

Aralia Fault Tree Analyzer (FT9) BPA Delivery 7 for V5R19 (V5.7)

User Guide

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Aralia Fault Tree Analyzer User Guide

This guide describes how to work with Aralia Fault Tree Analyzer

Overview

Welcome to the *Aralia Fault Tree Analyzer User's Guide*. This 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 enables safety engineers to perform systems probability risk assessment using Fault Trees. It provides them tools to create, organize, manage and assess Fault Trees

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;
- 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 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 functionalities.

The Interface Description section, which describes the commands that are specific to Aralia Fault Tree Analyzer will also certainly prove useful.

Organizing a model

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

[About worksheets and folders](#) on page 4

[Working with folders](#) on page 6

About worksheets and folders

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

The following topics are discussed:

Model Explorer

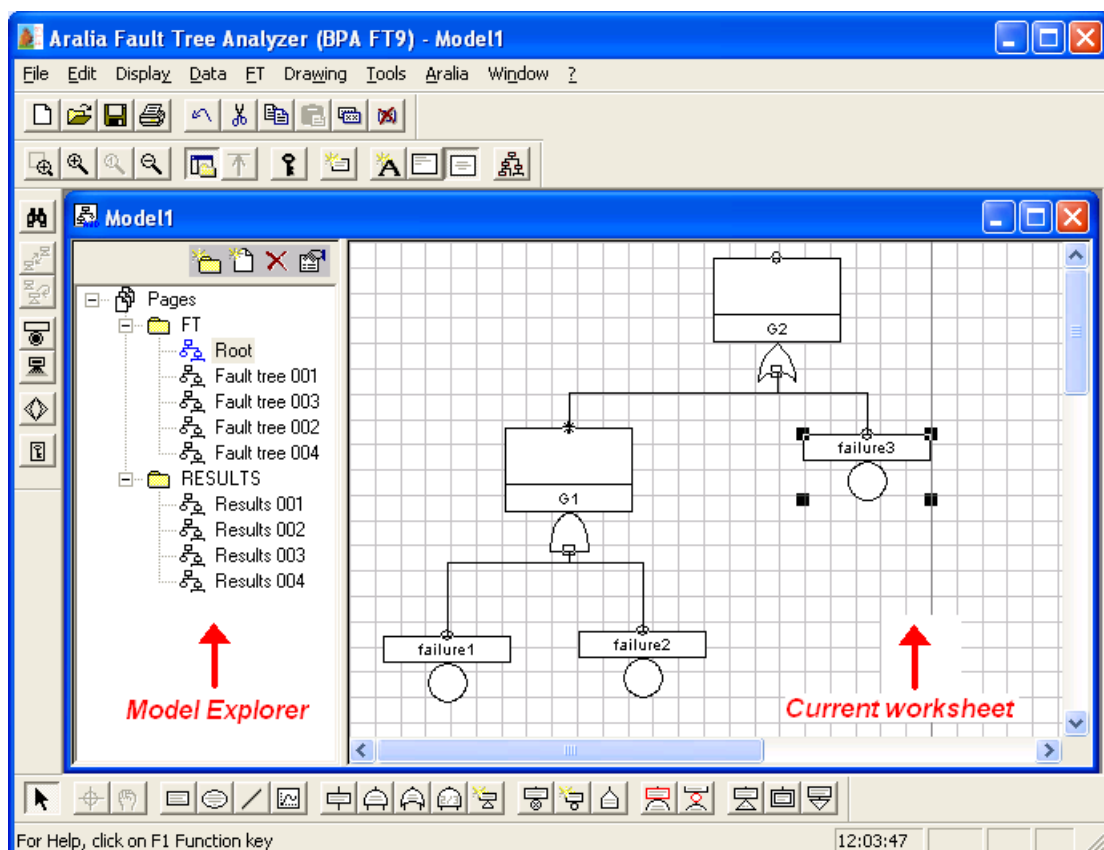
The model organization is displayed in the **Model Explorer** in the left part of the application.

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 **Model Explorer** select the command from the menu **Display > Model Explorer**.



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

Worksheet

A worksheet is a graphical zone used to create a Fault Tree graphical representation and to display results.

A worksheet 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 transfer gates (insert link).

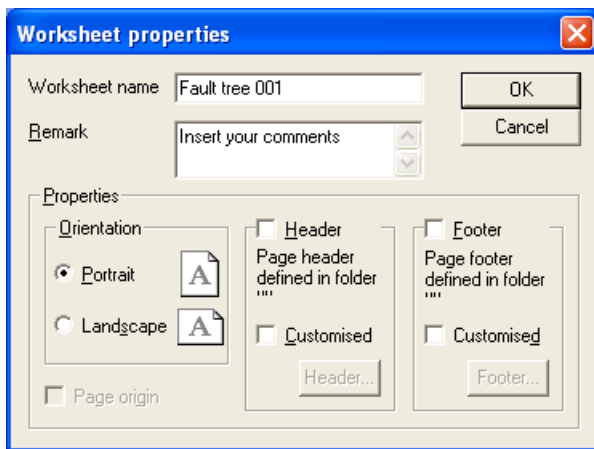
A worksheet can contain:

- Fault Tree graphical representation, and/or
- Shapes with comments or results, and/or
- Charts.

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 characters. 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.

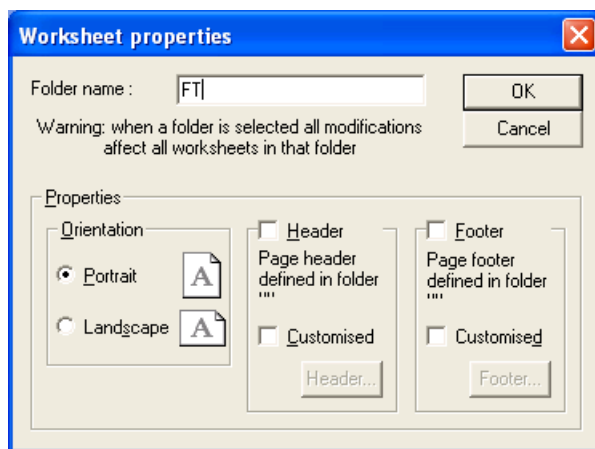
A Folder can contain worksheets and/or other folders.

You can use folders to group worksheets by concerned systems.

Folder properties

In Aralia Fault Tree Analyzer folders have the following properties:

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



Note: Folder properties affect the properties of all its worksheets.



Note: You can customize information displayed in the footers and headers of the worksheets in the folder.



Note: You can't add remarks to the folders properties.


Working with folders

This task shows you how to 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**.

Creating a folder

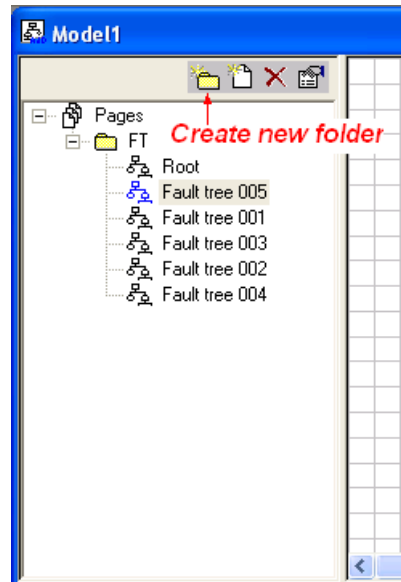
1. In the **Model Explorer** tree select a folder where you want to create a subfolder or select the root element **Pages**.
The selected element becomes active.

2. Select command **New Folder** from the menu **Display > Worksheet** or click the icon  in the **Model Explorer** toolbar.
New folder with a default name appears in the **Model Explorer** tree.




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

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



Deleting a folder


1. In the **Model Explorer** select the folder to delete.
The folder becomes active.
2. Select the command **Delete** from the menu **Display > Worksheet** or click the icon  in the **Model Explorer** toolbar.

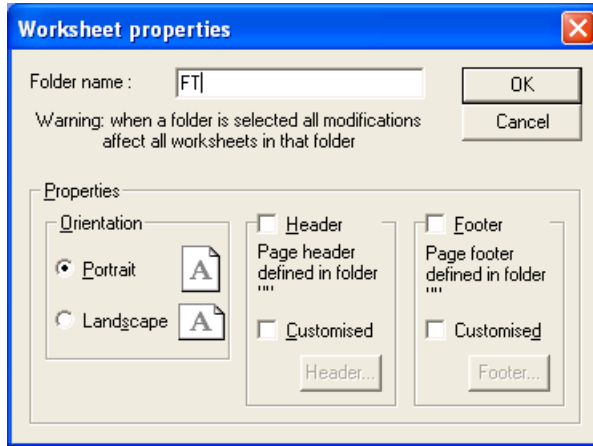


Important: The folder is deleted without asking confirmation from user.

The folder is deleted with all contained worksheets.

Editing folder properties

1. Select a folder in the **Model Explorer** tree.
The folder becomes active.
2. Select the command **Properties** from the menu **Display > Worksheet** or click the icon  from the **Model Explorer** toolbar.
Folder properties dialog window appears:



3. In the **Folder name** dialog 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. Check the box **Header** and/or **Footer** if necessary
A header and/or a footer will be displayed in all worksheets in the current folder. The information displayed in the footer and in the header will be 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 check the box **Customised** and follow the instructions in [Customizing worksheet headers and footers](#) on page 10.

6. Click **Ok**.

The properties of the selected folder are changed.




Note: You can rename the folder following the task [Renaming a worksheet](#) on page 10.

Working with worksheets

This section describes how to create, delete and edit worksheets.

- Launch Aralia Fault Tree Analyzer ;
- Create a new model
- Open the **Model Explorer** from the menu **Display > Model Explorer**.

Creating a worksheet

1. In the **Model Explorer** select a folder where you want to place the new worksheet or select **Pages** to create the worksheet under the root element in the **Model Explorer** tree.
The selected element becomes active.
2. Select the command **New Worksheet** in the menu **Display > Worksheet** or click the icon  of the **Model Explorer** toolbar.
New worksheet with the default name appears in the **Model Explorer** tree in the previously selected folder.
The created worksheet becomes active.



Note: You can move worksheets in the **Model Explorer** tree using drag and drop.



Note: To rename the worksheet see

3. You can now create your Fault Tree in the created worksheet. See

Deleting a selected worksheet

1. In the **Model Explorer** select the worksheet to delete.
The worksheet becomes active.



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


2. Select the command **Delete** from the menu **Display > Worksheet** or click the icon  from **Model Explorer** toolbar.

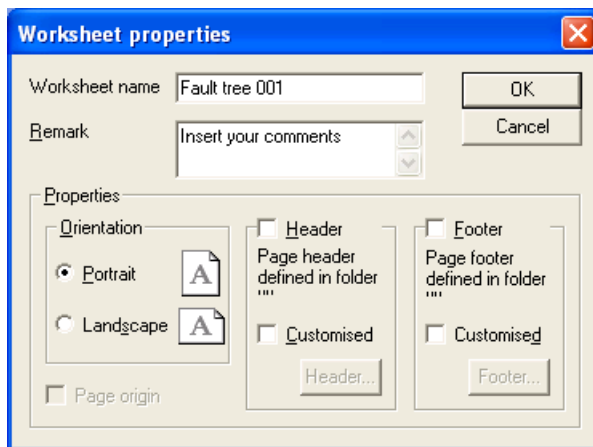


Important: The worksheet is deleted without confirmation.

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

Editing worksheet properties

1. Select the worksheet in the **Model Explorer** tree.
The worksheet becomes active.
2. Select the command **Properties** from the menu **Display > Worksheet** or click the icon  from the **Model Explorer** toolbar.
The **Worksheet properties** window appears:



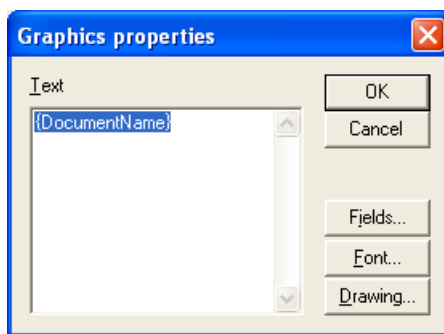
3. Type the new folder name in the **Worksheet name** dialog box.
4. Insert your comments in the **Remark** dialog box.
5. You can the worksheet orientation in the **Properties/Orientation** area.
6. To insert a header and/or a footer in the worksheet check the box:

- **Header** and/or **Footer** in the **Properties** area to insert the information defined for the folder of the current selected worksheet.
 - **Customized** to insert customized information in the footer and header of the selected worksheet.
7. Click **Ok** to save changes.
The worksheet has new properties.

Customizing worksheet headers and footers

This task shows you how to customize the information displayed in the header and/or footer of the selected worksheet.

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

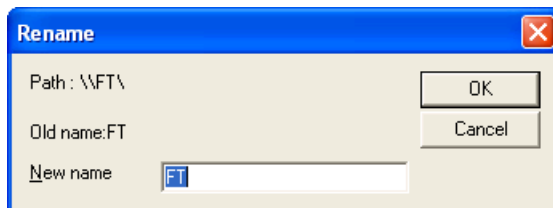


3. Click **Fields...** to choose fields to be displayed in the header or in the footer. See [About dynamic fields](#) on page 89 to know more about fields.
4. You can change text style by clicking **Font...** and/or **Drawing...**

The selected information will be displayed in the header and/or footer of each print page of the worksheet.

Renaming a worksheet

1. In the **Model Explorer** select the worksheet to rename.
The worksheet becomes active.
2. Select the command **Rename** from the menu **Display > Worksheet**.
A **Rename** dialog window appears:



3. In the **New name** dialog box enter the new worksheet name.
4. Click **Ok**.

You can also rename the worksheet using the icon **Properties** of the **Model Explorer** toolbar.

In the **Model Explorer** tree the selected worksheet changes its name.

Creating a Fault Tree

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

[About Fault Trees](#) on page 11

[About events](#) on page 12

[Working with gates](#) on page 13

[Working with basic events](#) on page 18

[Working with house events](#) on page 29

[Working with intermediate events](#) on page 35

[Common Cause Failure](#) on page 38

[Creating a link between two objects](#) on page 45

[Autoconnecting objects](#) on page 46

[Working with transfer gates](#) on page 46

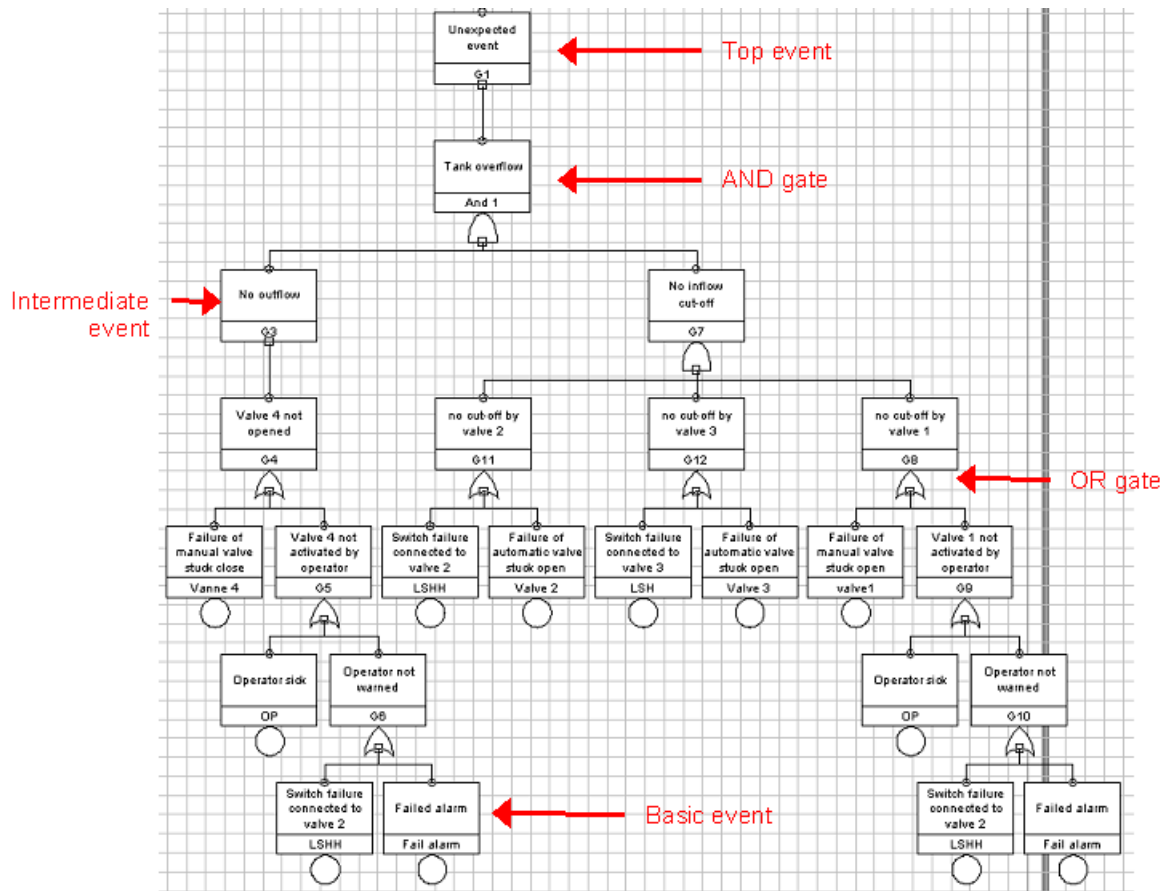
About Fault Trees

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 FT 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 FT 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 FT to model causes of this situation.

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



A Fault Tree structure contains two basic elements:

- [About gates](#) on page 13
- [About events](#) on page 12

The top event corresponds to the Unexpected Event of the system. It is developed until basic component failures are encountered.

About events

This section 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 36.
Basic event	Basic events are the lowest level events. They indicate the limit of a Fault Tree resolution. See About basic events on page 19.
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 35.

Event	Definition
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 29.

Working with gates

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

[About gates](#) on page 13

[Creating a gate](#) on page 16

[Editing a gate](#) on page 17

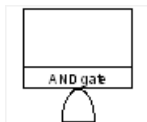
About gates

A gate shows the relationship between the events needed for 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 introduces different types of gates available in Aralia Fault Tree Analyzer .

AND gate

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

The AND gate is represented by the following figure:

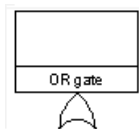


Note: The number of input events of the AND gate should be 2.

OR gate

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

The OR gate is represented by the following figure:

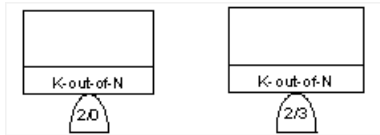


Note: The number of input events of the OR gate should be 2.

K out of N gate

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

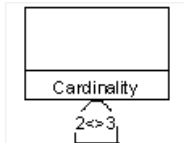
The K out of N gate is represented by the following figure:



Cardinality gate

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

The Cardinality gate is represented by the following figure:

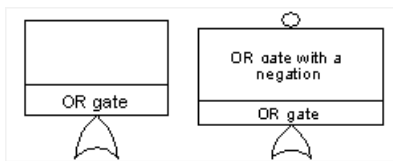


Note: User can define K and N values. See working with Gates section.

Negation

It is possible to add a negation logical operator on events and gates. AND gate with a negation becomes a NAND gate. 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:

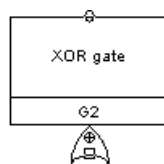


Important: A negation can make a Fault Tree no-coherent!

XOR Gate

The output event of XOR Gate occurs 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

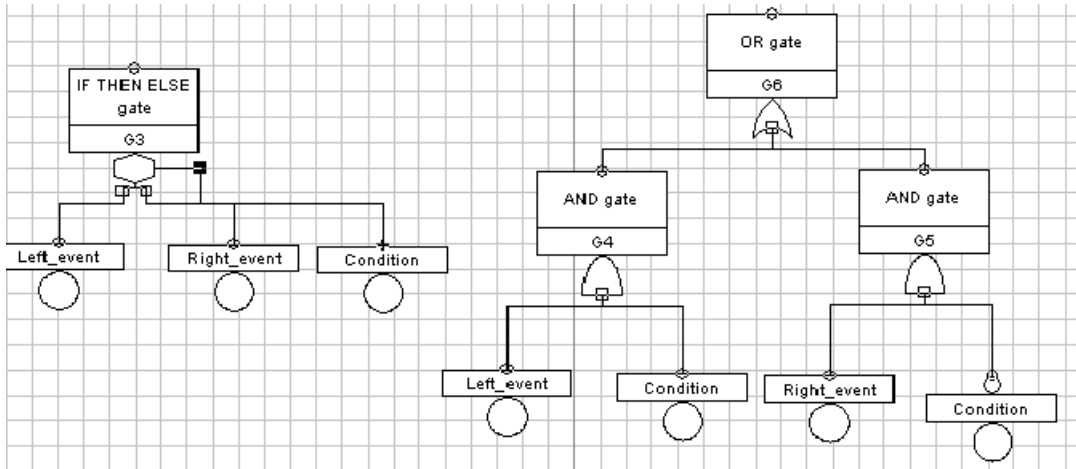
The output event of the If Then Else Gate is its left input event if the the event Condition occurs, otherwise the output event is its right input event.

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.



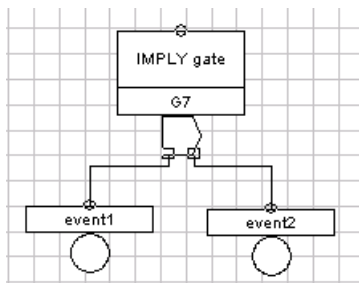
ImPLY gate

The 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

The 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 two.

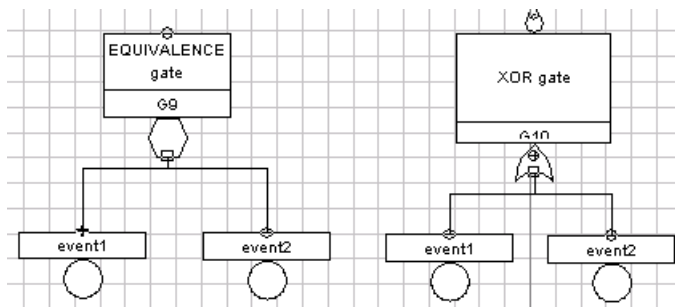


Important: The Imply gate may make a Fault Tree no-coherent!

Equivalence gate

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

The EQUIVALENCE gate can be represented by XOR and NEGATION gates. See the following figure:



Note: The number of input events should be two.

Creating a gate

This task shows you how to create a gate.

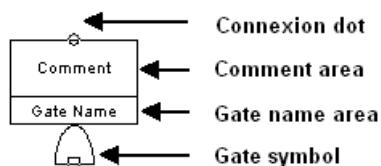
- Launch Aralia Fault Tree Analyzer
 - Open an empty model.
1. From **Graphics** toolbar select a gate you want to create.



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.

