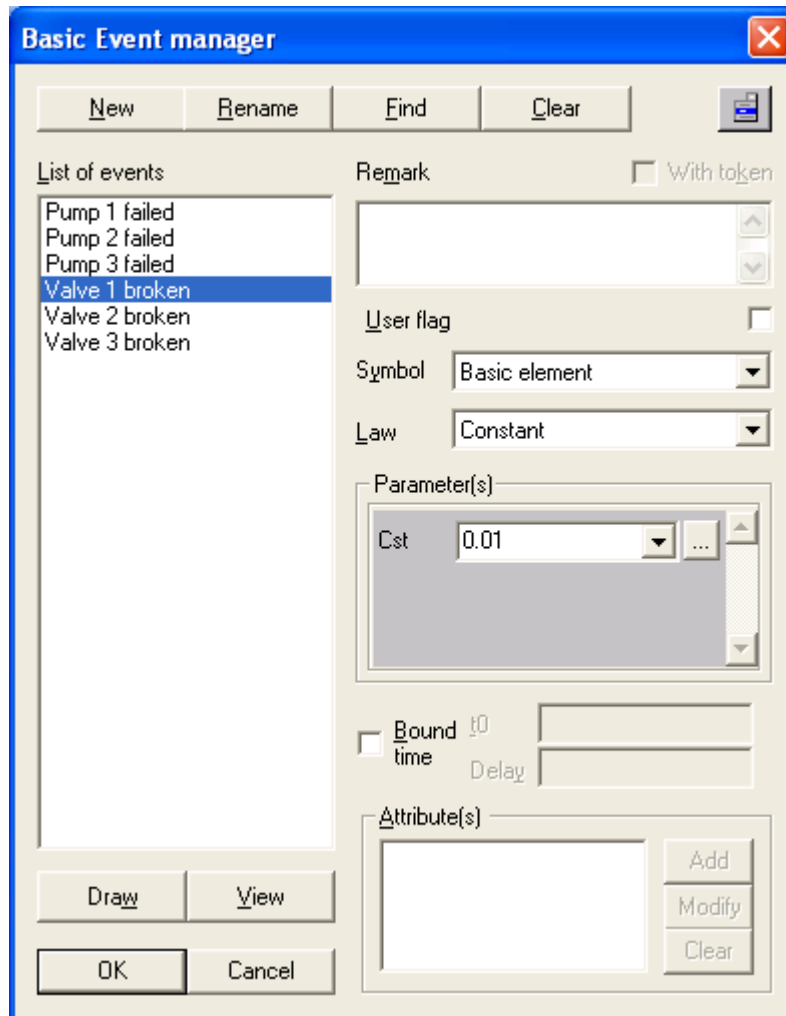
You can associate a named parameter to a probability distribution.

Named parameter can be used as a parameter of a basic event probability distribution. Named parameters are generally used when you have to fill in a numerical value. Several objects can use the same named parameter.

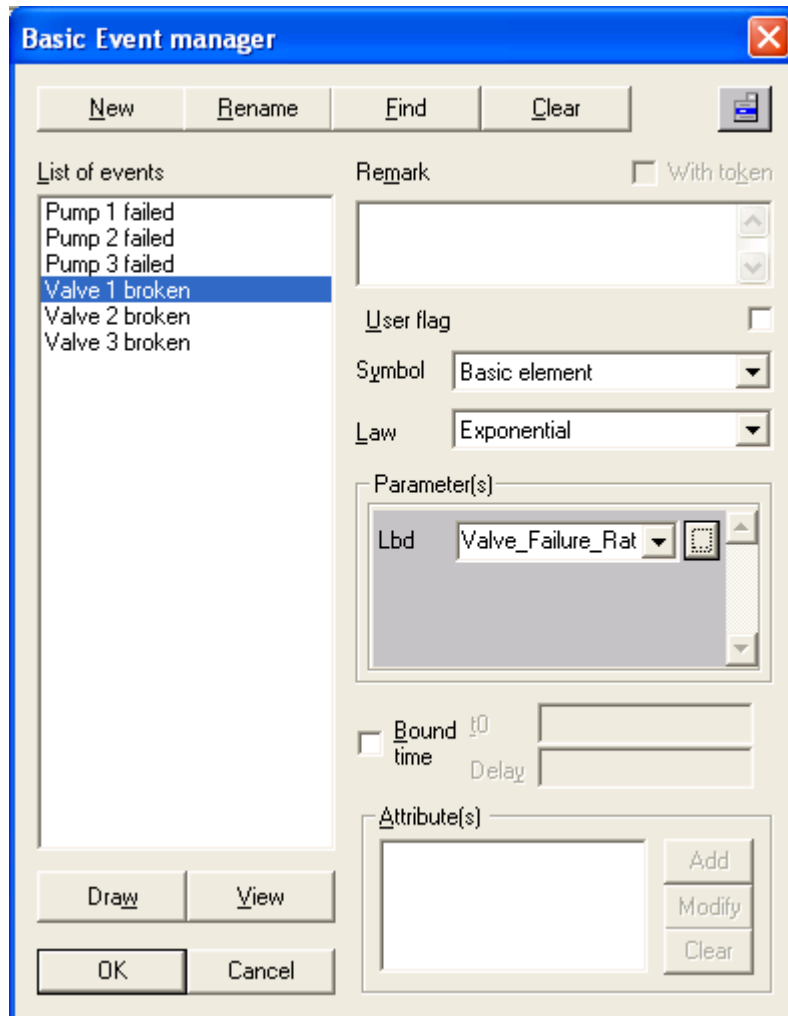
- Launch Aralia Fault Tree Analyzer.
 - Open an existing Fault Tree model.
1. Create a named parameter **Valve_Failure_Rate** of type **Rate**.
See [Creating a Named Parameter](#) on page 85.




2. In the **Basic Event Manager** dialog box, select a basic event in the **List of basic events** box.
See [Editing a Basic Event](#) on page 33.



3. In the **Law** box, select **Exponential**.
4. In the **Parameter(s)** area, select **Valve_Failure_Rate**.



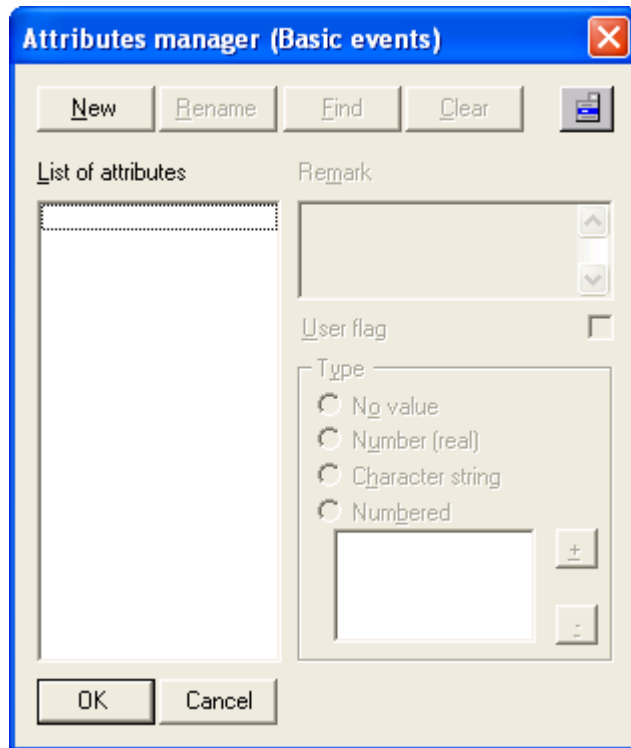
5. Click **OK** to save changes and close **Basic Event Manager** dialog box.

 **Important:** Named parameters are typed. If you select the **Exponential** probability distribution, only named parameters of type **Rate** can be used as parameters of this distribution.

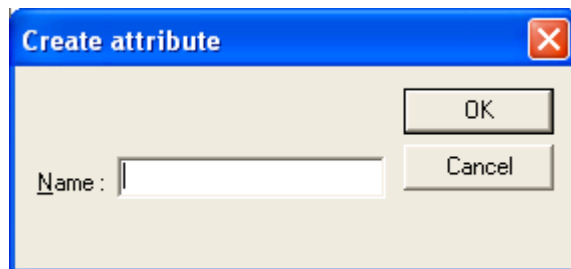
Creating an Attribute

You can create an attribute.

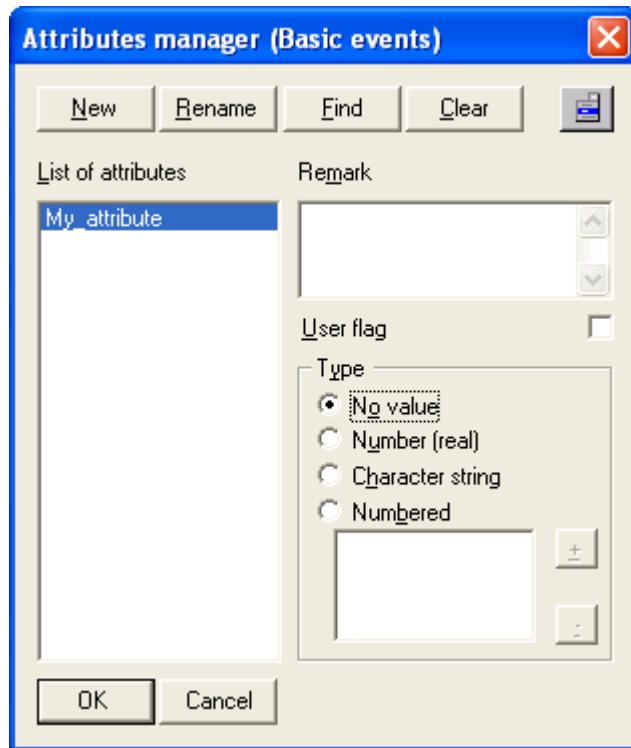
- Launch Aralia Fault Tree Analyzer.
 - Open a Fault Tree model (possibly empty).
1. Select **Data > Attribute Manager...**
The **Attributes manager** dialog box appears.



2. Click **New**.
The **Create attribute** dialog box appears.



3. In the Name box, enter an attribute name.
4. Click **OK**.
The new attribute appears in the **List of attributes** box.

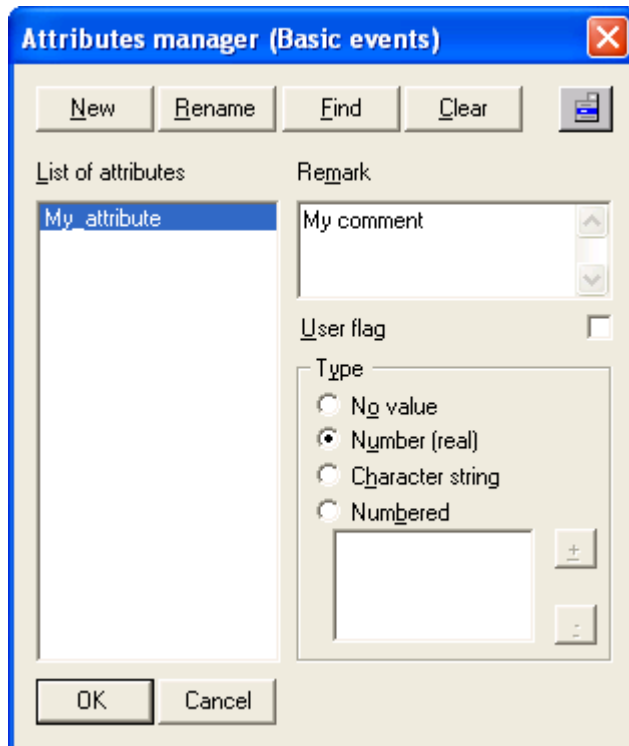



5. In the **Type** area, select the type of the selected attribute.

 **Note:** If you select *Enumeration* type, add its values in the dialog box below.

6. Add comments in the **Remark** dialog box if necessary.

7. Click **OK** to save changes and to close the **Attribute manager** dialog box.



 **Note:** The value of the attribute is not defined in the **Attribute manager** dialog box, but when the attribute is assigned to a basic event.

Editing an Attribute

You can edit an attribute.

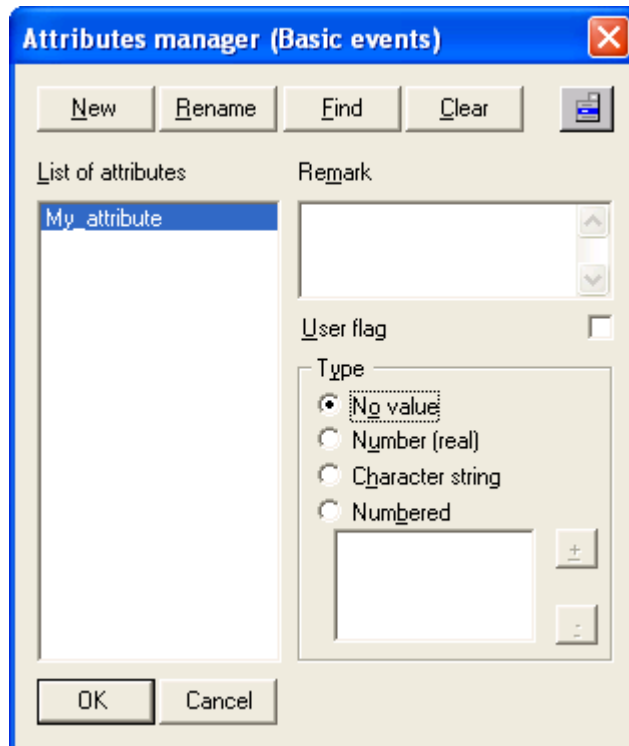
To edit an attribute open **Attribute manager** dialog box.

Create an attribute. See [Creating an Attribute](#) on page 91.

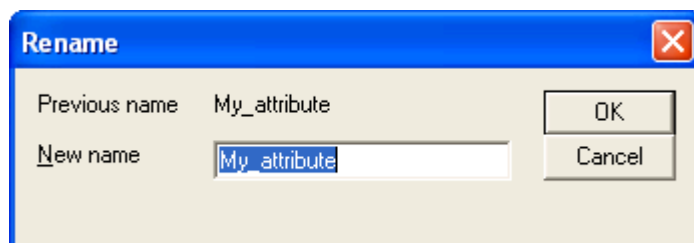
Rename an Attribute

You can rename an attribute.

1. Select **Data > Attribute Manager...**
The **Attributes manager** dialog box appears.




2. In the **List of attributes** box, select an attribute.
3. Click **Rename**.
The **Rename** dialog box appears.



4. In the **New name** box, enter new name.
5. Click **OK**.

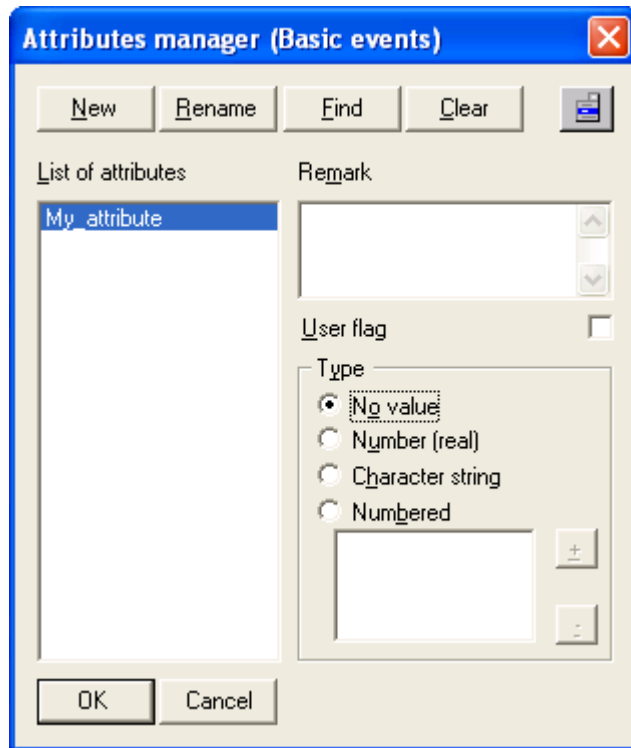
The attribute is renamed.

