SAFRAN TUTORIALS

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Introduction

The SAFRAN (Safety Assessment Framework) is a user-friendly software application that incorporates the methodologies developed in SADRWMS (Safety Assessment Driven Radioactive Waste Management Solutions) project.

SAFRAN addresses all predisposal waste management activities. It has the following main functions:

- To define facilities for storing or processing radioactive waste including their relevant design features.
- To define waste streams including all relevant radiological and non-radiological properties and their changes through the waste management activities.
- To define relevant requirements from the regulatory framework (criteria, endpoints, other requirements).
- To perform safety assessments for all steps of predisposal waste management.
- To perform calculations for quantitative analysis.
- To perform analysis of the safety assessment results and identify necessary modifications in safety elements and safety functions
- To provide review comments to facilitate the development and review of safety assessments.

Objects and groups of objects in SAFRAN project can be exported as the tables in various formats (MS Excel, PDF, RTF, text) or copied to the clipboard. There is additional tool available helping to easy incorporate these tables in any MS Word document with the possibility to synchronize tables with the latest updates in the SAFRAN project.

The purpose of this series of tutorials is to give an introduction to the user on how to generate a SAFRAN model of a site and then to perform a safety assessment of that site.

To perform such an assessment, it is needed to first define the system configuration into the SAFRAN tool; System configuration consists of ‘facilities’, ‘rooms’ within those facilities (and “areas” within the rooms if necessary), waste management activities taking place within those facilities, rooms and areas, and processes – the chains of waste management activities. Producing this site configuration is illustrated in Tutorial 2.

It is then necessary to specify the properties of each room, area and waste management activity. These parameters include external dose rate, activity concentration in air, nuclides, etc. Specification of these properties is illustrated in Tutorial 3.

The incoming waste and ‘waste streams’ are then defined, in a way that shows the waste properties at each stage through the different steps of processing, storing and clearing of those wastes. For example there may be reduction factors for volume or activity concentration of the waste, e.g. by sorting or compaction. Definition of the waste components and waste streams are illustrated in Tutorial 4 and 5.

The regulatory framework is then defined into the model, using national and IAEA frameworks as relevant. Examples of the regulatory criteria may include dose limits to workers and the public for normal and accidental situations. Specification of the regulatory framework is illustrated in Tutorial 6.

Safety assessment is required for both normal operations and accident conditions. The model is developed by defining:

- the links to the regulatory framework,
- the purpose of the safety assessment, e.g. compliance with regulatory criteria,
- the scope of the assessment defining which facilities, rooms, areas and waste management activities need to be considered the assessment approach (this may include Potential Initiating Events, screening of hazards, compliance with safety requirements),
- the endpoints, e.g. dose to the worker and public,
- the scenarios where those end points could occur, their properties, probabilities etc,
- the impacts that may result,
- the assessment cases for endpoints relevant to each impact.

The safety assessment process is illustrated in Tutorial 7.

Safety assessments calculations widely use SAFRAN database. Overview of the database is given in the Tutorial 8.

Tutorial 9 illustrates how to make the system description if for sealed sources.

Tutorials 10-11 shows the assessment for normal operation for the situation described in Tutorial 9. Calculation of dose rates for external exposure (for normal operation) shown in the Tutorial 11 is applicable not only for sealed sources, but also for solid and liquid waste.

Tutorial 12 provides the analysis of the safety assessment done in Tutorials 9-11. It covers advanced topics, such as discussions and link of assessment results with safety elements which was not covered in the Tutorial 7.

Tutorial 13 shows how to import user-defined site-specific data in the database.

Tutorial 14 gives the overview of the libraries – the storages for generic facilities, processes and scenarios which can be easy reused in your project.

Waste stream illustrated by Tutorial 5 was intentionally made very simple. Tutorial 15 provides advanced exercise which will help you to get deeper experience with SAFRAN functionality relevant to complex waste streams and ‘check for clearance’ of waste by

comparing activity concentrations in the waste components against IAEA´s and user defined clearance criteria.

Important notes:

There are parts of the tutorials marked as “Advanced exercise”. These parts can be skipped if you are performing tutorials the first time. These parts are relevant to:

- exercises demonstrating assessments for different types of impacts for normal operation and accidental situations (basic exercises demonstrate one type of impacts for normal operation and one for accidental situation)

- exercises demonstrating working with complex waste streams including branching, merging and check for clearance (basic exercises demonstrate waste stream features using simple waste stream without branching as example)

- exercises demonstrating possibility to extend database with user-defined values (basic exercise demonstrates the overview of database)

Tutorial 1. Installing SAFRAN. Creating of the SAFRAN tutorial project.

SAFRAN installation instructions

If SAFRAN is not yet installed on your computer, install it following the instructions below:

- Navigate to the site http://safran.facilia.se

- If you are not yet registered on this web-site - click on the "Register" link in the right-up corner and provide necessary data. After submitting of registration date you will get e-mail asking you to confirm the registration.

- After completing the registration - click Login link on the same site and login with your user name and password

- Using site menu navigate to the "Resources"->"Downloads" page

- Download and run the latest release of SAFRAN installation

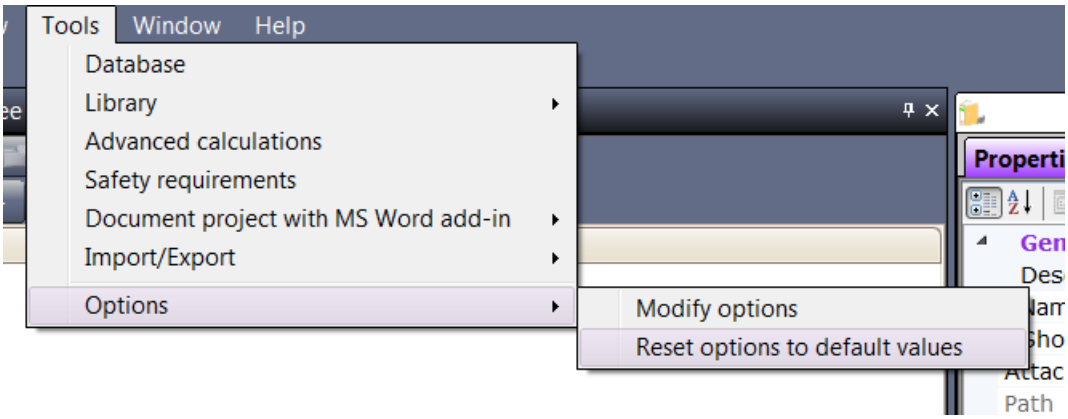
Start SAFRAN

SAFRAN starts after installation. Next time you can start it using desktop shortcut or shortcut in the Start menu (Apps page on Windows 8.1) created by installation program.

Reset SAFRAN's options

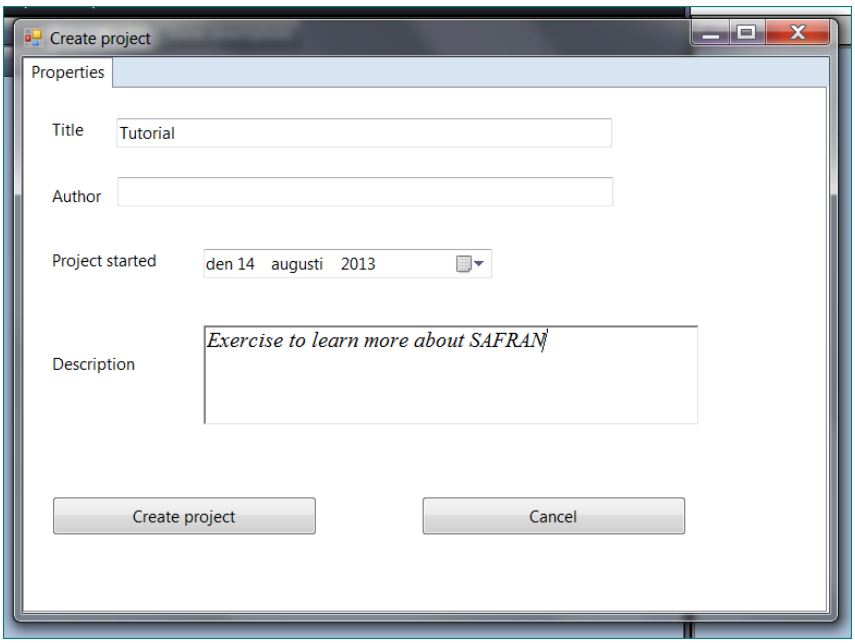
If you already use SAFRAN in order to make sure that screenshots presented in the tutorials will correspond to what you will see on your screen, it is recommended to reset the options of the SAFRAN Tool as shown below.

Select **Tools/Options / Reset to default values** from the main menu.



Create the SAFRAN tutorial project

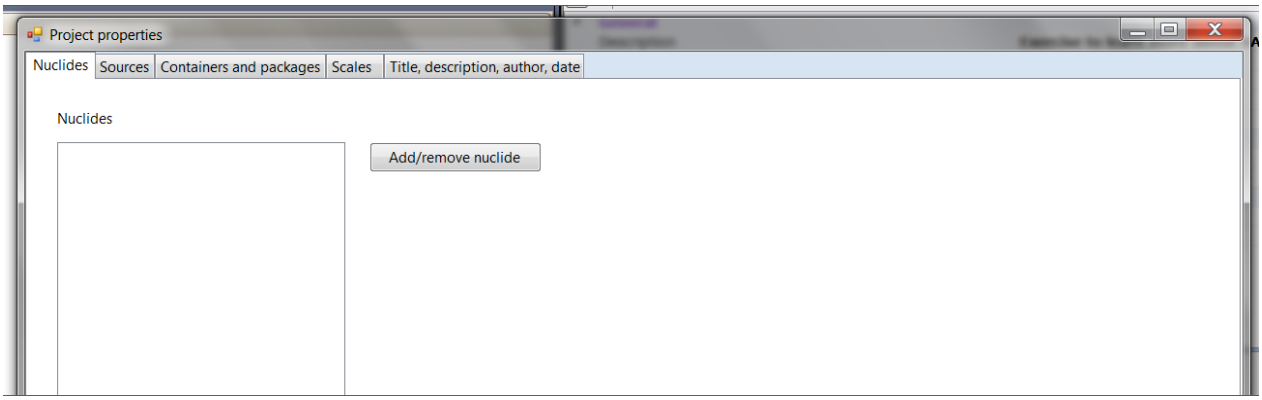
Select **File / New project** from the main menu to create a new project. The "Create project" dialog box will appear.

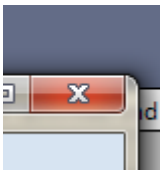


Enter the title: "*Tutorial*" and type under description: "*Exercise to learn more about SAFRAN.*" in the window that appears. Press "**Create project**".

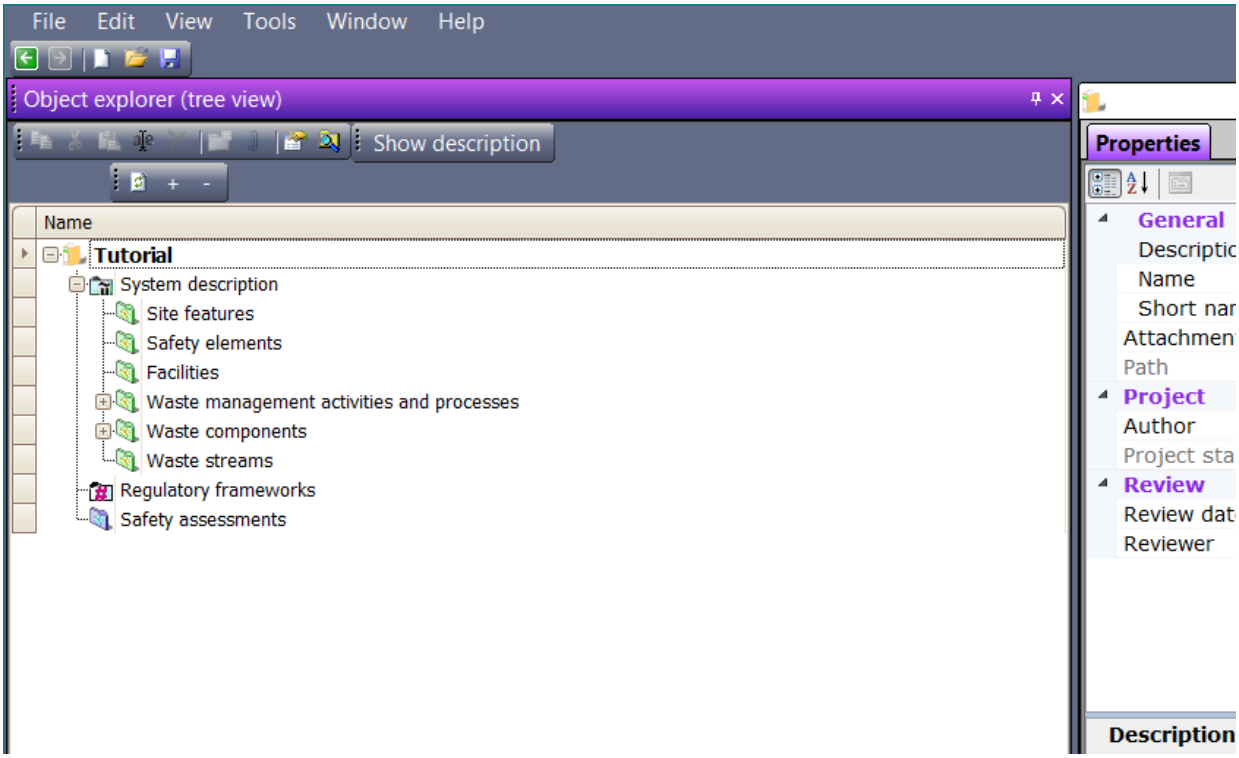
The "**Save as**" dialog box appears. Save the file as "*Tutorial.safx*" (name which is suggested by SAFRAN).

The "Project properties" dialog box will appear.



Here among other you are able to add nuclides and containers you will use to describe your waste components. This will be done later in the Tutorial 3. Close the dialog box without entering information by clicking 

In the "**Object explorer (tree view)"** window (located in the left part of the screen) click on "Tutorial" (root node of the tree) and expand the tree by clicking on '+' button located in the left of each tree node as shown in the picture:



Tutorial 2. Define facilities, processes and waste management activities.

In this tutorial, you will describe a new site. This site has two facilities: a waste processing facility and a storage facility. The processing facility has two rooms; the room for sorting and compaction and another room – for packaging of the waste. The storage facility has one room for storage of the waste until final disposal can take place.

An overview of the facilities, rooms, areas and waste management activities is shown in the Table 1.