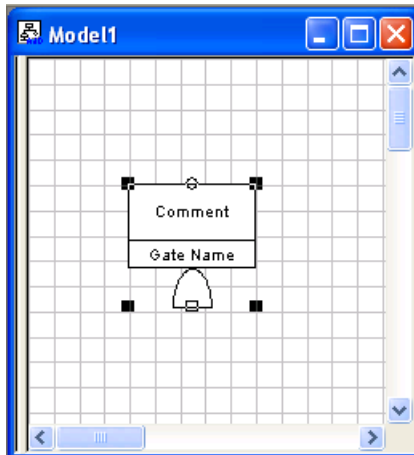
-
4. Right click the *Gate name area* to change the gate name.

Editing a gate

Create a gate.

Selecting a gate

1. From **Graphics toolbar** click the icon .
2. Click in the middle of the gate to select it
Small black squares (handles) that appear at the corners of the object indicate that the object is selected.




Selecting 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 command **Select All** from **Edit** menu or press **CTRL + A**.

2. To define a selection area, click the icon  from **Graphics toolbar**.
3. Drag and drop in the current worksheet to define a square area.
All objects contained in this area are selected.

Moving a gate

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

Resizing a gate

1. Select a gate to resize.
Sizing handles become visible.
2. Drag these handles to change the size of the gate.

Deleting a gate

1. Select a gate or multiple gates.
2. To delete the selected objects you can
 - Press **Delete**.
 - Or, select the command **Delete** from **Edit** menu.

The selected objects will be deleted from the model.

Duplicating a gate

This function enables to duplicate a selected object in the same worksheet.

1. Select a gate or multiple gates.
2. Select the command **Duplicate** from menu **Edit**.

The duplicated objects appear in the same worksheet.

Copying/pasting a gate

This function enables to 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 the command **Copy** or **Cut** from the menu **Edit**.
3. Open another worksheet or stay in the current worksheet.
4. Select the command **Paste** from the menu **Edit**.

The gates appear in the worksheet.

Converting gates

This function is used 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 a command from menu **FT** > **Replace**.
The selected gate is replaced by another one.

Working with basic events

This section introduces basic events and describes how to create and edit basic events.

[About basic events](#) on page 19

[Creating a basic event](#) on page 19

[Creating a basic event with Basic Event Manager](#) on page 20

[Editing a basic event](#) on page 22

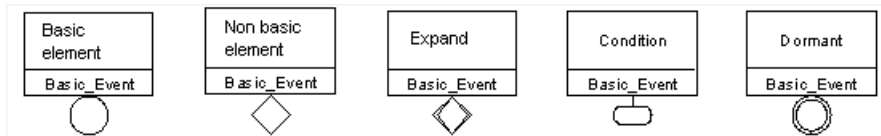
[Inserting basic events in the Fault Tree model](#) on page 25

[Viewing instances of a basic event in the current Fault Tree model](#) on page 28

About basic events

Basic event is the lowest level event. It indicates the limit of a Fault Tree resolution . To perform quantitative analysis, it is required to associate probabilistic data to basic events. Consequently, it is unnecessary to develop Fault Tree branches beyond the events for which data are available.

Traditional Fault Trees use different shapes to represent different events. Unlike gates, however, different events in a FT are not treated differently from an analytical perspective. Rather, the event shapes are used to convey additional information visually:




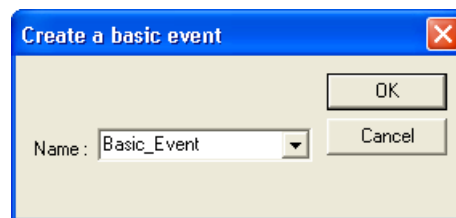
Basic event symbols	
Basic element	Event that do not need further development
Non basic element	Event that cannot be considered as elementary but it causes will not be developed
Expand	Event that should be developed
Condition	Event used in the gate IfThenElse as condition event
Dormant	Event that describes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

Creating a basic event

This task shows you how to create a basic event.

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

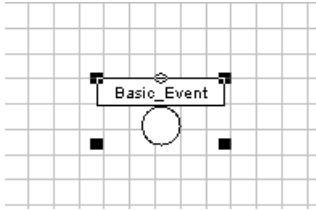
1. Click **New Basic Event**  in the **Graphic** toolbar or press **CTRL+SHIFT+E**. The **Create a basic event** dialog box opens:



2. Enter a name for the new basic event.
3. Click **Ok**.
4. Click in the worksheet to insert the basic event in the model.




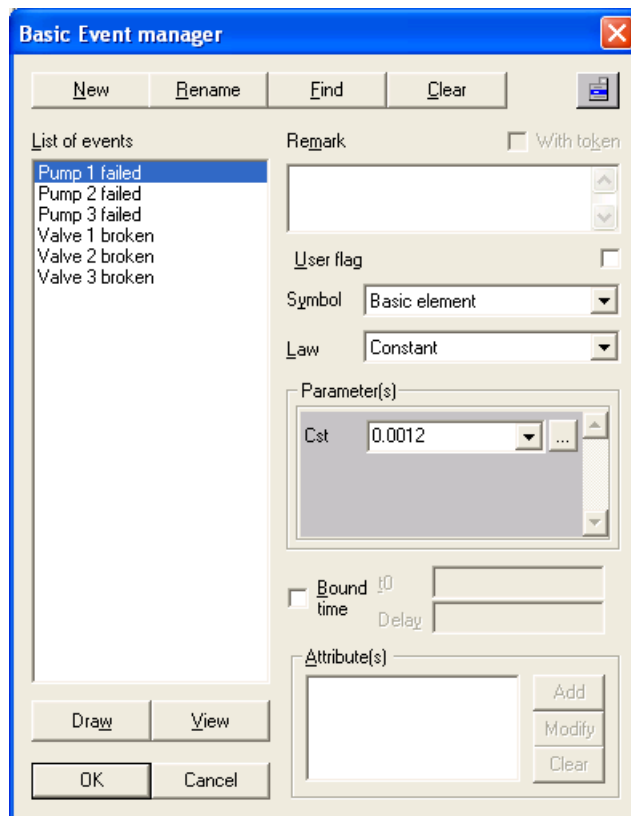
Note: The new Basic Event is created with default parameters. Open **Basic Event Manager** to edit parameters: distribution, symbol, attributes.



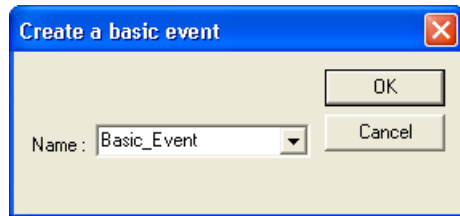
Creating a basic event with Basic Event Manager

This task shows you how to create basic events using **Basic Event Manager** dialog window.

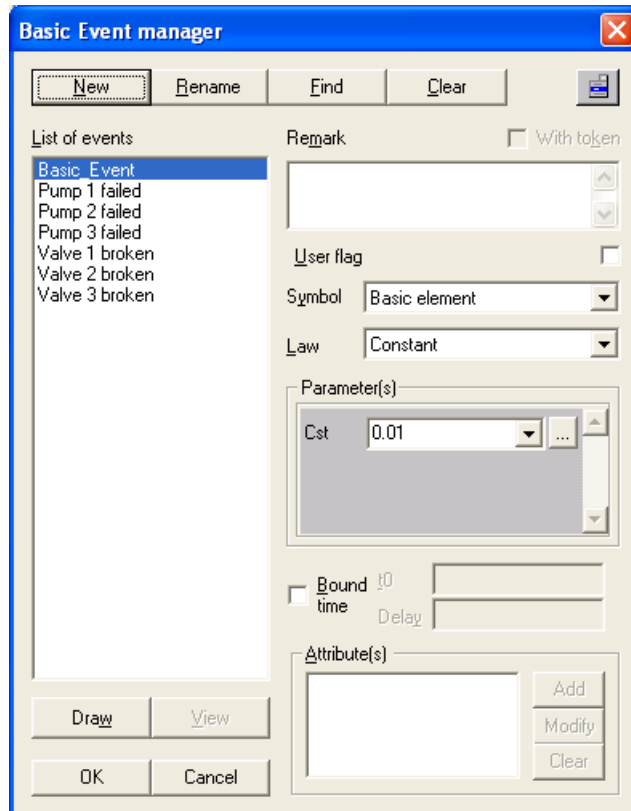
- Launch Aralia Fault Tree Analyzer
 - Create or open an existing Fault Tree model.
1. Select the command **Basic Event Manager...** from the menu **Data** or click the icon  from the **Graphic** toolbar or press **CTRL+E**.
The **Basic Event Manager** dialog window appears:



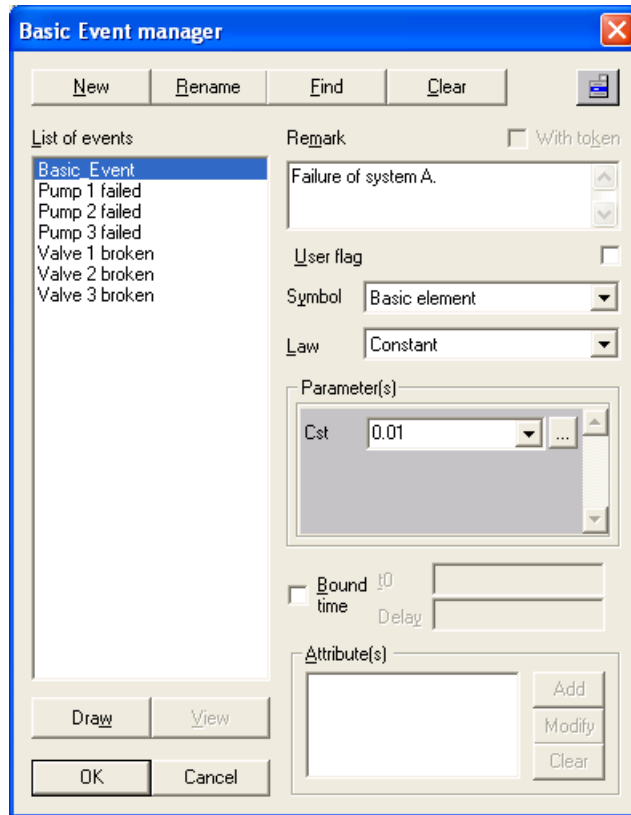
2. Click **New** to create a new basic event.
The **Create a basic event** dialog window appears:



3. Enter the name of the basic event in the **Name** dialog box and click **Ok**.
The new basic event appears in the **List of basic events** dialog box.



4. Add comment in the **Remark** area.



5. In the **Symbol** dialog box choose the symbol of the basic event. See About Basic Events to know more about symbols.
6. In the **Law** dialog box select the probability distribution of the basic event from the available list.
 - a) In the **Parameter(s)** area enter the values of probability distribution parameters.
7. Click **Ok**.



Note: You can also add attributes to the basic event if they were previously defined. See (...)

The new basic event with its properties has been created.

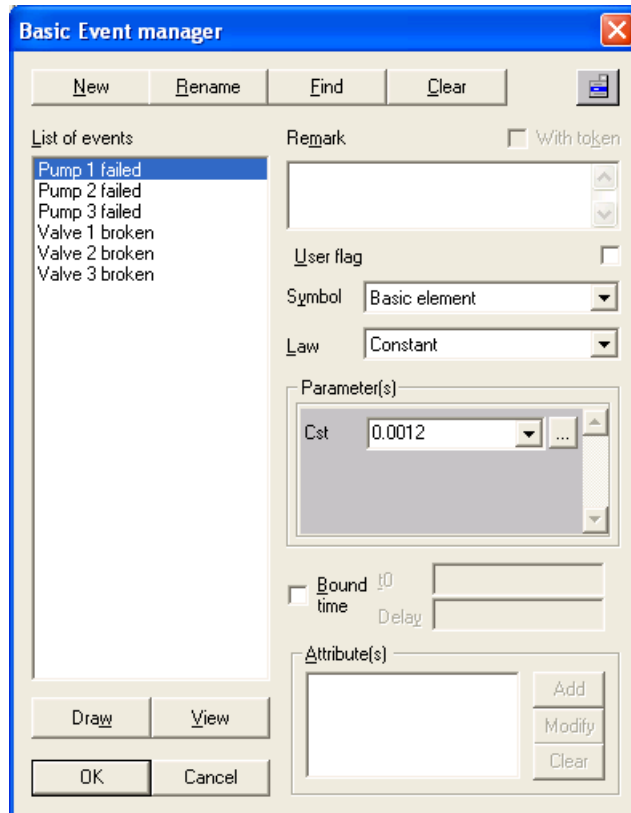
Editing a basic event

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

Create a basic event.

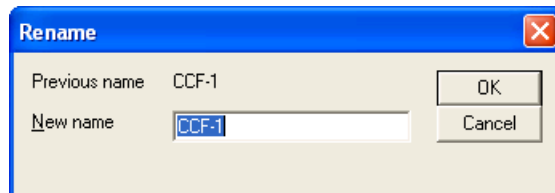
Renaming a basic event

1. Select a basic event in the worksheet and right click on it to open **Basic Event Manager** dialog window or open **Basic Event Manager** dialog window and select a basic event in the **List of basic events** dialog box.



2. Click **Rename**.

The **Rename** dialog window appears:



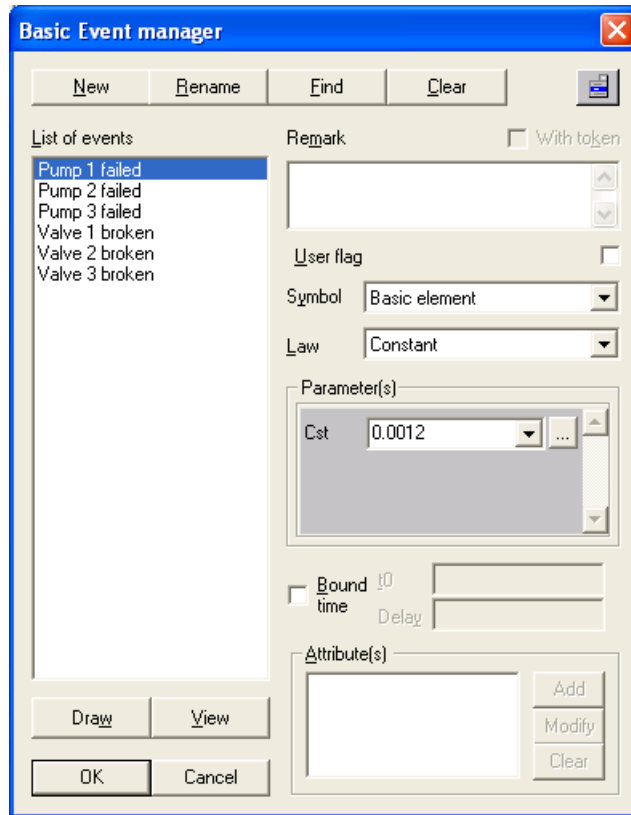
3. Enter new name in the **New name** dialog box and click **Ok**.

The selected basic event has been renamed.

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

Deleting basic events

1. Open **Basic Event Manager** dialog window.



2. Select basic events in the **List of basic events** dialog 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 window 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.

Deleting instances of a basic event

You can only delete the 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 the command **Delete** from the menu **Edit** or press **Del**.

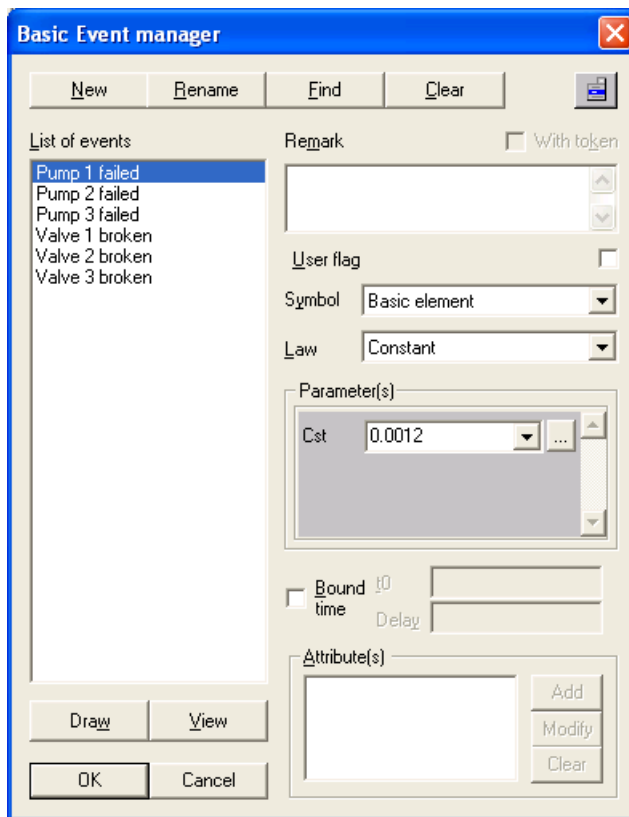
The selected instance of basic event is removed from the Fault Tree model.



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

Modifying basic event probability distribution

1. Open **Basic Event Manager** dialog window.



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** dialog box choose another probability distribution and change its parameters if necessary in the **Parameter(s)** area.
4. Click **Ok** to save changes and close the **Basic Event Manager** window.

The modifications have been saved.


Inserting basic events in the Fault Tree model

This task shows you how to insert existing basic events in the current Fault Tree model.

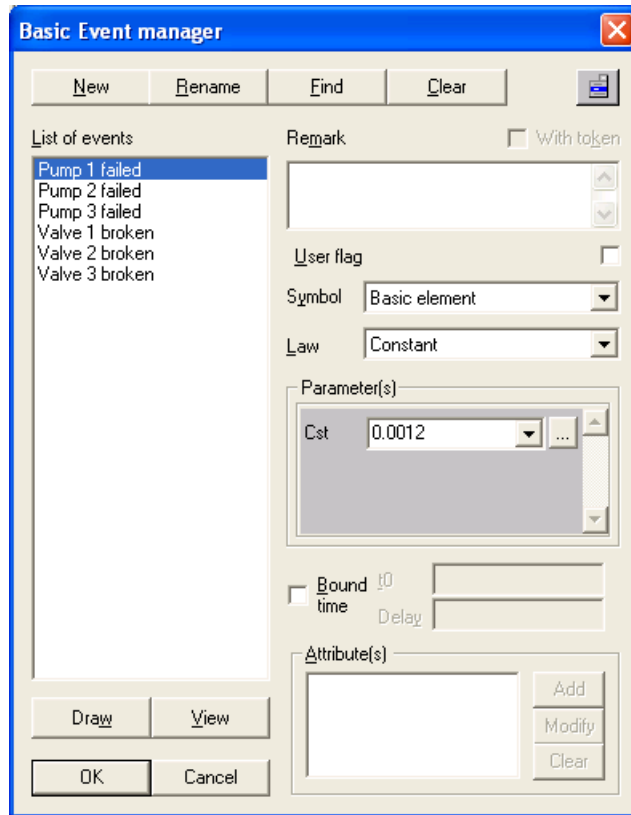
- Create a basic event;
- Create a gate.

1. Open **Basic Event Manager** dialog window.



Note: Select the command **Basic Event Manager...** from the menu **Data** or click the icon  in the **Graphic** toolbar or press **CTRL+E**.

The **Basic Event Manager** dialog window appears:

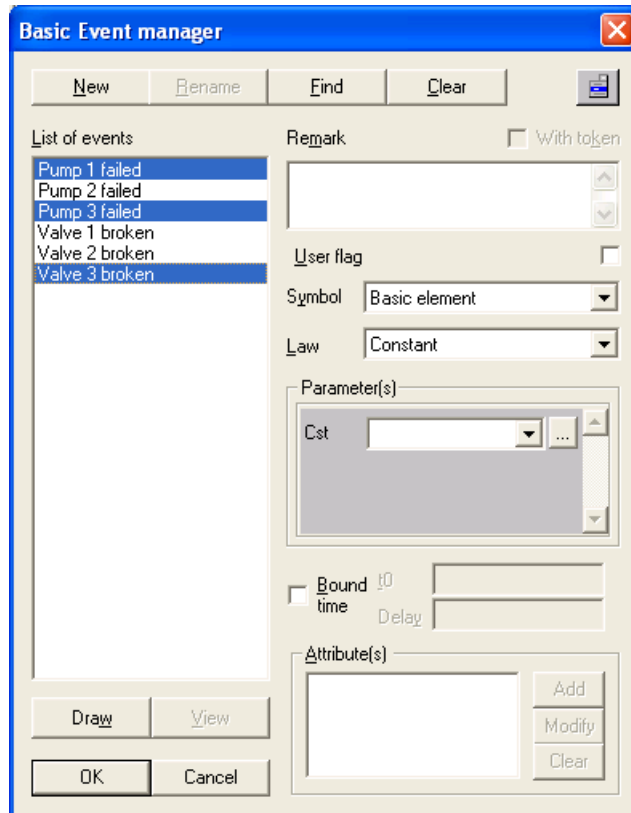


2. Select basic events from the **List of basic events** dialog box.

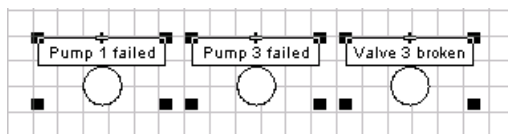


Tip: Use **CTRL** or **SHIFT** to select several basic events at the same time.

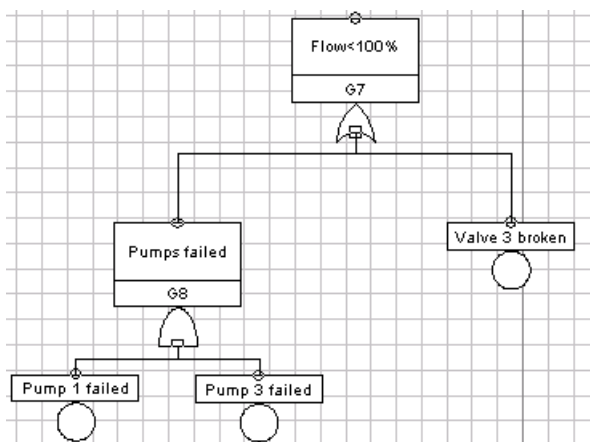
The selected basic events are marked in blue.



3. Click **Draw** and then click **Ok**.
The selected basic events appear in the current worksheet.
4. Click in the worksheet to place the selected basic events.



5. Connect basic events to the Fault Tree.





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



Note: You can move and select basic events graphical representations like gates.