 **Note:** You can also change the type of the selected attribute and add comments in the **Attribute manager** box.


Delete an Attribute

You can delete an attribute.

1. Select **Data > Attribute Manager...**



2. In the **List of attributes** box, select an attribute.

 **Tip:** Use **CTRL** or **SHIFT** to select several attributes from the list.

3. Click **Clear**.
The **Confirmation request** dialog box appears.
4. Click **Yes**.

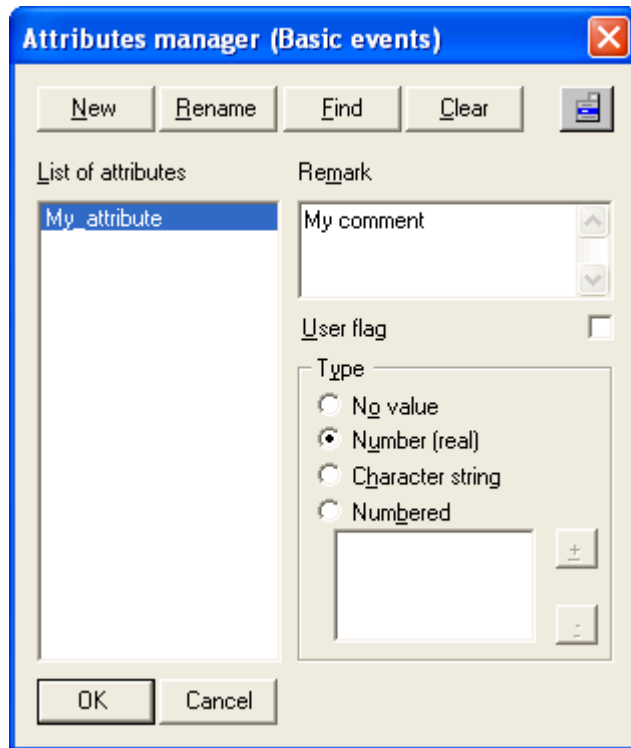
The selected attributes are removed from the list.

Assigning an Attribute to a Basic Event

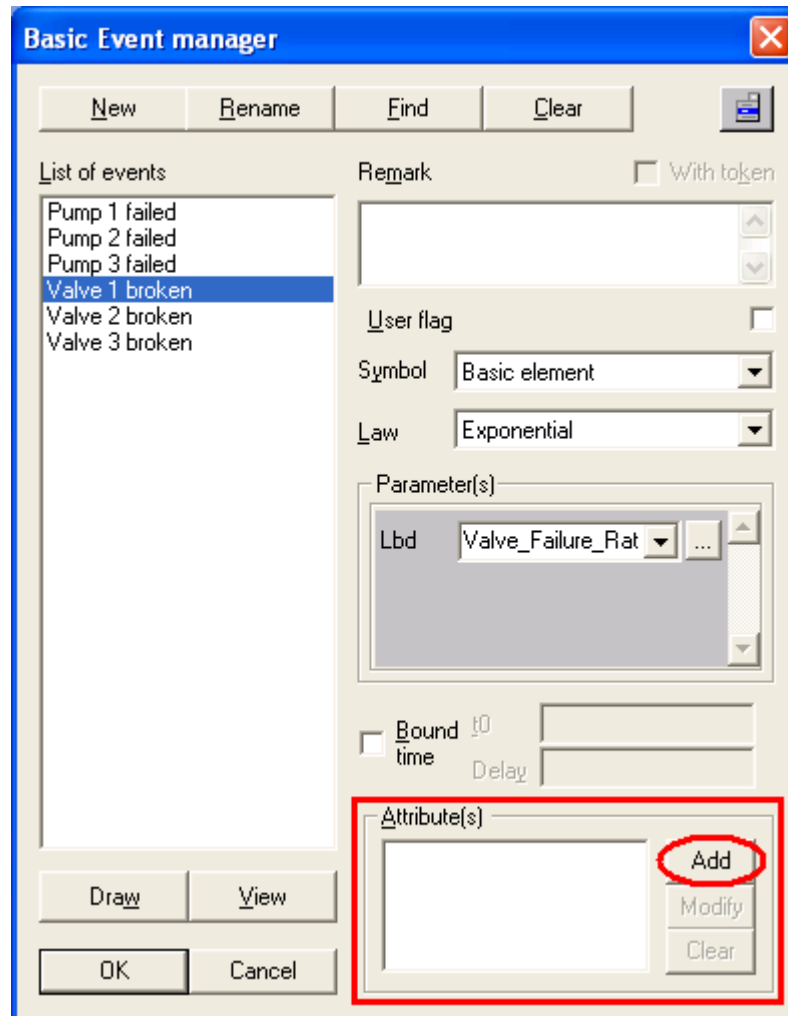
You can assign an attribute to a basic event. You can also assign a value to this attribute.

- Launch Aralia Fault Tree Analyzer.
- Open a Fault Tree model.

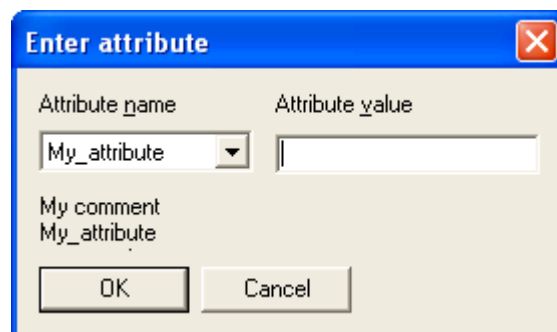
1. Create an attribute.
See [Creating an Attribute](#) on page 91.



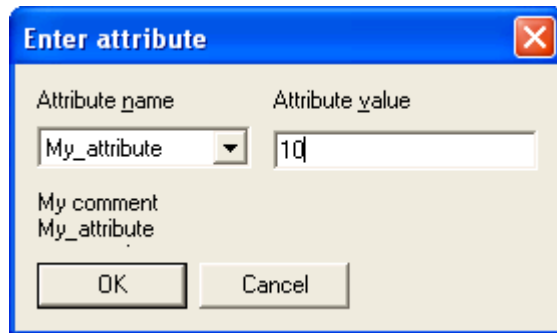
2. In the **Basic Event Manager** dialog box, select a basic event in the **List of basic events** box.
See [Editing a Basic Event](#) on page 33.



3. In the **Attribute(s)** area, click **Add** to add the created attribute.
The **Enter attribute** dialog box appears.



4. Select the attribute and enter its value in the **Attribute value** box.



Enter attribute

Attribute name Attribute value

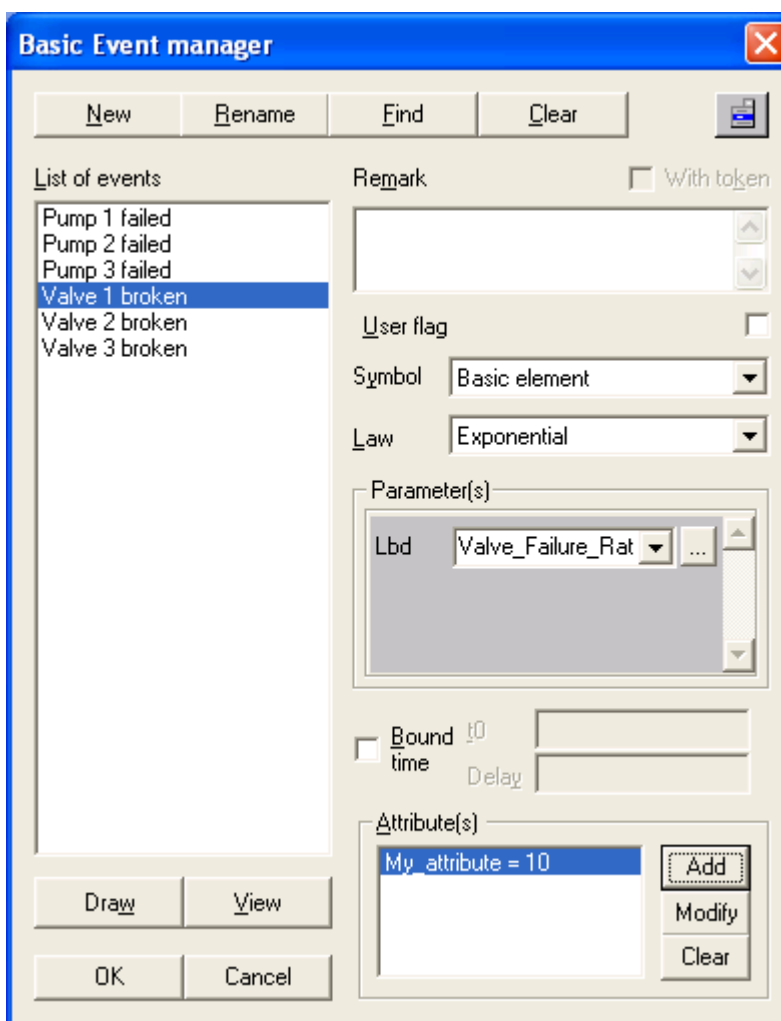
My_attribute 10

My comment
My_attribute


OK Cancel

5. Click **OK**.

The selected basic event is characterized by the **My_attribute** attribute.



Basic Event manager

New Rename Find Clear 

List of events Remark ☐ With token

Pump 1 failed
Pump 2 failed
Pump 3 failed
Valve 1 broken
Valve 2 broken
Valve 3 broken

User flag ☐

Symbol Basic element

Law Exponential

Parameter(s)

Lbd Valve_Failure_Rat ...


☐ Bound time
Delay

Attribute(s)

My_attribute = 10 Add Modify Clear

Draw View

OK Cancel

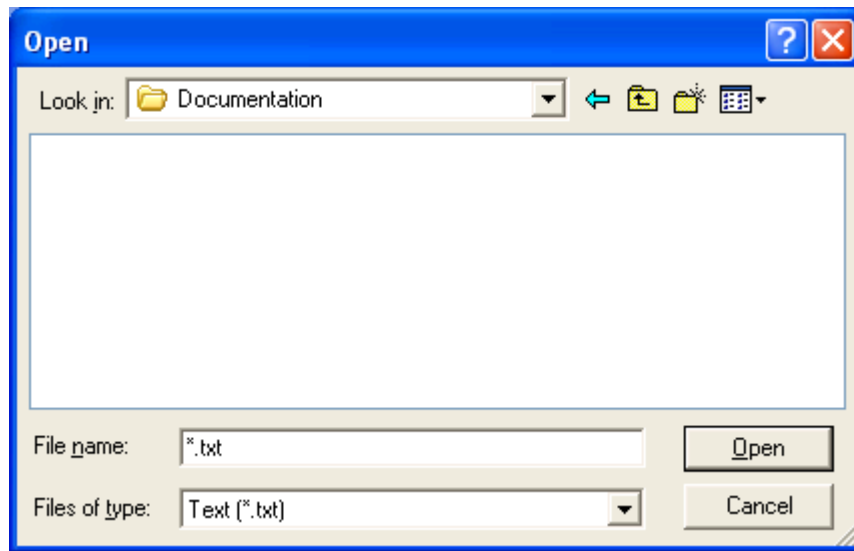
 **Note:** It is possible to assign multiple attributes to a basic event.

Importing data

You can import data to the Aralia Fault Tree Analyzer .

Launch Aralia Fault Tree Analyzer and open a Fault Tree model.

1. Select **Data > Import data....**
The **Open** dialog box appears.



2. Select the file to import.
3. Click **Open**.

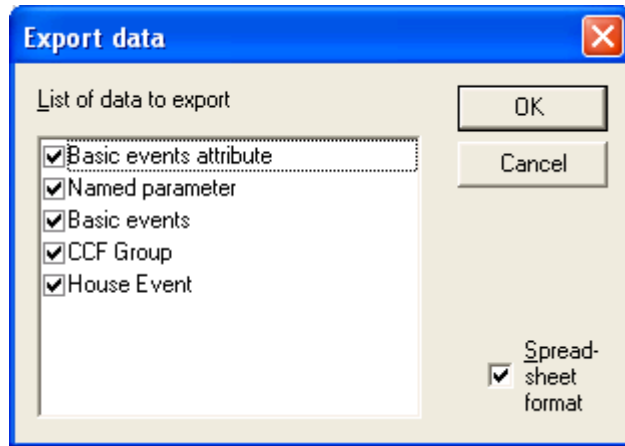
Exporting Data

You can export data from Aralia Fault Tree Analyzer.


Aralia Fault Tree Analyzer allows exporting different types of the Fault Tree model data to ASCII file.

Launch Aralia Fault Tree Analyzer and open a Fault Tree model.

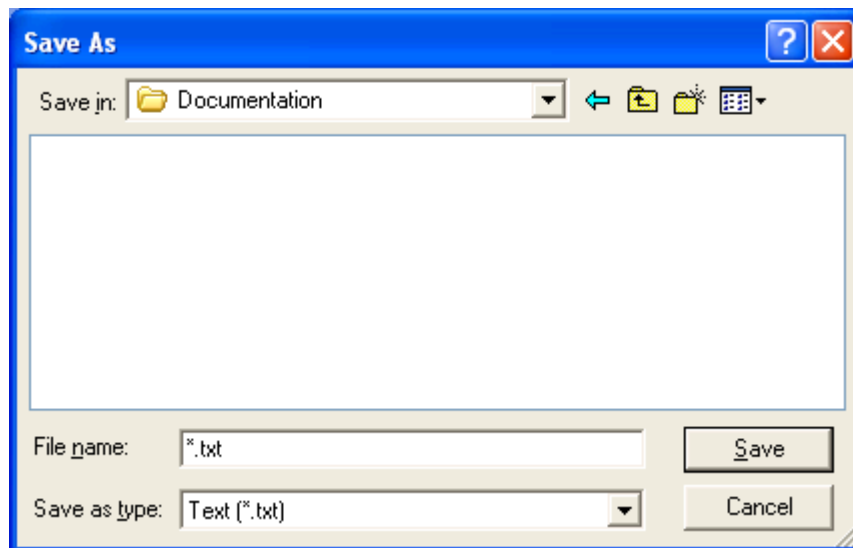
1. Select **Data > Export data....**
The **Export data** dialog box appears.



2. Select the data to export.

 **Note:** Select **Spreadsheet format** to export data in spreadsheet format.

3. Click **OK**.
The **Save as** dialog box appears.



4. Enter the file name.
5. Select the directory to save the file.
6. Click **Save**.

The data is exported to the selected file.

Performing Calculations

This section describes how to perform calculations with BPA-FT9 Aralia Fault Tree Analyzer.

[*About Fault Tree Assessment*](#) on page 102

[*Setting up Calculation Engine Aralia*](#) on page 104

[*Calculating Minimal Cutsets*](#) on page 105

[*Calculating Top Event Probability*](#) on page 109

[*Calculating Safety Integrity Levels\(SIL\)*](#) on page 113

[*Exporting Results*](#) on page 115

About Fault Tree Assessment

This page describes fault tree assessment.