Table 1

Facility	**Room**	**Waste management activity**
Processing facility	Sorting room	Sorting
	Compaction and packaging room	Compaction
		Packaging
Storage facility	Drum storage room	Storing

The schematic overview of the process[1] is shown in the Fig. 1

[1] For learning purposes, the fate of non-compactable waste is not described for all tutorials except Tutorial "Advanced exercise. Complex waste streams. Check for clearance"

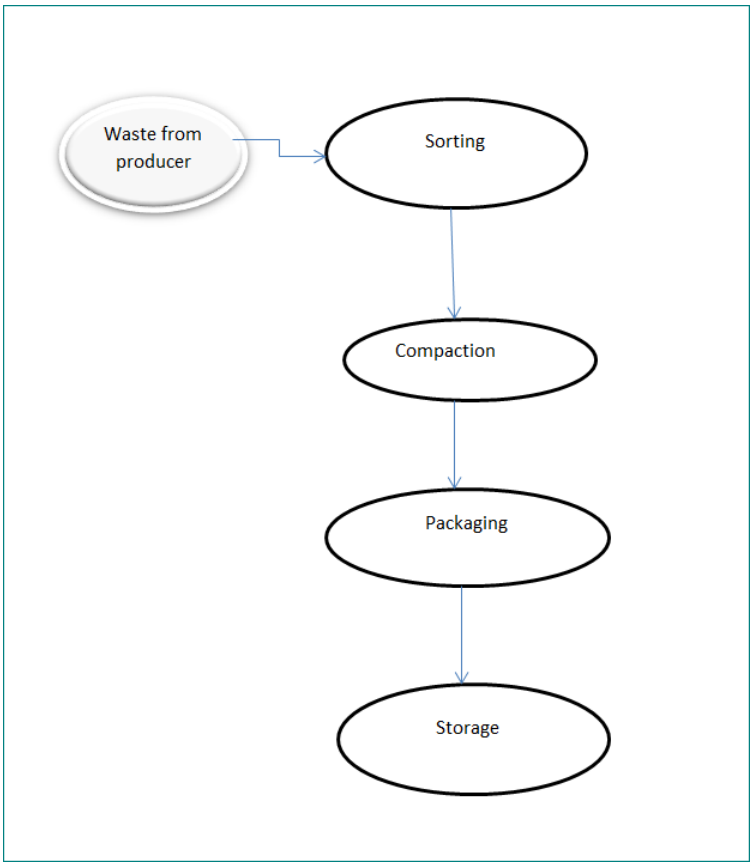
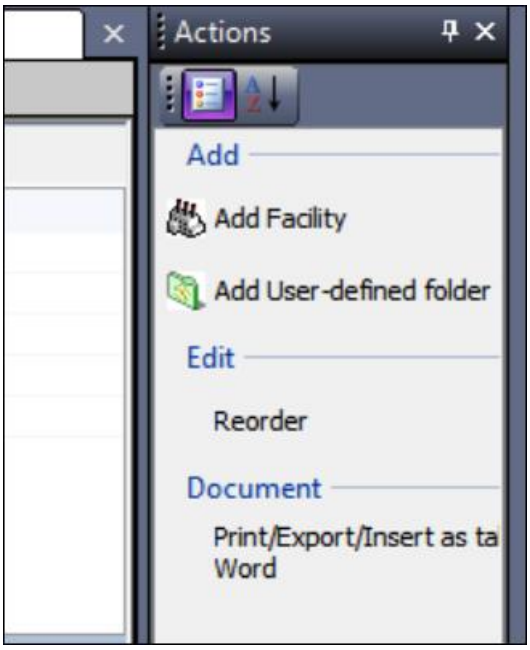


Fig. 1 Schematic overview of the process

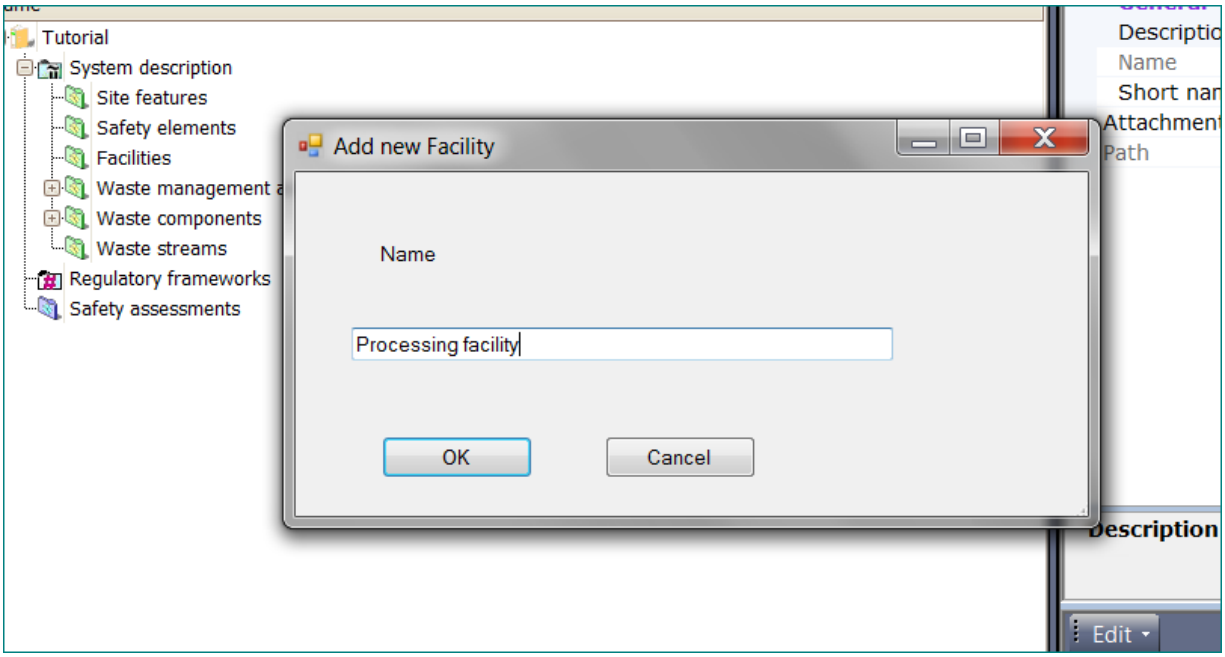
Add processing facility

Click on the **Facilities** and click "**Add facility**" in the "**Actions**" window (located in the right part of the screen) as shown in the picture:[2]

[2] Alternatively, you may click the right mouse button and select action from the context menu.

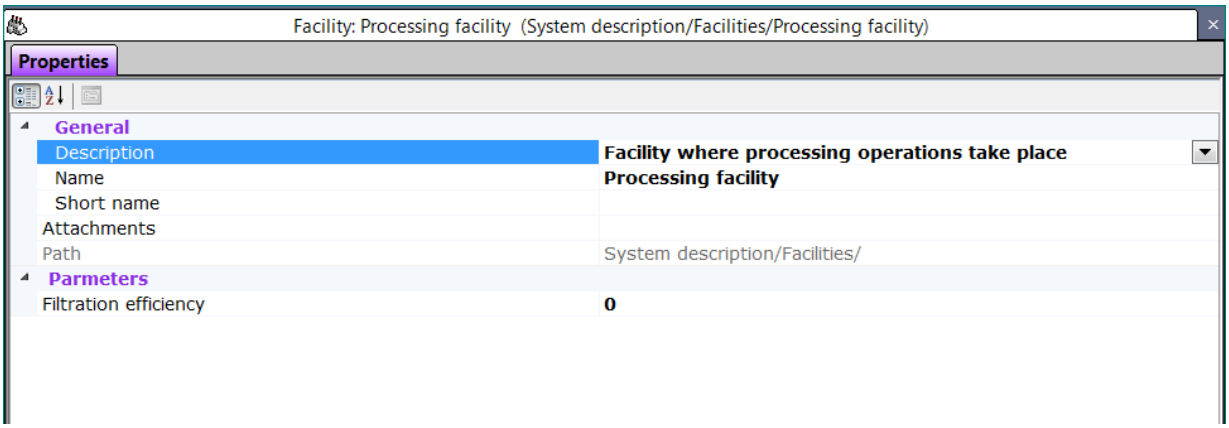


In the window that appears, change default name of new facility ("*Facility*") to the "*Processing facility*" and press "**OK**".



The node "*Processing facility*" will appear under "*Facilities*" in the "**Object explorer (tree view)"** window.

In the "**Properties**" window (located in the middle of the screen), click on the "**Description**" row and enter "*Facility where processing operations take place*" as shown in the picture below.



Expand the node "*Processing facility*" in the "**Objects explorer (tree view)"** window and click on the "*Rooms*" node. Click on the "**Add room**" command in the "**Actions**" window. In the window that appears, change the name "*Room*" to "*Sorting room*". Press "**OK**".

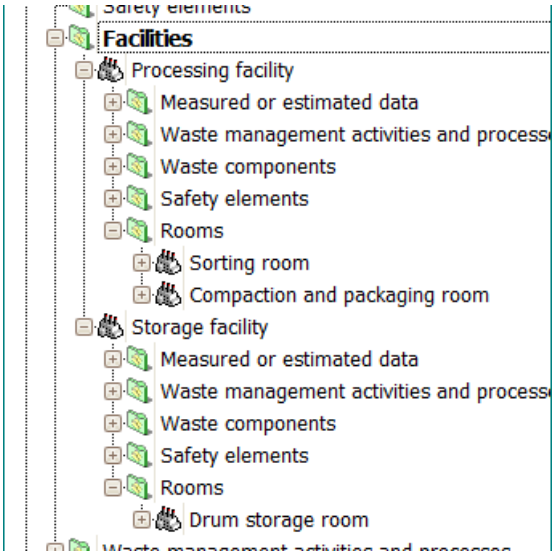
Add another room to the "*Processing facility*" with the name "*Compaction and packaging room*".

Add storage facility

Add new facility - "*Storage facility*".

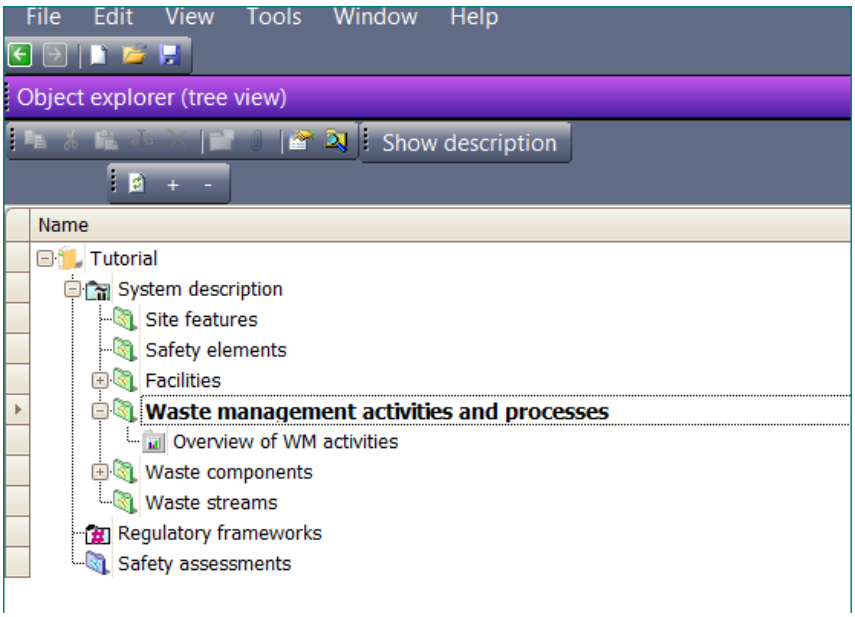
Add "*Drum storage room*" to the "*Storage facility"*.

Finally you will see the following structure of facilities and rooms.



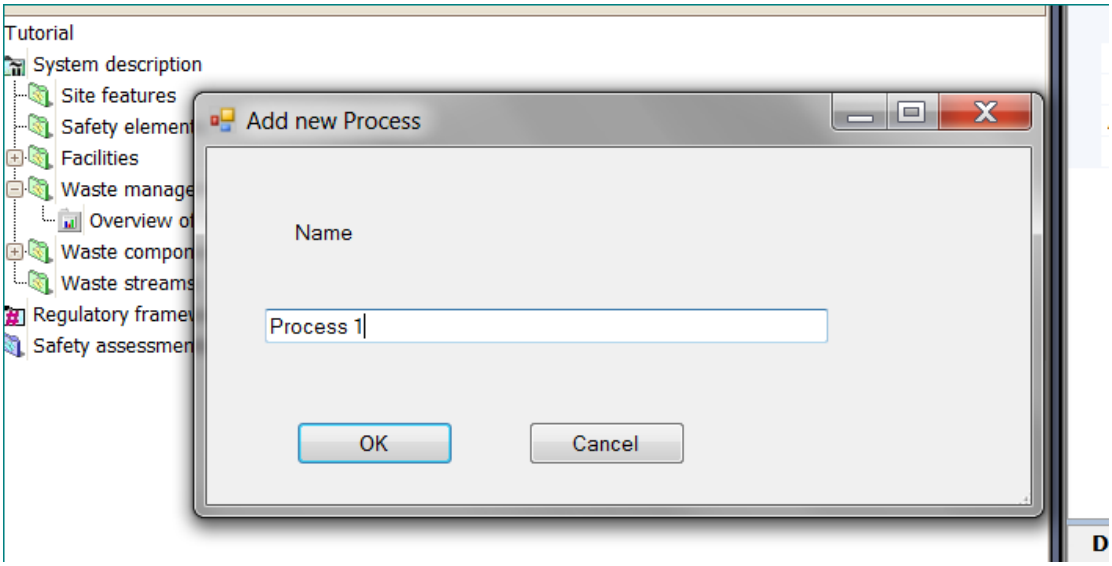
Add process and waste management activities

In the "**Object explorer (tree view)"**, select the node *System description/Waste management activities and processes*.



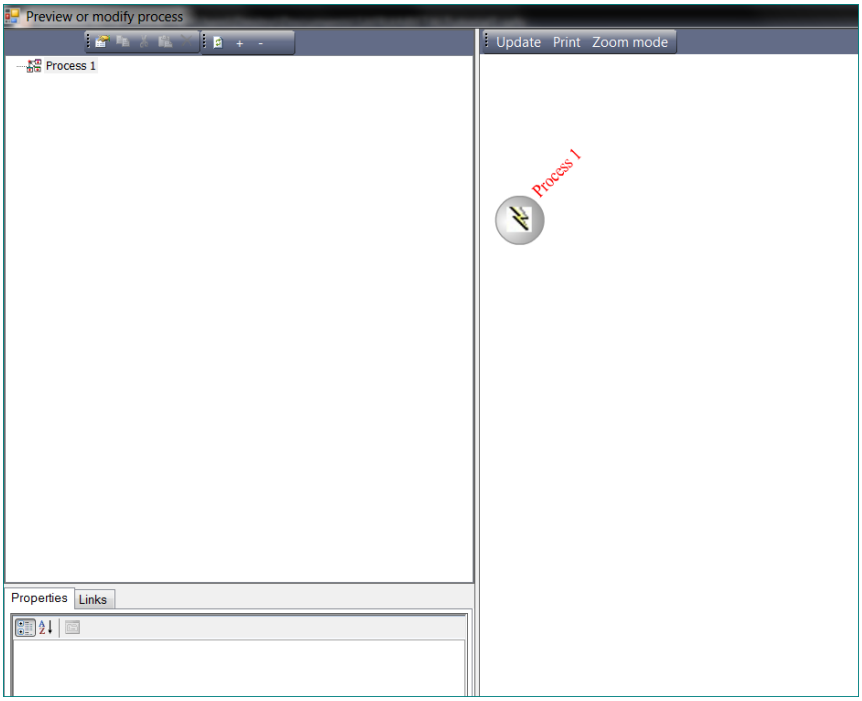
Select the action "Add process" in the "Actions" window.

Enter "Process 1" in the window "Add process" which will appear and click OK.



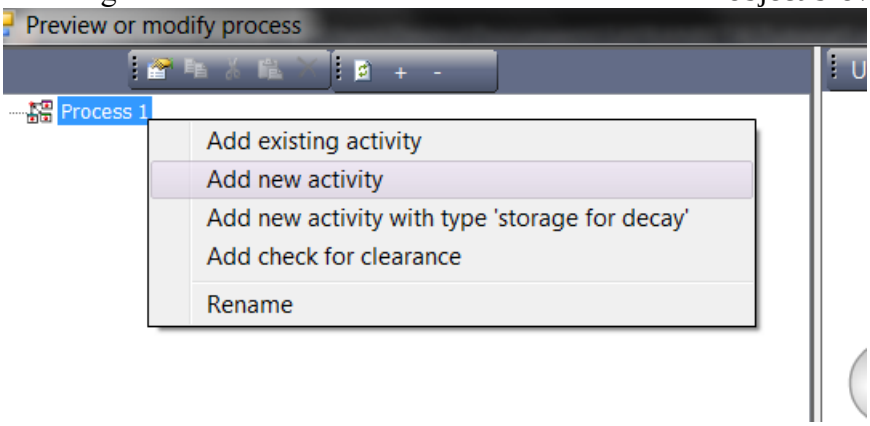
Double-click on the node "Process 1" (or select command "Edit process diagram" for this node).

The “Preview or modify process” window will appear.



Observe the structure of this window. The object browser panel is located in the upper-left part of the window. This object browser is similar by functionality to the object browser you already used in main SAFRAN window. A panel with two tabs “Properties” and “Links” is located in the left-down part of the window. The “Properties” panel is also similar to “Properties” panel you already used in the main window of SAFRAN. Diagram panel located in the right part presents same information as the object browser, but in graphical form.

Click right mouse button on the node “Process 1” in the object browser window.

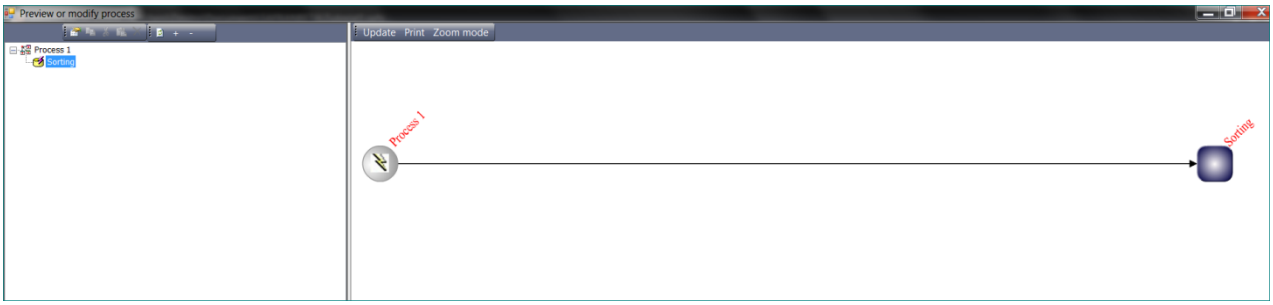


Select “Add new activity” command.