Viewing instances of a basic event in the current Fault Tree model

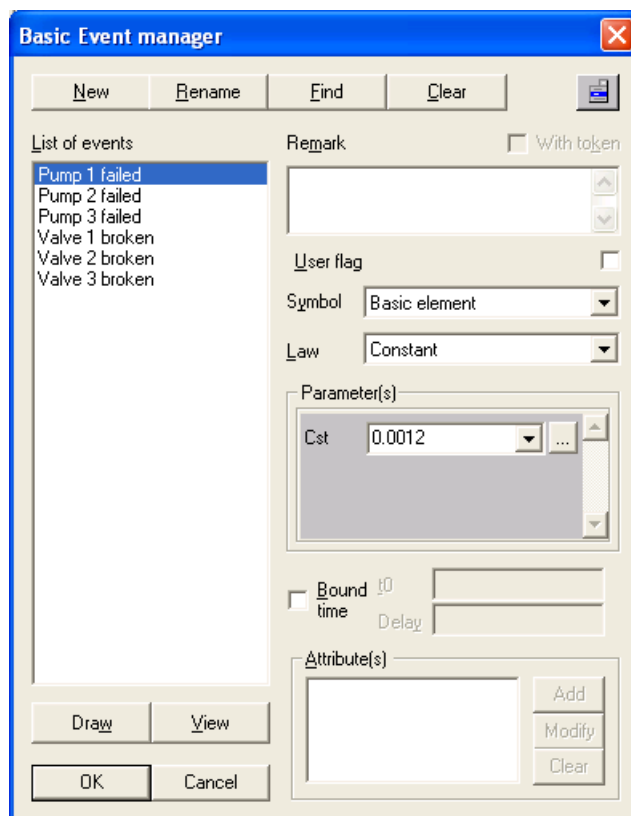
This task shows you how to view the instances of a basic event in the current Fault Tree model.

- Create basic events;
- Create a fault tree using created basic events.

1. Open **Basic Event Manager** dialog window.



Note: Select the command **Basic Event Manager...** from the menu **Data** or press **CTRL+E** or click the icon  from **Graphic** toolbar.



2. Select a basic event in the **List of basic events** dialog 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: 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 29

[Creating a house event](#) on page 30

[Editing a house event](#) on page 31

[Inserting house events in the current model](#) on page 33

[Performing Fault Tree analysis with house events](#) on page 34

About house event

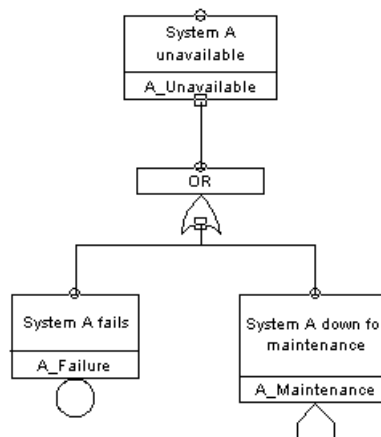
House event is used to model two different 'states' of a Fault Tree model with a specific event which occurs or does not occur. House event has a probability of occurrence equal to 1 or 0. It provides a very effective means of turning branches of Fault Tree on and off. Hence, a same Fault Tree can be 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:




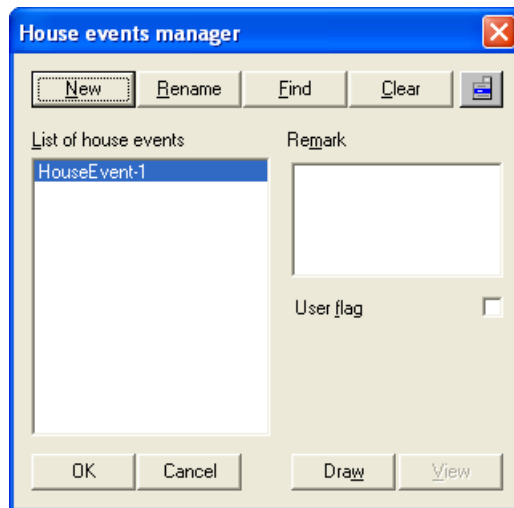
The House event 'A_Maintenance' represents the occurrence of maintenance action. Hence, the unavailability of the System A can be explained either by the system failure or by the system maintenance. To determine the

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.

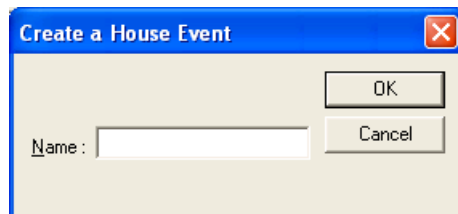
Creating a house event

This task shows you how to create a house event.

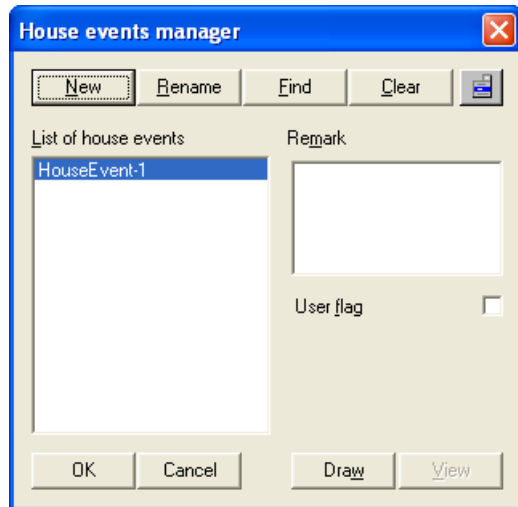
- Launch Aralia Fault Tree Analyzer
 - Create or open possibly empty Fault Tree model.
1. Select the **House Event Manager...** from the menu **Data** or press **CTRL+H** or click the icon  in the **Graphic** toolbar.
The **House Event Manager** dialog window appears:



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



3. Enter the house event name and click **Ok**.
The new house event appears in the list of house events:



4. To 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.

A new house event is created in the list of house events and appears in the current worksheet.



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



Note: Use **Find** to search house events by name or comment keywords.

Editing a house event


To manage your house events use **House Event Manager** dialog window available from the menu **Data > House Event Manager...**

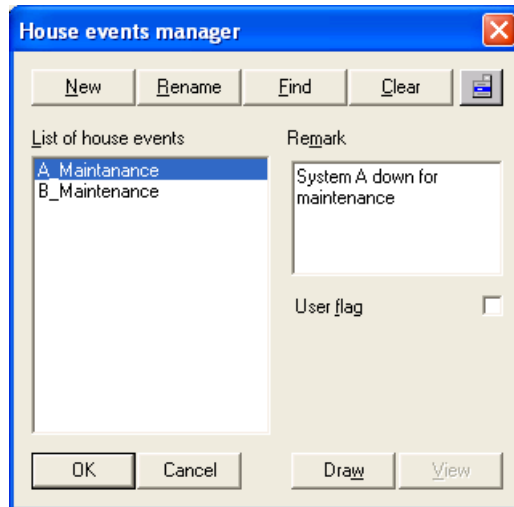
Create a house event.

Renaming a house event

1. Open **House Event Manager**.



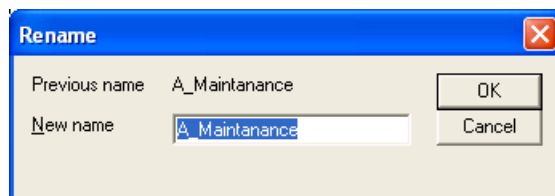
Note: To open **House Event Manager** click the icon  from **Graphic** toolbar.



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

3. Click **Rename**.

The **Rename** dialog window appears:



4. Enter the new name in the **New name** dialog box and click **Ok**.

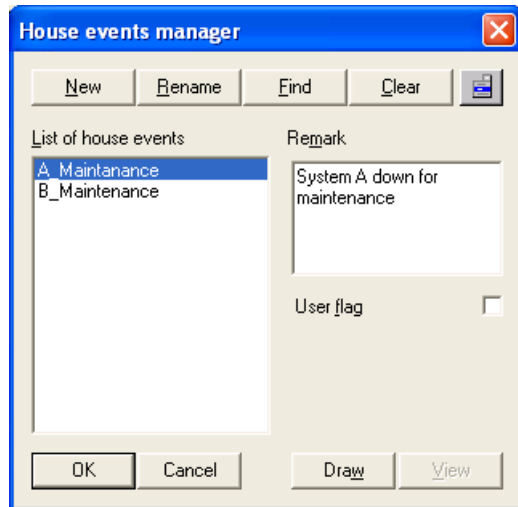
You can see the modification in the **List of house events** dialog box.

5. Click **Ok** to save changes and close **House Event Manager** dialog window.

The selected house event has been renamed.

Deleting a house event

1. Open **House Event Manager** dialog box.



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** window 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

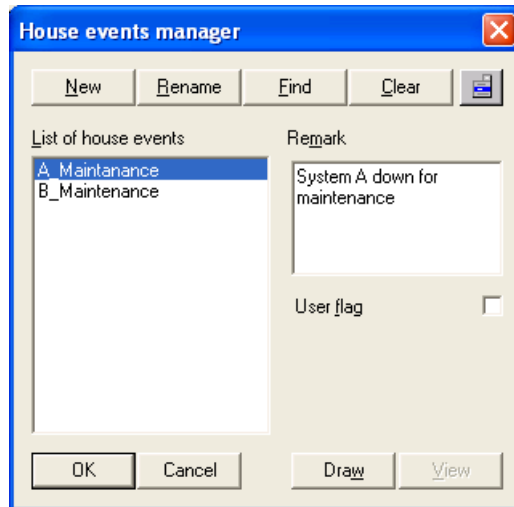
This task shows you how to insert house events in the current model.

Create a house event.

1. Open **House Event Manager** dialog box.



Tip: Press **CTRL+H** or click the icon  in the **Graphic** toolbar or select the command **House Event Manager...** from the menu **Data**.

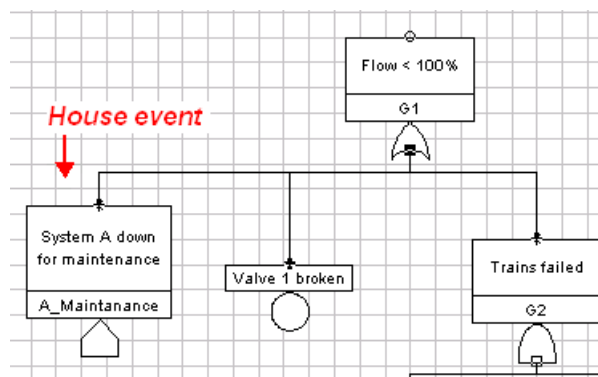


2. Select house events in the **List of house events** dialog box.



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

3. Click **Draw**, then click **Ok**.
The selected house events appear in the current worksheet.
4. Click in the current worksheet to place house events.
5. Connect house events to the Fault Tree.



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

Performing Fault Tree analysis with house events

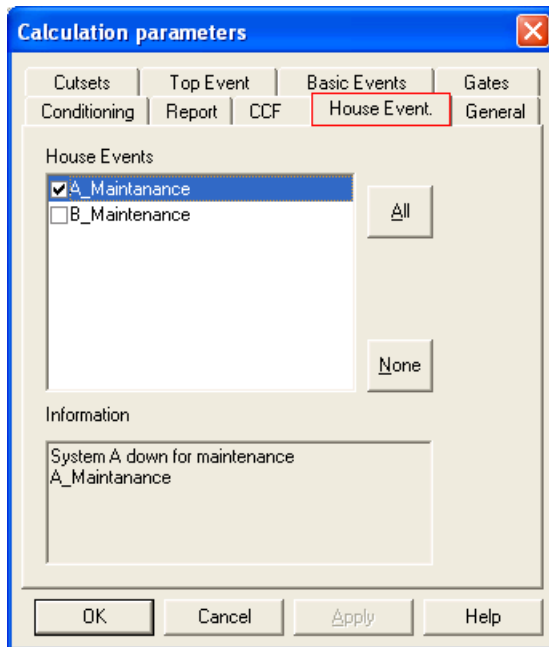
This task shows you how to enable house events in the Fault Tree assessment.

By default all house events are disabled.

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

1. Select the command **Aralia...** from the menu **Aralia > Set up**.
The **Calculation parameters** dialog window appears.

2. Select the tab **House event**.



3. In the **House events** dialog box select house events to be turned on.



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 disable house events follow the same procedure.

Working with intermediate events

This section describes how to create and edit an intermediate event.

[About intermediate events](#) on page 35

[About top events](#) on page 36

[Creating an intermediate event](#) on page 36

[Editing an intermediate event](#) on page 37

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.



Note: A Fault Tree model can be created without using intermediate events.

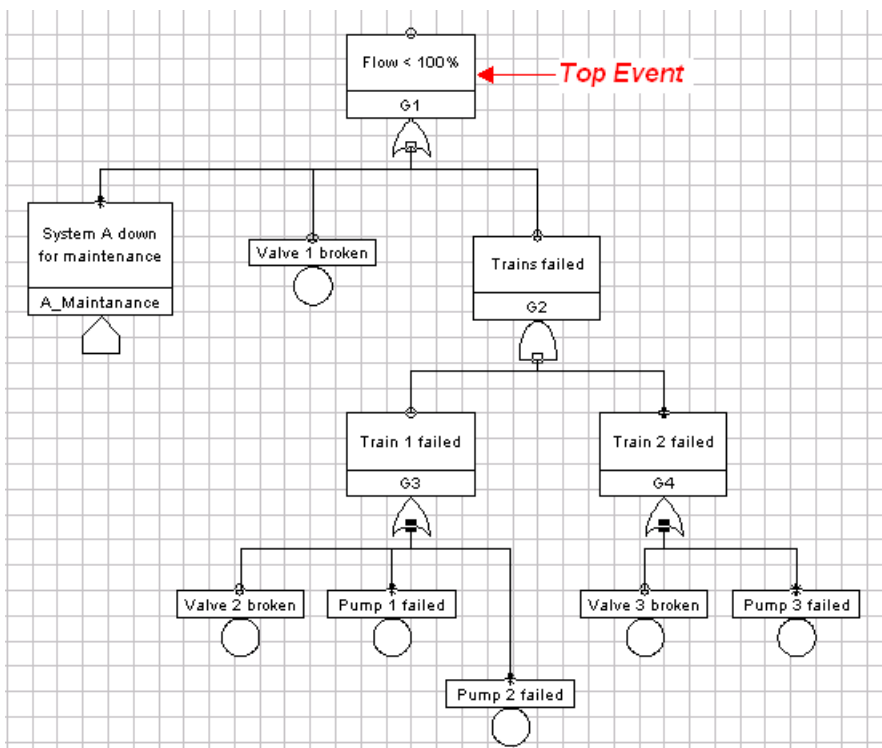


Note: An intermediate event is a graphical object like a gate. You can manipulate it like a gate.

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.




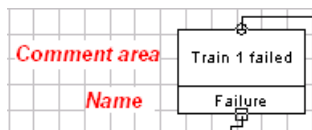
Note: The top event can be represented graphically by an intermediate event or by a gate.

Creating an intermediate event

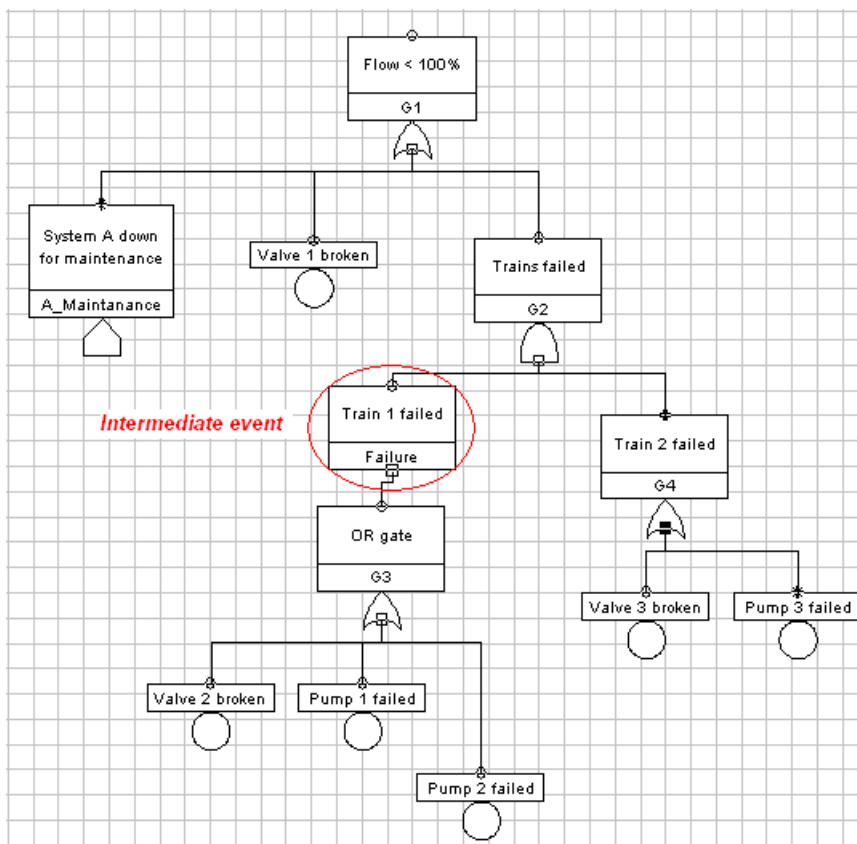
This task shows you how to create an intermediate event.

Create or open an existing Fault Tree model.

1. Select the comment **Intermediate event** from the menu **FT > Fault Tree Logic** or click the icon  from **Graphic** toolbar.
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 if necessary.



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



Editing an intermediate event

This task shows you how to edit an intermediate event.

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

Before you begin create an intermediate event.

To edit an intermediate event see [Editing a gate](#) on page 17.

Common Cause Failure

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

[About Common Cause Failure \(CCF\)](#) on page 38

[Creating a Common Cause Failure Group](#) on page 38

[Editing a Common Cause Failure Group](#) on page 40

[Performing Fault Tree analysis with Common Cause Failure](#) on page 43

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.

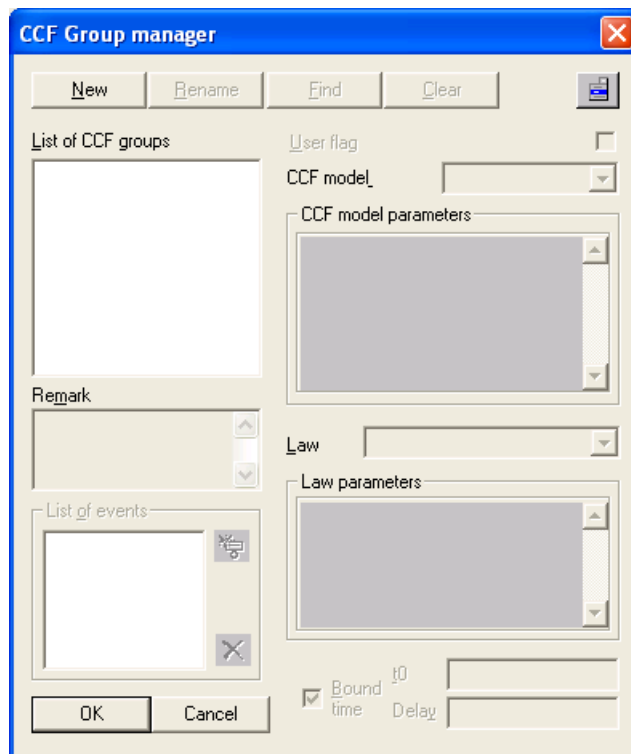
For example, if multiple pumps are connected to the same power supply, the failure of this power supply will cause the unavailability of all pumps.

Creating a Common Cause Failure Group

This task shows you how to create a Common Cause Failure Group.

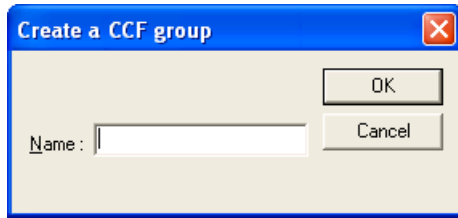
Create or open an existing Fault Tree model.


1. Select the command **CCF Group Manager...** from the menu **Data**.
The **CCF Group Manager** dialog window appears:




2. Click **New** to create new Common Cause Failure group.

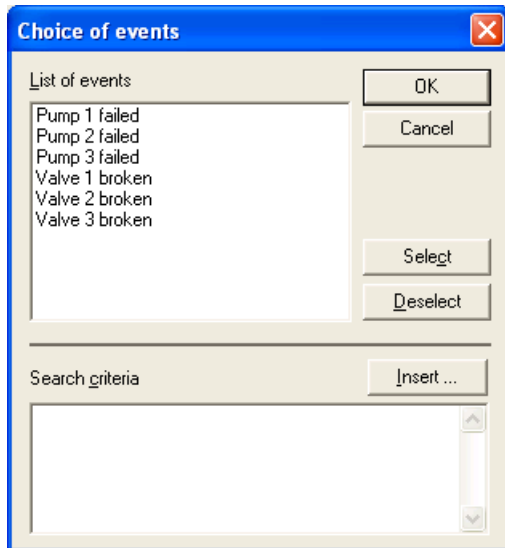
The **Create a CCF group** dialog window appears:



3. Enter a Common Cause Failure group name and click **Ok**.
The new Common Cause Failure Group appears in the list of the CCF groups.
4. In the **List of events** area click the icon  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 window appears:



5. Select basic events from the list of available basic events and click **Ok**.

 **Note:** You can use **CTRL** or **SHIFT** to select several basic events.


The selected basic events appear in the list.

 **Note:** To delete a basic event from the list select the basic event and click the icon .

6. CCF model:
 - a) In the **CCF model** dialog box select the type of CCF model.
 - b) In the **CCF model parameters** area enter the values of model parameters.
7. Probability distribution:
 - a) In the **Law** dialog box select the probability distribution of the CCF.

- b) In the **Law parameters** area enter values of probability distribution parameters.
8. Click **Ok**.

The screenshot shows the 'CCF Group manager' dialog box. It has a title bar with a close button. The main area is divided into several sections. On the left, there is a 'List of CCF groups' with a list box containing 'CCF-1'. Below this is a 'Remark' text area. Further down is a 'List of events' list box containing 'Pump 1 failed', 'Pump 3 failed', and 'Valve 2 broken'. On the right side, there is a 'User flag' checkbox, a 'CCF model' dropdown menu set to 'Beta', and a 'CCF model parameters' section with a text box for 'Beta' set to '0.1'. Below this is a 'Law' dropdown menu set to 'Exponential' and a 'Law parameters' section with a text box for 'Lbd' set to '0.001'. At the bottom right, there are 'Bound time' and 'Delay' checkboxes and text boxes. At the bottom left are 'OK' and 'Cancel' buttons.