Aralia Fault Tree Analyzer embeds a powerful engine to process Fault Trees: Aralia. Aralia is a calculation engine for processing probabilistic Boolean formulae. It relies on a coding of the formulae in Binary Decision Diagrams (BDD). They are used to perform:

Qualitative Assessment

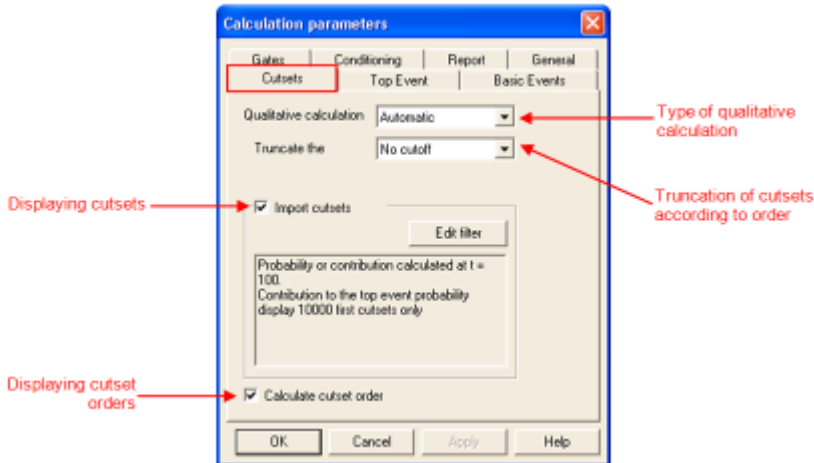
Qualitative assessment of Fault Trees includes the calculation of minimal cutsets or prime implicants.

Minimal cutsets are the key stone of the reliability studies. A minimal cutset is a minimal set of basic events that induces the occurrence of the top event.

This definition is not sufficient in case of non-coherent Fault Trees. In this case, the notion of minimal cutset is substituted by the notion of prime implicant. Prime implicants are sets of literals, i.e. they may contain negated variables, inducing the occurrence of the top event.

In Aralia Fault Tree Analyzer you can set up the type of qualitative assessment to be performed from the menu **Aralia > Setup**. Various processing algorithms are available. According to the Fault Tree structure (coherent, non-coherent) some algorithms are more efficient.

To set up qualitative assessment click the tab **Cutsets** in the **Calculation parameters** dialog window:



Note: Select *Automatic* mode for the **Qualitative calculation**. Aralia engine will select the relevant type of calculation (minimal cutset or prime implicant).

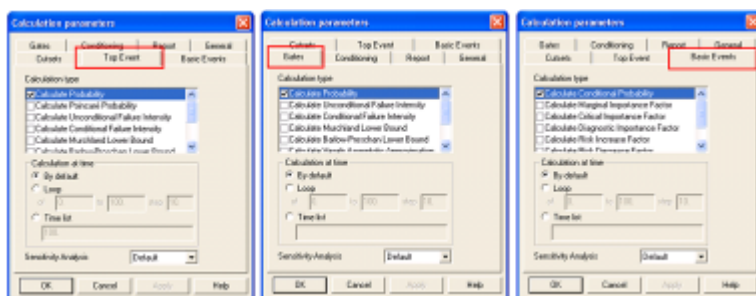
Quantitative Assessment

Quantitative assessment is the calculation of probability of different events of the Fault Tree and importance factors using probability distributions of basic events. Exact computations are performed with BDD (Binary Decision Diagram) based on the Shannon decomposition.

Quantitative assessment can be performed for:

- Top event;
- Gates;
- Basic events.

To select the type of calculation, click the tabs **Top Event**, **Gates**, **Basic Event** of the **Calculation parameters** dialog window available from the menu **Aralia > Setup > Aralia...** and check the box of the calculation type:



SIL Assessment

This topic describes SIL assessment.

Safety Integrity Levels (SIL) are defined by the norms IEC 61508 and IEC 61511. They are *"the measure of the quality or the dependability of a system which has a safety function"*, or in other words, *"the measure of the confidence with which the system can be expected to perform that function"*.

Safety Integrity Levels (SIL) are defined differently whether functions are with a low or high demand rate. In Aralia Fault Tree Analyzer only functions with a low demand rate are considered. In that case, the Safety Integrity Level L of a system S at time t is derived straight from the unavailability by the following formula:

$$10^{-(L+1)} \leq Q_s(t) < 10^{-L}$$

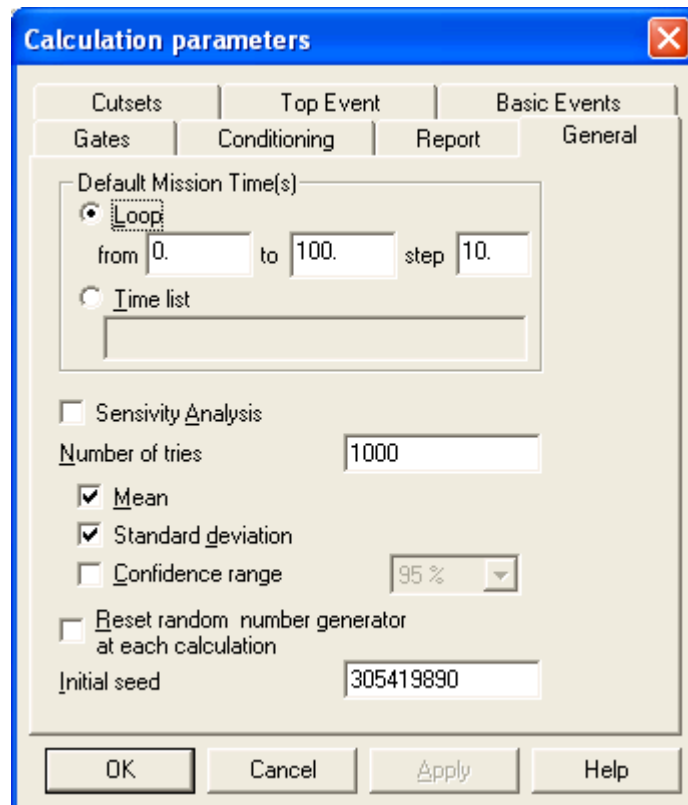
In the cited forms, levels 1 to 4 are considered.

Setting up Calculation Engine Aralia

You can set up the calculation engine Aralia.

To perform Fault Tree analysis with Aralia Fault Tree Analyzer you should first set up the calculation engine Aralia and then launch the calculation.

- Launch Aralia Fault Tree Analyzer.
 - Create a Fault Tree or open an existing Fault Tree Model.
1. Select **Aralia > Set up > Aralia**.
The **Calculation parameters** dialog box appears.



2. In the **Calculation parameters** dialog box you can choose the calculation type to be performed:
 - Click the **Cutsets** tab to set the calculation of minimal cutsets or prime implicants.

- Click the **Top Event** tab to set up the calculation of the top event probability or other quantitative values available to be computed for the Top event.
 - Click the **Gates** tab to set up the calculation of quantitative values available for gates.
 - Click the **Basic events** tab to set up the calculation of quantitative values available for basic events.
 - Click the **General** tab to set up the performance of sensitivity analysis.
3. Select the values to compute.
 4. Click **OK**.

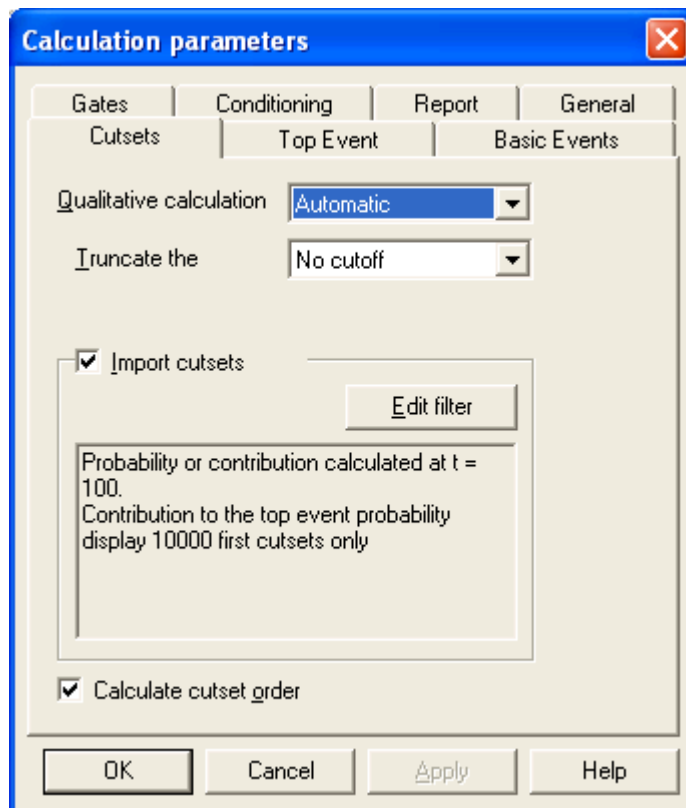
The calculation engine is set up. You can launch the calculation by selecting **Aralia > Calculate**.

Calculating Minimal Cutsets

You can calculate minimal cutsets of a Fault Tree.

You should first set up the calculation engine and then launch the calculation.

- Launch Aralia Fault Tree Analyzer.
 - Create a Fault Tree or open an existing Fault Tree model.
1. Select **Aralia > Set Up > Aralia...**
The **Calculation parameters** dialog box appears.



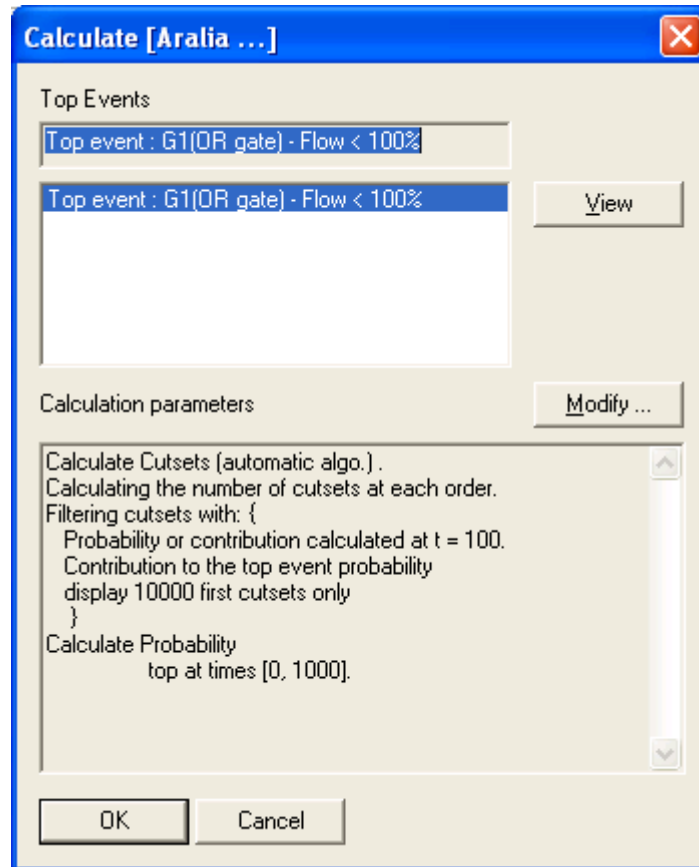
2. In the tab **Cutsets**,
 - a) In the **Qualitative calculation** box, select **Automatic**.

- b) In the **Truncate** box, select **No cutoff**.
- c) Select **Import cutsets** to display the result.
- d) Select **Calculate cutset order**.
- e) Click **OK**.


The calculation engine has been set up.

- 3. Select **Aralia > Calculate > Aralia....**

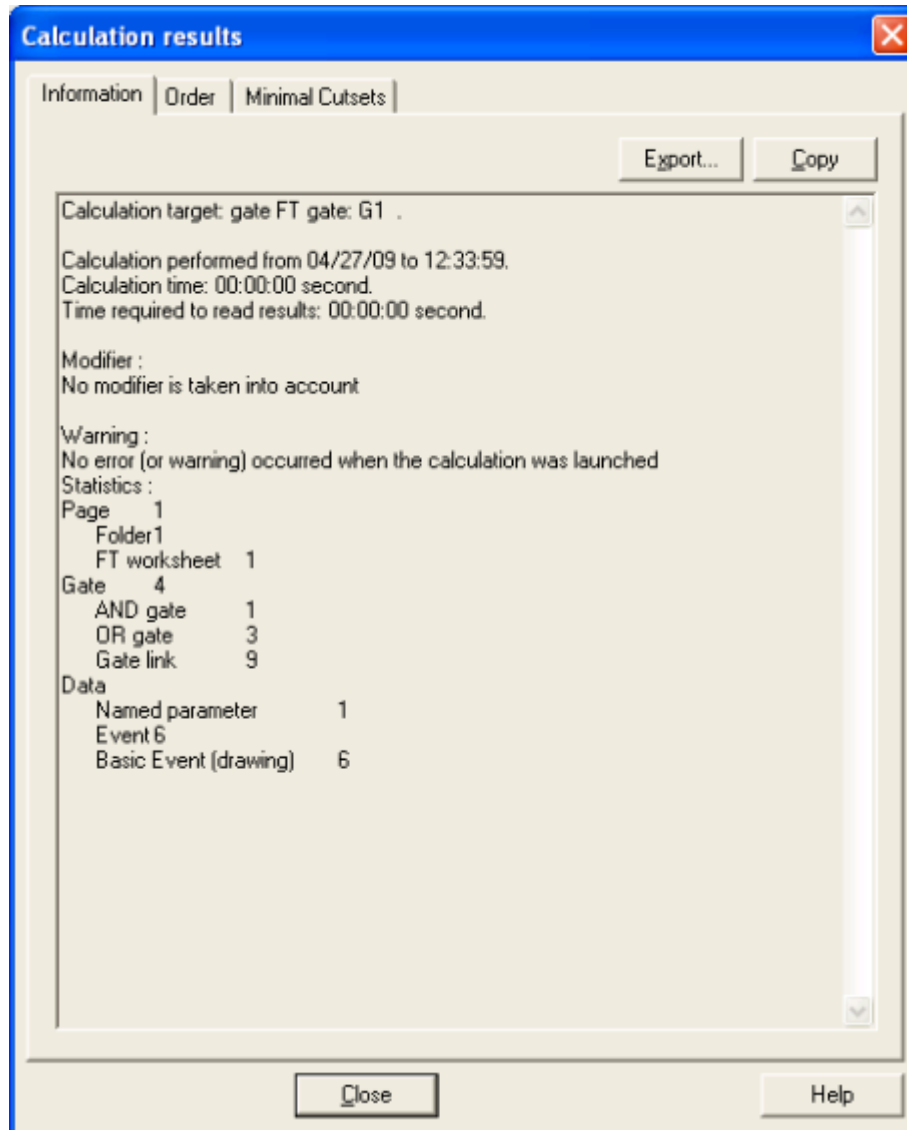
The **Calculate [Aralia...]** dialog box appears.