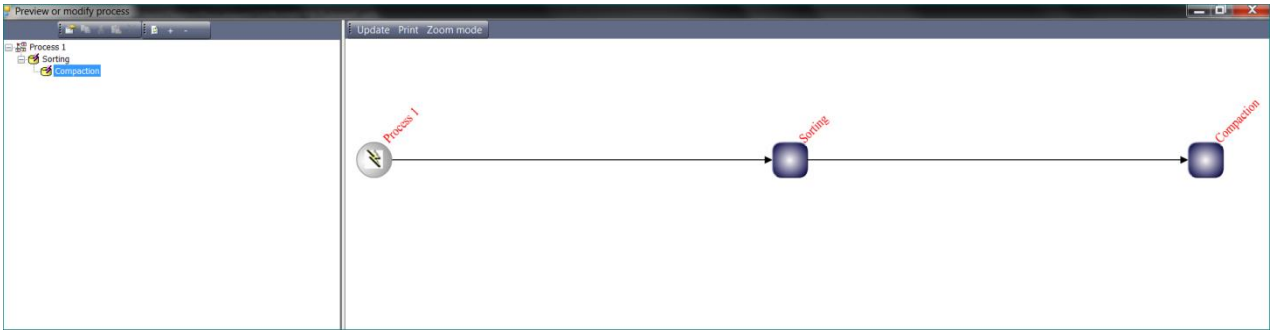
The “Add new activity” window will appear.

Enter “Sorting” instead of default name “WM activity” and click OK.

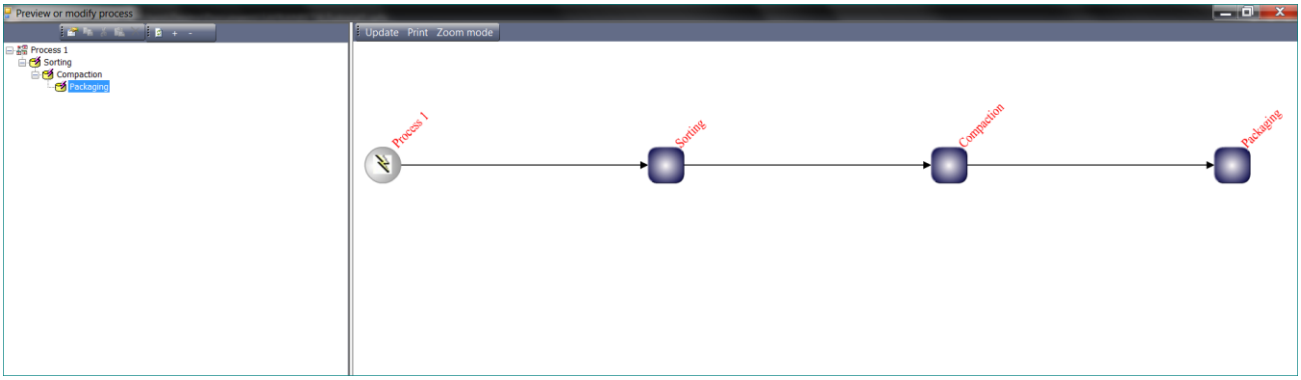
The new node “Sorting” will appear. Note the change in diagram window.



Click right mouse button on the “Sorting” node and add new activity “Compaction” (see diagram shown in Fig. 1).

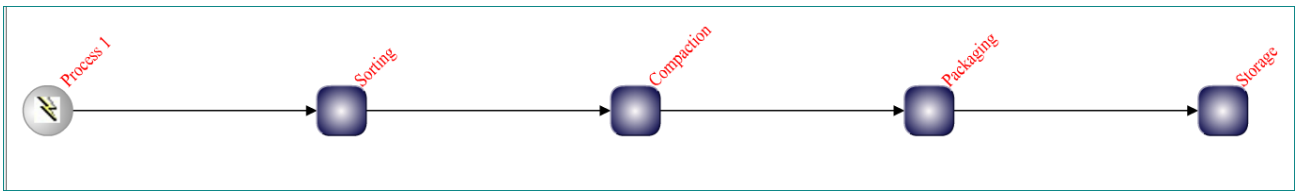


Add new activity “Packaging” to “Compaction”.



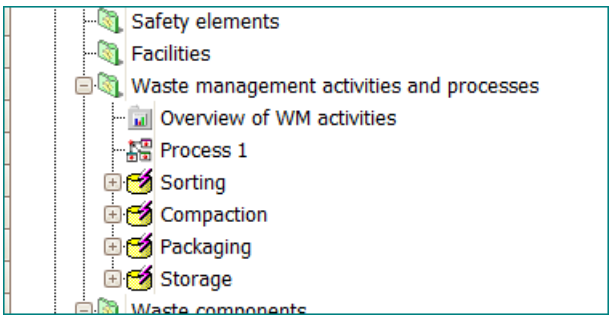
Add new activity “Storage” to “Packaging”.

Finally you will obtain the following process:



Close the “Preview or modify process” window.

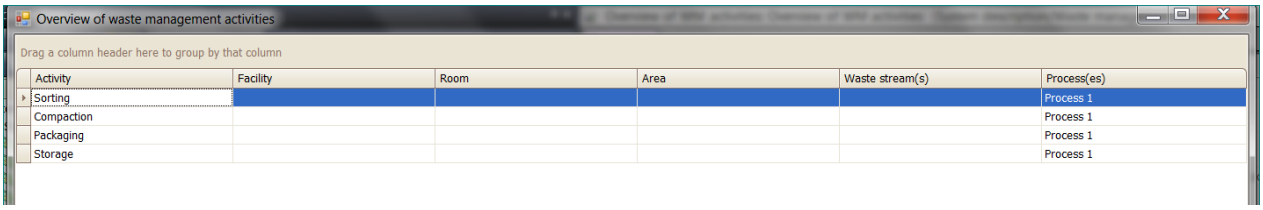
Note that new waste management activities were added under the “Waste management activities and processes”.



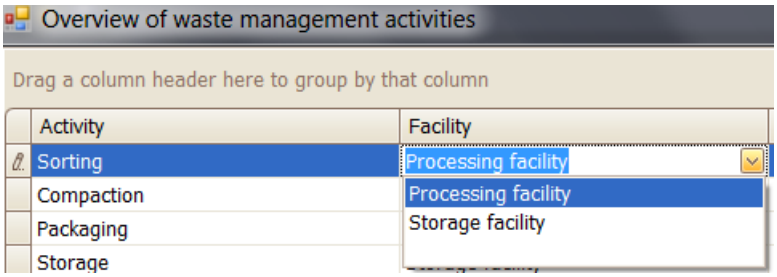
At the moment SAFRAN don't know in which facilities and rooms these activities take place. It is possible to simple copy and paste them to the right places, but it is quicker to move activities using "Overview of WM activities" window.

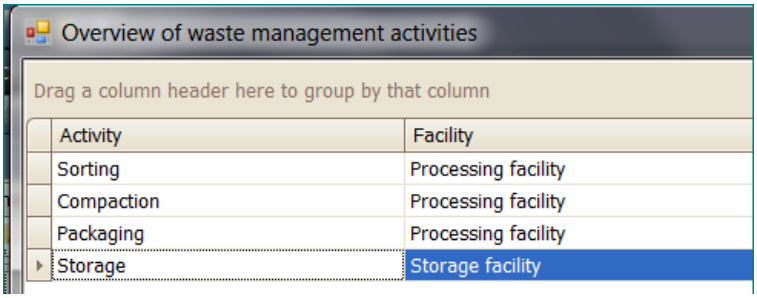
Double-click on the "Overview of WM activities" node.

The following table will appear.

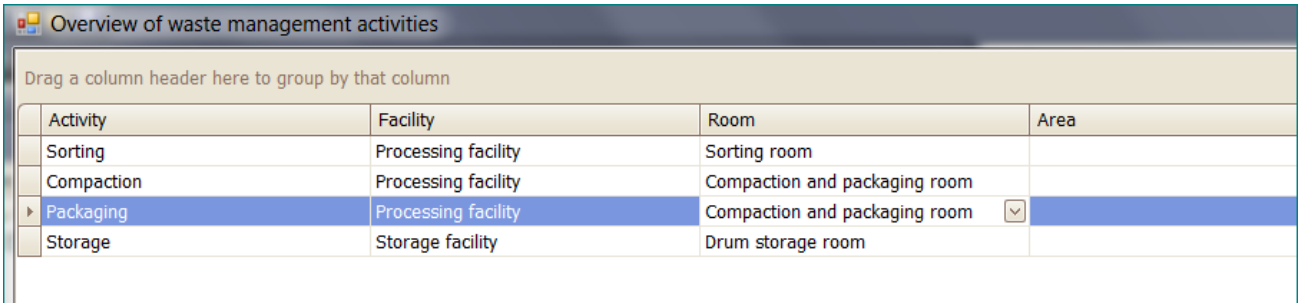


Click on the cell in the Facility column for each activity and select the facility corresponding to Table 1.





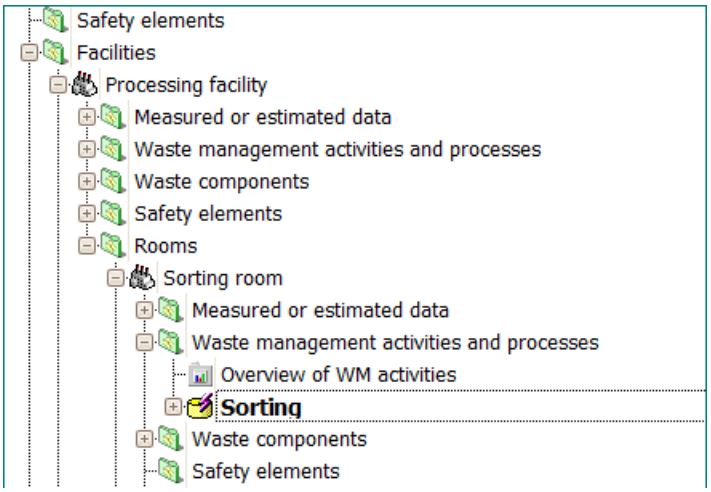
Similarly, select the room where each activity take place[3]:



Close the table.

Note that activities disappeared from the folder “Waste management activities and processes”.

They have been moved to the similar folder for corresponding rooms. For example, you can find Sorting in the folder “Waste management activities and processes” of the Sorting room located in the Processing facility:



SAVING THE FILE:

Select **File / Save project** from the main menu.

[3] If list of rooms is not appear in the cell, click outside the cell and then inside the cell

Tutorial 3. Numerical properties of facilities, rooms and waste management activities

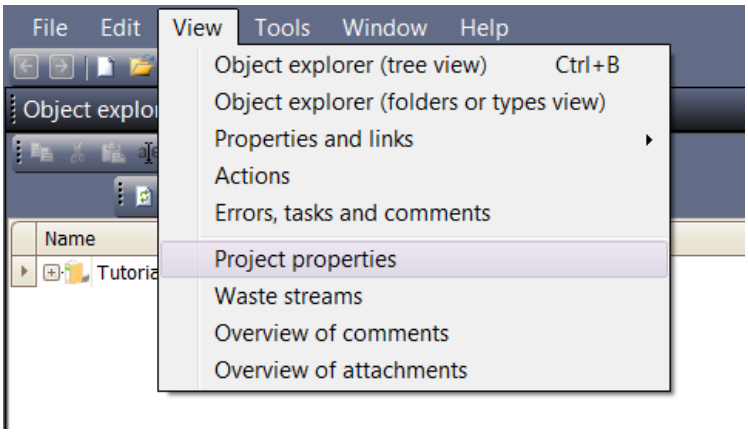
In this tutorial, you will specify properties for the rooms, areas and waste management activities defined in the Tutorial 1. The properties are summarised in the Table 2.

Table 2

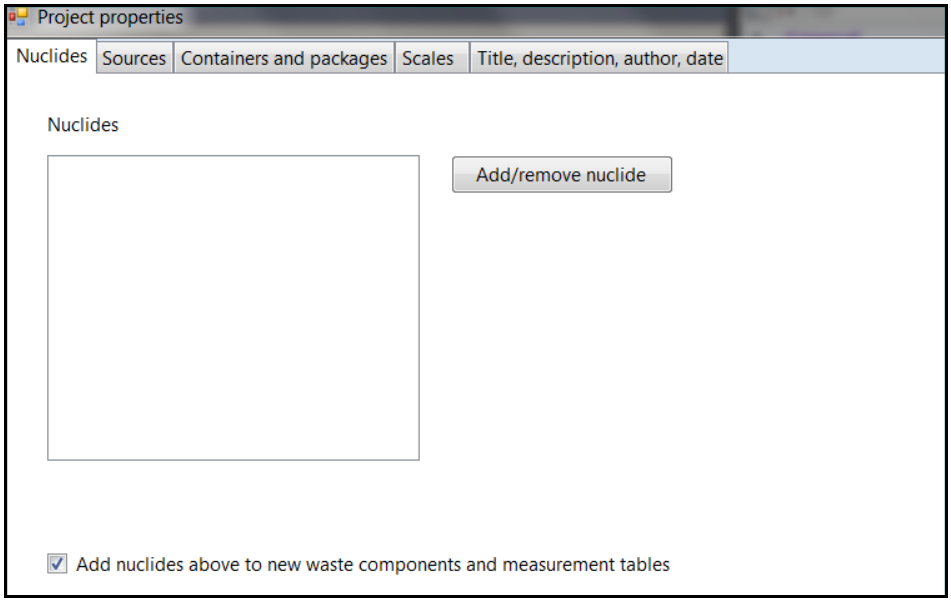
Processing facility	Release rate of Co-60	4.41E+06 Bq/y
	Release rate of Cs-137	2.27E+06 Bq/y
	Ventilation, filtration efficiency	90%
Sorting room	Concentration in air Co-60	2.8E-02 Bq/m^3
	Concentration in air Cs-137	1.7E-02 Bq/m^3
Sorting	Capacity of sorting equipment	0.5 m^3
	External dose rate	6E-07 Sv/h
Compaction and packaging room.	Concentration in air of Co-60	6.2E+01 Bq/m^3
	Concentration in air of Cs-137	1.75E+01 Bq/m^3
Compaction	Capacity of compactor	0.5 m^3
	External dose rate	3.2E-06 Sv/h
Packaging	Capacity of packaging equipment	0.5 m^3
	External dose rate	2E-06 Sv/h
Storage facility	Ventilation, filtration efficiency	90%
Drum storage room	Concentration in air of Co-60	3.5E-03 Bq/m^3
	Concentration in air of Cs-137	2.7E-03 Bq/m^3
	External dose rate	2.67E-06 Sv/h

List of radionuclides

Select View/Project properties in the main menu.



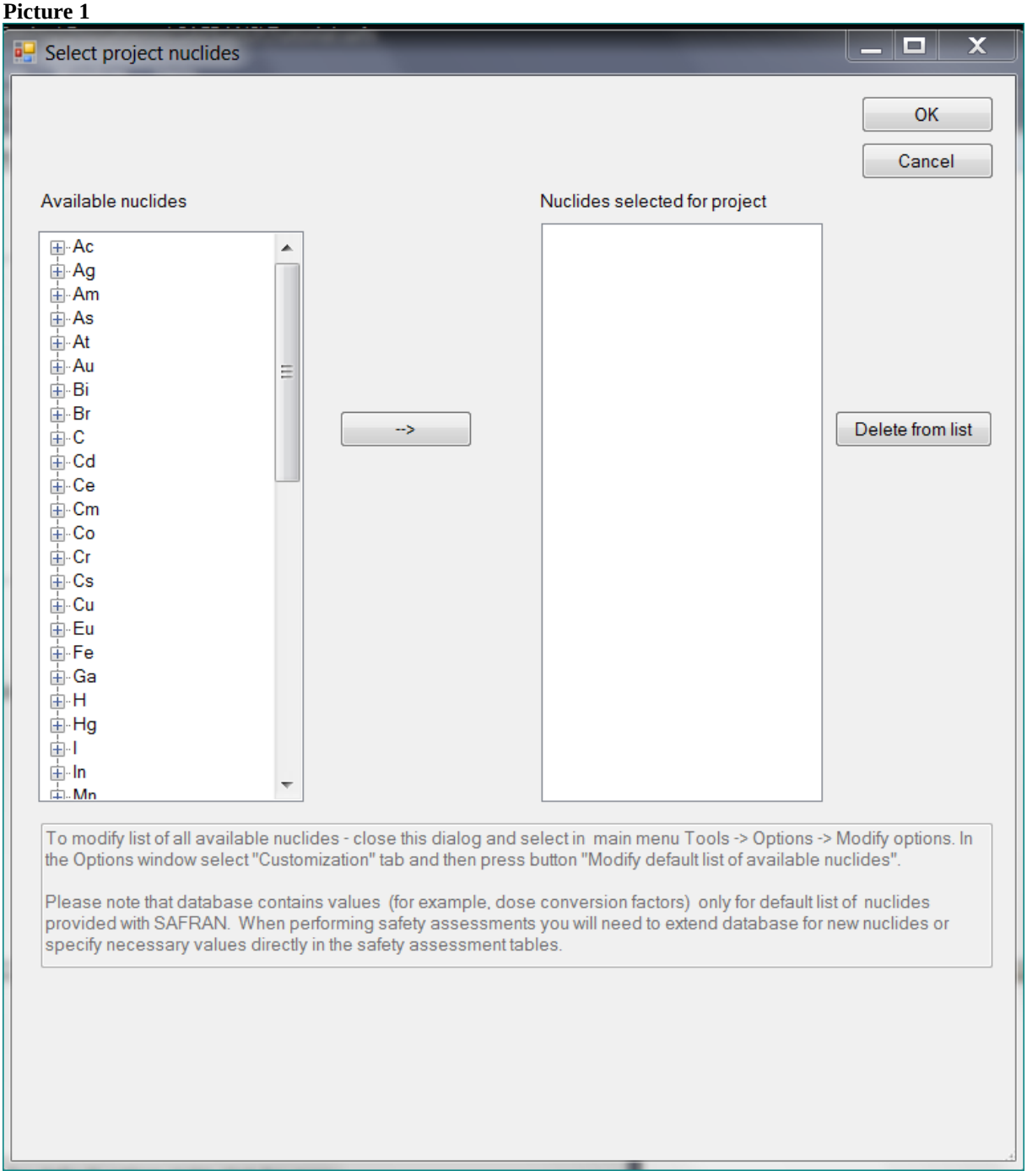
The Project properties window will appear.