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

Editing a Common Cause Failure Group

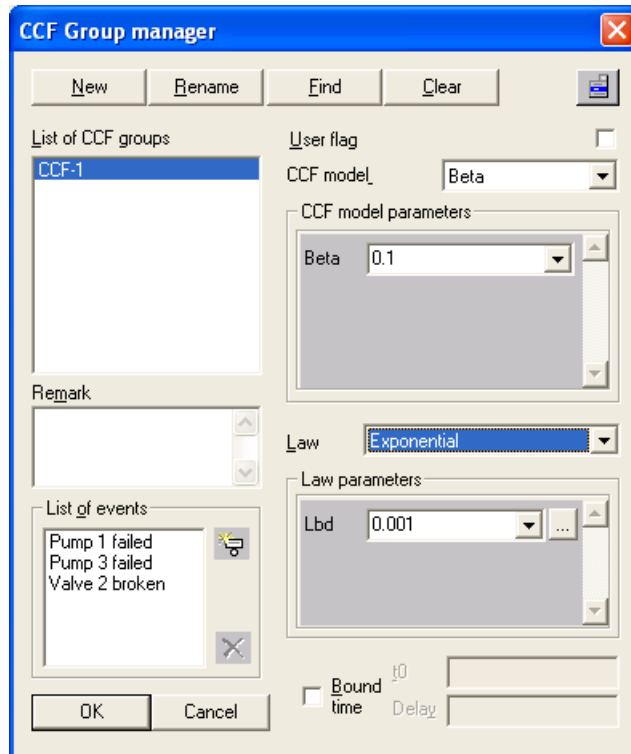
To edit a Common Cause Failure Group you can use **CCF Group Manager** available from the menu **Data**.

Before you begin

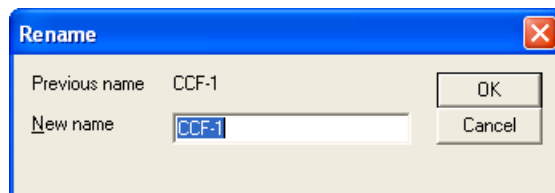
- Launch Aralia Fault Tree Analyzer
- Create or open an existing Fault Tree model
- Create a Common Cause Failure group.

Renaming a Common Cause Failure Group

1. Select the command **CCF Group Manager...** from the menu **Data**.
The **CCF Group Manager** dialog window appears:



2. Select a Common Cause Failure Group in the **List of CCF groups**.
 3. Click **Rename**.
- The **Rename** dialog window appears:

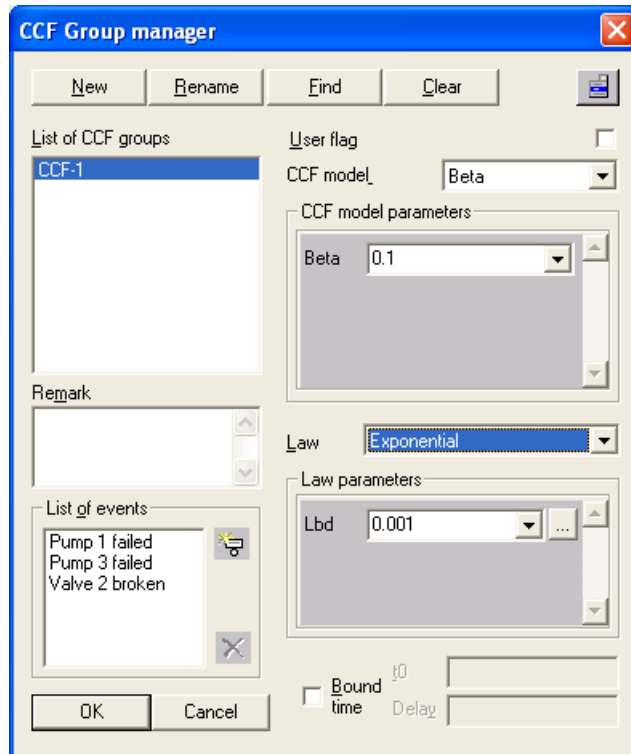


4. Enter new name in the **New name** dialog box and click **Ok**.
- The Common Cause Failure group has been renamed.

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

Deleting a CCF group

1. Select the command **CCF Group Manager...** from the menu **Data**.
- The **CCF Group Manager** dialog window appears:



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



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

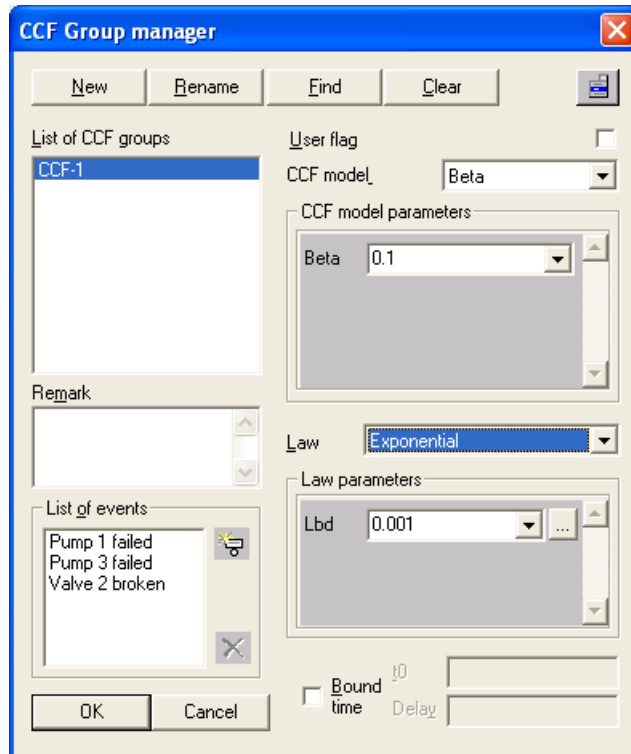
The selected CCF groups are marked in blue.

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

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

Modifying probability distribution of a CCF group

1. Select the command **CCF Group Manager...** from the menu **Data**.
The **CCF Group Manager** dialog window appears:



2. Select the CCF group in the **List of CCF groups** dialog box.
3. In the **CCF model** dialog box choose another model and change its parameters in the **CCF model parameters** area.
4. In the **Law** dialog 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

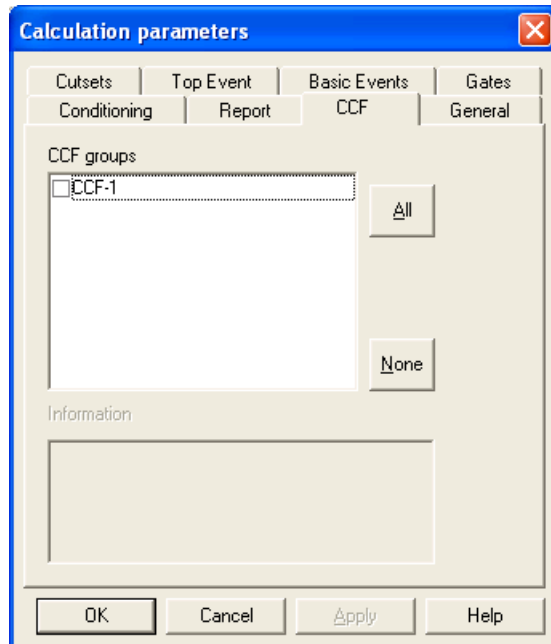
This task shows you how to perform a Fault Tree analysis taking into account Common Cause Failures.

By default Common Cause Failures are disabled.

Before you begin

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

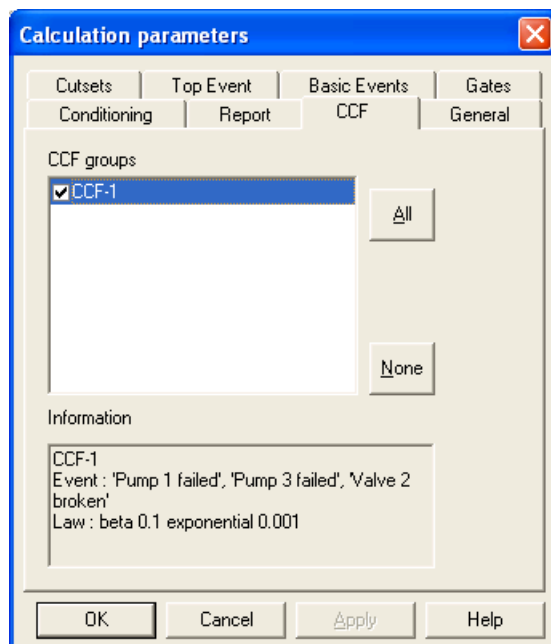
1. Select the command **Aralia...** from the menu **Aralia > Set up**.
2. Select the tab **CCF**.



3. In the **CCF groups** dialog 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**.



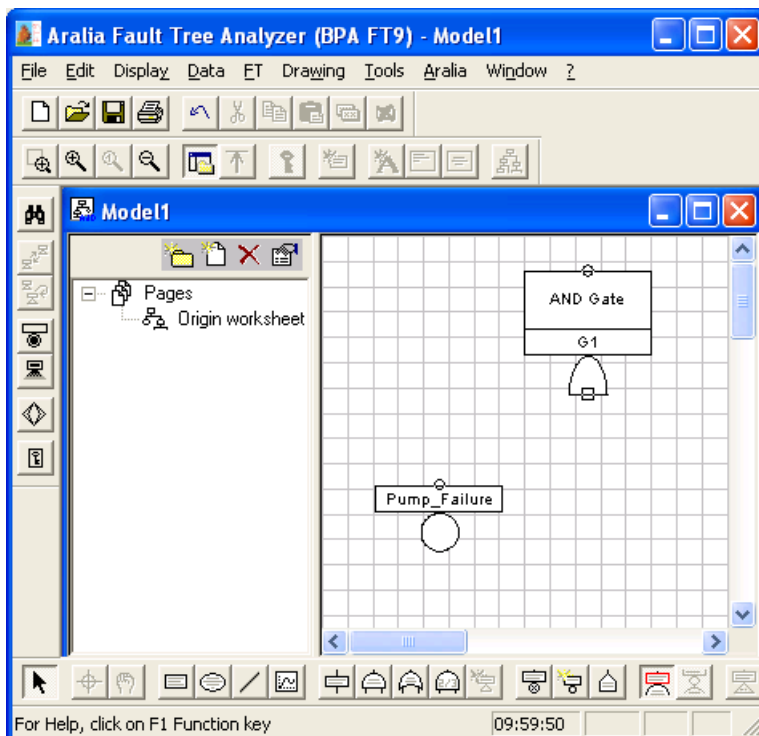
Note: When a quantitative assessment is performed with CCF, the probability law of the CCF is defined in **CCF Group Manager**. The laws associated with basic events are not considered in CCF laws.

Creating a link between two objects

This task shows you how to create a link between two objects, for example, between two gates or between a basic event and a gate.

Before creating a link, you should, for example

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

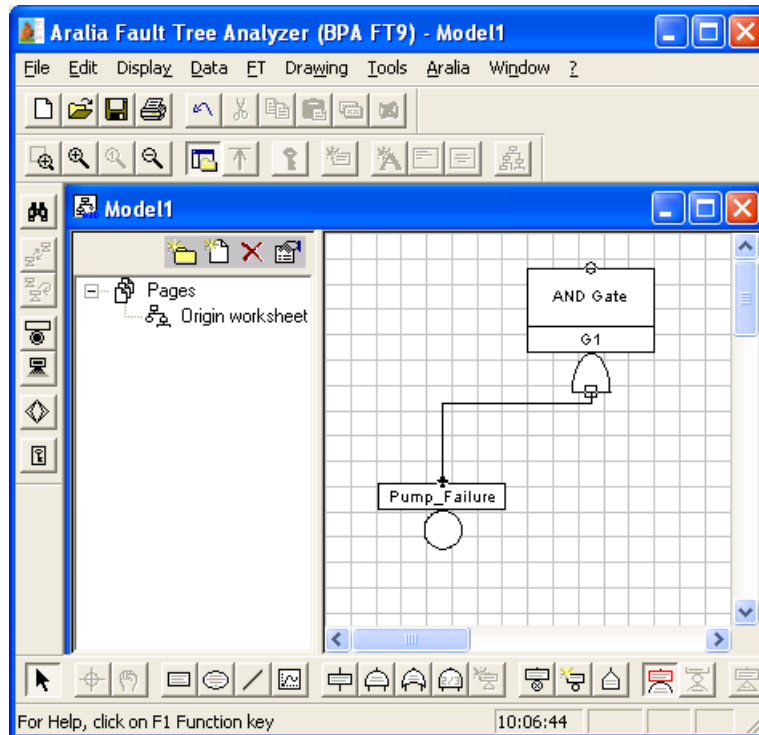


1. To create a link between two objects, click the connection dot of the first object. A line issued from the object appears.
2. Drag the line to the middle of the second object.



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

This task shows you how to create objects automatically connected to the selected gate.

Before doing this task:

- Open a Aralia Fault Tree Analyzer model.
 - Create a gate.
1. Select a gate.
 2. Select the icon  from **Graphics** toolbar or the command **Autoconnect** from the menu **Drawing**.
 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.

Working with transfer gates

This section describes how to use transfer gates.

[About transfer gates](#) on page 47

[Creating a transfer gate](#) on page 48

[Switching between transfers](#) on page 49

[Transferring a sub-tree in the current worksheet](#) on page 50

[Transferring a sub-tree to a new worksheet](#) on page 51

[Removing a transfer](#) on page 52

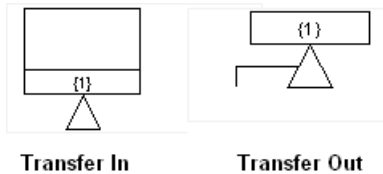
About transfer gates

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 two types of Transfer gates:

- Transfer In gate
- Transfer Out gate.

They are represented by the following figure:



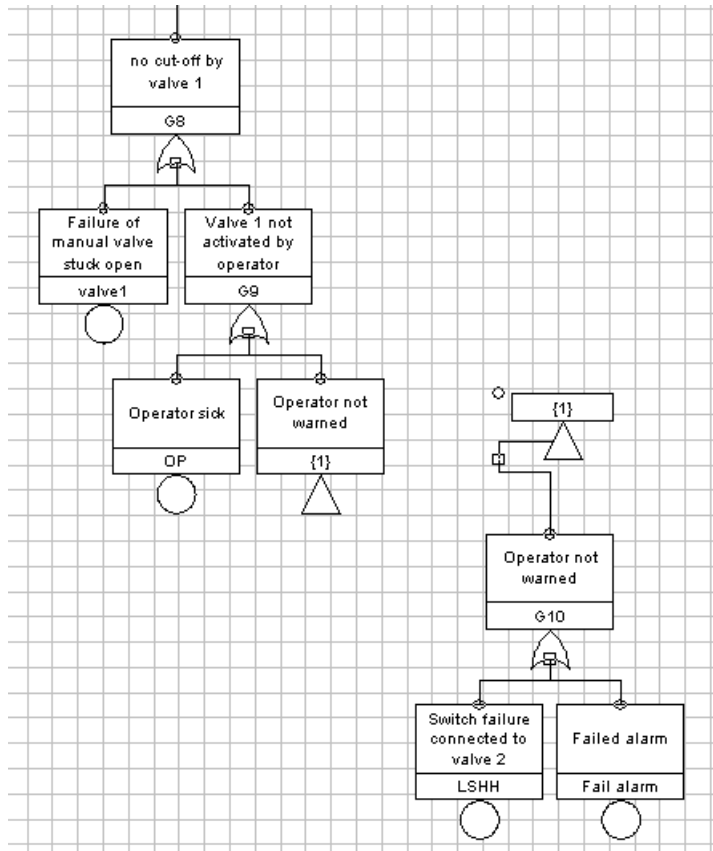
Transfer In Gate is used to indicate that a subtree of a Fault Tree is transferred to another place in the same worksheet or to a separate worksheet. Each Transfer In gate has a correspondent Transfer Out gate.

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.

Example of Transfer gate.

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

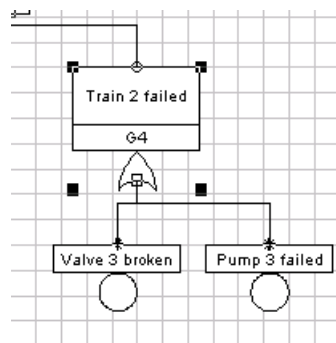



Creating a transfer gate

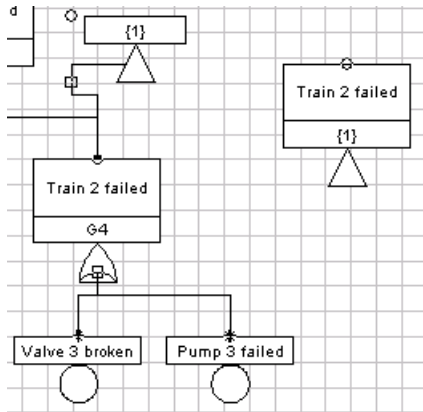
This task shows you how to create a transfer gate.

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. Select the command **Create transfer** from the menu **FT** or click the icon  in the **Graphic** toolbar 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.



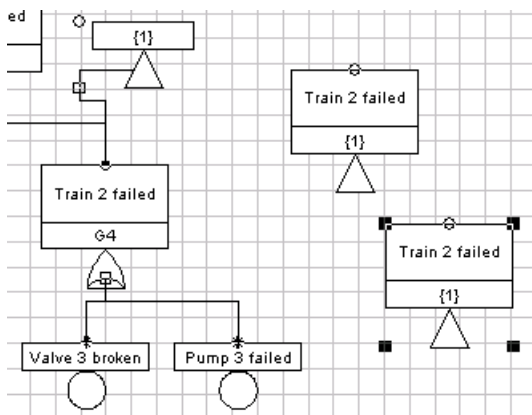
Note: A default number is associated to each new transfer gate.



Note: 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. To create additional Transfer In gate:
 - a) Select the existing Transfer In or Transfer Out gates;
 - b) Select the command **Create transfer** from the menu **FT** or click the icon  in the **Graphic** toolbar or press **CTRL+I**.

The additional Transfer In gate appears in the current worksheet.

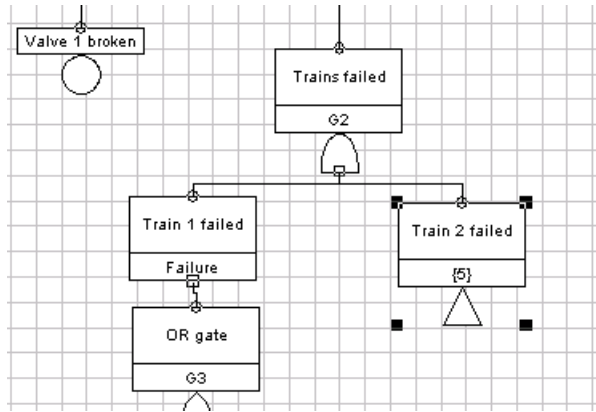


Switching between transfers

This task shows you how to switch from Transfer In gate to Transfer Out gate and vice-versa.

Before you begin create a transfer gate.

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



2. Right click on the selected gate.



Note: Click on the gate symbol of the selected gate.

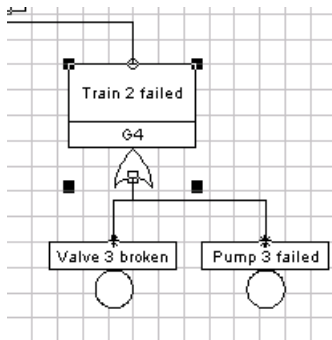
The worksheet with the corresponding Transfer In gate (Transfer Out gate) opens.

Transferring a sub-tree in the current worksheet

This task shows you how to transfer a sub-tree in the current worksheet.

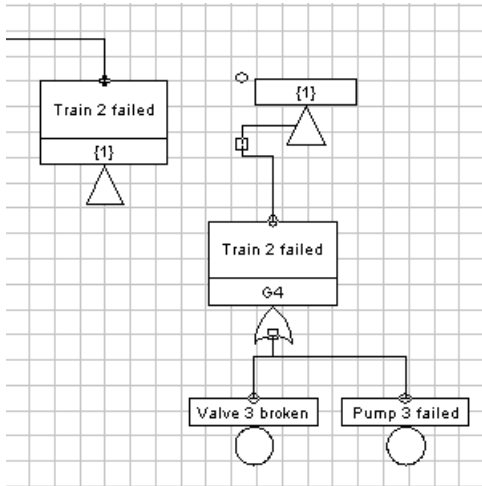
Create or open an existing Fault Tree model.

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



2. Select the command **Detach and transfer into the same worksheet** from the menu **FT**.

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

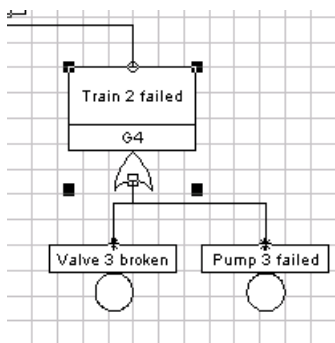


Transferring a sub-tree to a new worksheet

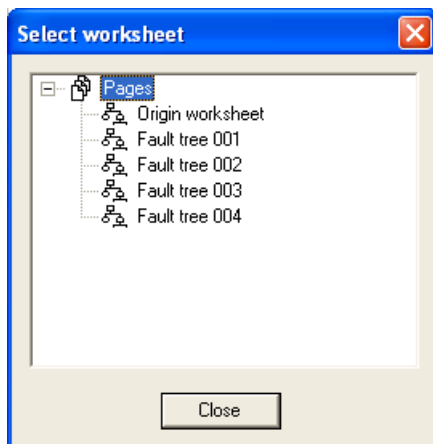
This task shows you how to transfer a sub-tree to a new worksheet.

Create or open an existing Fault Tree model.

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

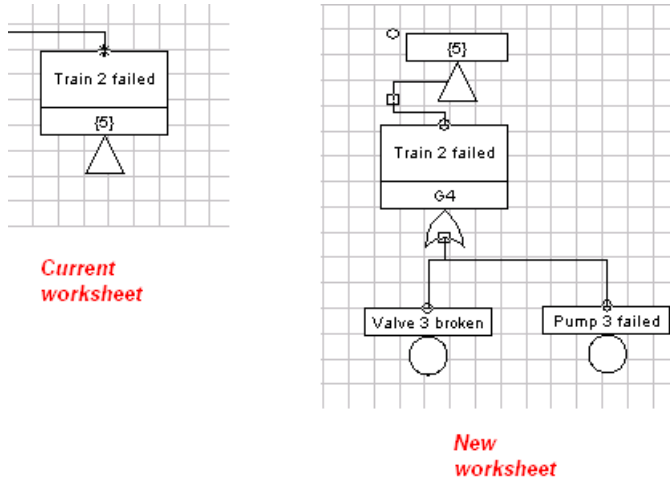


2. Select the command **Detach and transfer into a new worksheet** from the menu **FT**.
The **Select worksheet** dialog window appears:



3. Select the worksheet to transfer the sub-tree in this worksheet and click **Close**.

The sub-tree is transferred to the selected worksheet.



Note: If you select **Pages** the **Select worksheet** dialog window a new worksheet will be created containing the transferred sub-tree.



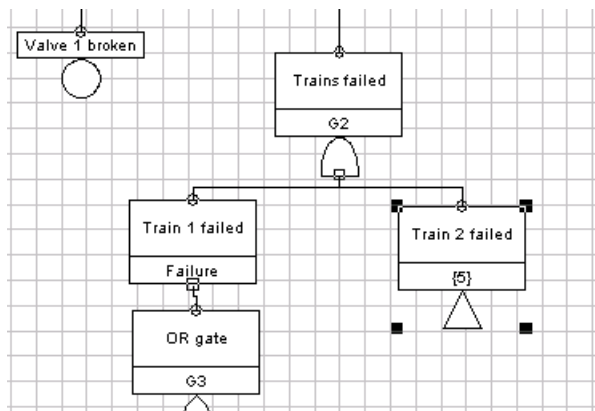
Note: If you select a folder in the **Select worksheet** dialog window, a new worksheet containing the transferred sub-tree will be created in the selected folder.