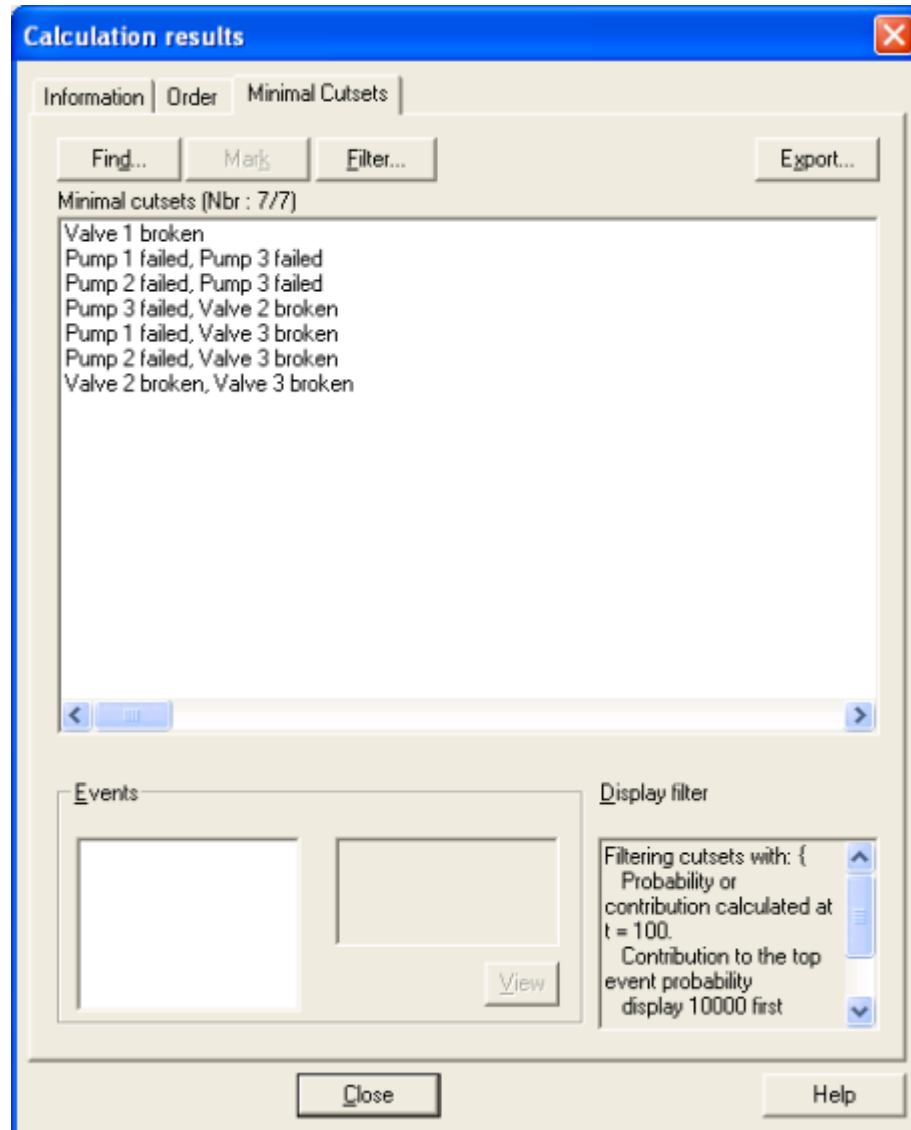
- 4. Click **OK** to launch the calculation.

 **Note:** To change calculation parameters click **Modify....**

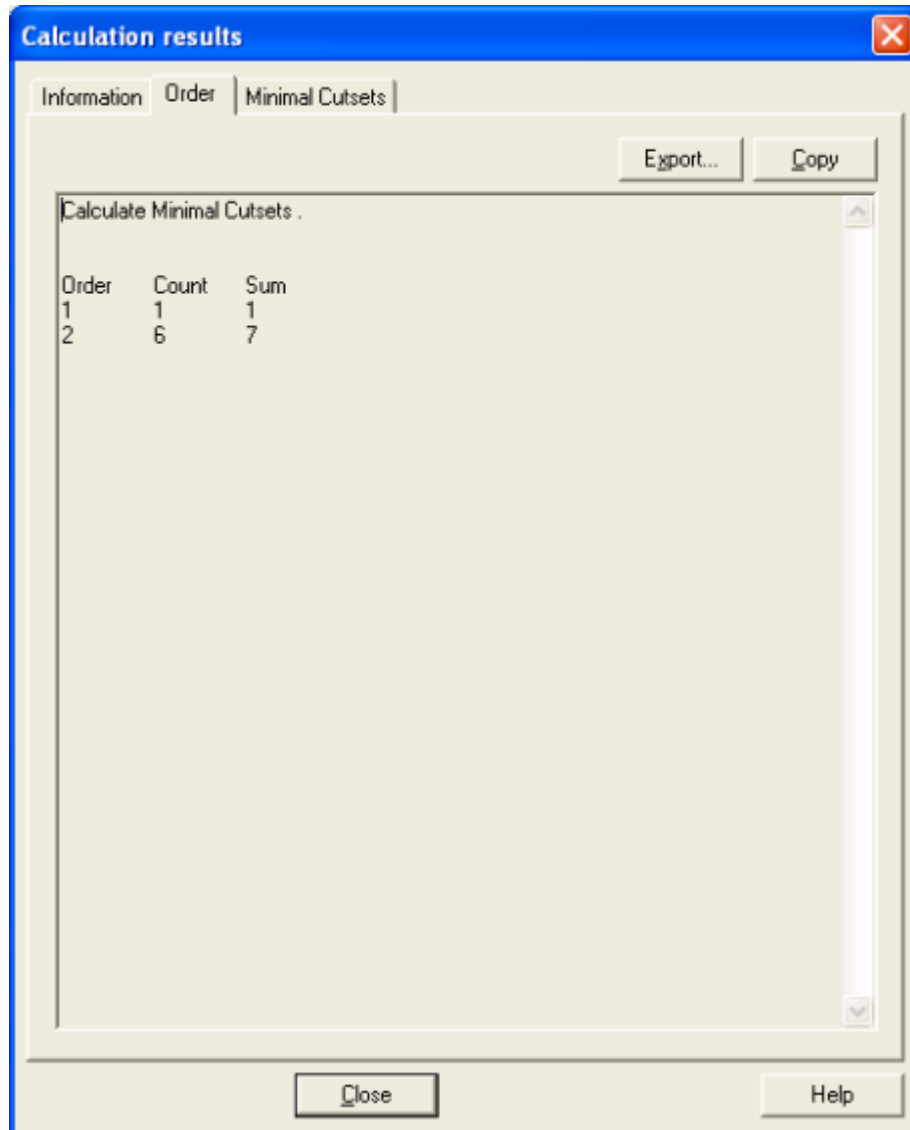
The **Calculation results** dialog box appears.



5. Click the **Minimal cutsets** tab to view the list of minimal cutsets.



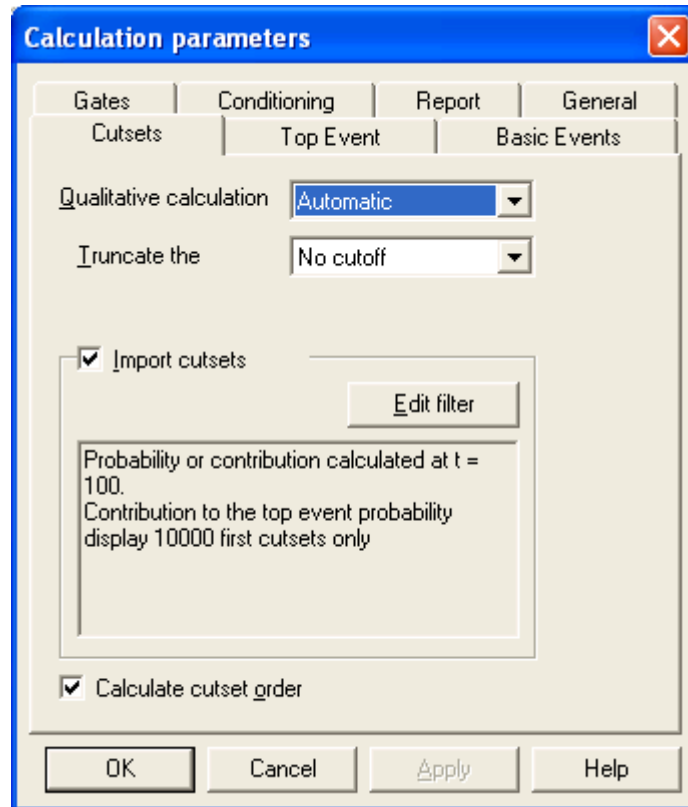
6. Click the **Order** tab to view the order of cutsets.



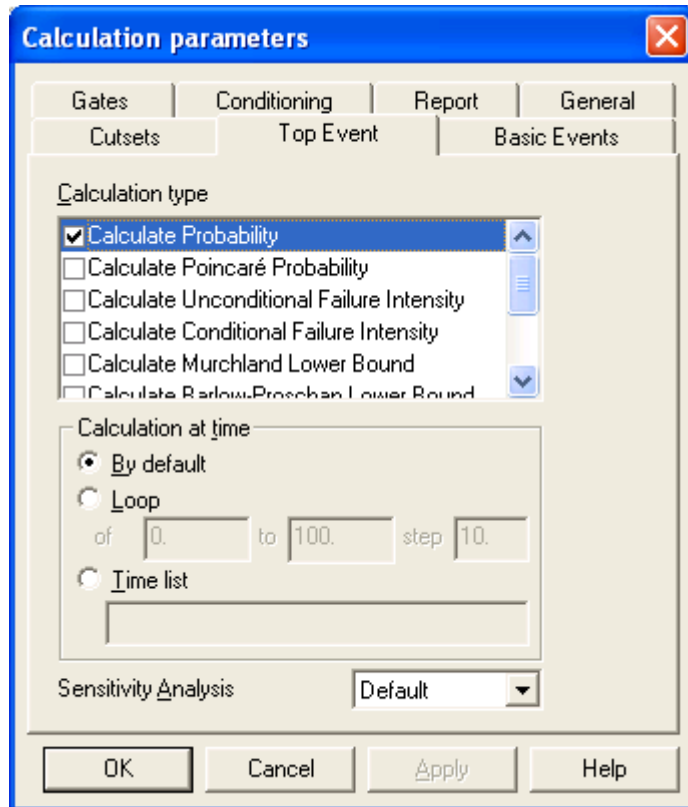
Calculating Top Event Probability

You can calculate Top Event probability.

- Launch Aralia Fault Tree Analyzer.
 - Create a Fault Tree or open an existing Fault Tree model.
1. Select **Aralia > Set up > Aralia**.
The **Calculation parameters** dialog box appears.



2. Select the **Top Event** tab.




3. Set up the calculation engine:
 - a) In the **Calculation type** box, select **Calculate Probability**.
 - b) In the **Calculation at time** area, select **By default**.
 - c) In the **Sensitivity Analysis** box, select **Default**.
 - d) Click **OK**.

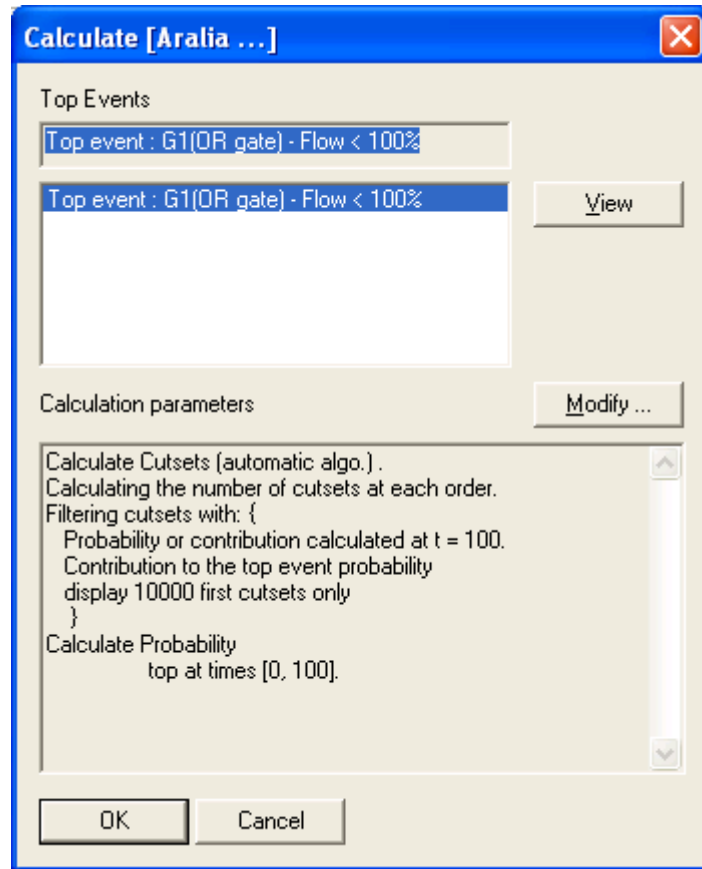
 **Note:** From **Calculation parameters** dialog box you can select different types of calculation.

The calculation engine has been set up.

4. Select **Aralia > Calculate > Aralia...**

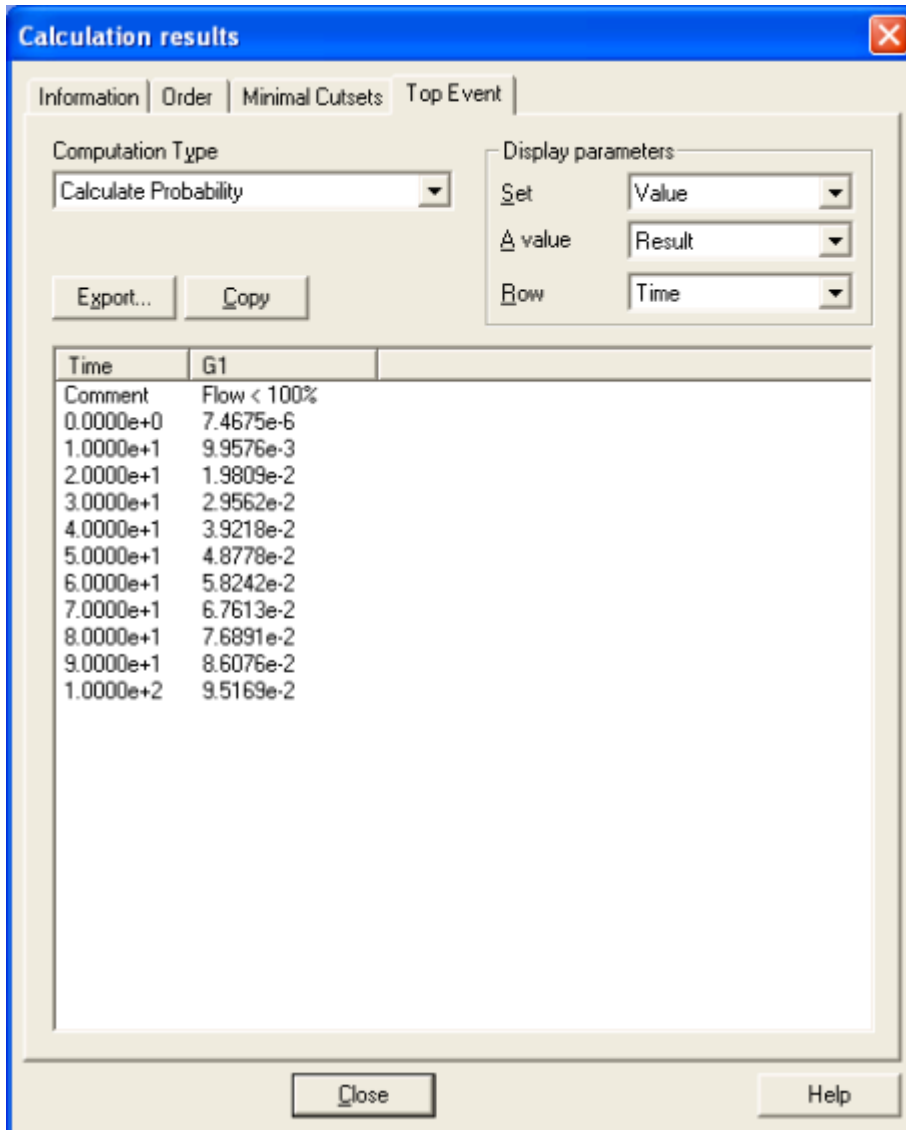
 **Note:** To change calculation parameters click **Modify...**

The **Calculate [Aralia...]** dialog box appears.