Click the “Add/remove nuclide” button.

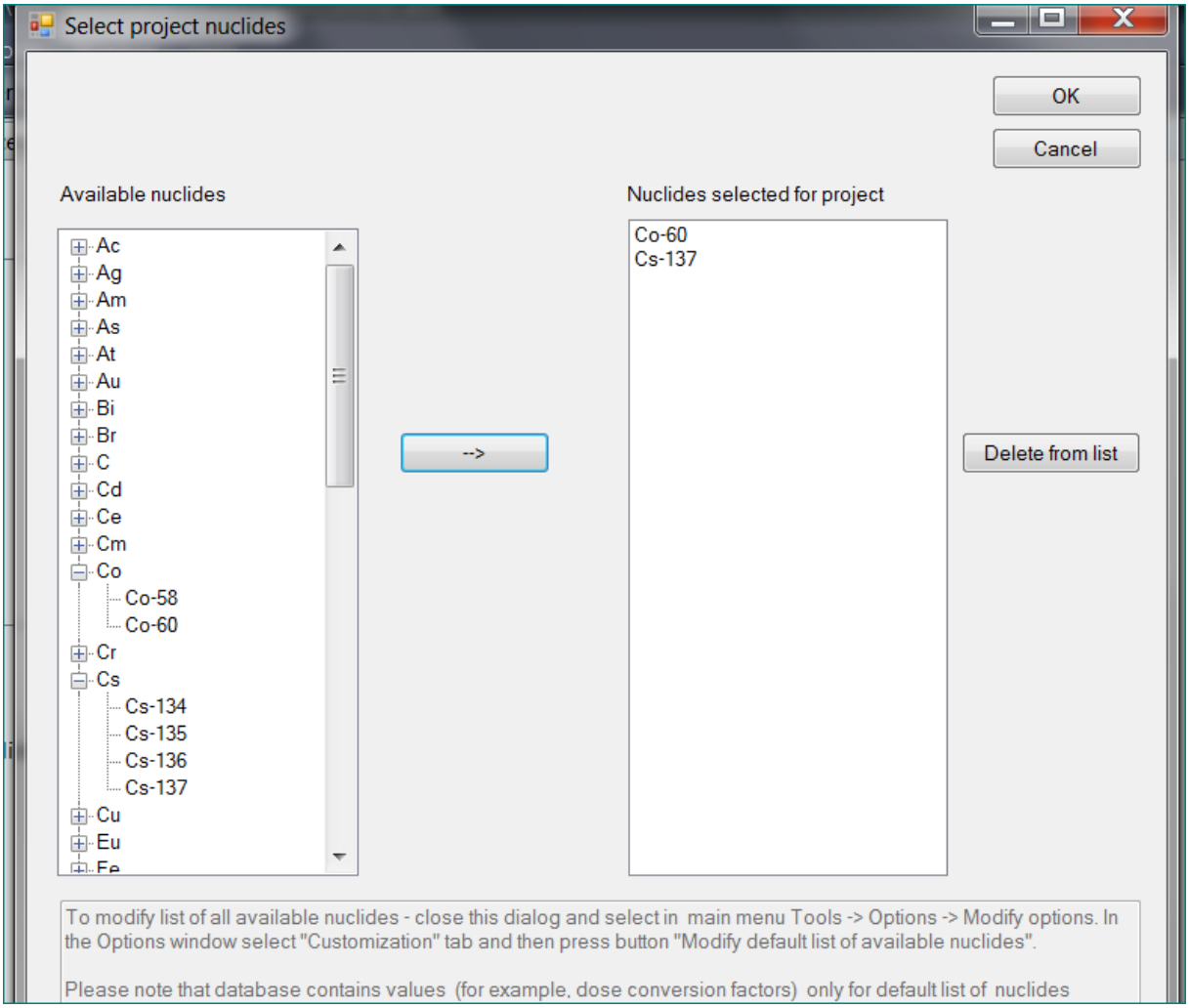
The following window will appear:

Picture 1



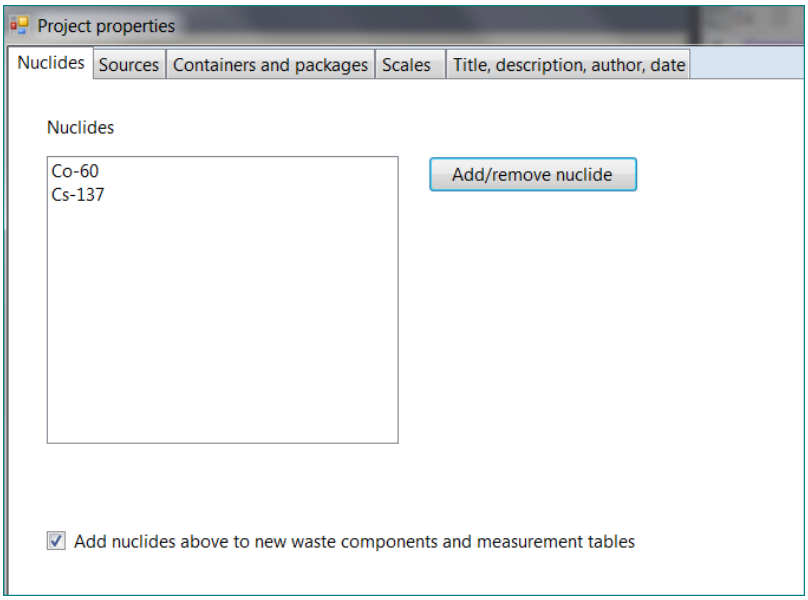
Select *Co-60* and *Cs-137* (with the tree-like list located in the right part of the form and button →) as shown in the Picture 2.

Picture 2



Click “OK”.

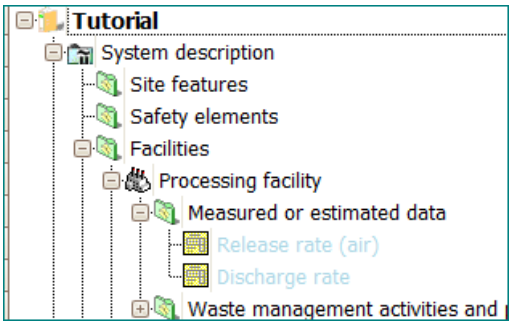
The list on the “Nuclides” tab of the “Project properties” window will look like:



Close the “Project properties” window.

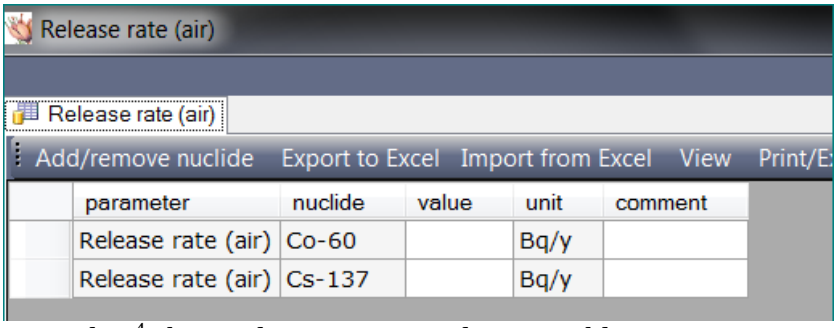
Properties of the processing facility

Expand the “Processing facility” in the “**Object explorer (tree view)”** window and expand node “Measured or estimated data” under “Processing facility” as shown in the picture below.

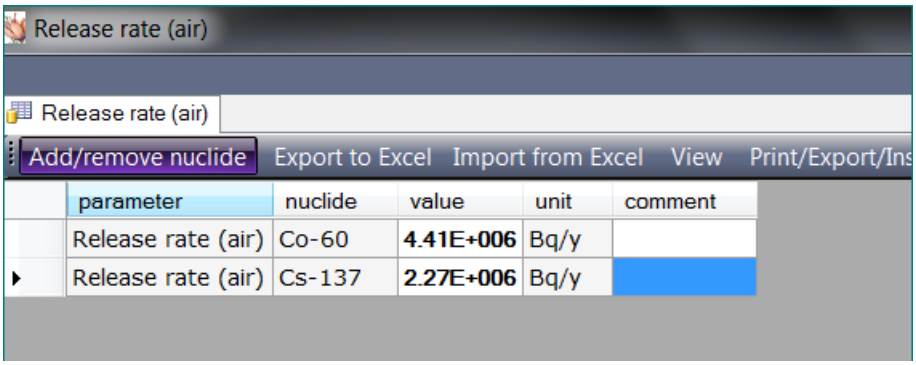


Double-click on the “Release rate (air)”.

The following table will appear:



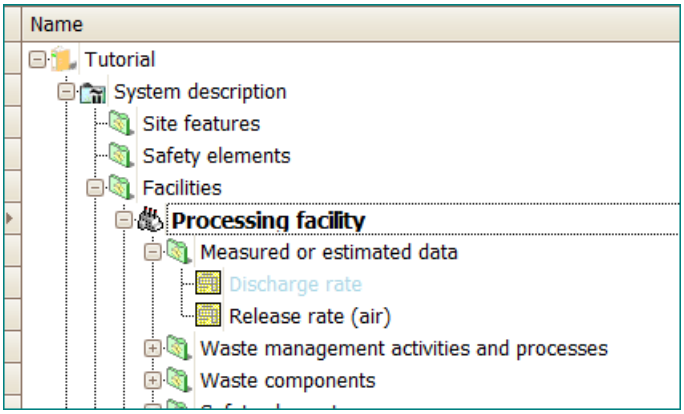
Enter data[4] about release rate according to Table 2.



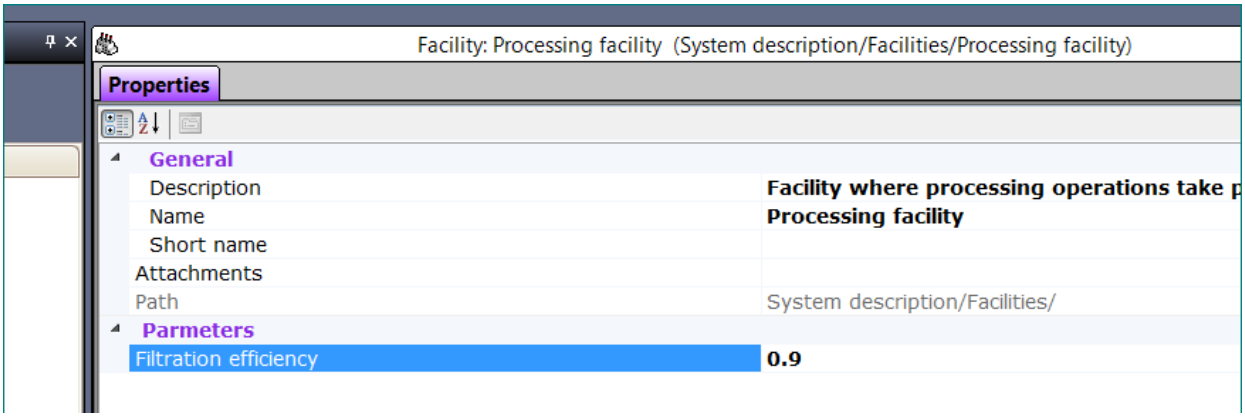
Close the table.

[4] Press Tab button after entering each value or click outside the cell.

Select “Processing facility”.

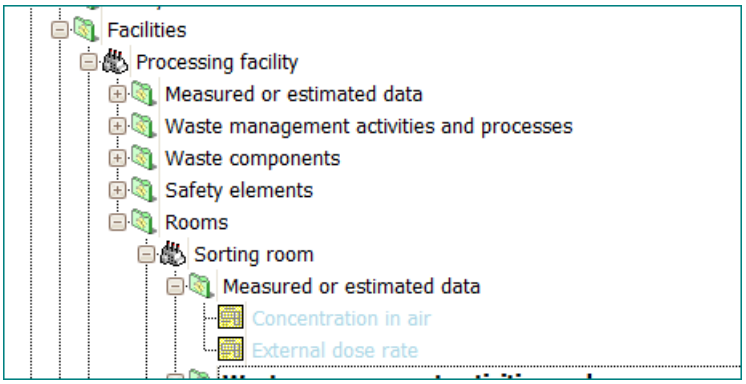


In the window “Properties” enter the filtration efficiency according to the data of Table 2. (change default value 0 to 0.9)



Properties of the sorting room

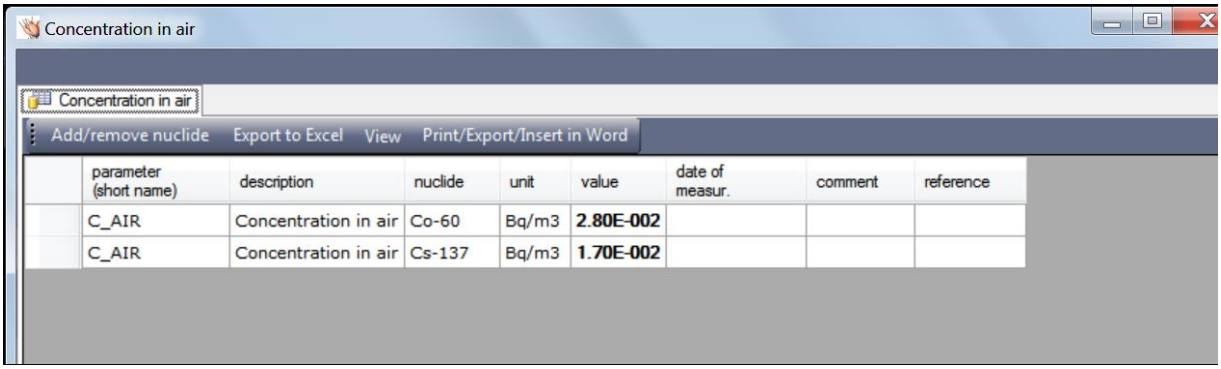
Expand “*Sorting room*” in the “**Object explorer (tree view)”** window as shown in the picture below and expand node “Measured or estimated data” under “*Sorting room*”.



Double-click on the “*Concentration in air”*.

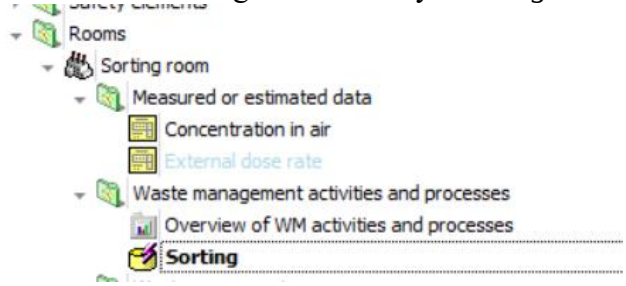
Enter the values for concentration in the air in the Sorting room (Table 2) as shown in the picture 3.

Picture 3

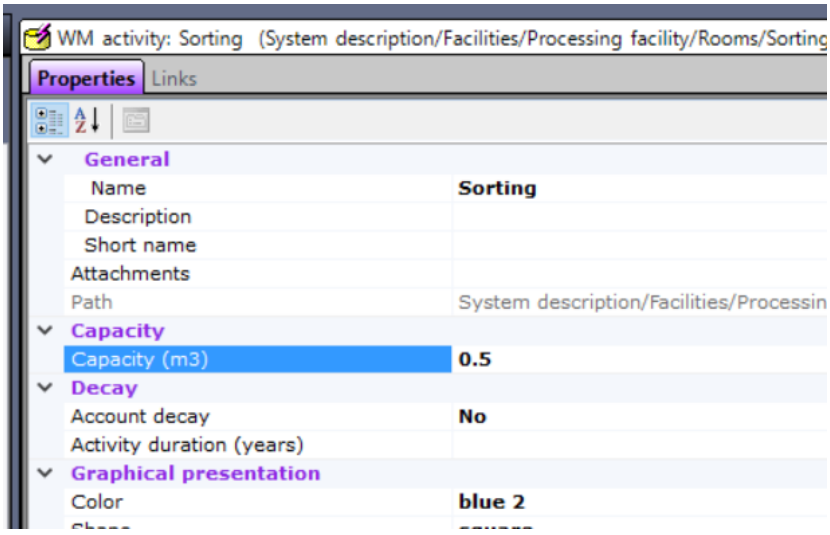


Close the table.