Removing a transfer

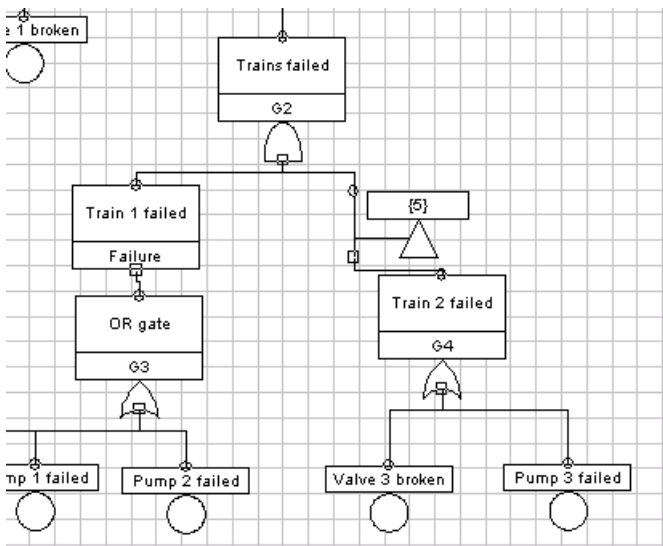
This task shows you how to bring back a transferred sub-tree to the corresponding Transfer In gate.

Before you begin create a transfer gate.

1. Select the Transfer In gate.



2. Select command **Expand transfer here** from the menu **FT**.
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.

Managing data

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

[About named parameters and attributes](#) on page 53

[Creating a named parameter](#) on page 54

[Editing a named parameter](#) on page 55

[Associating a named parameter to a probability distribution](#) on page 57

[Creating an attribute](#) on page 59

[Editing an attribute](#) on page 61

[Assigning an attribute to a basic event](#) on page 63

[Exporting data](#) on page 66

About named parameters and attributes

To make easier the management of events, provides two concepts to enhance these objects with additional information:

- Named parameters
- Attributes.

About 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.

About attributes

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

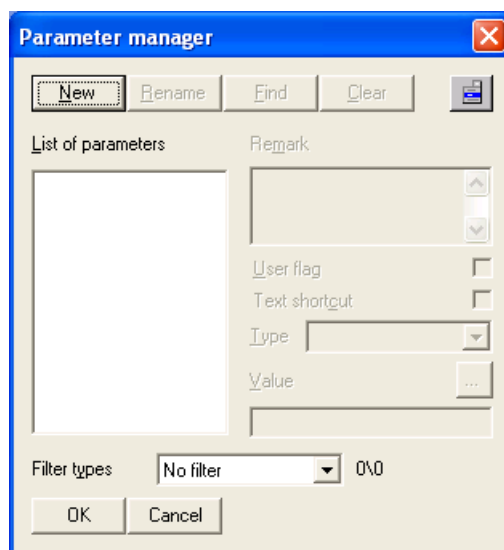
Attributes can have the following types:

- Real
- String
- Enumerated
- No value.

Creating a named parameter

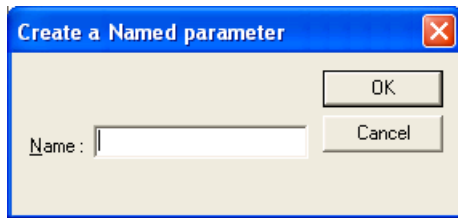
This task shows you how to create a named parameter.

- Launch Aralia Fault Tree Analyzer
 - Open a Fault Tree model (possibly empty).
1. Select the command **Parameter Manager...** from the menu **Data**.
The **Parameter Manager** dialog window appears:

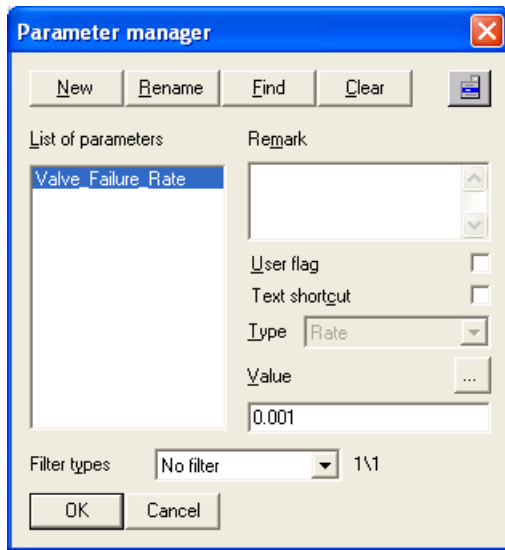


2. Click **New**.

The **Create a Named parameter** dialog window appears:



3. Enter the parameter name and click **Ok**.
The new parameter appears in the list of parameters:



4. In the **Type** dialog box select the type of the named parameter.
5. In the **Value** dialog 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.

6. Click **Ok** to save the parameter and close the **Parameter Manager** window.

The new named parameter is created.

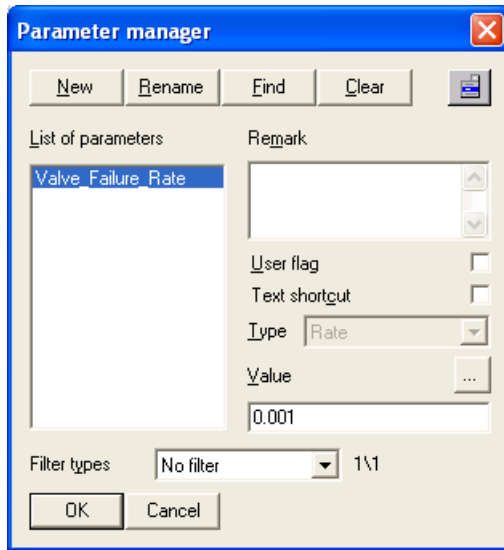
Editing a named parameter

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

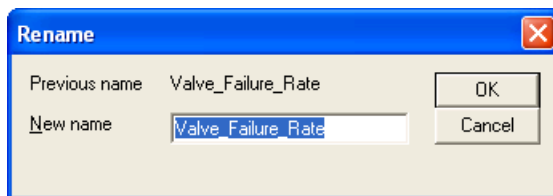
Create a named parameter.

Renaming a named parameter

1. Select the command **Parameter Manager...** from the menu **Data**.



2. Select a named parameter in the **List of parameters** dialog box.
3. Click **Rename**.
The **Rename** dialog window appears:



4. Enter new name of the selected parameter and click **Ok**.

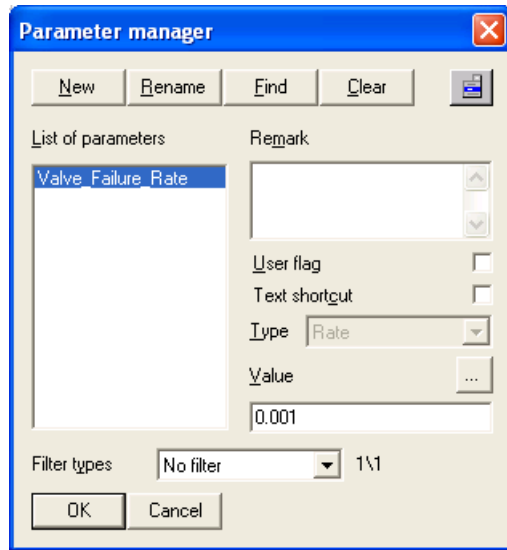
The selected parameter is renamed.



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

Deleting a named parameter

1. Select the command **Parameter Manager...** from the menu **Data**.



2. Select a named parameter in the **List of parameters** dialog box.



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

3. Click **Clear**.
The **Confirmation request** window appears.
4. Click **Yes**.

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

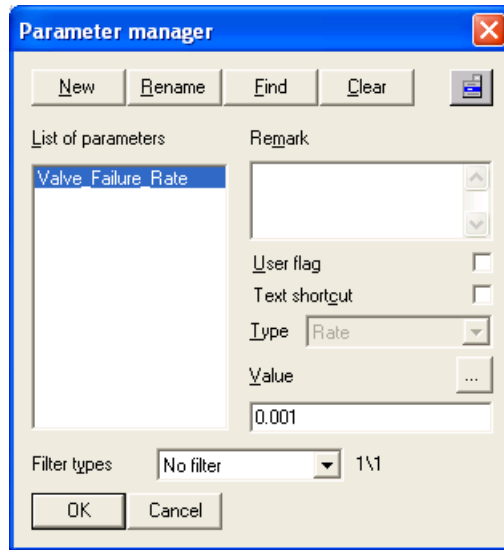
Associating a named parameter to a probability distribution

This task shows you how to associate a named parameter to a probability distribution.

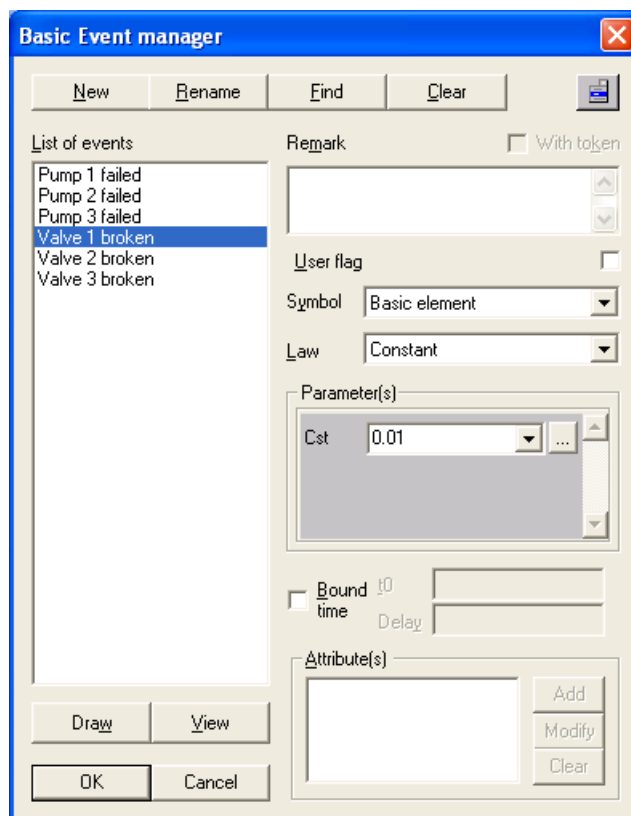
Named parameter can be used as a parameter of a basic event probability distribution. Named parameters are generally used when you have to fill in a numerical value. Several objects can use the same named parameter.

- Launch Aralia Fault Tree Analyzer ;
- Open an existing Fault Tree model.

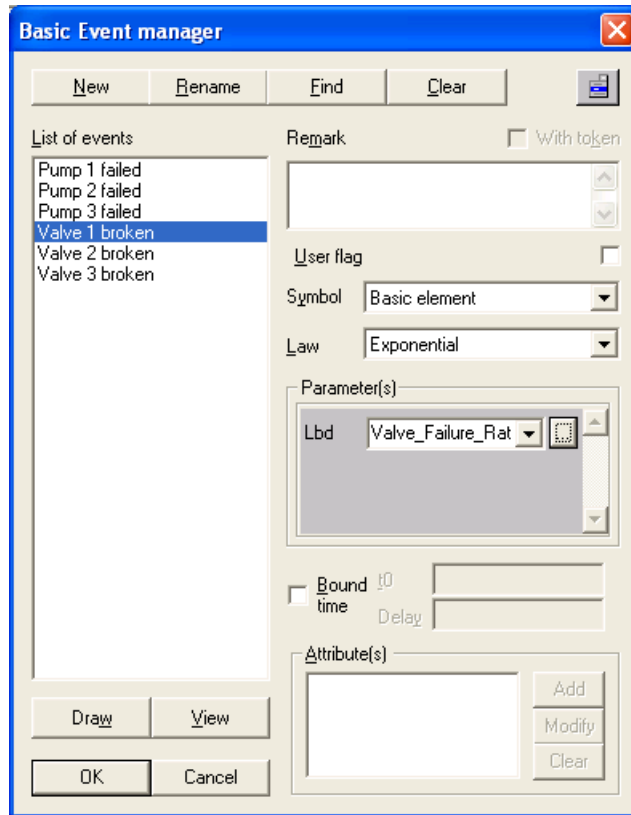
1. Create a named parameter *Valve_Failure_Rate* of type *Rate* . See [Creating a named parameter](#) on page 54



2. Open **Basic Event Manager** dialog window and select a basic event in the **List of basic events**. See [Editing a basic event](#) on page 22.



3. In the **Law** dialog 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 window.

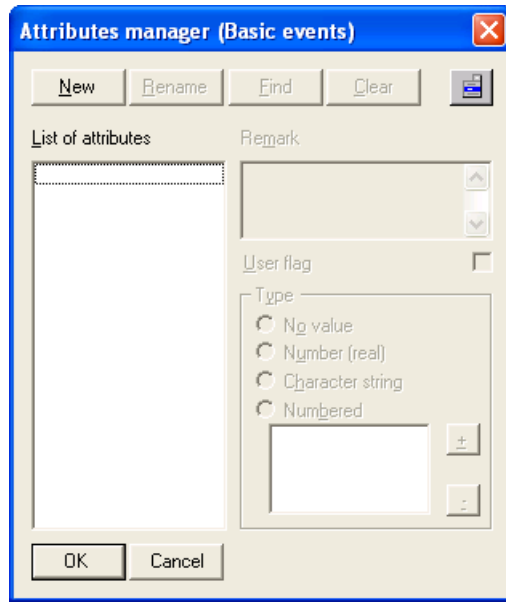


Important: Named parameters are typed. If you select the *Exponential* probability distribution, only named parameters of type *Rate* can be used as parameters of this distribution.

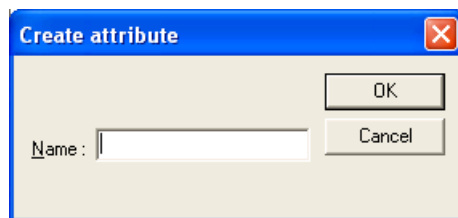
Creating an attribute

This task shows you how to create an attribute.

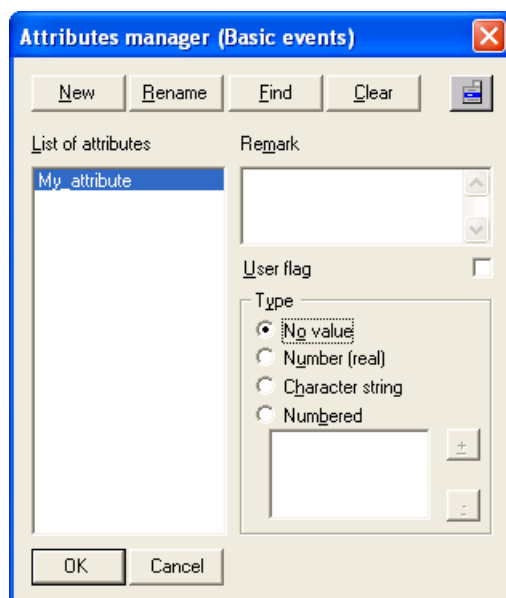
- Launch Aralia Fault Tree Analyzer ;
 - Open a Fault Tree model (possibly empty).
1. Select the **Attribute Manager...** from the menu **Data**.
The **Attributes manager (basic events)** dialog window appears:



2. Click **New**.
The **Create attribute** dialog window appears:



3. Enter the attribute name and click **Ok**.
The new attribute appears in the **List of attributes**:



4. 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.

5. Add comments in the **Remark** dialog box if necessary.
6. Click **Ok** to save changes and close the **Attribute manager (basic events)** dialog window.



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

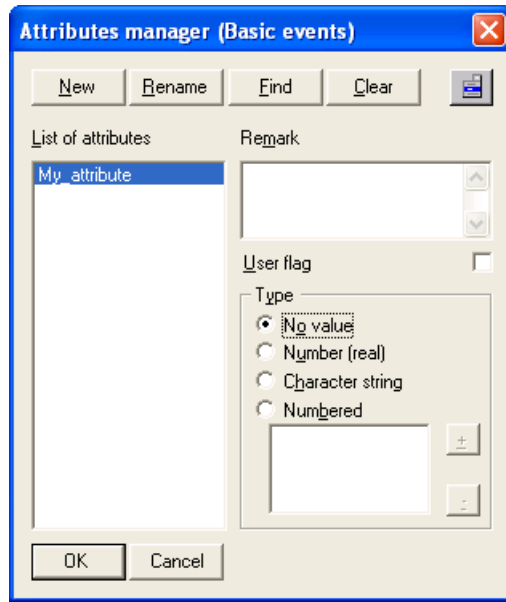
Editing an attribute

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

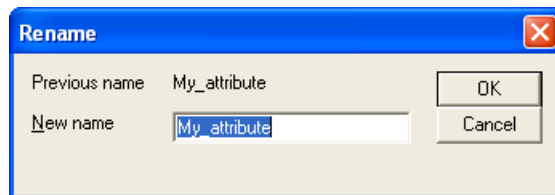
Create an attribute. See [Creating an attribute](#) on page 59.

Renaming an attribute

1. Select the command **Attribute Manager...** from the menu **Data**.



2. Select an attribute in the **List of attributes** dialog box.
 3. Click **Rename**.
- The **Rename** dialog window appears:



4. Enter new name and click **Ok**.

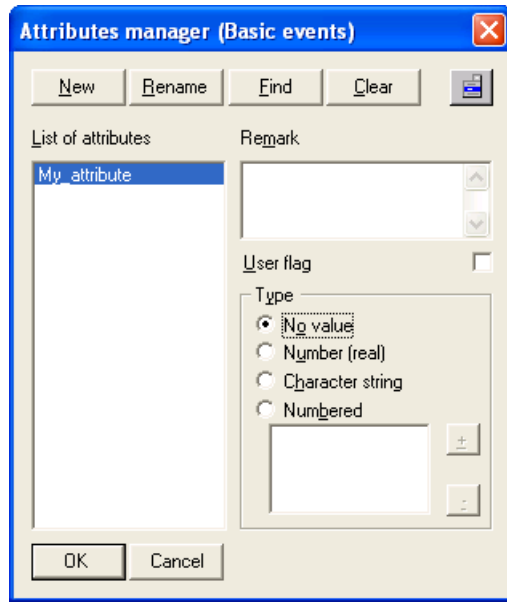
The attribute is renamed.



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

Deleting an attribute

1. Select the command **Attribute Manager...** from the menu **Data**.



2. Select an attribute in the **List of attributes** dialog box.



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

3. Click **Clear**.
The **Confirmation request** window appears.
4. Click **Yes**.

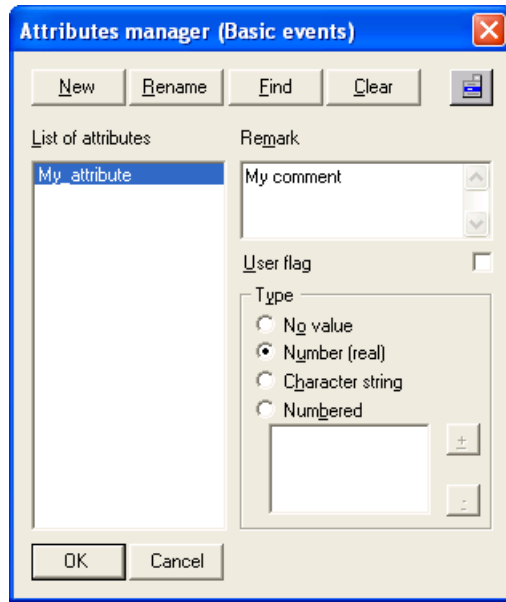
The selected attributes are removed from the list.

Assigning an attribute to a basic event

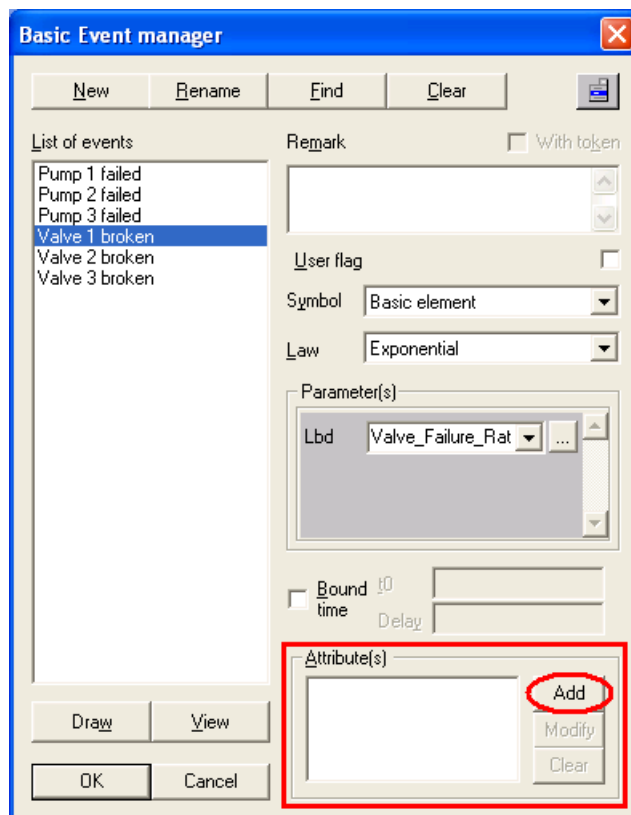
This task shows you how to assign an attribute to a basic event and how assigning a value to this attribute.

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

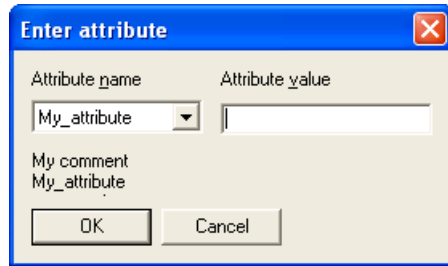
1. Create an attribute. See [Creating an attribute](#) on page 59



2. Open **Basic Event Manager** dialog window and select a basic event in the **List of basic events**. See [Editing a basic event](#) on page 22

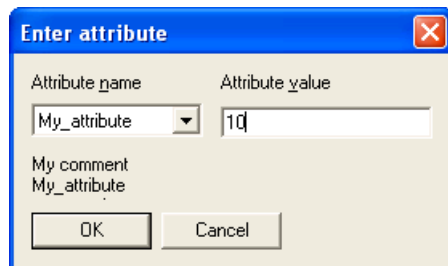


3. In the **Attribute(s)** area click **Add** to add the created attribute.
The **Enter attribute** dialog window appears:



The 'Enter attribute' dialog box has a blue title bar with a close button. It contains two input fields: 'Attribute name' with a dropdown menu showing 'My_attribute' and 'Attribute value' with a text box. Below these is a 'My comment' section with a text box containing 'My_attribute'. At the bottom are 'OK' and 'Cancel' buttons.