5. Click **OK**.

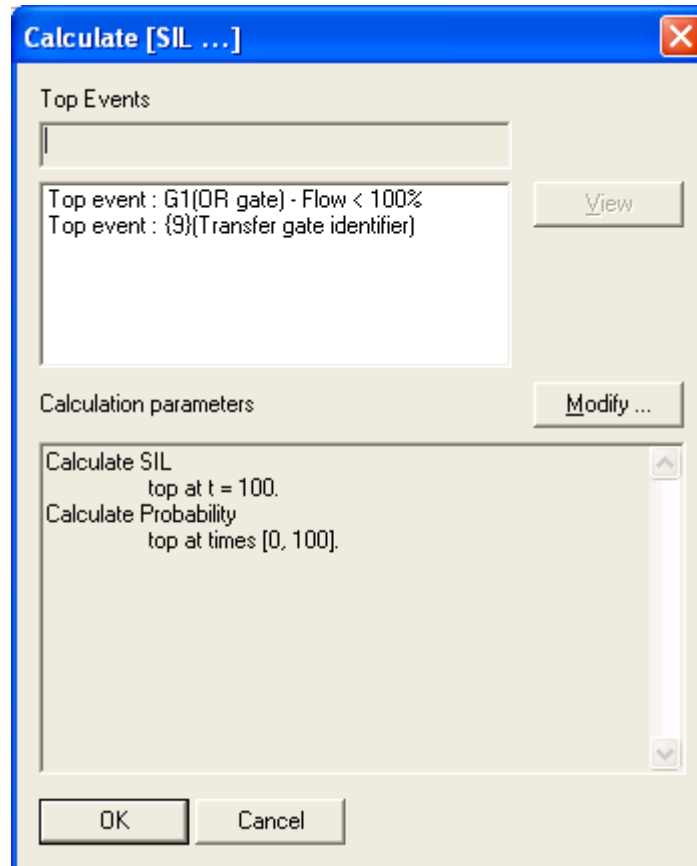
The **Calculation results** dialog box appears. The results are displayed in the **Top Event** tab.



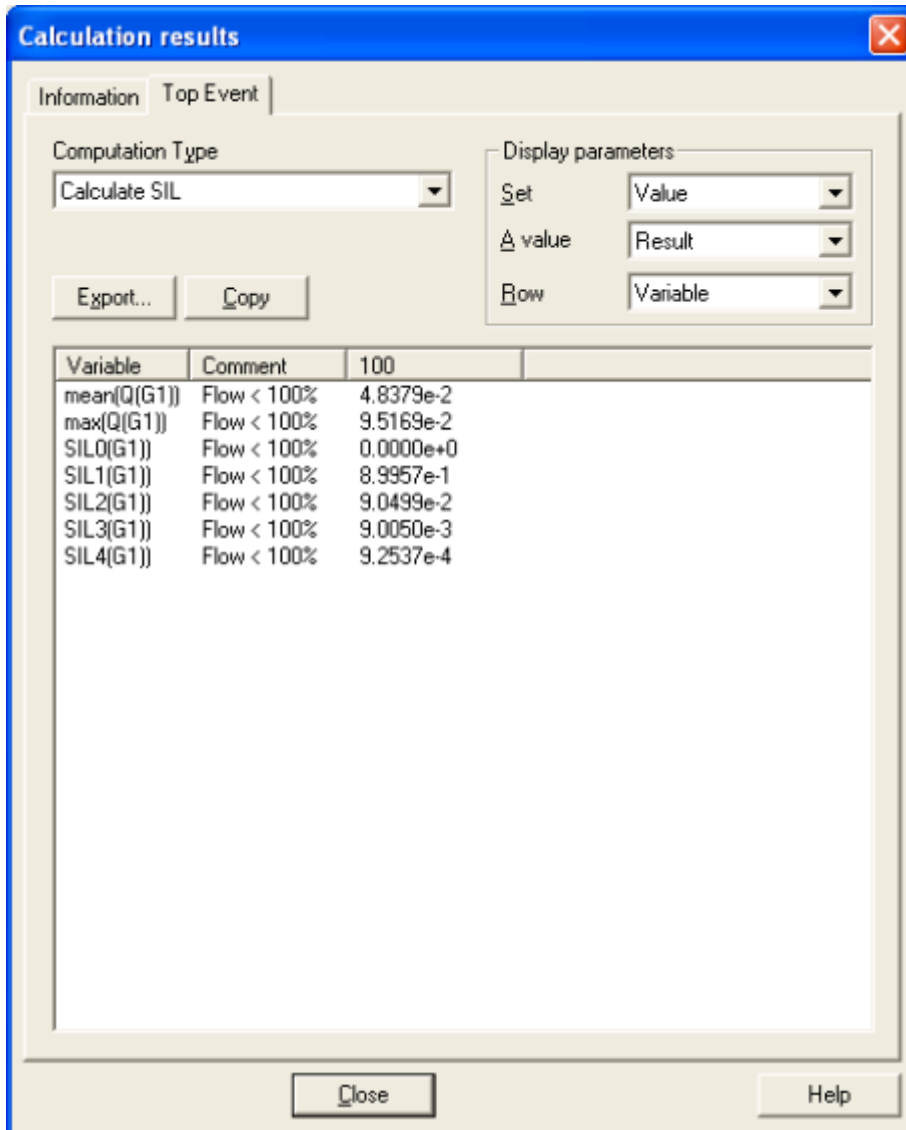
Calculating Safety Integrity Levels(SIL)

You can calculate Safety Integrity Levels (SIL).

- Launch Aralia Fault Tree Analyzer.
 - Create a Fault Tree or open an existing Fault Tree model.
1. Select **Aralia > Calculate > SIL....**
The **Calculate [SIL...]** dialog box appears.



2. Click **OK** to launch calculations.
The **Calculation results** dialog box appears.



Exporting Results

You can generate a report containing calculation results.

Create or open an existing Fault Tree model.

1. Select **Aralia > Setup > Aralia...**

 **Note:** You can also select **Aralia > Setup > SIL...**

The **Calculation parameters** dialog box or **Options for Safety Integrity Levels** dialog box appears.

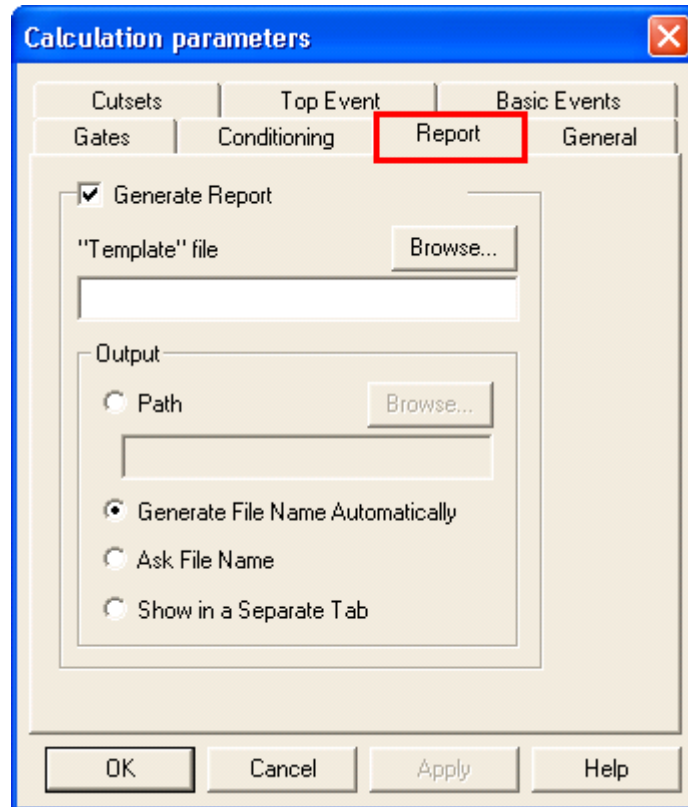


Figure 5: Calculation parameters dialog box

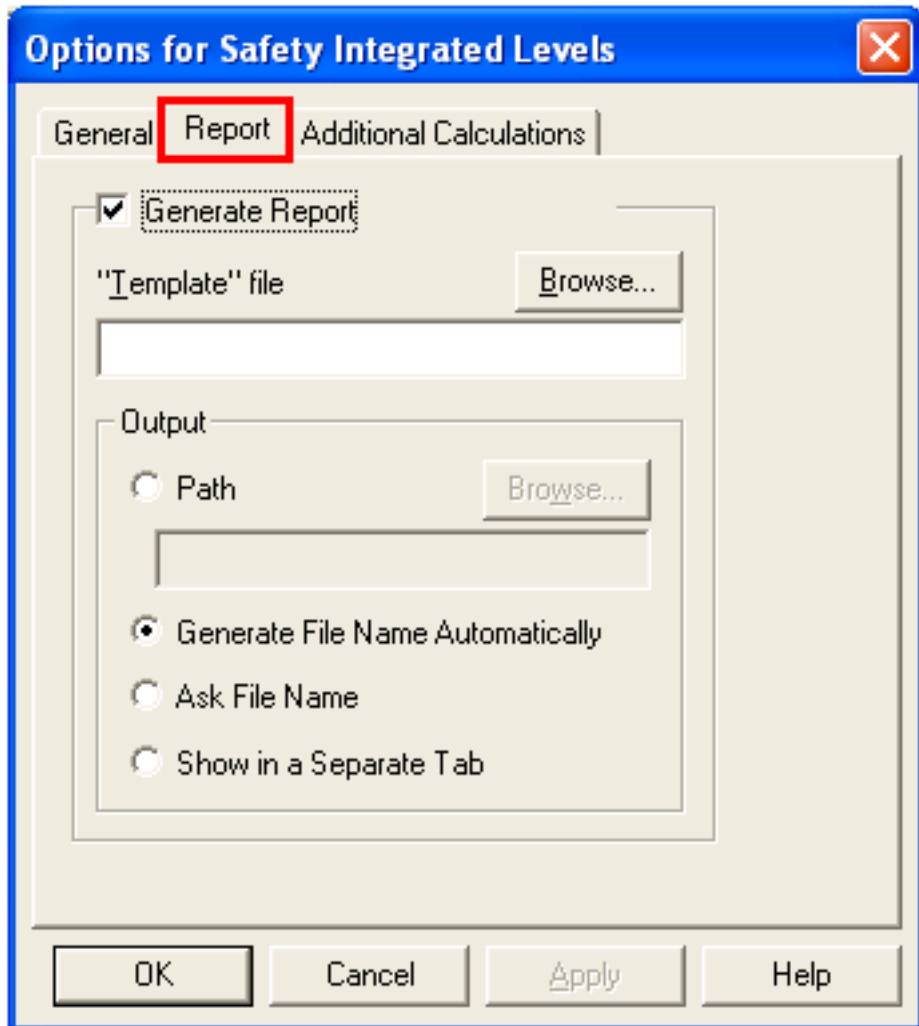


Figure 6: Options for Safety Integrity Levels dialog box

2. Select the **Report** tab.
3. Select the **Generate Report** check box.

 **Note:** The format of the report is defined by a Template file . This template contains local fields which specify the type of results. See [About Dynamic Fields](#) on page 129.

4. Click **OK**.

When calculations are performed, the report containing the results of calculations is generated.

Formatting a Model

This section describes how to insert charts and display calculation results in the worksheets.

Creating a Chart on page 118

Editing a Chart on page 122

Inserting a Shape in the Current Worksheet on page 127

About Dynamic Fields on page 129

Inserting a Local Field in a Shape on page 130


Inserting a Global Field on page 132

Generating a Report on page 134

Creating a Chart

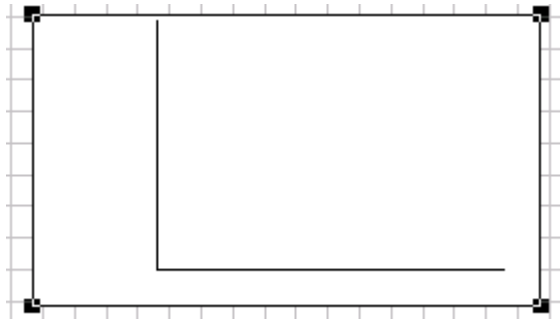
You can insert a chart in the current worksheet and display results.

Create or open an existing Fault Tree model.

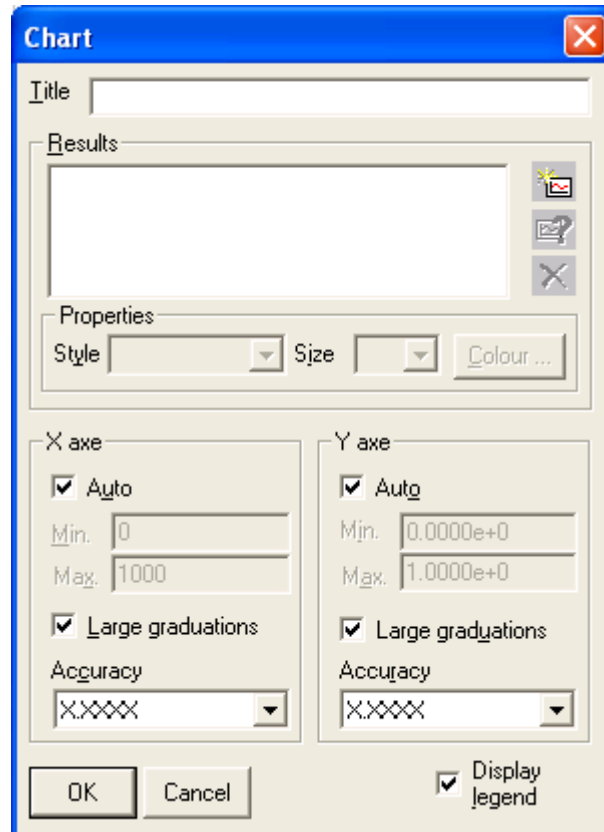
1. Click **Chart**  in the **Graphic** toolbar.


 **Note:** You can select **Drawing > Shapes > Chart**.

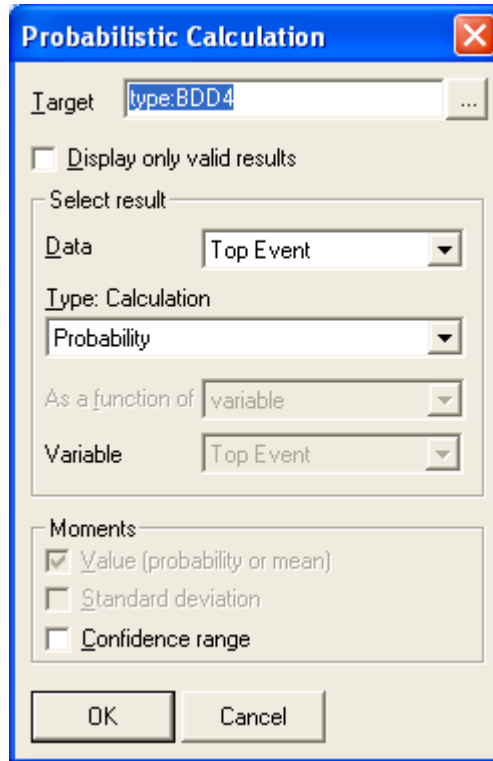
2. Drag and drop to define the position and the size.
An empty chart is inserted:



3. Right-click on the empty chart to define the type of result to be displayed in the chart (probability).
The **Chart** dialog box appears.