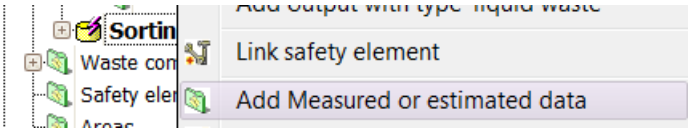
Select the waste management activity "*Sorting*" as shown below.



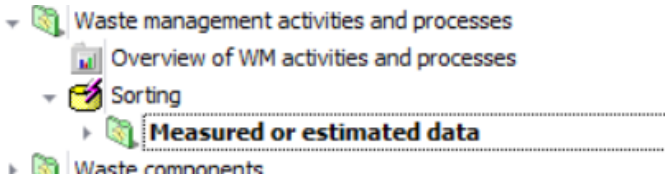
Enter capacity of waste management activity "Sorting" (Table 2) in the Properties window (property "**Capacity**") as shown in the picture:



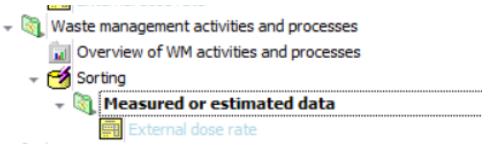
Right-click on "Sorting" and select in menu "Add measured or estimated data".



New folder “Measured or estimated data” will be added to “Sorting”.

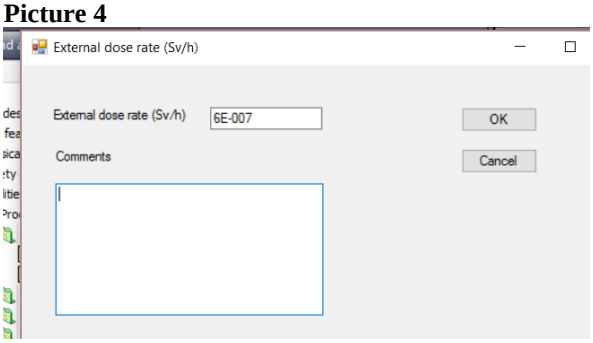


Expand this folder and double-click on the “*External dose rate*”.



In the window which appears, enter the value for dose rate (6E-07) associated with the Sorting (Table 2) as shown in the picture 4:

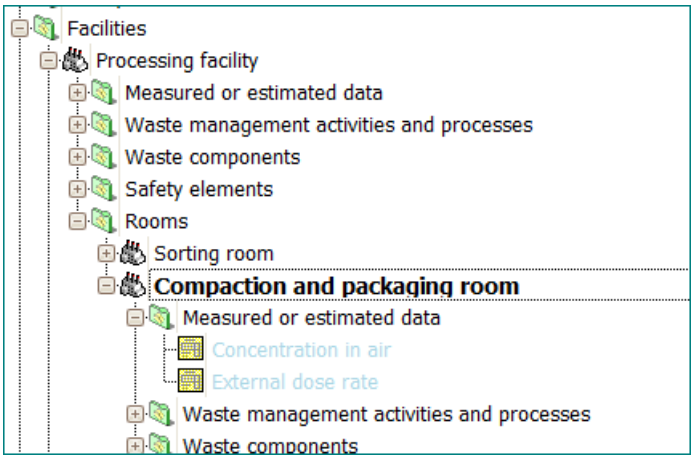
Picture 4



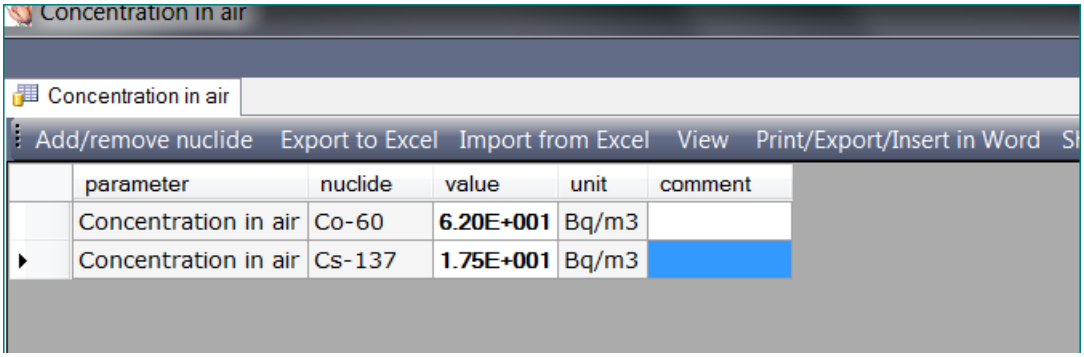
Click OK.

Properties of the compaction and packaging room

Select the “Compaction and packaging room” in the Object’s browser and expand “Measured or estimated data” folder.

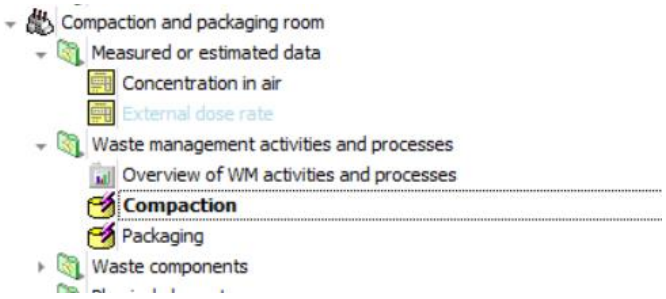


Double-click on the "Concentration in air" and enter the data about concentration in air for Compaction and packaging room according to Table 2.

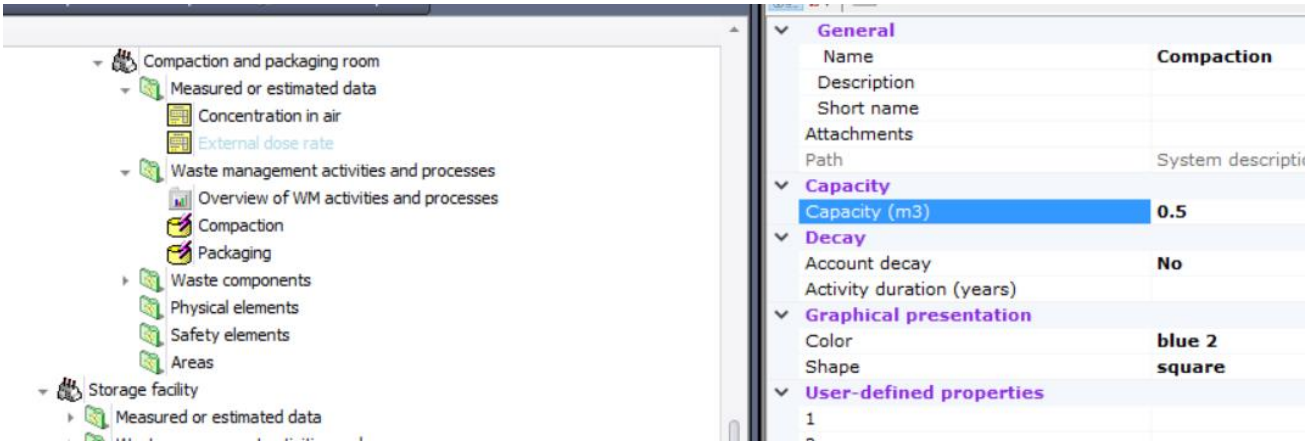


Close the table.

Select waste management activity Compaction.

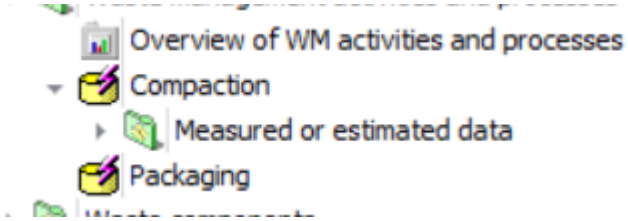


Provide data about its capacity according to Table 2.



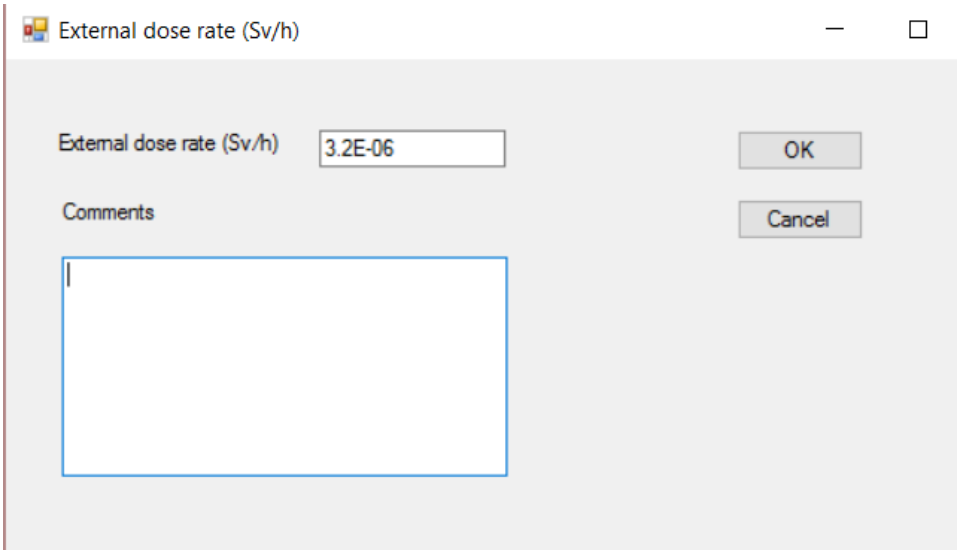
Right-click on “Compaction” and select “Add measured or estimated data” command from menu (or select same command from the Actions window).

The folder “Measured or estimated data” will be added to “Compaction”.



Expand this folder and double click on the “External dose rate”.

Provide the data about external dose rate associated with Compaction according to Table 2.



Press OK.

Using procedures similar to described above provide the data according to Table 2 for the:

- waste management activity **Packaging**

Properties of the storage facility

Using procedures similar to described above provide the following data according to Table 2:

- Specify filtration efficiency for the **Storage facility**
- Specify concentration in air and external dose rate for the **Drum storage room** of the Storage facility.

SAVING THE FILE:

Save your project.

Tutorial 4. Incoming waste component.

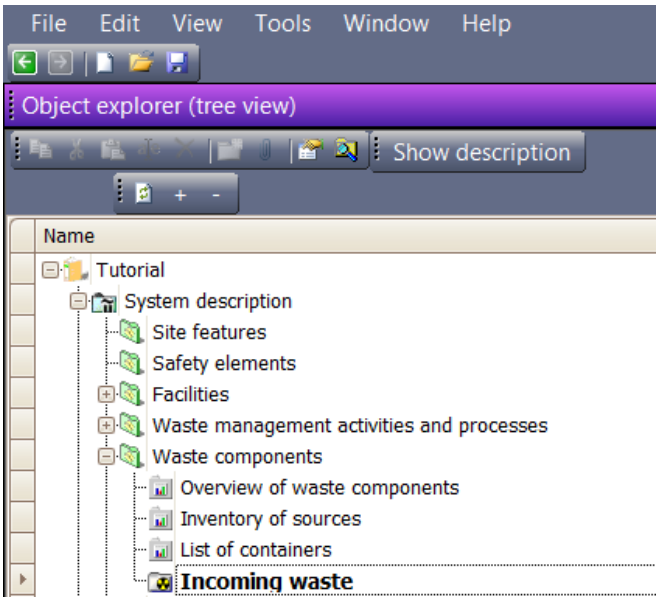
In this tutorial, you will define the incoming waste. It will be considered that a producer (named 'Producer of primary waste') produces the waste arriving in the facility (named 'Waste from producer'). Properties of the waste are summarised in the Table 3.

Table 3

Parameter	**Value**
Duration of the waste processing	3 years
Annual volume	27 m^3 / y
Annual mass	11000 kg/y
Volumetric concentration of Co-60[5]	1.26E+12 Bq/m^3
Volumetric concentration of Cs-137	3.5E+10 Bq/m^3

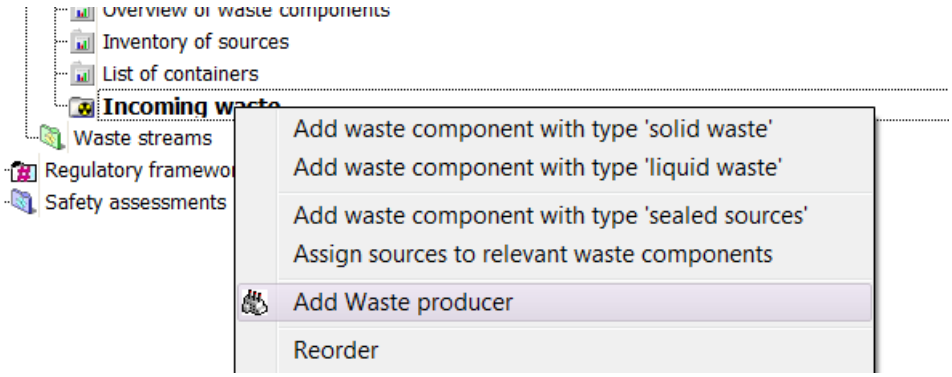
Add waste producer

Select "System description/Waste components/Incoming waste" in the "**Object explorer (tree view)**" window.

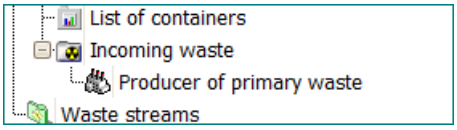


Select command "Add waste producer" from the context menu or in the "Actions" window.

[5] Values for concentration are not realistic. These are given for illustration.

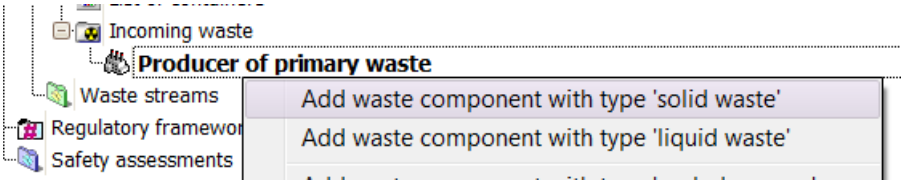


Add new waste producer with the name "Producer of primary waste".



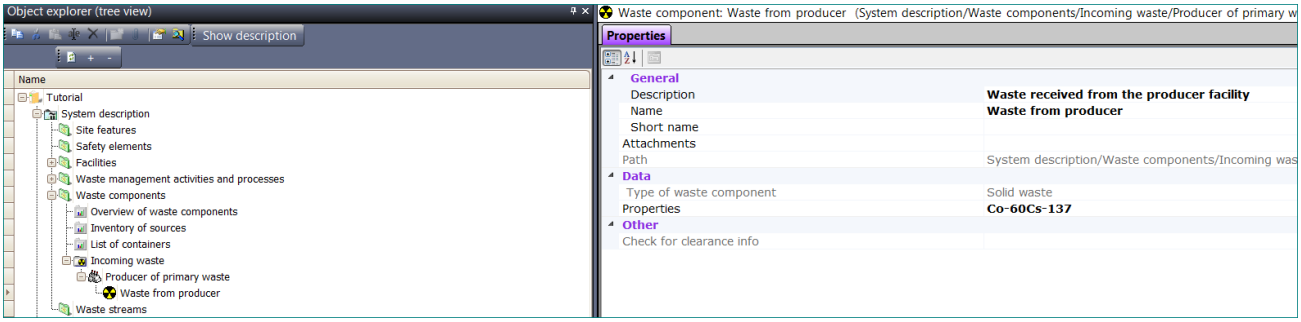
Add incoming waste component

Select "Producer of primary waste" and select command "Add waste component with type 'solid waste".



Give a name for waste component – "Waste from producer".

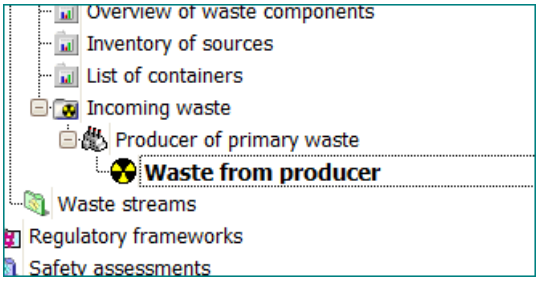
Provide the description for this waste component (in **Properties** window): "*Waste received from the producer facility*".