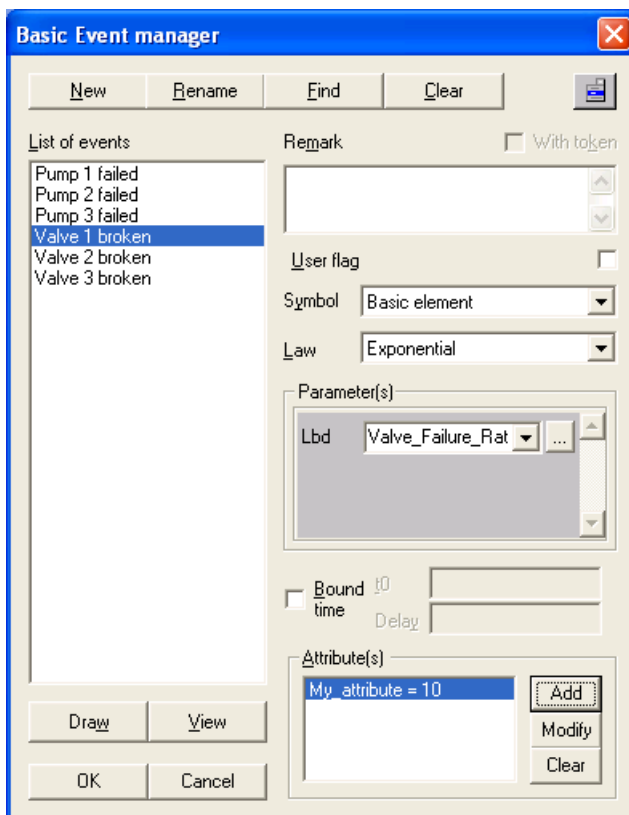
4. Select the attribute and enter its value in the **Attribute value** dialog box.



This 'Enter attribute' dialog box is identical to the previous one, but the 'Attribute value' text box now contains the number '10'.

5. Click **Ok**.

The selected basic event is characterized with *My_attribute* attribute:



The 'Basic Event manager' dialog box has a blue title bar and a close button. It features a toolbar with 'New', 'Rename', 'Find', 'Clear', and a save icon. On the left is a 'List of events' with a scrollable list containing 'Pump 1 failed', 'Pump 2 failed', 'Pump 3 failed', 'Valve 1 broken' (highlighted), 'Valve 2 broken', and 'Valve 3 broken'. To the right of the list is a 'Remark' text box and a 'With token' checkbox. Below these are 'User flag' and 'Symbol' (set to 'Basic element') dropdowns, and a 'Law' dropdown set to 'Exponential'. A 'Parameter(s)' section contains a list with 'Lbd' and 'Valve_Failure_Rat'. At the bottom, there are 'Bound time' and 'Delay' input fields, an 'Attribute(s)' section with 'My_attribute = 10' and 'Add', 'Modify', and 'Clear' buttons, and a final row of 'Draw', 'View', 'OK', and 'Cancel' buttons.



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

Exporting data

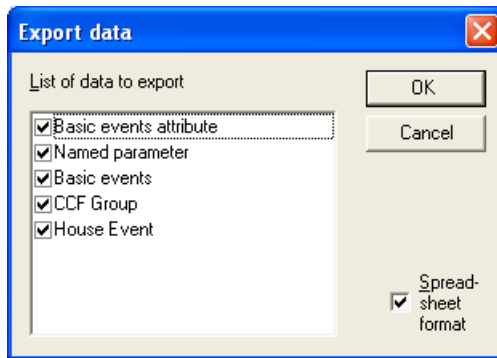
Aralia Fault Tree Analyzer allows exporting different types of the Fault Tree model data to ASCII file.

This task shows you how to export data from Aralia Fault Tree Analyzer .

You should launch Aralia Fault Tree Analyzer and open a Fault Tree model before you begin.

1. Select the command **Export data...** from the menu **Data**.

The **Export data** dialog window appears:



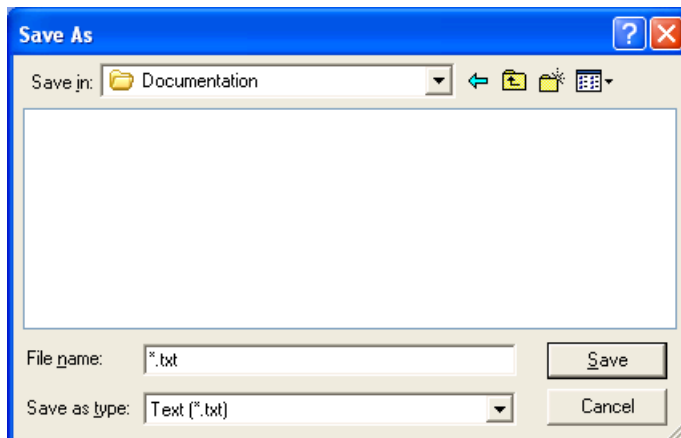
2. Select the data to export.



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

3. Click **Ok**.

The **Save as** dialog window appears:



4. Enter the file name and select the directory to save the file. Then click **Save**.

The data is exported to the selected file.

Performing Fault Tree Analysis

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

About Fault Tree assessment on page 67

Setting up calculation engine Aralia on page 69

Calculating minimal cutsets on page 70

Calculating Top event probability on page 75

Calculating Safety Integrity Levels(SIL) on page 78

Exporting results on page 80

About 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 analysis;
- Quantitative analysis;
- Safety Integrity Level (SIL) assessment.

Qualitative assessment

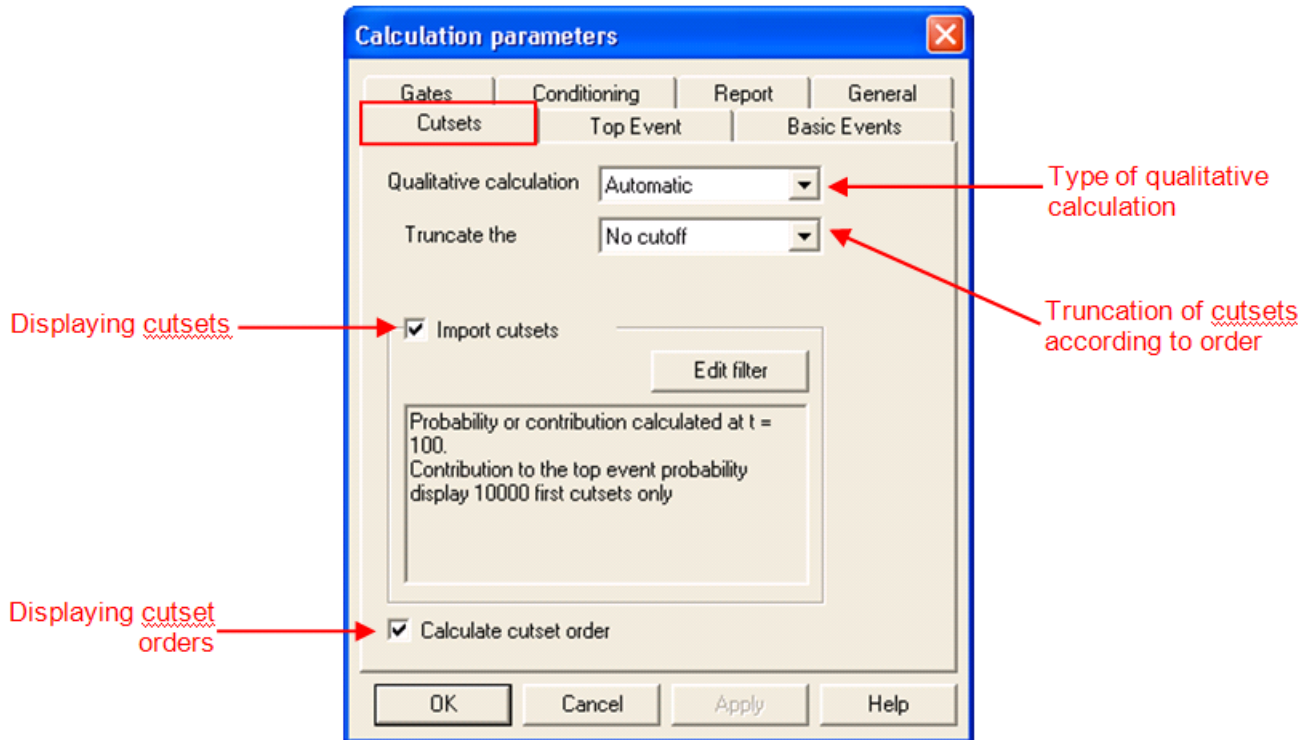
Qualitative assessment of Fault Trees includes the calculation of minimal cutsets or prime implicants.

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 literal, 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).

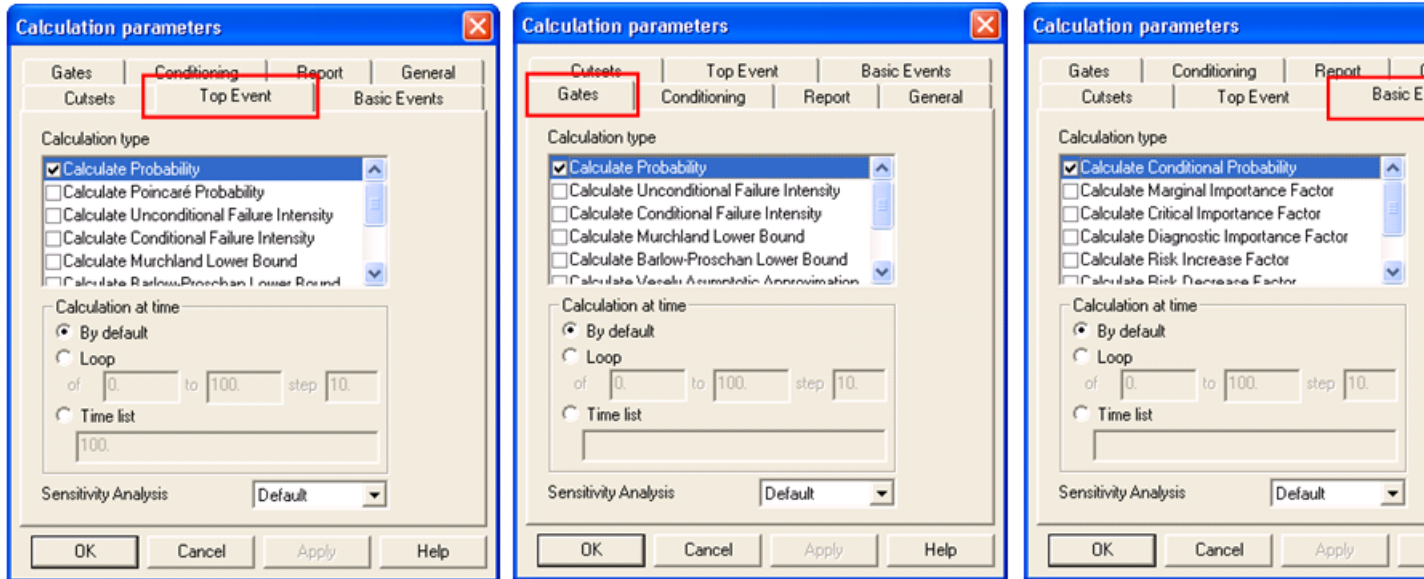
Quantitative assessment

Quantitative assessment is the calculation of probability of different events of the Fault Tree and importance factors from probability distributions of basic events. Exact computations are performed on 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

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:

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

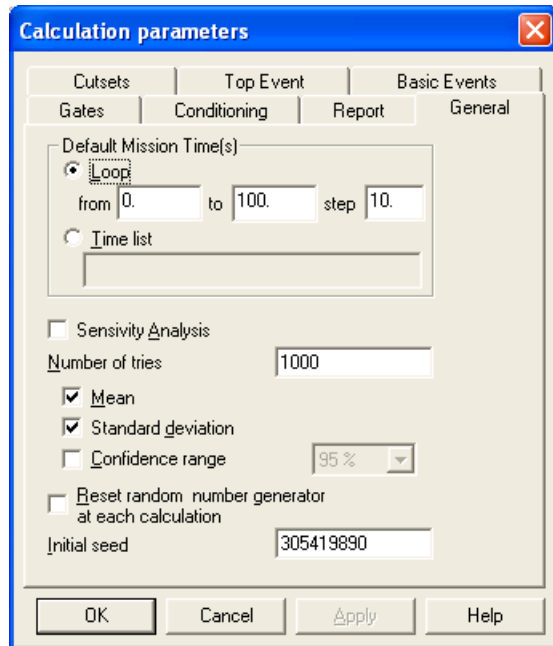
In the cited forms, levels 1 to 4 are considered.

Setting up calculation engine Aralia

To perform Fault Tree analysis with you should first set up the calculation engine Aralia and then launch the calculation. This task shows you how to set up the calculation engine Aralia.

Before you begin

- Launch ;
 - Create a Fault Tree or open an existing Fault Tree Model.
1. Select the command **Aralia** from the menu **Aralia > Set up**.
The **Calculation parameters** dialog window appears:



2. From **Calculation parameters** dialog window you can chose the calculation type to be performed:
 - Click the tab **Cutsets** to set the calculation of minimal cutsets or prime implicants.
 - Click the tab **Top Event** to set up the calculation of the top event probability or other quantitative values available to be computed for the Top event.
 - Click the tab **Gates** to set up the calculation of quantitative values available for gates.
 - Click the tab **Basic events** to set up the calculation of quantitative values available for basic events.
 - Click the tab **General** to set up the performance of sensitivity analysis.
3. Select the values to compute and click **Ok**.

The calculation engine is set up. You can launch the calculation from the menu **Aralia > Calculate**.

Calculating minimal cutsets

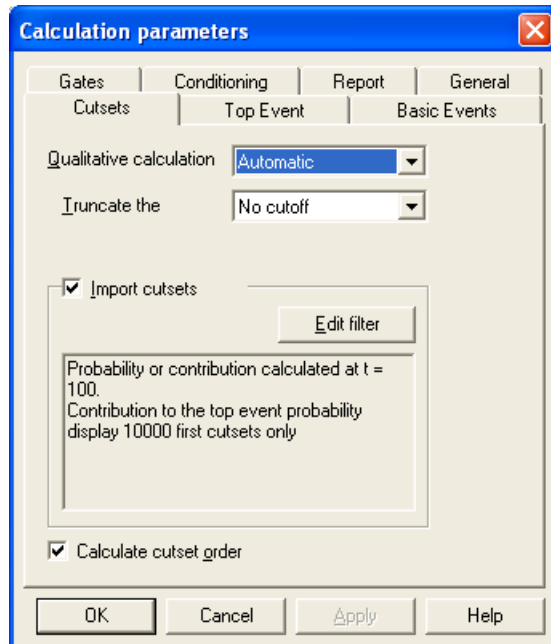
This task shows you how to calculate minimal cutsets of a Fault Tree.

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

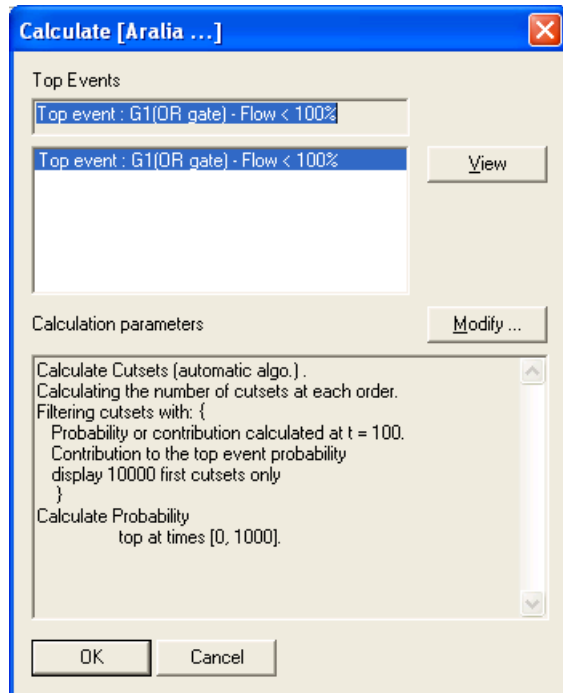
Before you begin

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

1. Select the command **Aralia...** from the menu **Aralia > Set Up**.
The **Calculation parameters** dialog window appears:



2. In the tab **Cutsets**:
 - a) In the **Qualitative calculation** dialog box select **Automatic**.
 - b) In the **Truncate** dialog 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 the command **Aralia...** from the menu **Aralia > Calculate**.
The **Calculate [Aralia...]** dialog window appears:

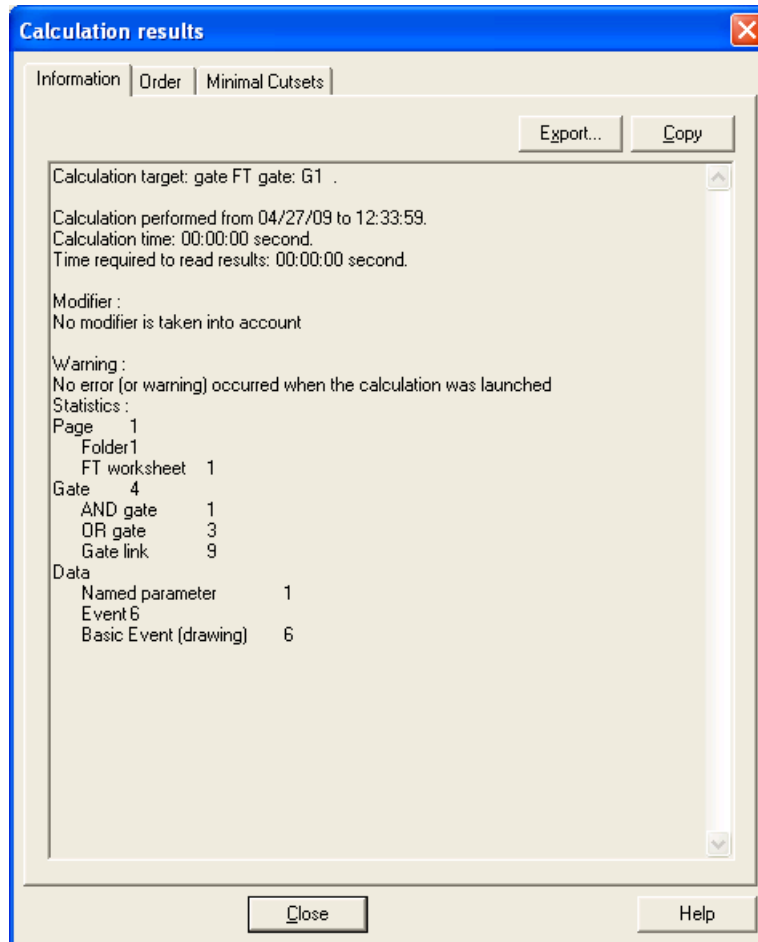


4. Click **Ok** to launch the calculation.

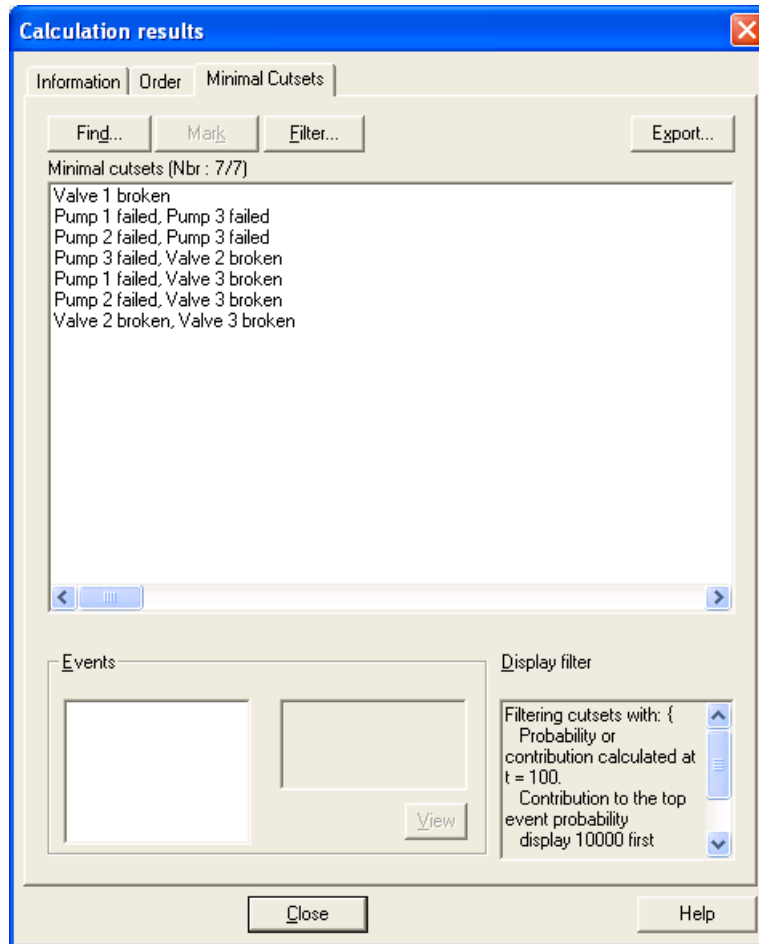


Note: To change calculation parameters click **Modify...**

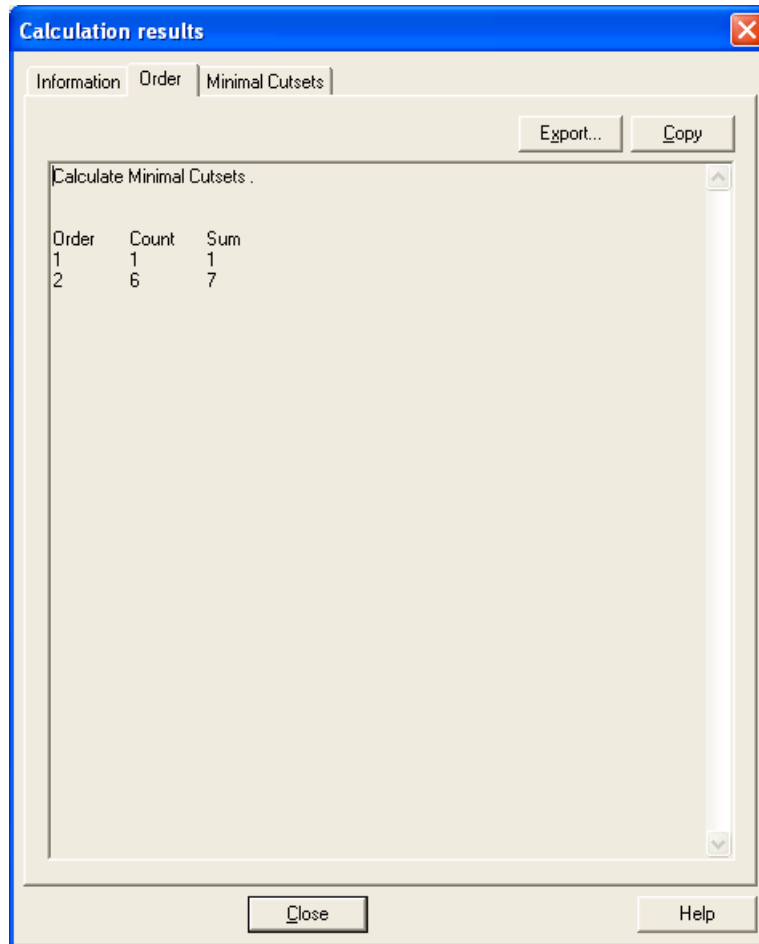
The **Calculation results** dialog window appears:



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



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



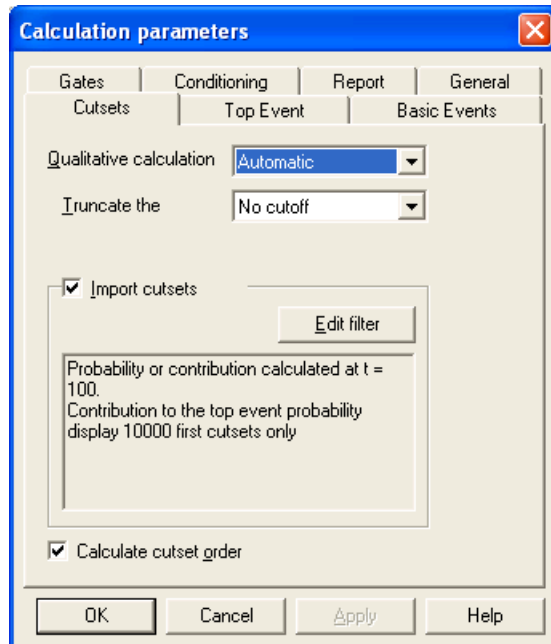
Calculating Top event probability

This task shows you how to calculate Top Event probability.