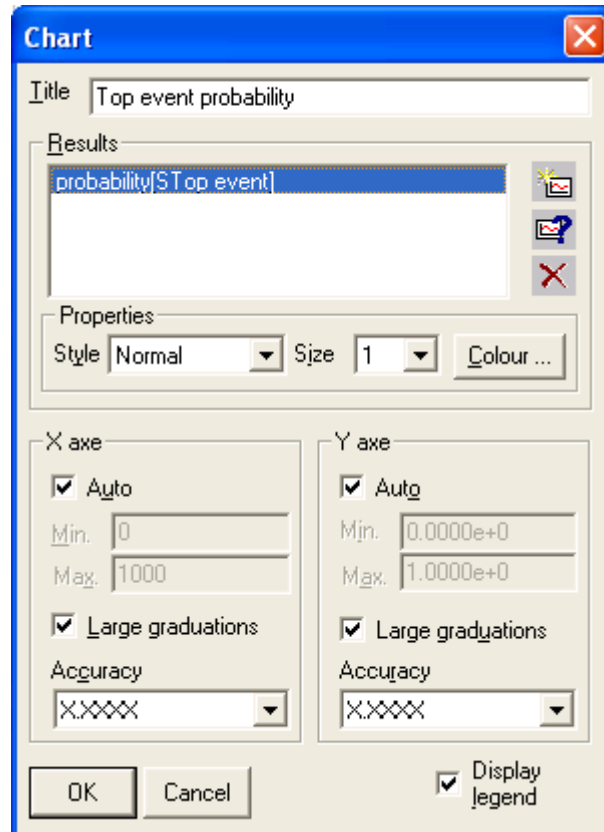



4. In the **Title** box, enter the title of the chart.
5. In the **Results** area, click the icon  to select the type of calculation to be displayed. The **Probabilistic calculation** dialog box appears.



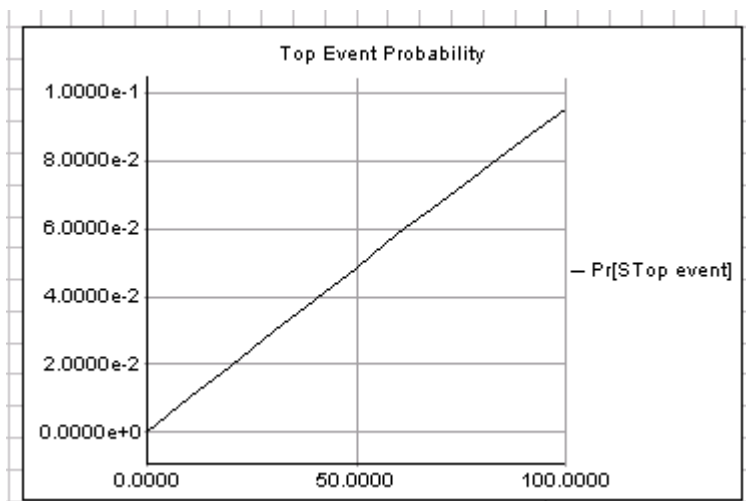
6. In the **Probabilistic calculation** dialog box:
 - a) In the **Select result** area, in the **Data** box select the object: **Top event, gate** or **basic** event.
 - b) In the **Type: Calculation** box, select the calculation result to be displayed.
 - c) If **Gates** or **Basic Events** are selected in the **Data** box, in the **Variable** dialog box select the element to be concerned.
 - d) Click **OK**.


The result to display appears in the **Results** box.



 **Note:** You can add multiple results to display on the same chart.

7. Click **OK**.



 **Note:** A particular type of calculation results can be displayed on a chart, only if Aralia calculation engine is configured to assess this type of calculation and the calculation has been done. Every time the calculation is launched, the chart is updated.

Editing a Chart

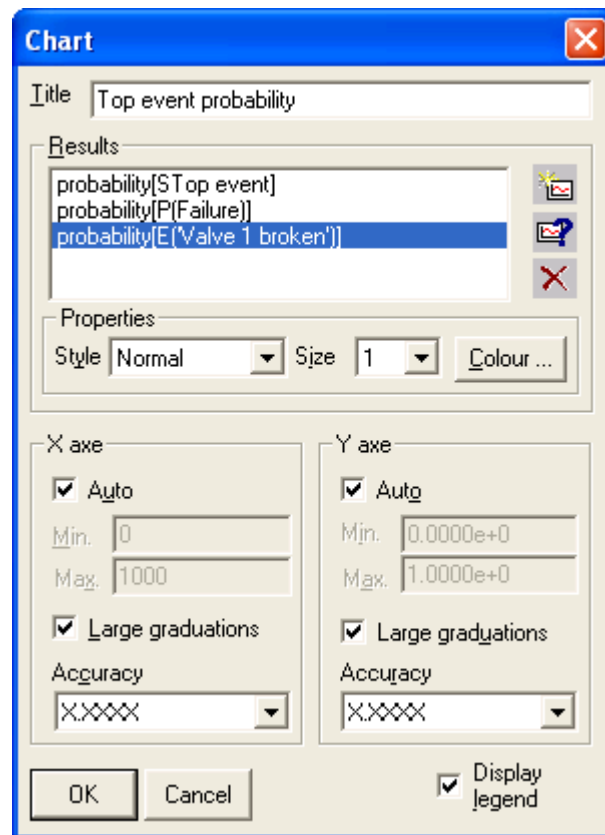
You can edit a chart.


Create a chart in the current worksheet. See [Creating a Chart](#) on page 118.

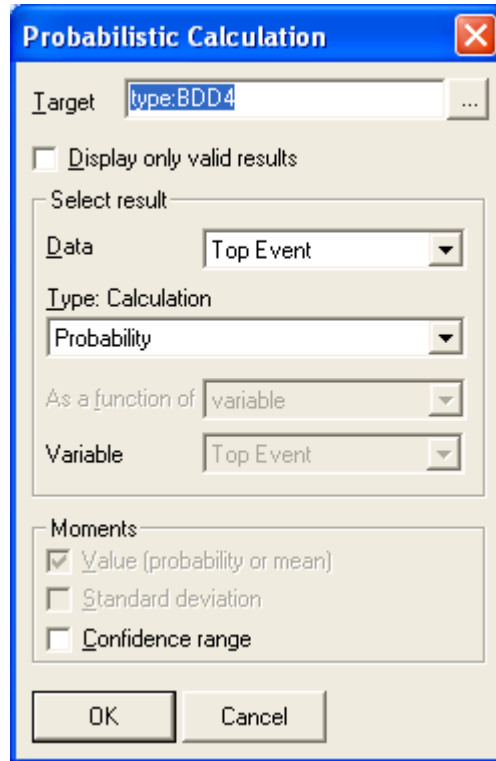
Edit Results to Display


You can edit results to display.

1. Right-click on the chart to edit.
The **Chart** dialog box appears.





2. To add a new result to display:
 - a) Click .
The **Probabilistic Calculation** dialog box appears.

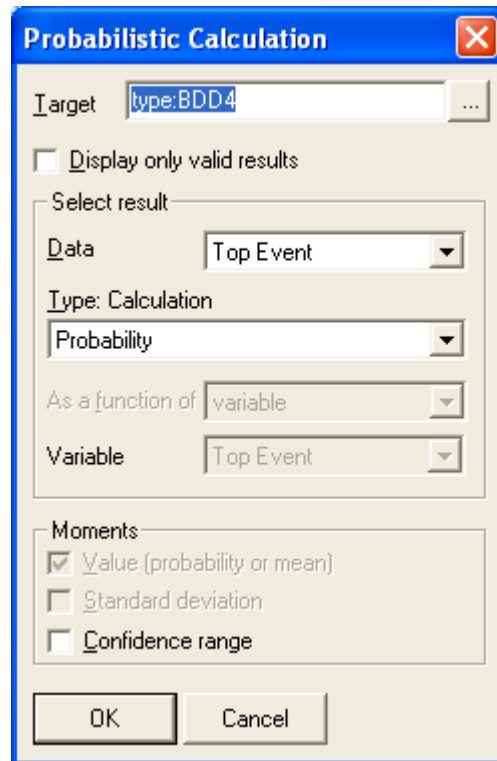


- b) Follow the step 6 in the [Creating a Chart](#) on page 118 task.
The new result to display appears in the **Results** box.
3. Delete a result to display:
- Select the result to delete in the **Results** box.
 - Click .

The result is removed from the list.

 **Important:** The confirmation to delete is not requested.

4. Modify the result to display:
- Select the result in the **Results** box.
 - Click .
- The **Probabilistic calculation** dialog box appears.



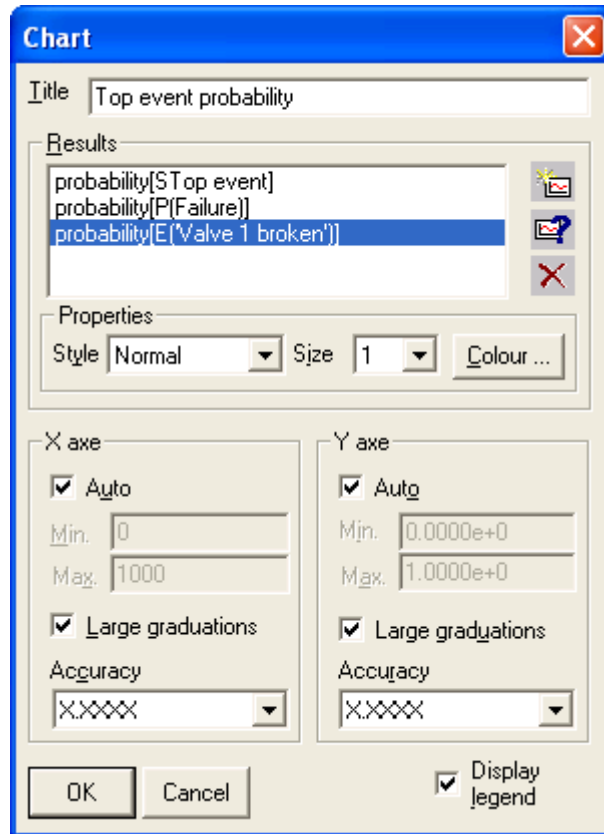
c) Follow step 6 in the [Creating a Chart](#) on page 118 task.

The result to display is modified.

Edit a Curve Style

You can edit a curve style.

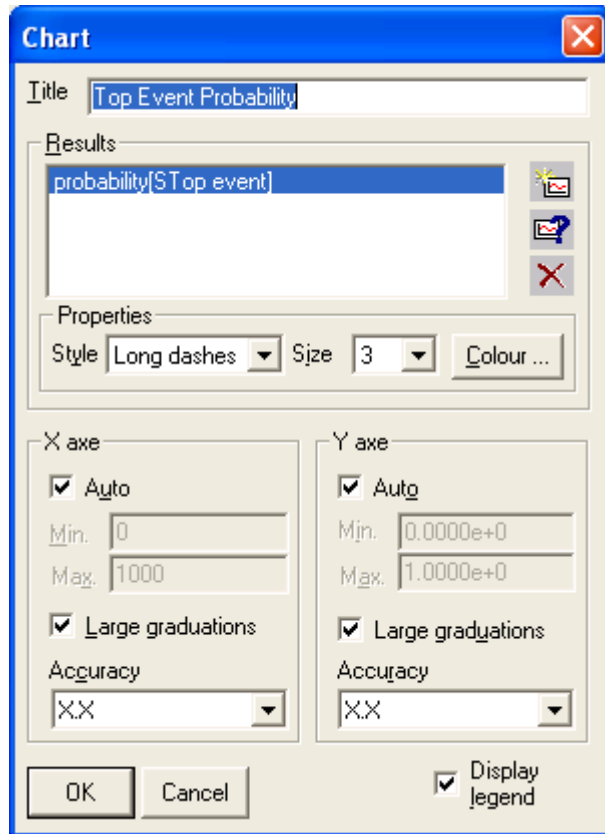
1. Select the result to display in the **Results** box.



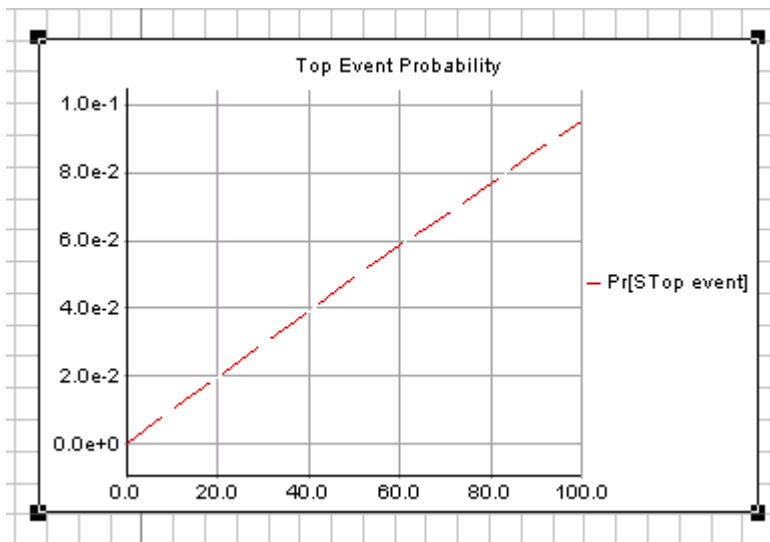
2. In the **Properties** area,
 - a) In the **Style** box, select the line style: Normal, Long dashes, Single mixed, Double mixed.
 - b) In the **Size** box, select the line size.
 - c) Click **Colour...** to change the line colour.The following window appears:



- d) Select a colour.
 - e) Click **OK**.
3. In the **X axis** or **Y axis** areas
- a) Unselect **Auto** to be able to change axes scale in **Min** and **Max** dialog boxes.
 - b) Select **Large graduations** to display the grid.
 - c) In the **Accuracy** box select the number of digits after the digital point to display.
4. Select **Display legend** to display a legend in the chart.



5. Click **OK**.



Inserting a Shape in the Current Worksheet

You can insert a shape in the current worksheet.


Aralia Fault Tree Analyzer allows inserting different types of shapes in the current worksheet:

- Rectangle;
- Oval, and
- Line.

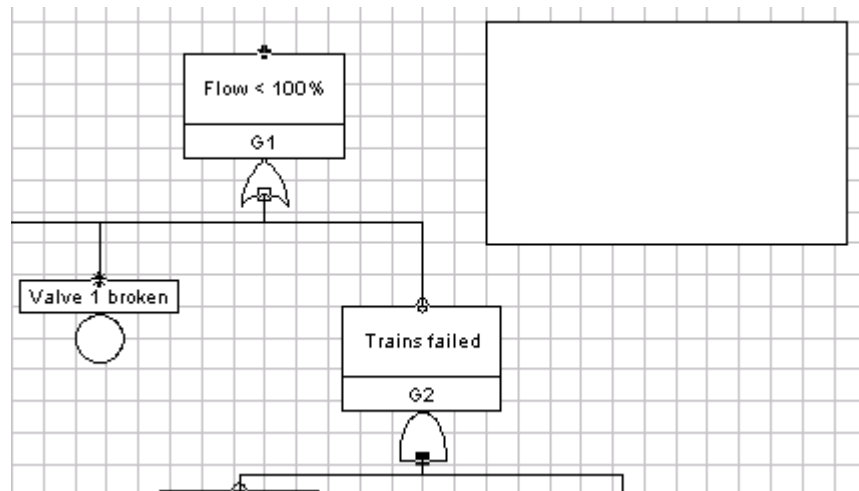
These shapes are used to add static and dynamic information in the current worksheet.