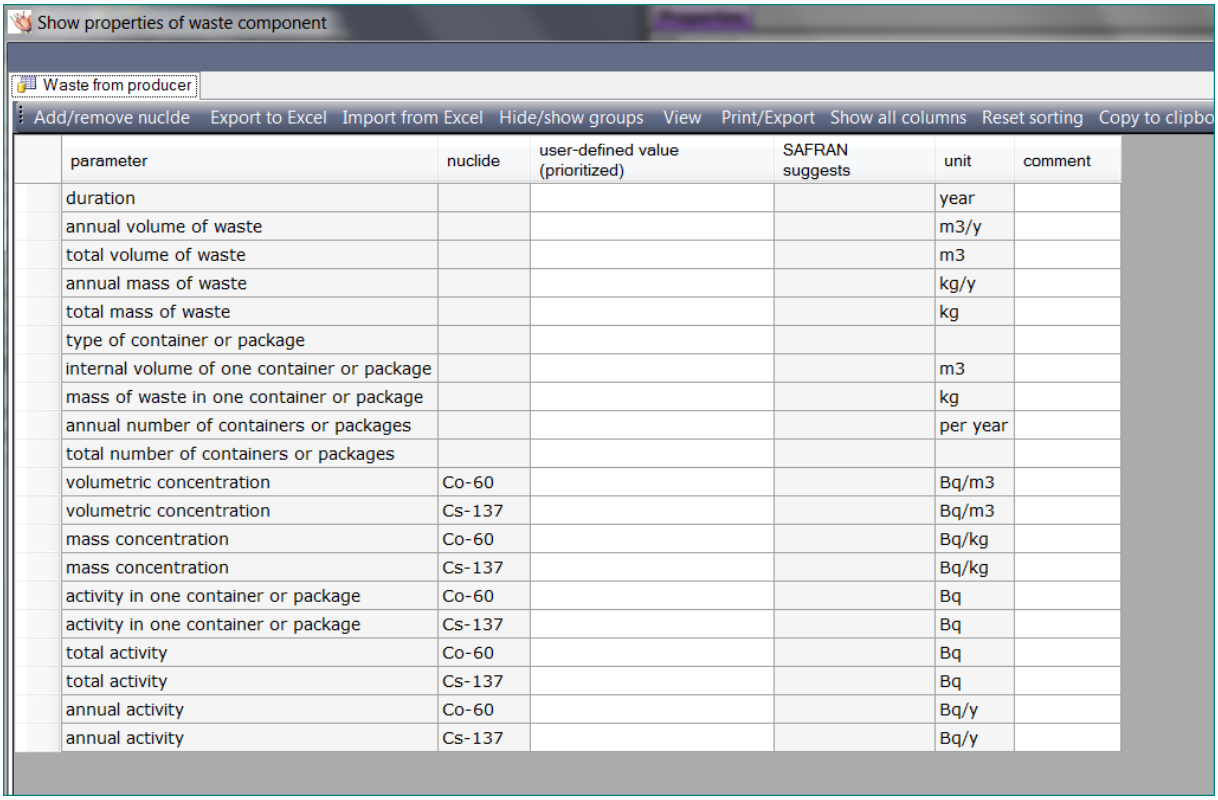
Note (row Data-Properties in the "Properties window") that SAFRAN assumes that this waste component contains radionuclides specified via "Project properties" window during Tutorial 2.

Properties of the waste component

Double-click on the “Waste from producer”.

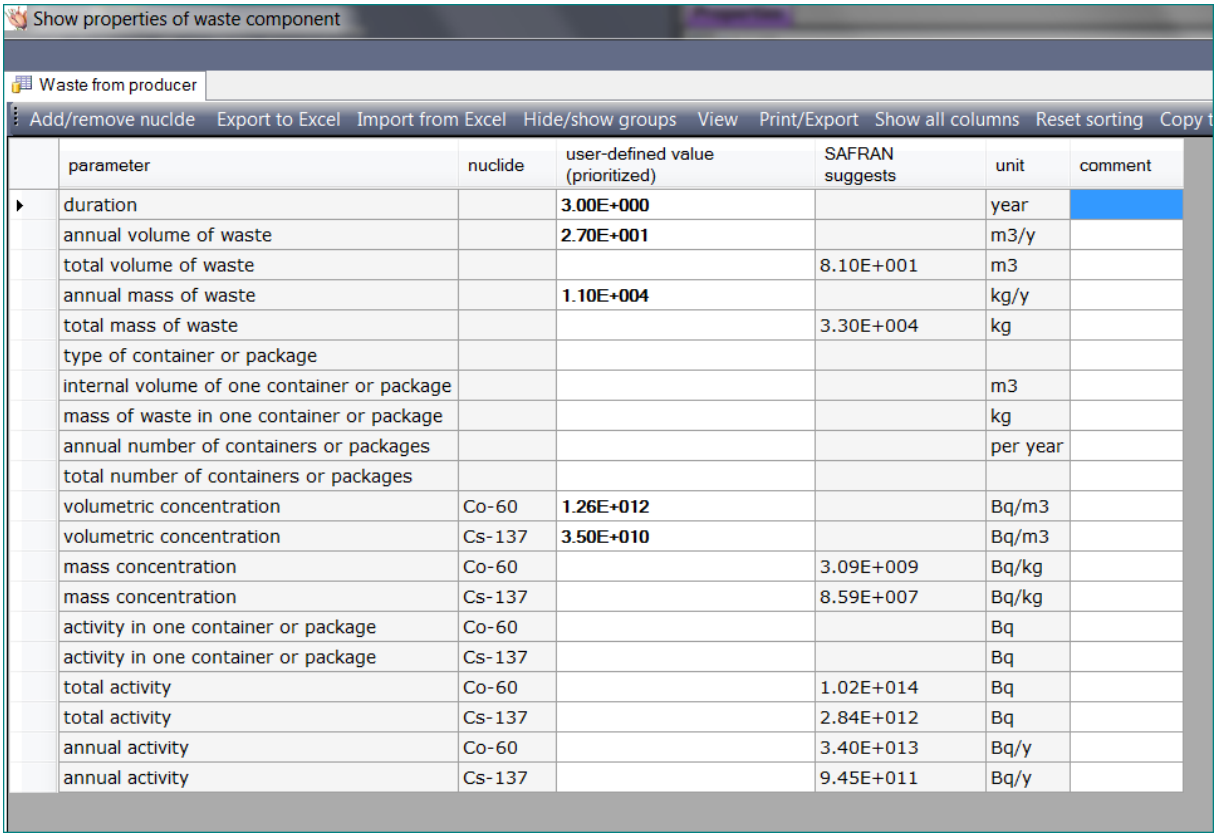


The following table will appear:



parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration				year	
annual volume of waste				m3/y	
total volume of waste				m3	
annual mass of waste				kg/y	
total mass of waste				kg	
type of container or package					
internal volume of one container or package				m3	
mass of waste in one container or package				kg	
annual number of containers or packages				per year	
total number of containers or packages					
volumetric concentration	Co-60			Bq/m3	
volumetric concentration	Cs-137			Bq/m3	
mass concentration	Co-60			Bq/kg	
mass concentration	Cs-137			Bq/kg	
activity in one container or package	Co-60			Bq	
activity in one container or package	Cs-137			Bq	
total activity	Co-60			Bq	
total activity	Cs-137			Bq	
annual activity	Co-60			Bq/y	
annual activity	Cs-137			Bq/y	

Specify the amount and activity data according to the Table 3.



parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration		**3.00E+000**		year	
annual volume of waste		**2.70E+001**		m3/y	
total volume of waste			8.10E+001	m3	
annual mass of waste		**1.10E+004**		kg/y	
total mass of waste			3.30E+004	kg	
type of container or package					
internal volume of one container or package				m3	
mass of waste in one container or package				kg	
annual number of containers or packages				per year	
total number of containers or packages					
volumetric concentration	Co-60	**1.26E+012**		Bq/m3	
volumetric concentration	Cs-137	**3.50E+010**		Bq/m3	
mass concentration	Co-60		3.09E+009	Bq/kg	
mass concentration	Cs-137		8.59E+007	Bq/kg	
activity in one container or package	Co-60			Bq	
activity in one container or package	Cs-137			Bq	
total activity	Co-60		1.02E+014	Bq	
total activity	Cs-137		2.84E+012	Bq	
annual activity	Co-60		3.40E+013	Bq/y	
annual activity	Cs-137		9.45E+011	Bq/y	

Close the table.

SAVING THE FILE:

Save the project.

Tutorial 5. Waste stream.

In this tutorial, you will define the waste stream describing processing of incoming waste 'Waste from producer' by Process 1 (see Tutorial 2). For the calculations, the following properties of waste management activities will be taken into account:

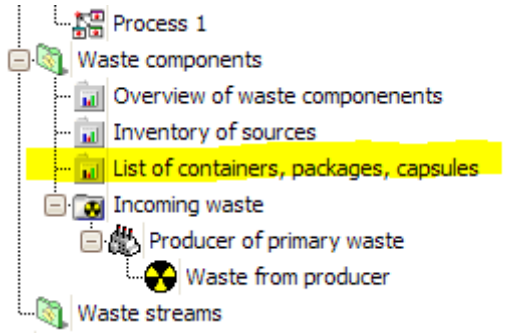
Table 4

Sorting	The mass, volume and activity of compactable waste after sorting is 80% of the mass, volume and activity of incoming waste.
Compaction	The waste obtained as result of the Compaction has the volume which is 35% of the volume before compaction.
Packaging	Waste is packaged into 500 l drums.

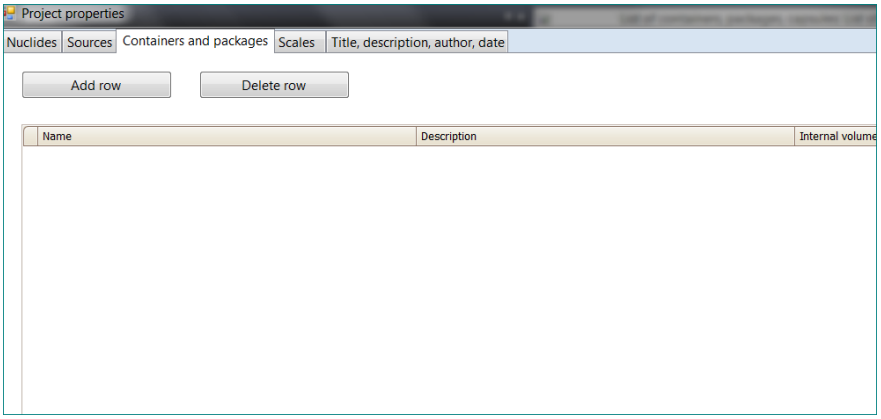
Define type of container used for this project

Before starting to work with waste stream we will add definition of 500 liter drum to the project's database of containers

Double-click on the node "List of containers, packages, capsules" located above the "Incoming waste" node.

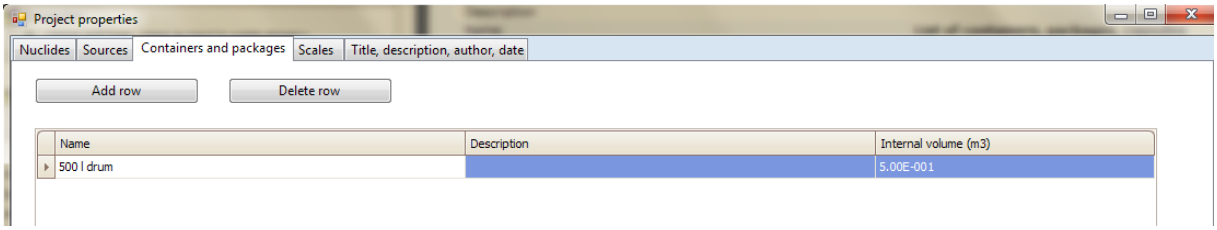


The "Project properties" form will appear. The tab "Containers and packages" is selected.



Click "Add row" button.

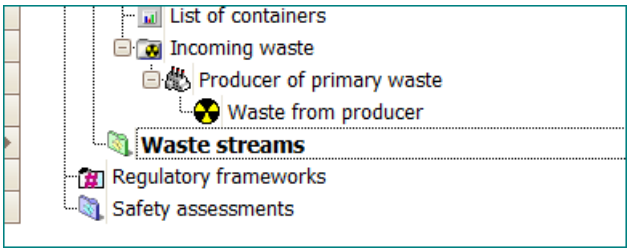
Enter data (according to Table 4) in the table as shown in the picture below



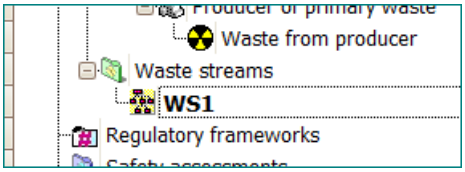
Close the "Project properties" window.

Create the waste stream

In the "**Object explorer (tree view)**" window select the folder "Waste streams".

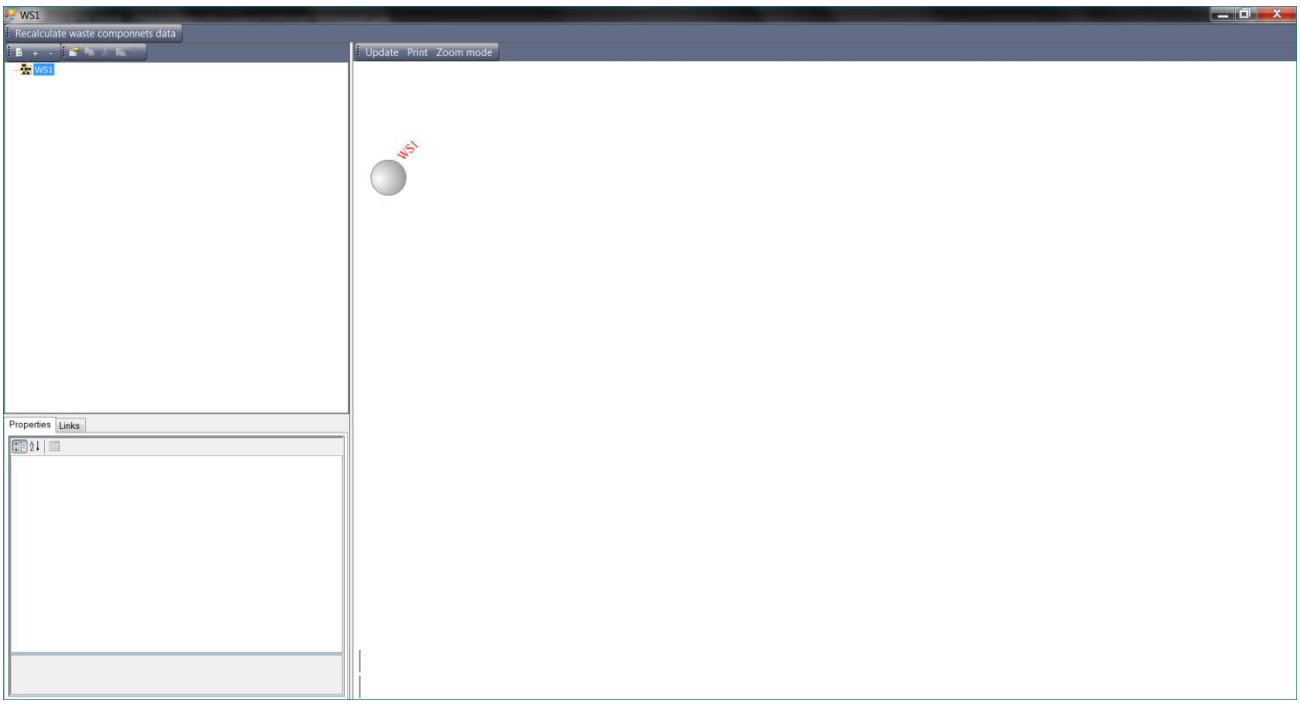


Add new waste stream (name it WS1) by selecting command "Add waste stream" for this folder.