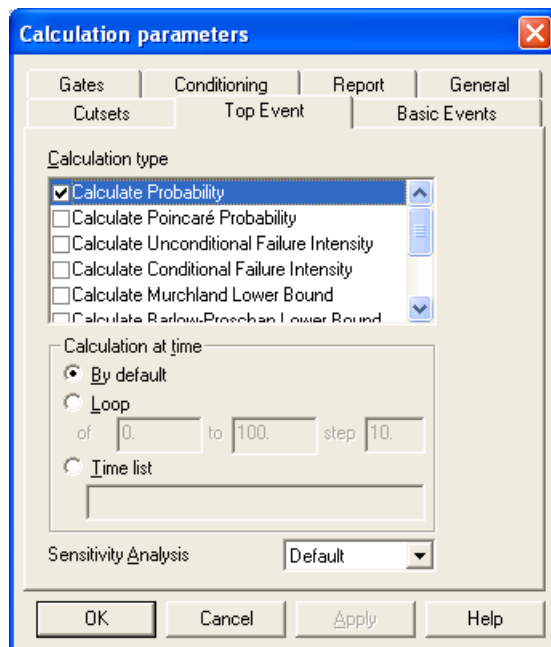
Before you begin

- Launch ;
- Create a Fault Tree or open an existing Fault Tree model.

1. Select the command **Aralia** from the menu **Aralia > Set up**.
The **Calculation parameters** dialog window appears:



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



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



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

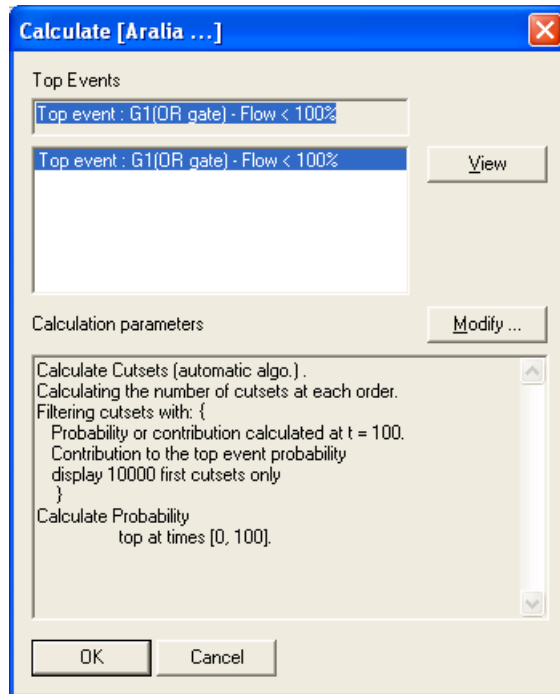
The calculation engine has been set up.

4. Select the command **Aralia...** from the menu **Aralia > Calculate**.



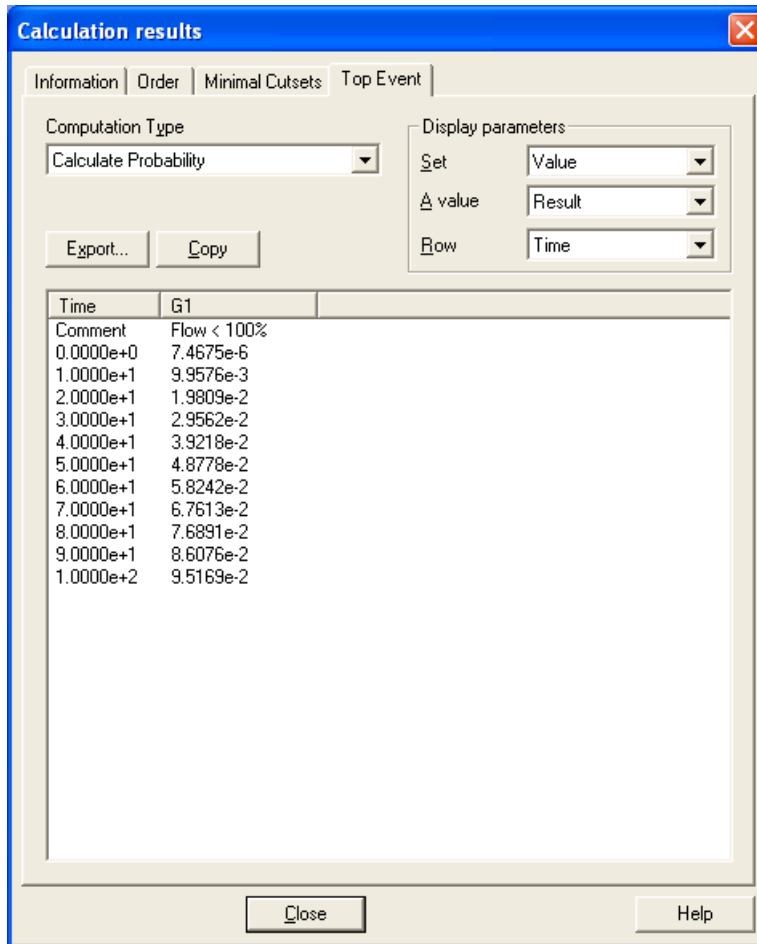
Note: To change calculation parameters click **Modify...**

The **Calculate [Aralia...]** dialog window appears:



5. Click **Ok**.

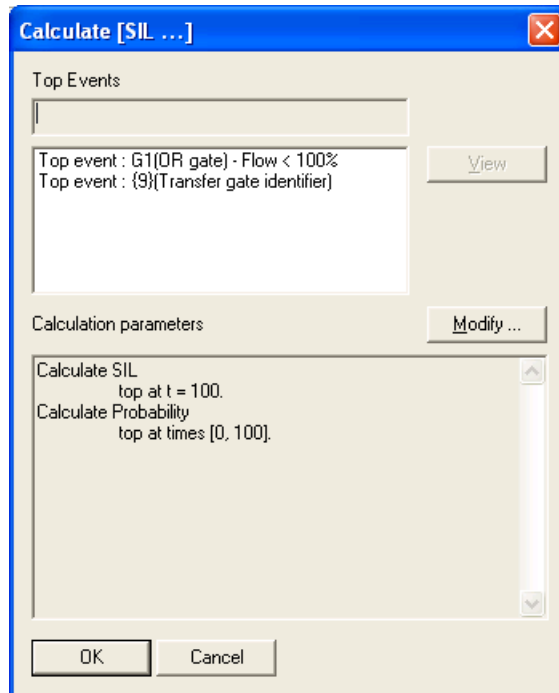
The **Calculation results** window appears. The results are displayed in the tab **Top Event**:



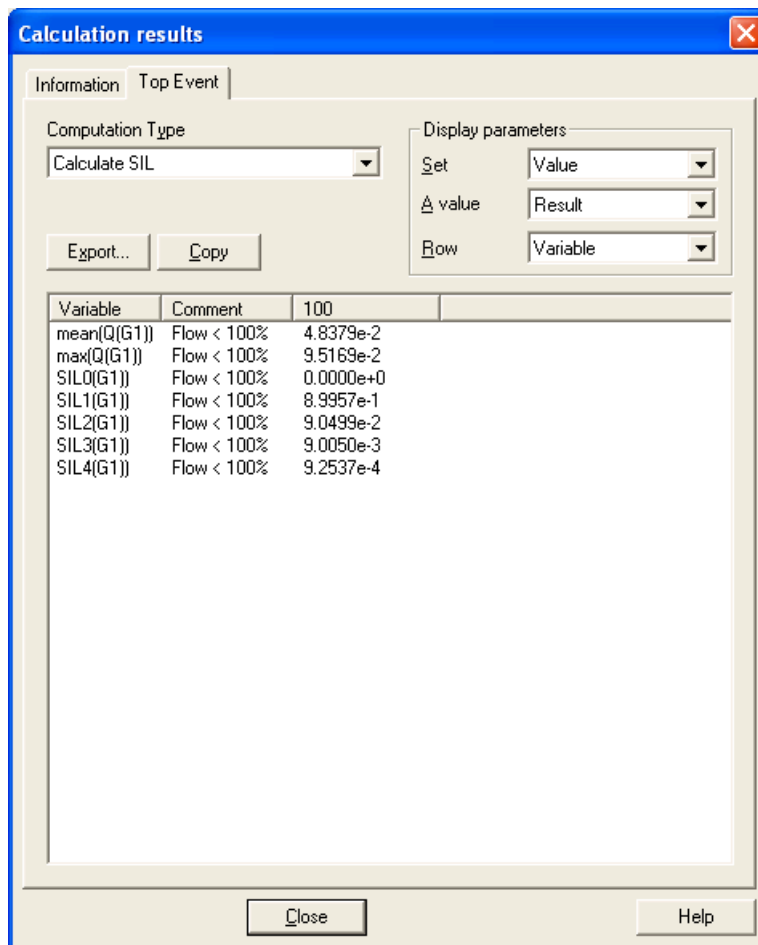
Calculating Safety Integrity Levels(SIL)

This task shows you how to calculate Safety Integrity Levels(SIL).

- Launch Aralia Fault Tree Analyzer ;
 - Create a Fault Tree or open an existing Fault Tree model.
1. Select the command **SIL...** from the menu **Aralia > Calculate**.
The **Calculate [SIL...]** dialog window appears:



2. Click **Ok** to launch calculations.
The **Calculation results** dialog window appears.



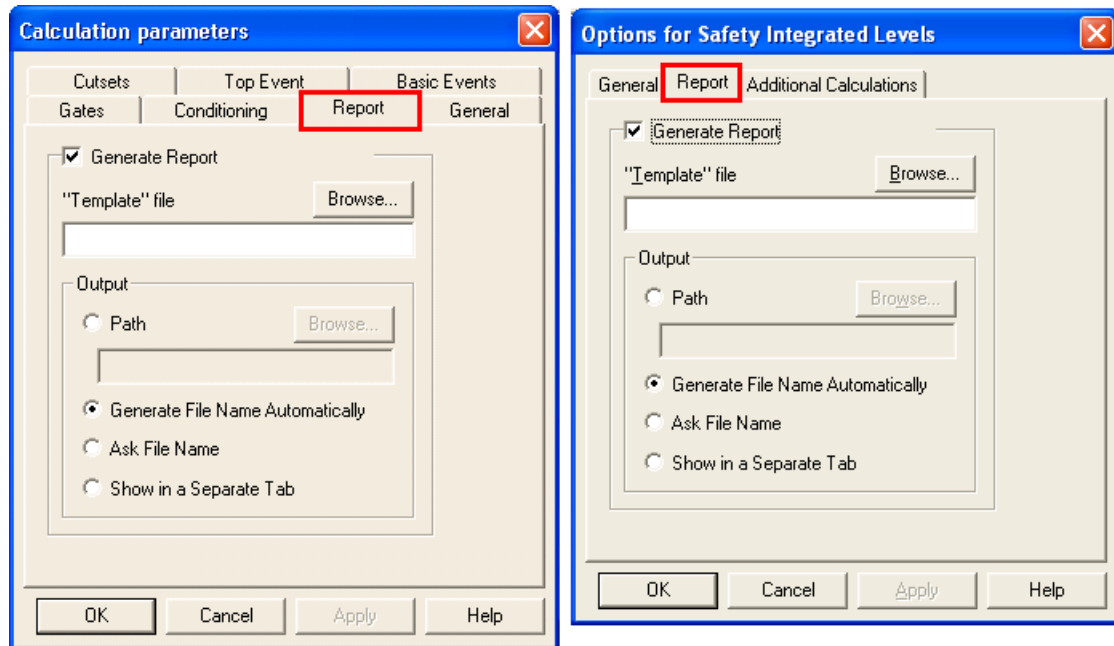
Exporting results

This task shows you how to generate a report containing calculation results.

Create or open an existing Fault Tree model.

1. Select the command **Aralia...** or **SIL...** from the menu **Aralia > Setup**.

The **Calculation parameters** dialog window or **Options for Safety Integrity Levels** dialog window appear:



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



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 89.

4. Click **Ok**.

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

Formatting a Fault Tree model

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

[Creating a chart](#) on page 81

[Editing a chart](#) on page 84

[Inserting a shape in the current worksheet](#) on page 88

[About dynamic fields](#) on page 89

[Inserting a local field in a shape](#) on page 91


[Inserting a global field](#) on page 92

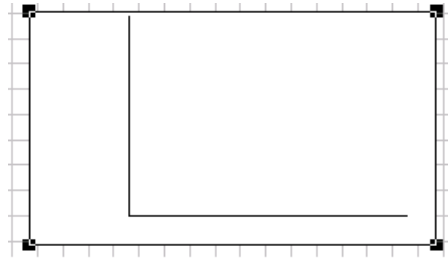
[Generating a report](#) on page 94

Creating a chart

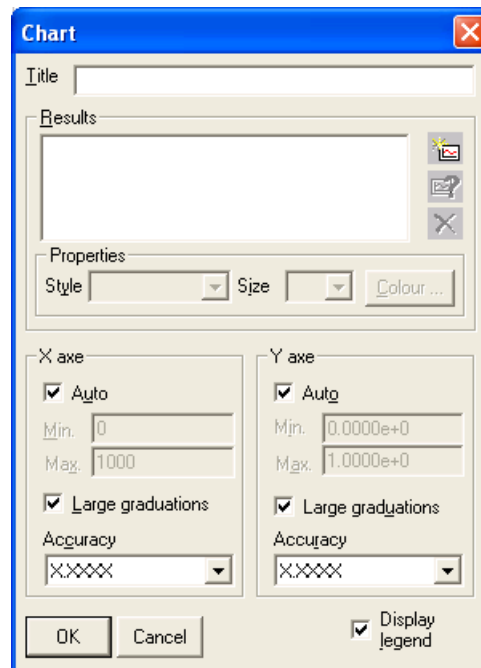
This task shows you how to insert a chart in the current worksheet and display results.


Create or open an existing Fault Tree model.

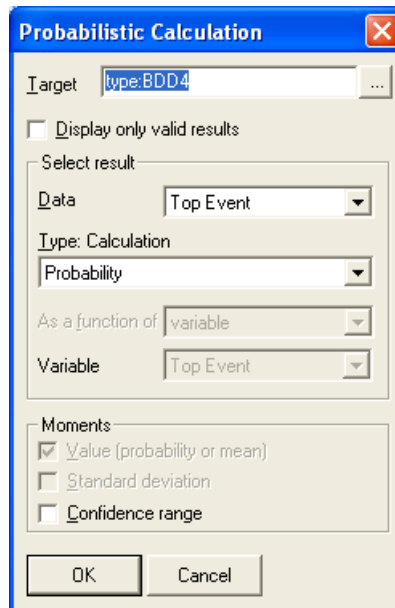
1. Select the command **Chart** from the menu **Drawing > Shapes** or click the icon  in the **Graphic** toolbar.
2. Drag & drop to define the position and the size.
An empty chart is inserted:



3. To define the type of result to be displayed in the chart(probability) right click on the empty chart.
The **Chart** dialog window appears:

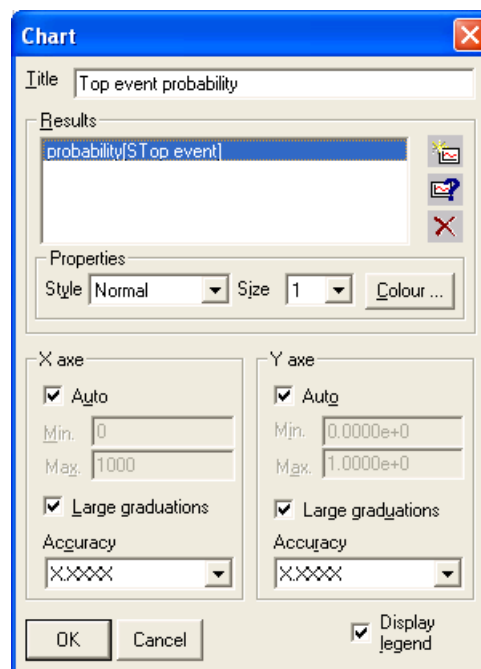


4. In the **Title** dialog box enter the title of the chart.
5. In the **Results** area click the icon  to select the type of calculation to be displayed.
The **Probabilistic calculation** dialog window appears:



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

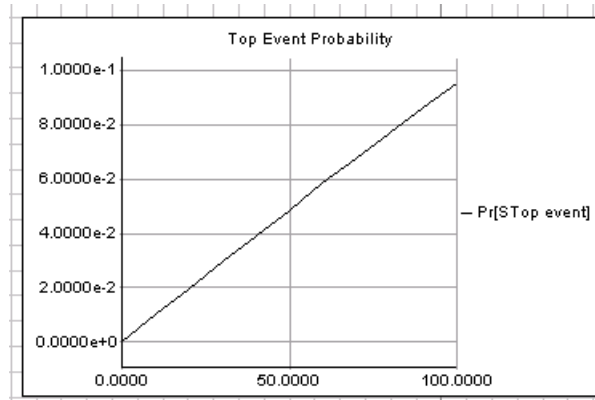
The result to display appears in the **Results** dialog box.





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

7. Click **Ok**.



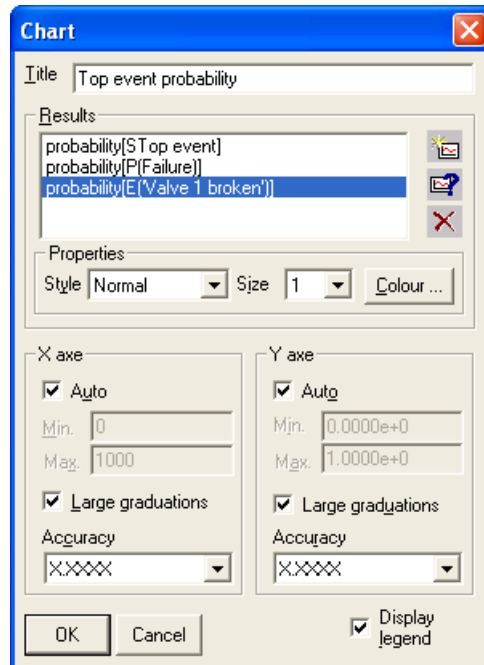
Note: A type of calculation can be drawn in a chart, only if Aralia calculation engine is configured to assess this type of calculation and the calculation has been done. Every time the calculation is launched, the chart is updated.

Editing a chart

Create a chart in the current worksheet. See [Creating a chart](#) on page 81.

Editing results to display

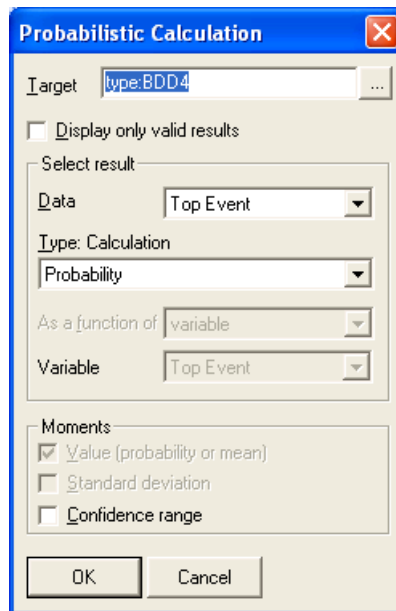
1. Right click on the chart to edit.
The **Chart** dialog window opens:



2. To add a new result to display:

a) Click the icon

The **Probabilistic Calculation** dialog window appears:




b) Follow the step 6 in the [Creating a chart](#) on page 81 task.

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

3. To delete a result to display:

a) Select the result to delete in the **Results** dialog box.


-
- b) Click the icon .

The result is removed from the list.

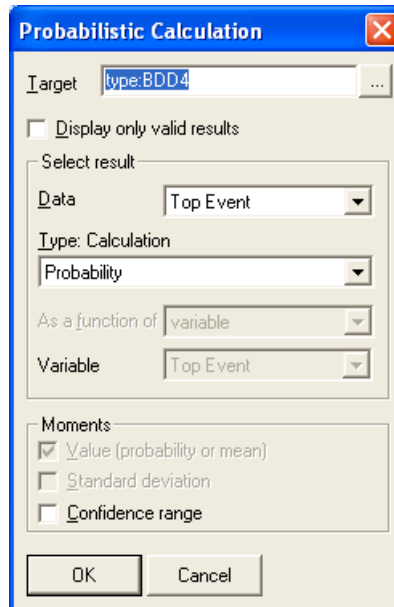


Important: The confirmation to delete is not requested.

4. To modify the result to display:
- a) Select the result in the **Results** dialog box.

- b) Click the icon .