Create or open an existing Fault Tree model.


1. Click **Rectangle**  or **Oval**  or **Line**  in the **Graphic** toolbar.

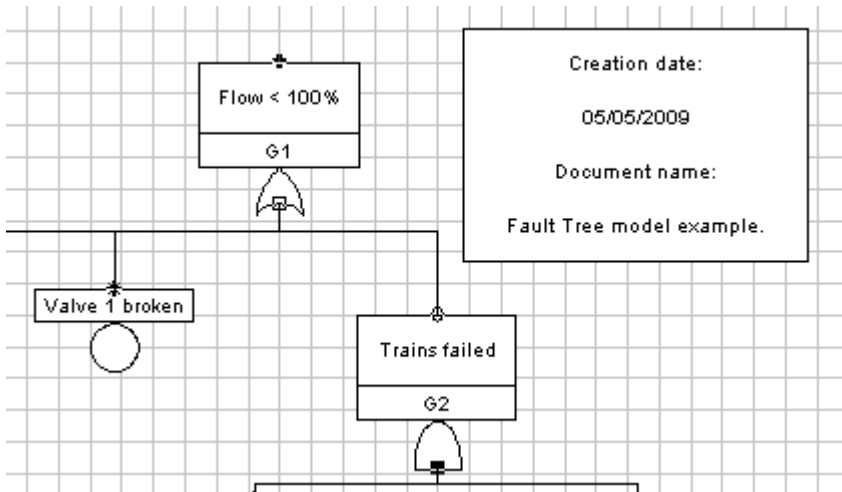
 **Note:** You can also select **Drawing > Shapes > Rectangle** or **Oval** or **Line**.

2. Click in the worksheet to place the shape.
You can select, move and resize a shape like a graphical object.



3. Right-click on the shape and add static text.

 **Note:** You can add dynamic fields to the shape in order to enhance the study with the model features (list of gates, basic events, etc...), document properties or updated results. To define dynamic fields see [Inserting a Global Field](#) on page 132.



About Dynamic Fields

This topic describes about dynamic fields.

To enhance the model formatting, it is possible to introduce information in objects and shapes. A code is associated to each type of information.

This concept is very useful to display updated information. The updating is performed automatically. Two concepts of dynamic fields are available:

Local Field

This topic describes about the local fields.

Local field is a code that can be inserted in a shape.

This code represents a type of information to be displayed.

Example of information having a code:

- Calculation
 - Warnings
 - Calculation target
 - Processing duration
 - Calculation start
 - Calculation end
 - Qualitative information
 - Number of cutsets
 - Parameters
 - Statistics
 - Quantitative results
- Document
 - Document path
 - Creation date
 - Last modification date

-
- Statistics
 - Document name
 - Data
 - Attrinutes
 - CCF groups
 - Named parameters
 - General
 - Date
 - Time
 - Worksheets
 - Path
 - Name
 - Number.

Global Field

This topic describes about the global fields.

Global field is a dynamic information which is inserted in all objects belonging to a category.

The following categories of objects are considered:

- Gates;
- Events;
- Transfer gates;
- Top event.

Information which can be displayed in the objects:

Gate	Gate probability
Event	Event probability or a particular calculation result
Transfer In gate	List of corresponding Transfer Out gates
Top event	Quantitative result at time t

Global fields allow inserting calculation results in the Fault Tree model. The results are updated after each calculation.

Inserting a Local Field in a Shape

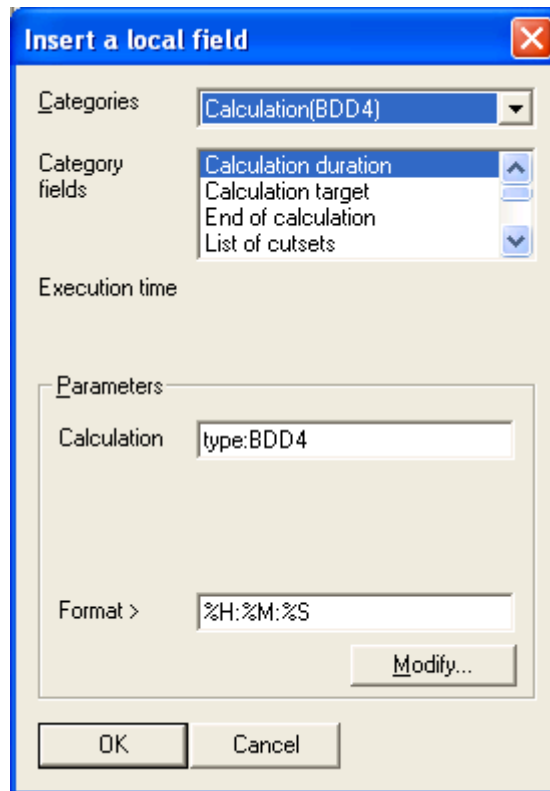
You can insert a local field in a shape.

Local fields allows displaying different types of information in the worksheet, for example calculation results. The displayed information is updated dynamically.


Create or open an existing Fault Tree model.

1. Insert a shape in the current worksheet.
See [Inserting a Shape in the Current Worksheet](#) on page 127.
2. Right-click in the shape to edit it.

3. Select **Edit > Insert Local Field...**
The **Insert a local field** dialog box appears.

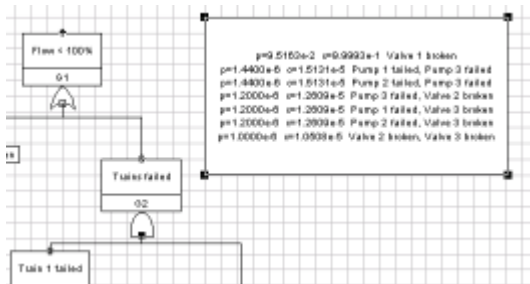


4. In the **Categories** box, select the category of information to display.
5. In the **Category fields** box, select the information to display.
For example, **List of cutsets**.
6. Click **OK**.

 **Note:** If the calculation is not performed, a message informs that results are not available.

7. Launch the calculations to update the shape content.

The results of the calculation are displayed in the shape.



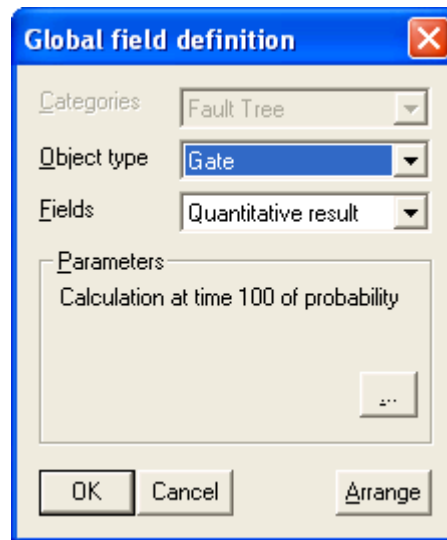
Inserting a Global Field

You can define a global field.

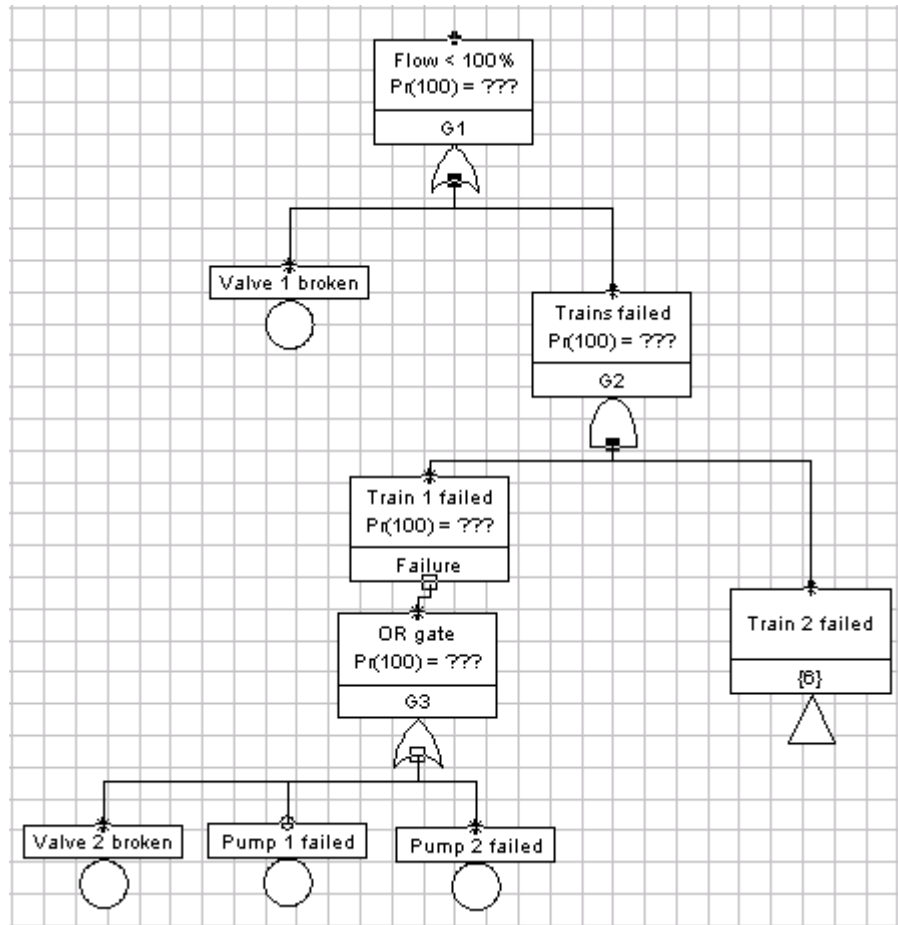
Global fields allow displaying information, for example calculation results, in the graphical representations of Fault Tree elements.


Create or open an existing Fault Tree model.

1. Select **Insert Global Field...**
The **Global field definition** dialog box appears.

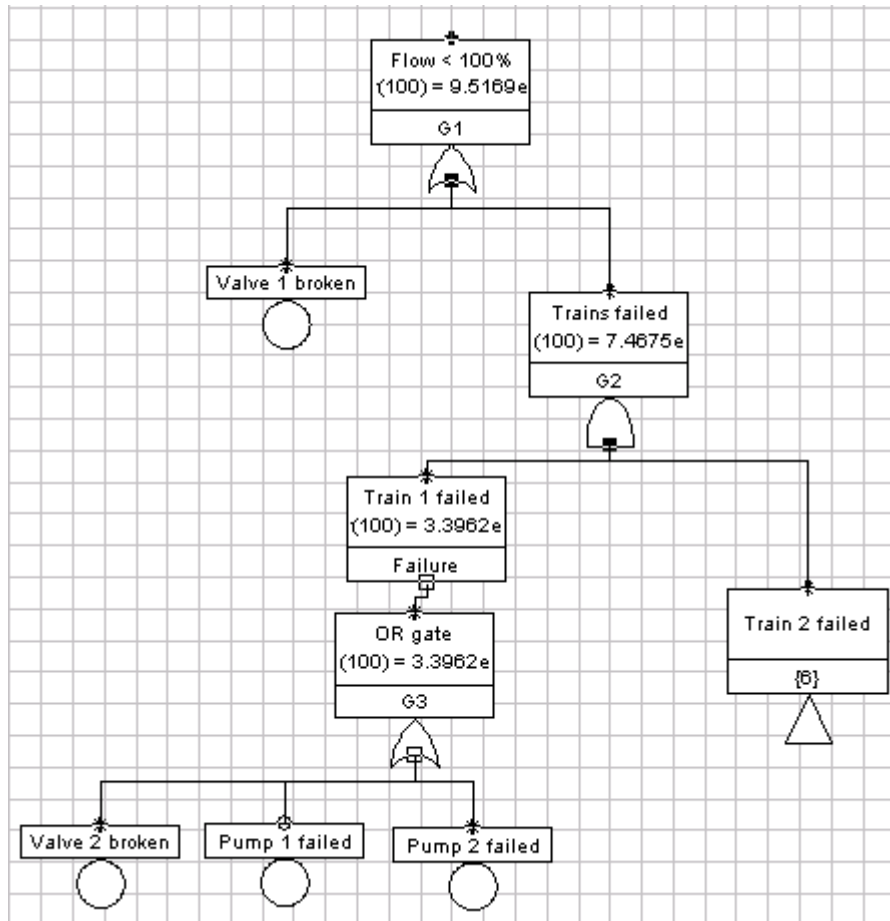


2. In the **Object type** box, select the type of object.
For example, **Gate**.
3. Select the type of information to display.
For example, **Quantitative result**.
4. Click **OK**.
The calculation result (gate probability) is displayed in the gate graphical object in the worksheet:



 **Note:** If the calculation is not performed, no result is available.

5. Set up and launch the calculations.



Generating a Report

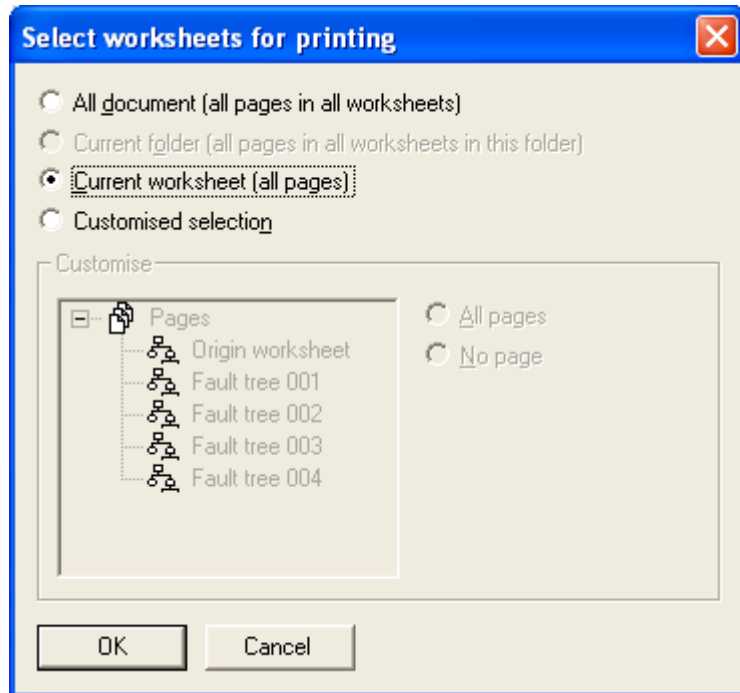
You can generate a RTF document containing the full model including Fault Tree model, shapes and results.

You can also generate a report containing only a part of the model (selected folders or worksheets).

Create or open an existing Fault Tree model.


1. Select **File > Export to RTF...**

The **Select worksheets for printing** dialog box appears.