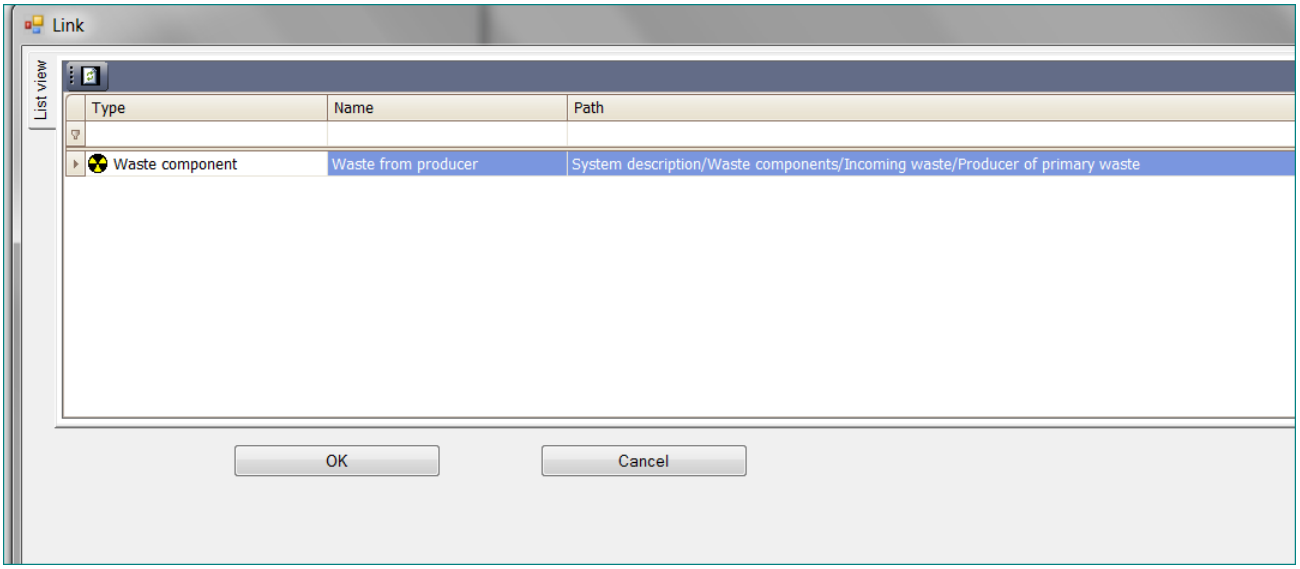
Double-click on the "WS1".

The window allowing previewing and constructing waste stream will appear. Note that layout and sub-windows of this window are similar to the ones in the window "Create/modify process" you used during the performing of Tutorial 1.

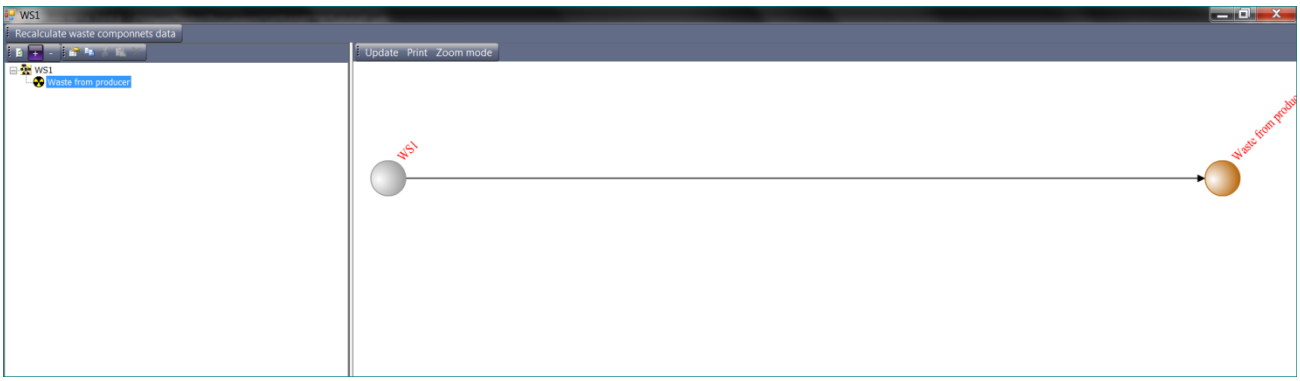


Right-click on the "WS1" in the browser located in the upper-left part of the window and select command "Select the starting waste component of the stream".

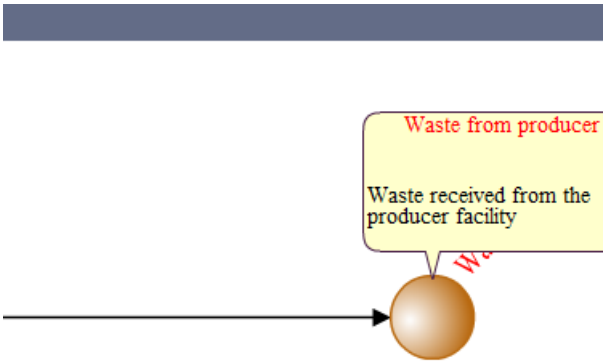
The list which will appear contains only one waste component – “Waste from producer”. Click OK.



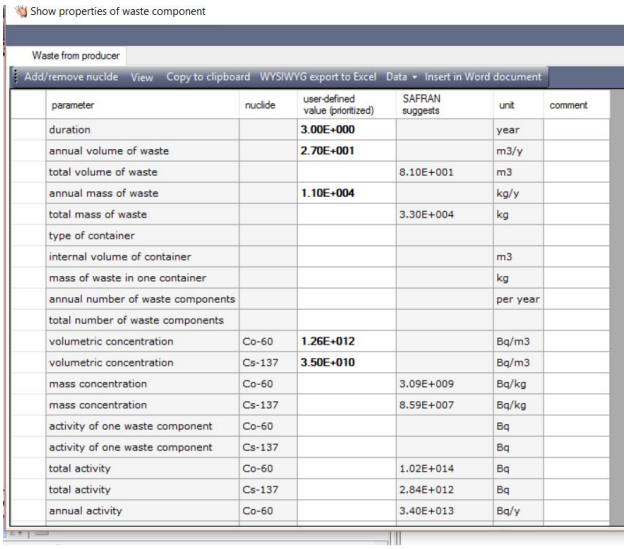
Note the changes in the browser window and graphical presentation of the stream.



Hover mouse over the circle with label “Waste from producer” located in the right part of the window. You will see the description of the waste component.



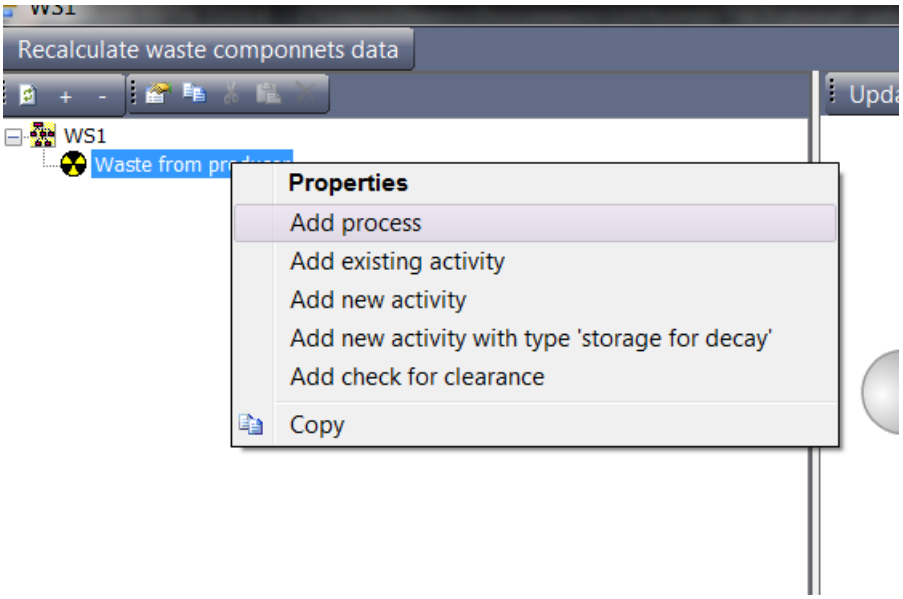
Click on the circle. The same table of properties as you already observed working with Tutorial 3 will appear:



parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration		**3.00E+000**		year	
annual volume of waste		**2.70E+001**		m3/y	
total volume of waste			8.10E+001	m3	
annual mass of waste		**1.10E+004**		kg/y	
total mass of waste			3.30E+004	kg	
type of container					
internal volume of container				m3	
mass of waste in one container				kg	
annual number of waste components				per year	
total number of waste components					
volumetric concentration	Co-60	**1.26E+012**		Bq/m3	
volumetric concentration	Cs-137	**3.50E+010**		Bq/m3	
mass concentration	Co-60		3.09E+009	Bq/kg	
mass concentration	Cs-137		8.59E+007	Bq/kg	
activity of one waste component	Co-60			Bq	
activity of one waste component	Cs-137			Bq	
total activity	Co-60		1.02E+014	Bq	
total activity	Cs-137		2.84E+012	Bq	
annual activity	Co-60		3.40E+013	Bq/y	

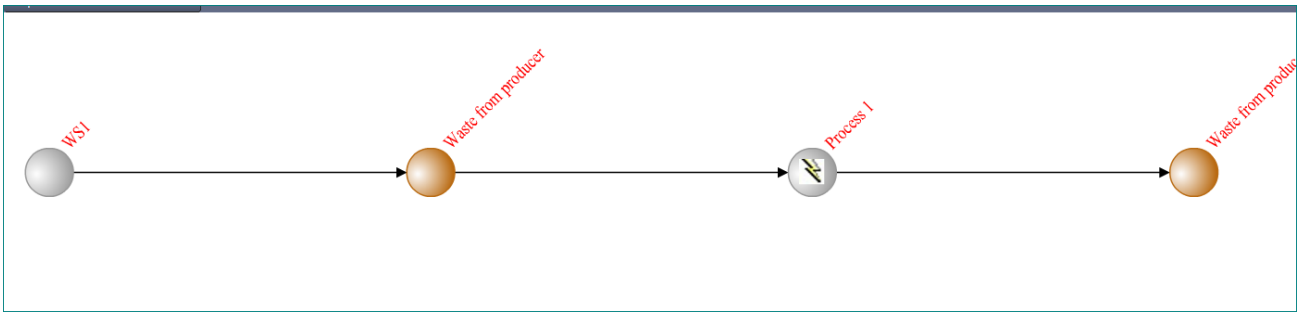
Close the table.

Expand “WS1” in the browser window, right-click on “Waste from producer” and select “Add process”.



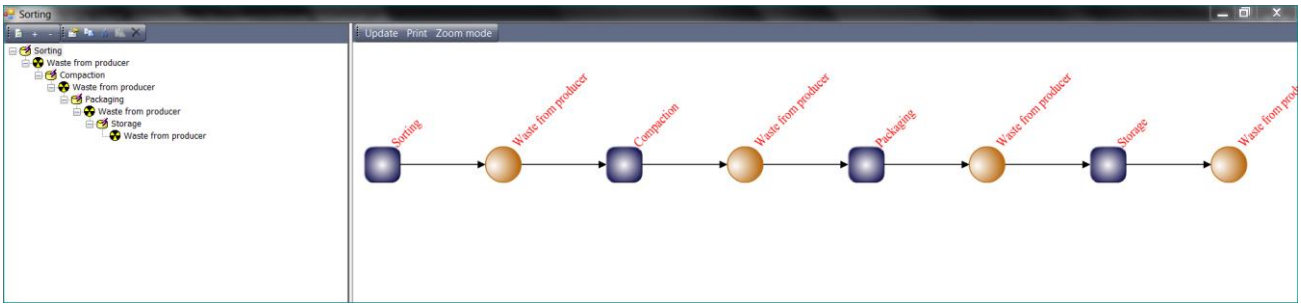
The window which will appear contains only one process – Process 1. Select OK.

Note the changes in the waste stream diagram.



The waste stream has been constructed. Now we are able to specify the properties of the waste after the different waste management activities.

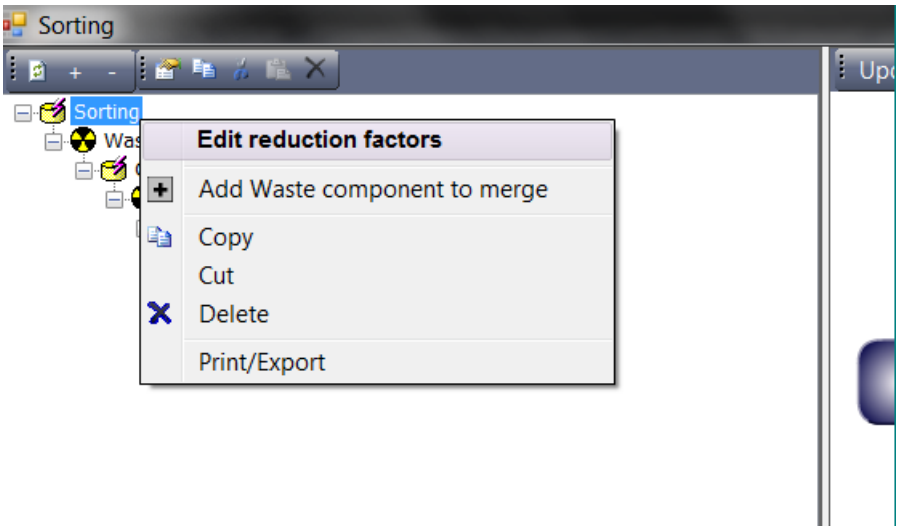
Click on the “Process 1” circle in the graphical presentation of the waste stream diagram. The new window with detailed presentation of application of Process 1 to the incoming waste will appear.



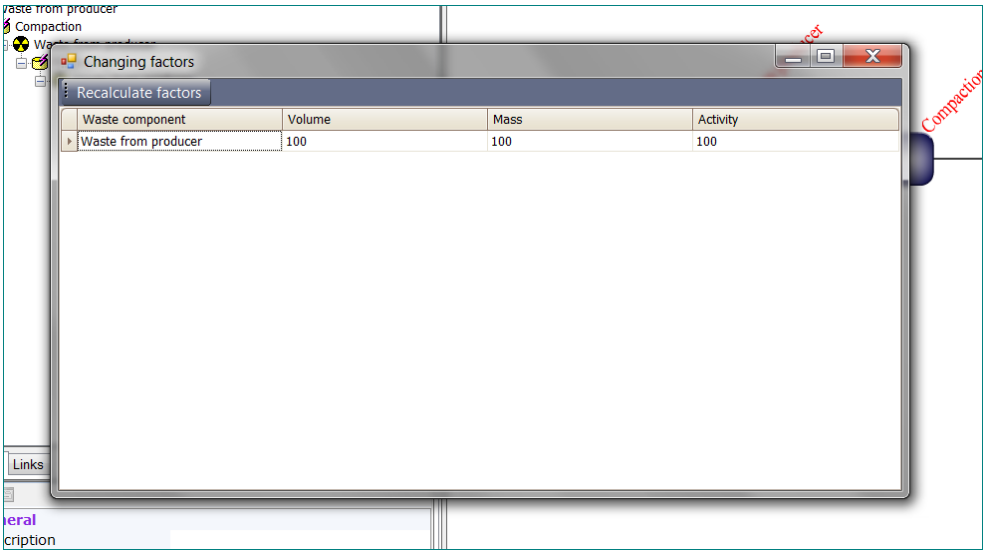
Numerical properties of the waste components

Now you will specify the properties enumerated in the Table 4.

Right-click on the “Sorting” in the objects browser and select command “Edit reduction factors” from the menu.

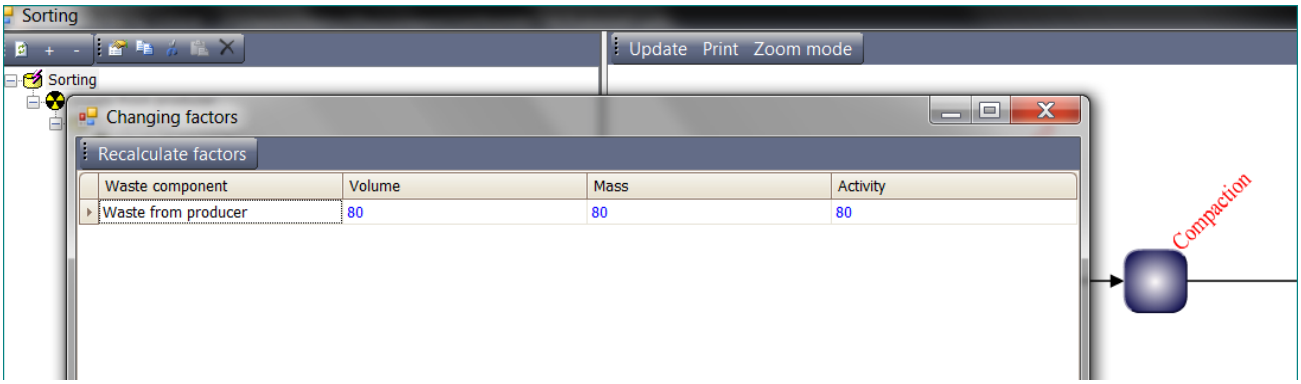


The following table will appear:



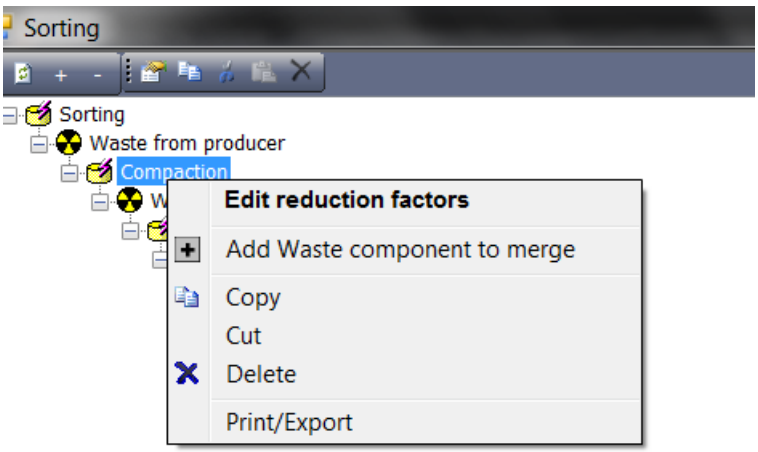
Place in the table “80” instead of “100” according to the Table 4[6].