The **Probabilistic calculation** dialog window appears:



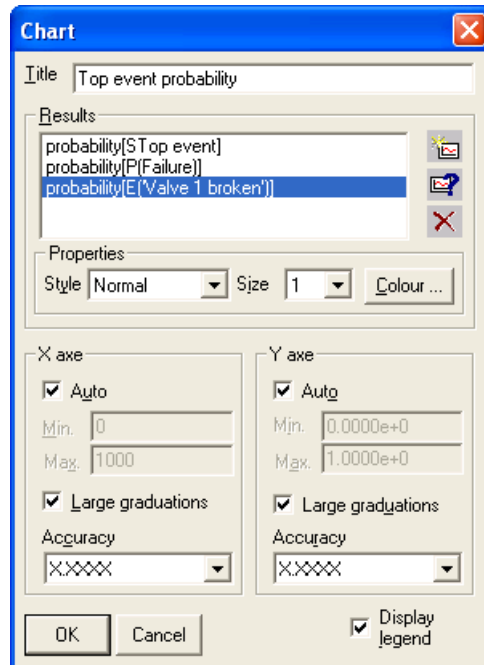
The **Probabilistic Calculation** dialog box is shown. It has a blue title bar with a close button. The **Target** field contains "type:BDD4". There is a checkbox for **Display only valid results** which is unchecked. Under **Select result**, the **Data** dropdown is set to "Top Event", the **Type: Calculation** dropdown is set to "Probability", and the **As a function of** dropdown is set to "variable". The **Variable** dropdown is set to "Top Event". Under **Moments**, the **Value (probability or mean)** checkbox is checked, while **Standard deviation** and **Confidence range** are unchecked. At the bottom are **OK** and **Cancel** buttons.

- c) Follow step 6 in the [Creating a chart](#) on page 81 task.

The result to display is modified.

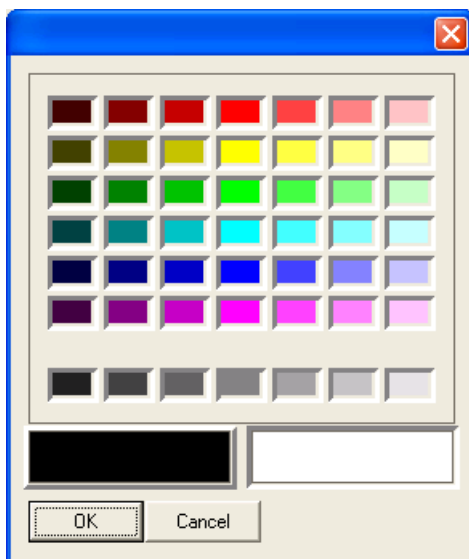
Editing curve style

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



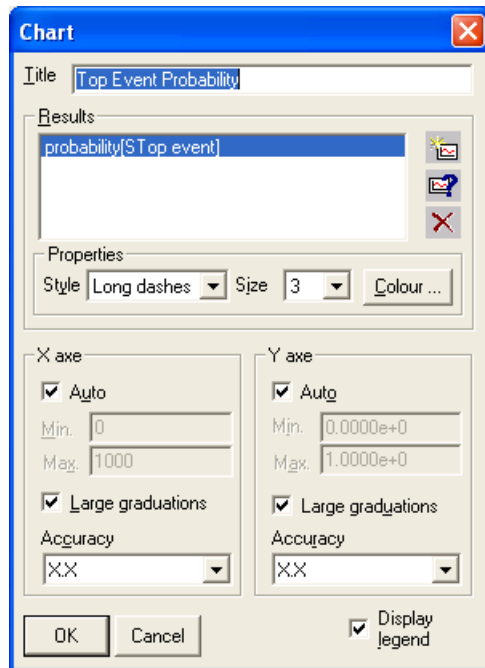
2. In the **Properties** area
 - a) In the **Style** dialog box select the line style: Normal, Long dashes, Single mixed, Double mixed.
 - b) In the **Size** dialog box select the line size.
 - c) Click **Colour...** to change the line colour.

The following window appears:

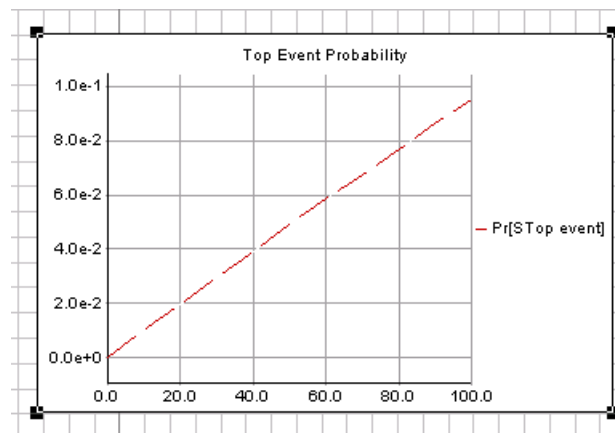


- d) Select a colour and click **Ok**.
3. In the **X axis** or **Y axis** areas
 - a) Unselect **Auto** to be able to change axes scale in **Min** and **Max** dialog boxes.
 - b) Select **Large graduations** to display the grid.
 - c) In the **Accuracy** dialog box select the number of digits after the 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




This task shows you how to insert a shape in the current worksheet.

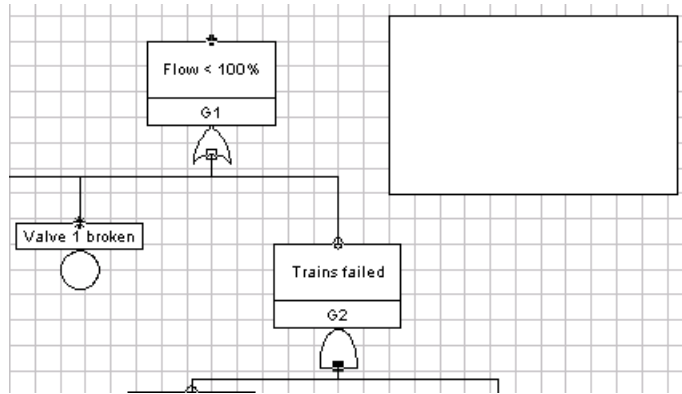
Aralia Fault Tree Analyzer allows inserting different types of shapes in the current worksheet:

- 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.

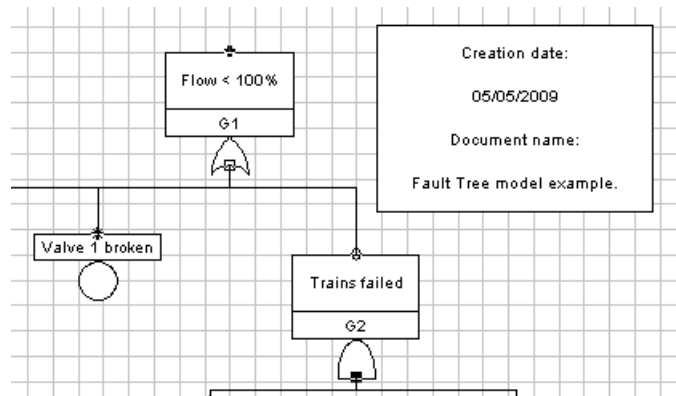
1. Select the command **Rectangle** or **Oval** or **Line** from the menu **Drawing > Shapes** or click the icon  or  or  in the **Graphic** toolbar.
2. Click in the worksheet to place the shape.
You can select, move and resize a shape like a graphical object.



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 the model features (list of gates, basic events, etc...), document properties or updated results. To define dynamic fields see ...



About dynamic fields

To enhance the model formatting, it is possible to introduce information in objects and shapes. A code 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:

- Global fields;
- Local fields.

Local field

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
 1. Warnings
 2. Calculation target
 3. Processing duration
 4. Calculation start
 5. Calculation end
 6. Qualitative information
 7. Number of cutsets
 8. Parameters
 9. Statistics
 10. Quantitative results
- Document
 1. Document path
 2. Creation date
 3. Last modification date
 4. Statistics
 5. Document name
- Data
 1. Attributes
 2. CCF groups
 3. Named parameters
- General
 1. Date
 2. Time
- Worksheets
 1. Path
 2. Name
 3. Number.

Global field

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

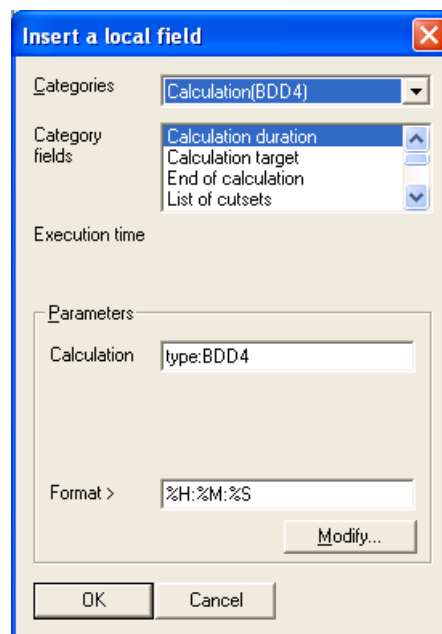
This task shows you how to insert a local field in a shape.

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.

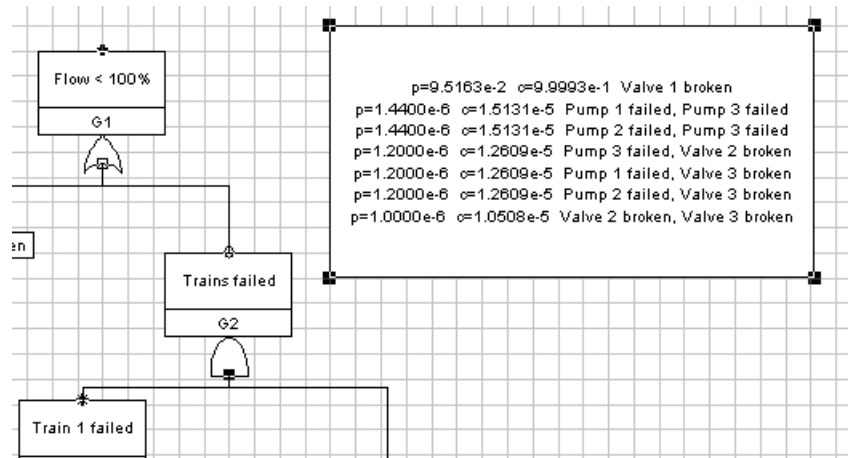
1. Insert a shape in the current worksheet. See [Inserting a shape in the current worksheet](#) on page 88.
2. Right click in the shape to edit it.
3. Select the command **Insert Local Field...** from the menu **Edit**.

The **Insert a local field** dialog window appears:



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

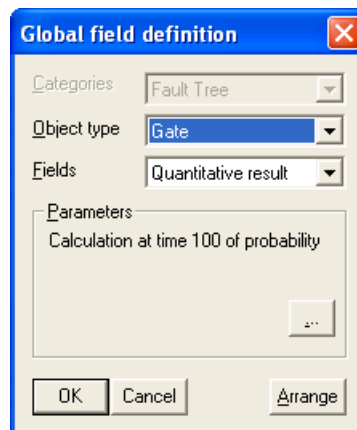
This task shows you how to define a global field.

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.

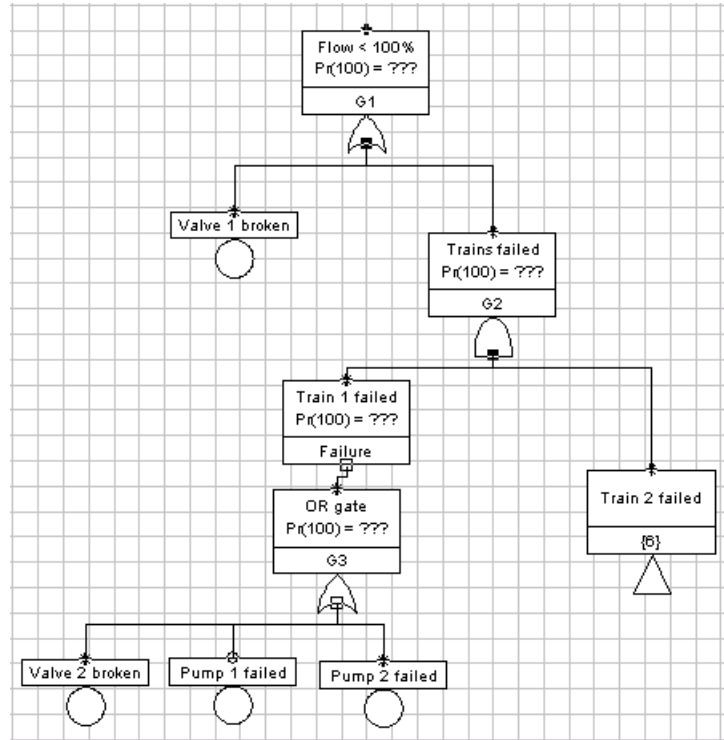
1. Select the command **Insert Global Field...**

The **Global field definition** dialog window appears:



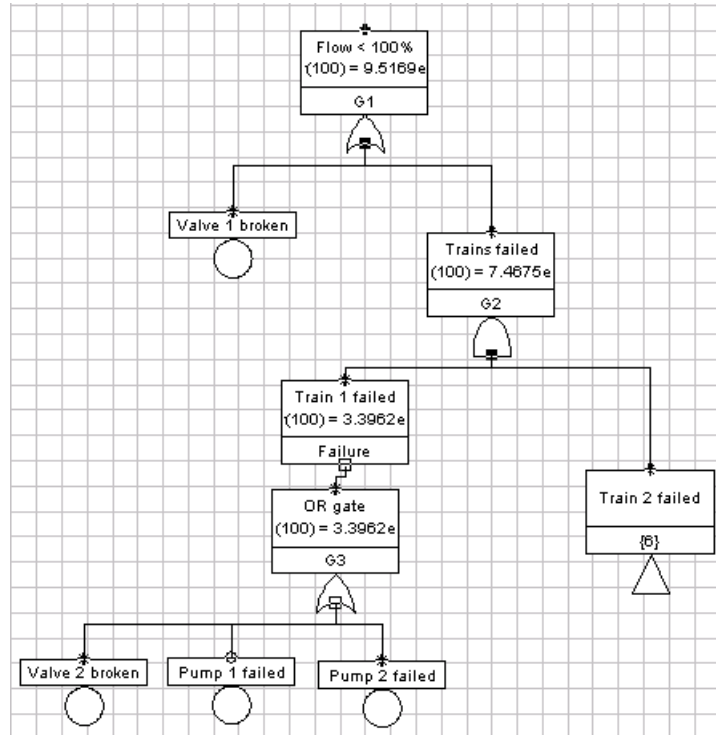
2. In the **Object type** dialog box select the type of object. For example, *Gate*.
3. Select the type of information to display. For example, *Quantitative result*.
4. Click **Ok**.

The calculation result (gate probability) will be 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.



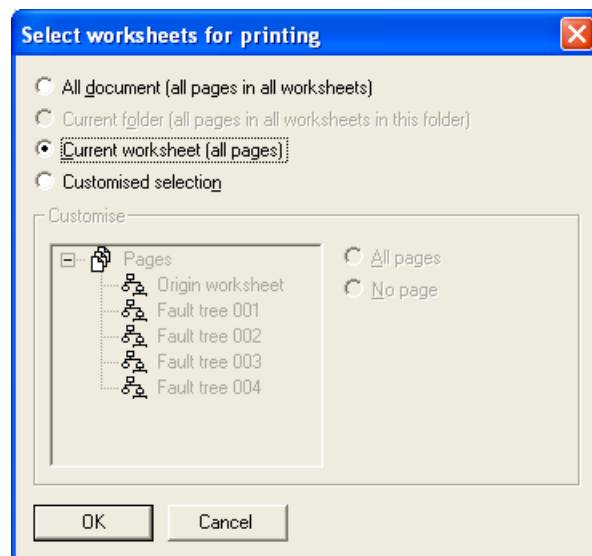
Generating a report

This task shows you how to 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 the command **Export to RTF...** from the menu **File**.
The **Select worksheets for printing** dialog window appears:



2. Select worksheets to include in the report.

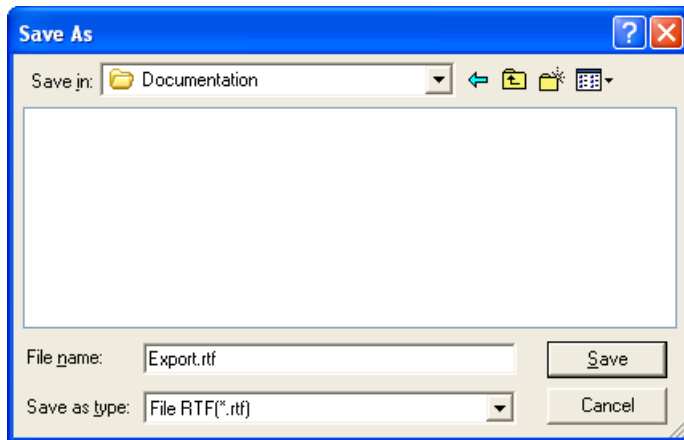
- If All document is selected, the generated document will contain all worksheets in the model.
- If Current folder is selected, the generated document will contain all worksheets from the current folder.
- If Current worksheet is selected, the generated document will contain only the current worksheet.
- If Customised selection is selected, 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**.

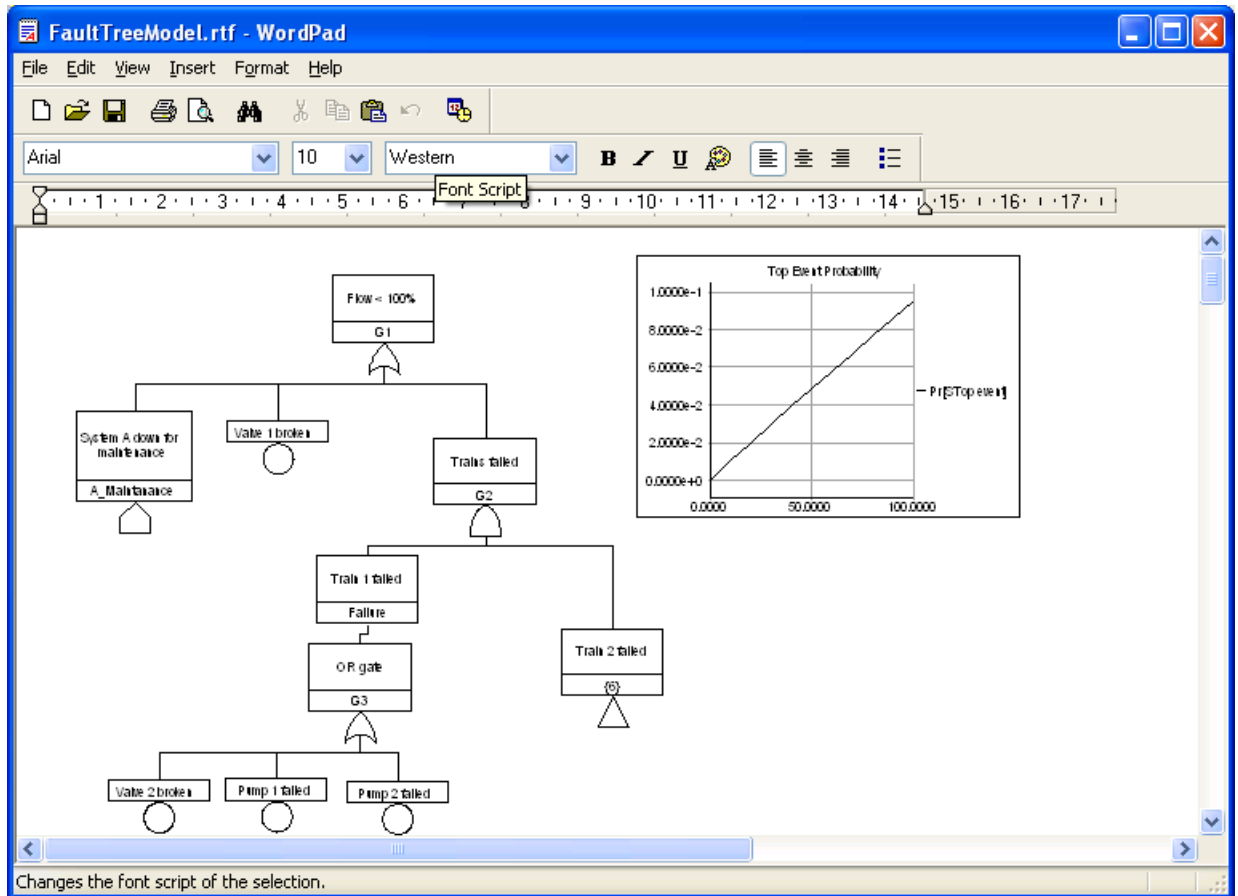
The **Save As** dialog window appears:



4. Select a file path and enter the report name and click **Save**.

The rtf document is generated.

Example of generated rtf document:



Interface Description

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

[Tool bars](#) on page 96

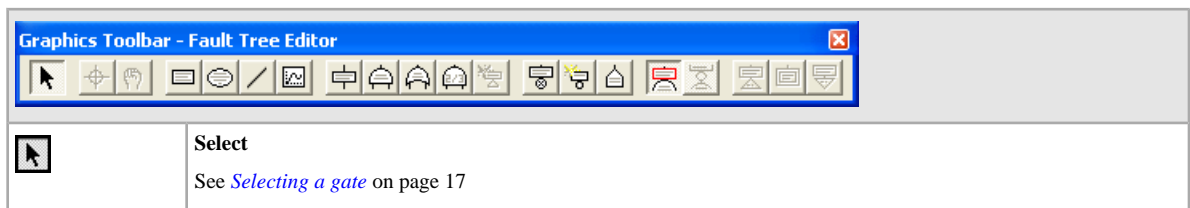
Tool bars



















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

[Graphic Toolbar](#) on page 96

[Model Explorer toolbar](#) on page 98






Graphic Toolbar



Graphics Toolbar - Fault Tree Editor	
	Automatically connect object to a gate See Autoconnecting objects on page 46
	Maintain a tool selected
	Insert a rectangle in the worksheet See Inserting a shape in the current worksheet on page 88
	Insert an oval in the worksheet See Inserting a shape in the current worksheet on page 88
	Insert a line in the worksheet See Inserting a shape in the current worksheet on page 88
	Insert a graph in the worksheet See Creating a chart on page 81
	Add an intermediate event in the Fault Tree See Creating an intermediate event on page 36
	Create an And gate in the worksheet See Creating a gate on page 16
	Create an Or gate in the worksheet See Creating a gate on page 16
	Create a K-out-of-N gate in the worksheet See Creating a gate on page 16
	Open Basic Event Manager See Editing a basic event on page 22
	Create a basic event See Creating a basic event on page 19
	Open House Event Manager See Editing a house event on page 31
	Open/Hide comment
	Negation To create a negation gate
	Create a transfer gate See Creating a transfer gate on page 48
	Create a transfer gate in a new worksheet See Transferring a sub-tree to a new worksheet on page 51
	Create an unexpanded clone

Model Explorer toolbar

This section 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 Creating a folder on page 6 .
	New Worksheet See Creating a worksheet on page 8.
	Delete To delete a folder or a worksheet. See Deleting a folder on page 7or Deleting a selected worksheet on page 9.
	Properties To view and modify folder or worksheet properties. See Editing folder properties on page 7or Editing worksheet properties on page 9.