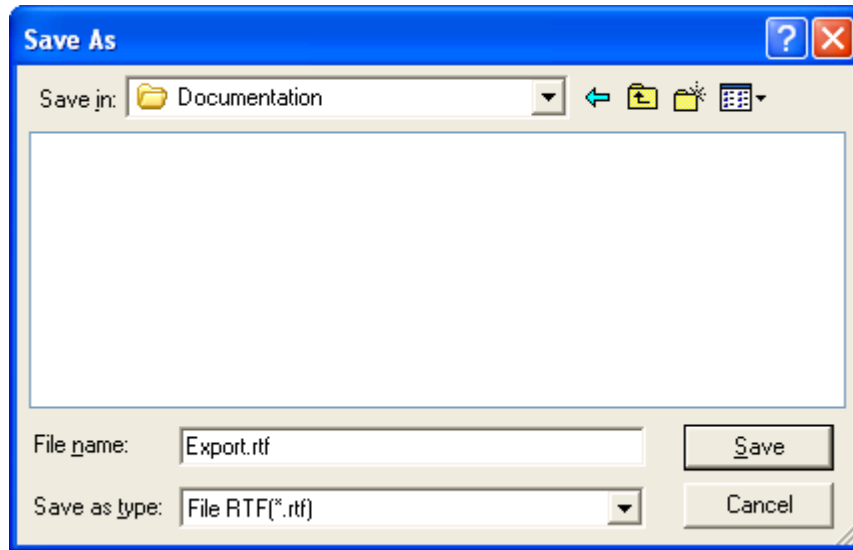
2. Select worksheets to include in the report.

- If **All document** is selected, then the generated document contains all worksheets in the model.
- If **Current folder** is selected, then the generated document contains all worksheets from the current folder.
- If **Current worksheet** is selected, then the generated document contains only the current worksheet.
- If **Customised selection** is selected, then in the **Customise** area select the worksheet or folder to include in the report.

 **Note:** If a folder is selected you can choose the worksheets to include in the generated document with the radio buttons **All pages** or **No pages**.

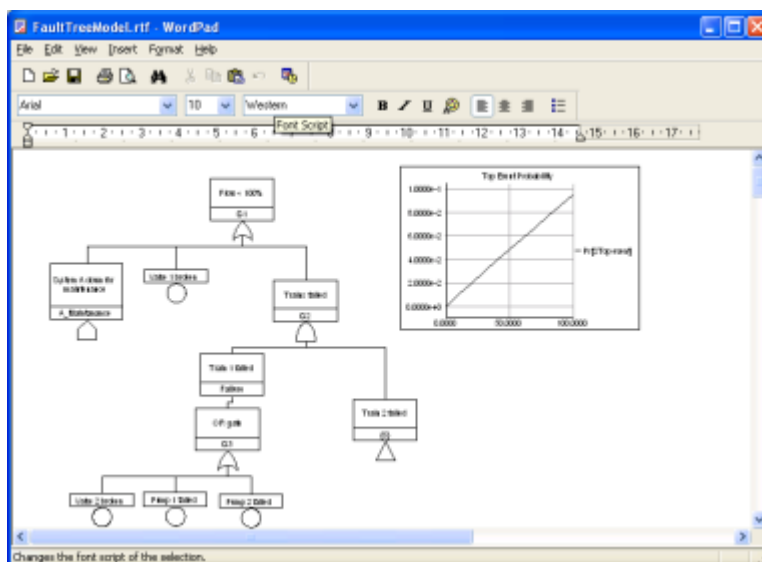
3. Click **OK**.

The **Save As** dialog box appears.



4. Select a file path.
 5. Enter a report name.
 6. Click **Save**.
- A RTFdocument is generated.

Example of a generated RTF document:



Interface Description

This section describes the menu and toolbar commands that are specific to the Aralia Fault Tree Analyzer workbench.

[Toolbars](#) on page 137

[Dialog Boxes](#) on page 140

Toolbars

This section provides tool bars description specific to the Aralia Fault Tree Analyzer product.

[Model Explorer Toolbar](#) on page 137

[Graphic Toolbar - Fault Tree Editor](#) on page 137

[Graphic Toolbar - Reliability Block Diagram Editor](#) on page 139

Model Explorer Toolbar

This topic describes Model Explorer toolbar. This toolbar enables to manager your Fault Tree model organization. To view this toolbar select the command **Model Explorer** from the menu **Display**.






	New Folder See Create a Folder on page 9 .
	New Worksheet See Create a Worksheet on page 11.
	Delete To delete a folder or a worksheet. See Delete a Folder on page 10or Delete a Selected Worksheet on page 12.
	Properties To view and modify folder or worksheet properties. See Edit Folder Properties on page 10or Edit Worksheet Properties on page 12.

Graphic Toolbar - Fault Tree Editor

This topic describes **Graphic Toolbar - Fault Tree Editor**.

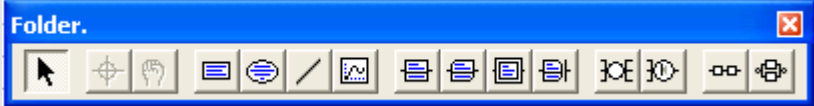










	Select See Select a Gate on page 27






Graphic Toolbar - Fault Tree Editor	
	Automatically connect object to a gate See Autoconnecting Objects on page 21
	Maintain a tool selected Lets you maintain a tool selected.
	Insert a rectangle in the worksheet See Inserting a Shape in the Current Worksheet on page 127
	Insert an oval in the worksheet See Inserting a Shape in the Current Worksheet on page 127
	Insert a line in the worksheet See Inserting a Shape in the Current Worksheet on page 127
	Insert a graph in the worksheet See Creating a Chart on page 118
	Add an intermediate event in the Fault Tree See Creating an Intermediate Event on page 50
	Create an And gate in the worksheet See Creating a Gate on page 26
	Create an Or gate in the worksheet See Creating a Gate on page 26
	Create a K-out-of-N gate in the worksheet See Creating a Gate on page 26
	Create a transfer Lets you create a transfer.
	Create a not elementary event See Creating a Not Elementary Event on page 65
	Open Basic Event Manager See Editing a Basic Event on page 33
	Create a basic event See Creating a Basic Event on page 29
	Open House Event Manager See Editing a House Event on page 44
	Create a house event See Creating a House Event on page 42

Graphic Toolbar - Fault Tree Editor	
	
	Open/Hide comment Lets you display or hide a comment.
	Create a transfer gate See Creating a Transfer Gate on page 52
	Create a transfer gate in a new worksheet See Transferring a sub-tree to a New Worksheet on page 55
	Create an unexpanded clone See Working with Clone Transfer Gates on page 58

Graphic Toolbar - Reliability Block Diagram Editor

This page describes **Graphic Toolbar - Reliability Block Diagram Editor**.

Folder.	
	
	Select See Select a Gate on page 27
	Automatically connect object to a gate See Autoconnecting Objects on page 21
	Maintain a tool selected Lets you maintain a tool selected.
	Insert a rectangle in the worksheet See Inserting a Shape in the Current Worksheet on page 127
	Insert an oval in the worksheet See Inserting a Shape in the Current Worksheet on page 127
	Insert a line in the worksheet See Inserting a Shape in the Current Worksheet on page 127
	Insert a graph in the worksheet See Creating a Chart on page 118
	Create an elementary block See Creating an Elementary Block on page 67
	Create a not elementary block See Creating a Not Elementary Block on page 69
	Create a hierarchical block See Creating a Hierarchical Block on page 68

	Create a house event block See Creating a House Event Block on page 68
	Create a connector See Connect using Simple Connector on page 70
	Create a k/n connector See Connect using K-out-of-N Connector on page 72
	Connect two blocks in series See Connect Blocks in Parallel on page 74
	Connect two blocks in parallel See Connect Blocks in Parallel on page 74

Dialog Boxes

This section provides dialog box description specific to the Aralia Fault Tree Analyzer product.

[Basic Event Manager Dialog Box](#) on page 140

[Attribute Manager Dialog Box](#) on page 142

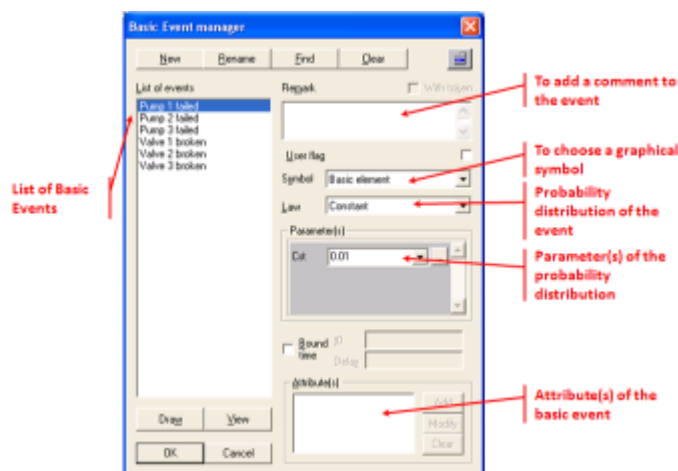
[Parameter Manager Dialog Box](#) on page 143

[House Event Manager Dialog Box](#) on page 145

Basic Event Manager Dialog Box

This document describes the **Basic Event Manager** dialog box, which appears when **Data/Basic Event Manager...** is selected.

This dialog box contains controls for:



New, Rename, Find, Clear

New	To create new basic event.
Rename	To rename selected basic event in the list of basic events.
Find	To find a basic event in the list of basic events.
Clear	To delete selected basic events from the list of basic events.

List of events

To display the list of all basic events defined in the model.

Remark

To add a comment to the selected basic event.

User flag

To mark the basic event and use it as a search criterion.

Draw, View

Draw	To create basic events selected from the list in the worksheet.
View	To view basic events selected from the list in the worksheet.

OK, Cancel

OK	To commit all changes and close the Basic Event Manager .
Cancel	To abort all changes and close the Basic Event Manager .

Symbol

To associate different graphical symbols with a basic event. The options in the **Symbol** are as follows:

Basic element	This symbol means that this basic event is elementary and does not need further development.
Non basic element	This symbol means that this basic event cannot be considered as elementary but its causes will not be developed further.
Expand	This symbol means that this basic event should be developed further.
Condition	This symbol means that this basic event is a conditional event in the If Then Else gate.
Dormant failure	This symbol means that this basic event corresponds to a back-up component whose failures appear only when it is up (i.e. during maintenance or failure of the principal component).

See graphical representations of these symbols in [About Basic Events](#) on page 29.

Law

To choose a probability distribution of basic event.

The options in the **Law** are as follows:

- Constant
- Exponential
- Gamma-Lambda-Mu
- Weibull
- Simple periodic test
- Extended periodic test
- Full periodic test
- NRT
- Constant Mission Time
- Asymptotic GLM
- Dormant.

To learn more about probability distributions and their parameters, refer to the *Aralia User's Guide*.

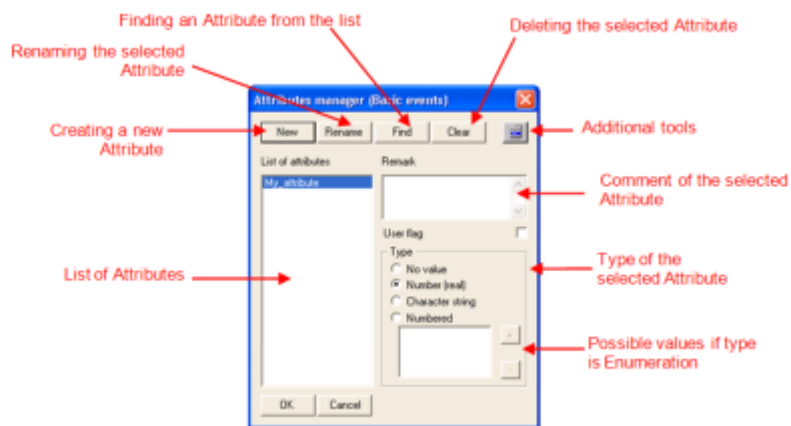
Attribute

Add	Add an attribute to selected basic events from a previously created list.
Modify	To modify the selected attribute value if the attribute is typed.
Clear	To delete selected attributes from the list.

Attribute Manager Dialog Box

This document describes the **Attribute Manager** dialog box, which appears when **Data/House Event Manager...** is selected.


This dialog box contains controls for:



New, Rename, Find, Clear

New	To create new attribute.
Rename	To rename selected attribute in the list.
Find	To find an attribute in the list.
Clear	To delete selected attributes from the list.

Additional tools

If you click **Additional tools** , the following commands are available:

- Duplicate
- Select
- Set default
- Import
- Export.

List of attributes

To view all created attributes and to select them.

Remark

To add comments to the selected attribute.

User flag

To mark the attribute and use it as a search criterion.

Type

To select the attribute type. The **Type** contains the following options:

No value	No value is assigned to the attribute.
Real	Attribute has real values.
String	The value of attribute is of type string.
Enumeration	The value of the attribute is of type enumeration. Click + to add an enumeration field. Click - to delete a selected field.

Parameter Manager Dialog Box

This document describes the **Parameter Manager** dialog box, which appears when **Parameter Manager...** is selected.


This dialog box contains controls for:



New, Rename, Find, Clear

New	To create new parameter.
Rename	To rename a parameter selected in the list.
Find	To find a parameter in the list.
Clear	To delete selected parameters from the list.

Additional tools

If you click **Additional tools** , the following commands are available:

- Duplicate
- Select
- Set default
- Import
- Export.

List of parameters

To view all created parameters and to select them.

Remark

To add comments to the selected parameter.

User flag

To mark the parameter and use it as a search criterion.

Type

To choose the type of the parameter from the following list:

- Probability

-
- Rate
 - Duration
 - Factor
 - Boolean
 - Other.

Value

To enter a constant value of the parameter or associate a probability distribution.

Filter Types

To view the list of parameters filtered by type.

OK, Cancel

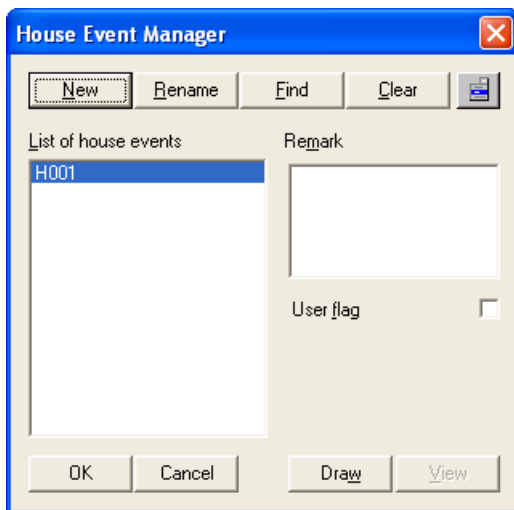
OK To commit all changes and close the **Parameter Manager**.

Cancel To abort all changes and close the **Parameter Manager**.

House Event Manager Dialog Box

This document describes the **House Event Manager** dialog box, which appears when **House Event Manager...** is selected.

This dialog box contains controls for:



New, Rename, Find, Clear


New To create new house event.

Rename To rename a house event selected in the list.

Find To find a house event in the list.

Clear To delete selected house events from the list.

Additional tools

If you click **Additional tools** , the following commands are available:

- Duplicate
- Select
- Set default
- Import
- Export.

List of house events

To view all created house events and to select them.

Remark

To add comments to the selected house event.

User flag

To mark the house event and use it as a search criterion.

Draw, View

Draw	To create house events selected from the list in the worksheet.
View	To view house events selected from the list in the worksheet.

OK, Cancel

OK	To commit all changes and close the House Event Manager .
Cancel	To abort all changes and close the House Event Manager .

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