[6] After entering value in each cell click Tab button or click mouse outside the cell

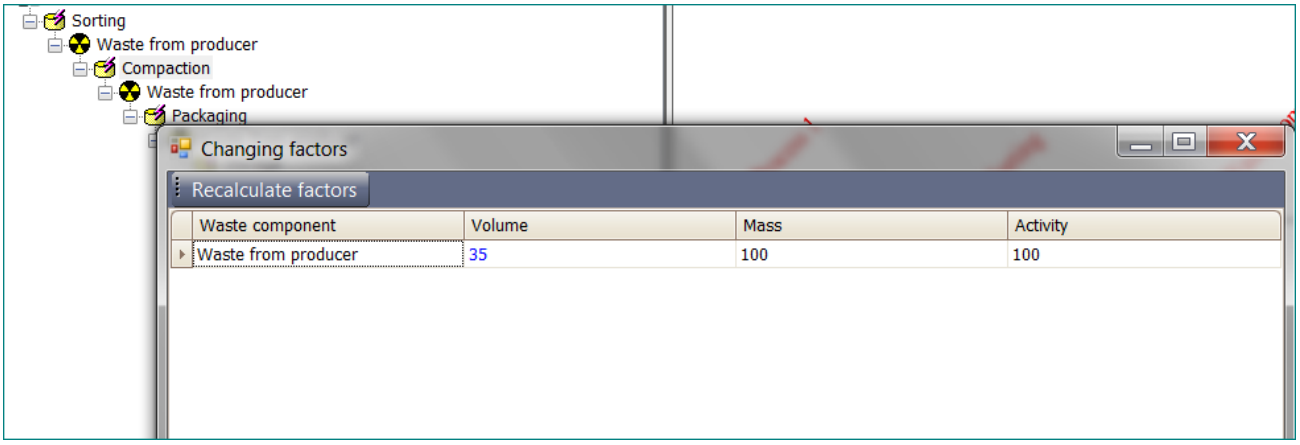


Close the table.

Right-click “Compaction” and select “Edit reduction factors”.



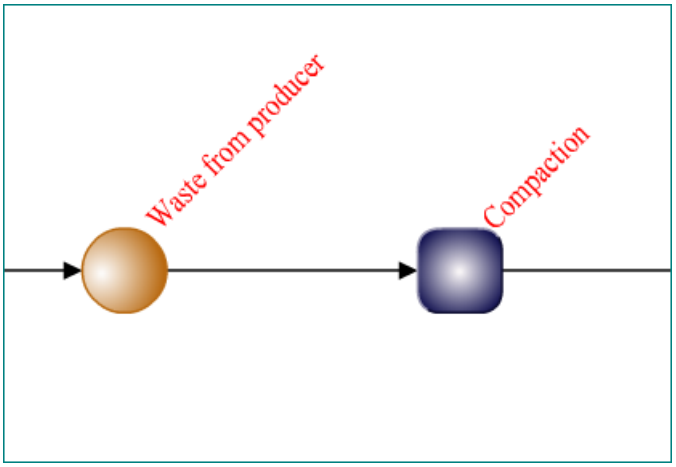
According to Table 4, specify the following factors:



Close the table.

Now you can compare the data calculated by SAFRAN before and after Sorting and before and after Compaction:

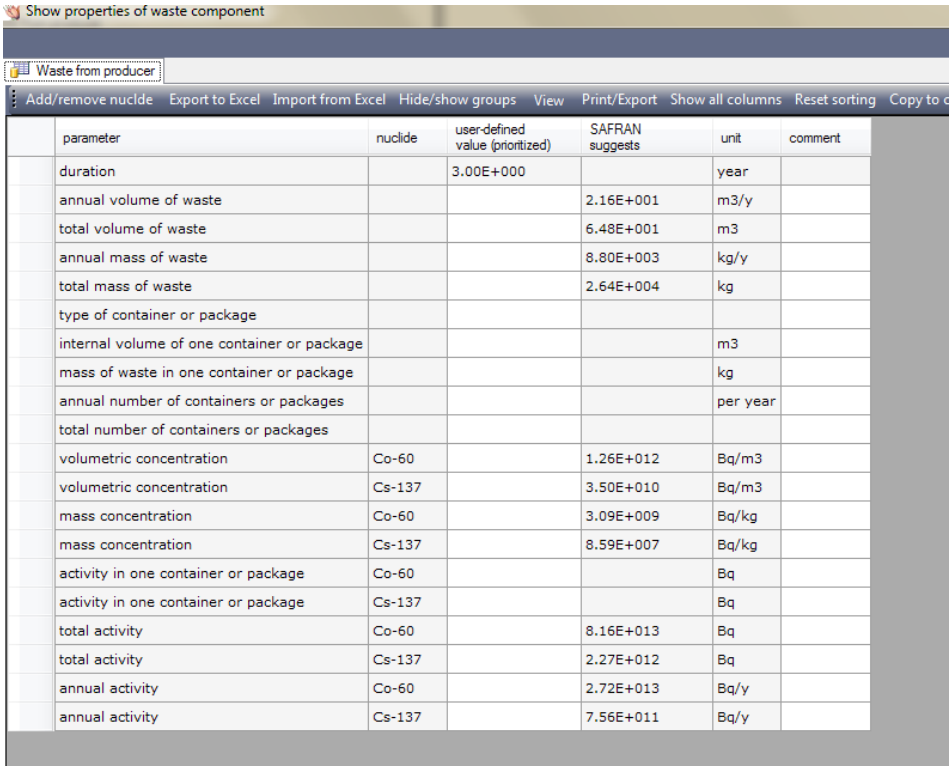
Click on the circle “Waste from producer” located before Compaction.



The following table will appear[7]:

Waste properties after Sorting, before Compaction

[7] If cells with calculated data are empty – close the table; press button “Recalculate waste components data” located on the toolbar of Process preview window and then open the table again.

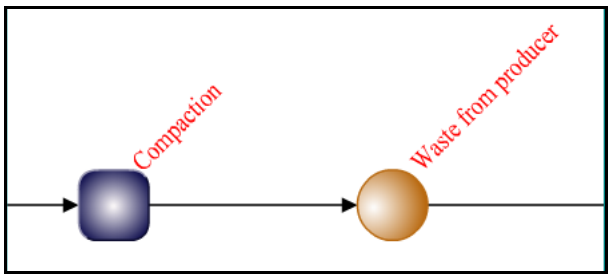


parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration		3.00E+000		year	
annual volume of waste			2.16E+001	m3/y	
total volume of waste			6.48E+001	m3	
annual mass of waste			8.80E+003	kg/y	
total mass of waste			2.64E+004	kg	
type of container or package					
internal volume of one container or package				m3	
mass of waste in one container or package				kg	
annual number of containers or packages				per year	
total number of containers or packages					
volumetric concentration	Co-60		1.26E+012	Bq/m3	
volumetric concentration	Cs-137		3.50E+010	Bq/m3	
mass concentration	Co-60		3.09E+009	Bq/kg	
mass concentration	Cs-137		8.59E+007	Bq/kg	
activity in one container or package	Co-60			Bq	
activity in one container or package	Cs-137			Bq	
total activity	Co-60		8.16E+013	Bq	
total activity	Cs-137		2.27E+012	Bq	
annual activity	Co-60		2.72E+013	Bq/y	
annual activity	Cs-137		7.56E+011	Bq/y	

Note that annual volume, mass and activity are 80% of annual volume, mass and activity for the incoming waste (see Table 3 of Tutorial 4).

Close the table.

Double-click on the node “Waste from producer” located after Compaction.



Corresponding table will look like:

Waste propeties after Compaction

Show properties of waste component

Waste from producer

Add/remove nuclde | Export to Excel | Import from Excel | Hide/show groups | View | Print/Export | Show all columns | Reset sorting | Copy t

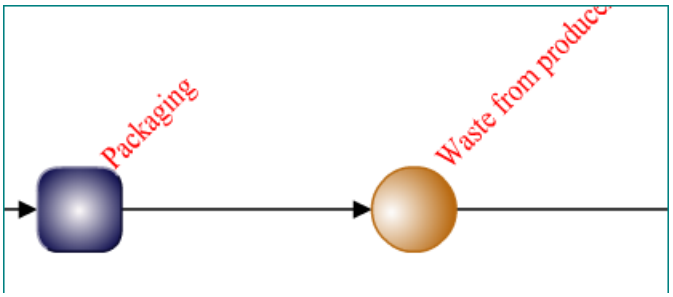
parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration		3.00E+000		year	
annual volume of waste			7.56E+000	m3/y	
total volume of waste			2.27E+001	m3	
annual mass of waste			8.80E+003	kg/y	
total mass of waste			2.64E+004	kg	
type of container or package					
internal volume of one container or package				m3	
mass of waste in one container or package				kg	
annual number of containers or packages				per year	
total number of containers or packages					
volumetric concentration	Co-60		3.60E+012	Bq/m3	
volumetric concentration	Cs-137		1.00E+011	Bq/m3	
mass concentration	Co-60		3.09E+009	Bq/kg	
mass concentration	Cs-137		8.59E+007	Bq/kg	
activity in one container or package	Co-60			Bq	
activity in one container or package	Cs-137			Bq	
total activity	Co-60		8.16E+013	Bq	
total activity	Cs-137		2.27E+012	Bq	
annual activity	Co-60		2.72E+013	Bq/y	
annual activity	Cs-137		7.56E+011	Bq/y	

Compare table *Waste propeties after Compaction* with the table *Waste properties after Sorting, before Compaction.* Note that annual volume of the waste is 35% of the volume with the corresponding changes in total volume and volumetric concentration.

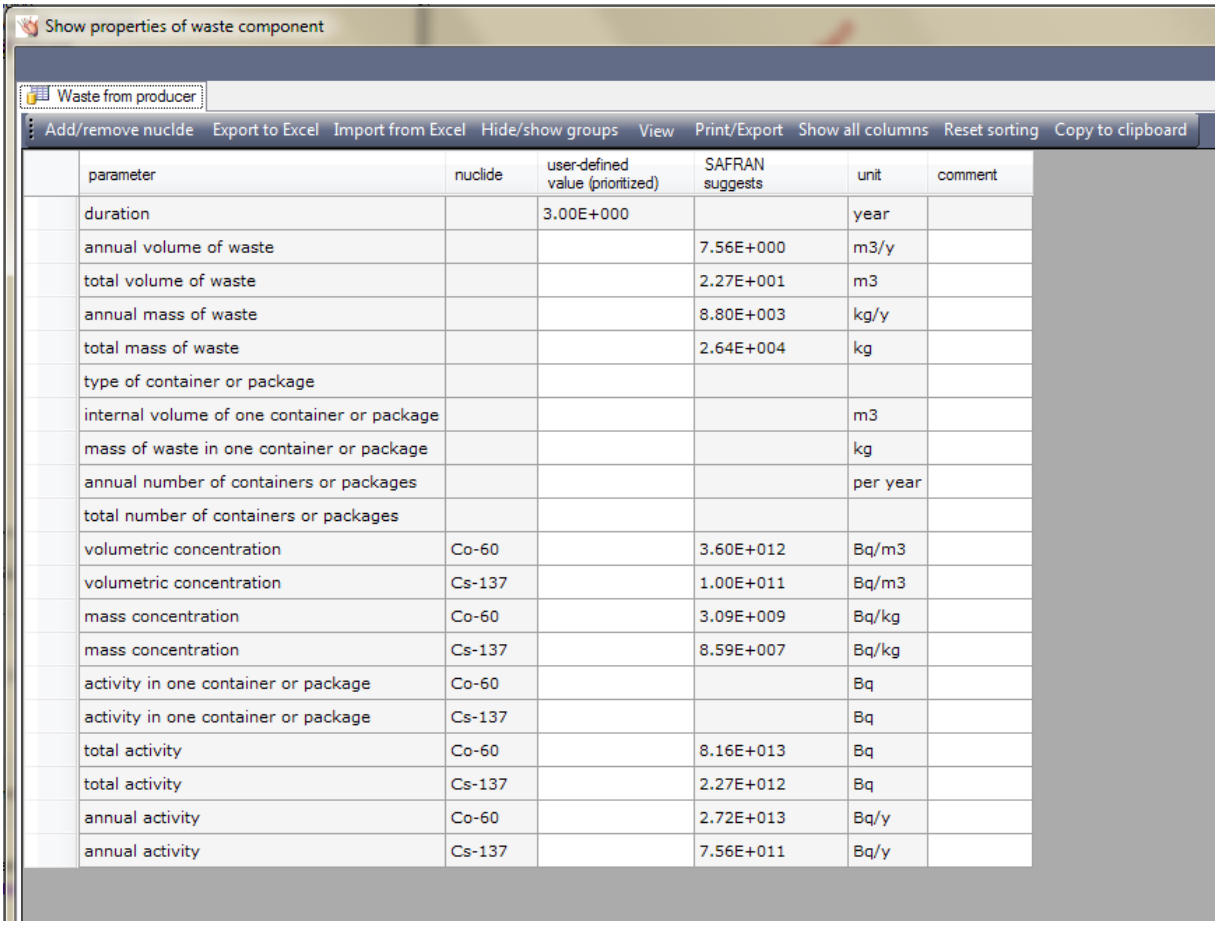
Close the table.

Now the ouput of Packaging activity can be specified.

Click on the circle “Waste from producer” located after Packaging activity.



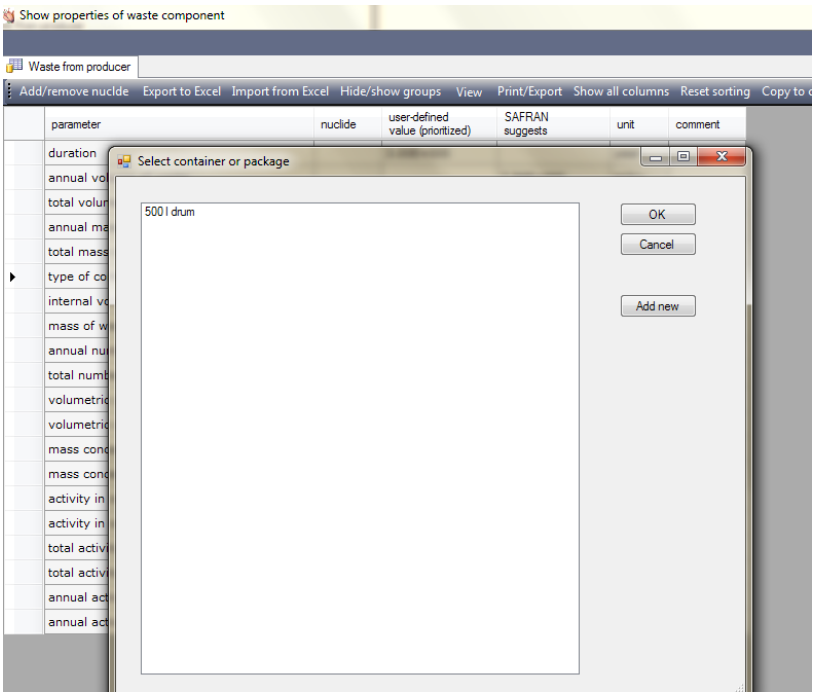
The following table will appear:



parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration		3.00E+000		year	
annual volume of waste			7.56E+000	m3/y	
total volume of waste			2.27E+001	m3	
annual mass of waste			8.80E+003	kg/y	
total mass of waste			2.64E+004	kg	
type of container or package					
internal volume of one container or package				m3	
mass of waste in one container or package				kg	
annual number of containers or packages				per year	
total number of containers or packages					
volumetric concentration	Co-60		3.60E+012	Bq/m3	
volumetric concentration	Cs-137		1.00E+011	Bq/m3	
mass concentration	Co-60		3.09E+009	Bq/kg	
mass concentration	Cs-137		8.59E+007	Bq/kg	
activity in one container or package	Co-60			Bq	
activity in one container or package	Cs-137			Bq	
total activity	Co-60		8.16E+013	Bq	
total activity	Cs-137		2.27E+012	Bq	
annual activity	Co-60		2.72E+013	Bq/y	
annual activity	Cs-137		7.56E+011	Bq/y	

Click on the cell in the column “user-defined value” for the parameter ”type of container”.

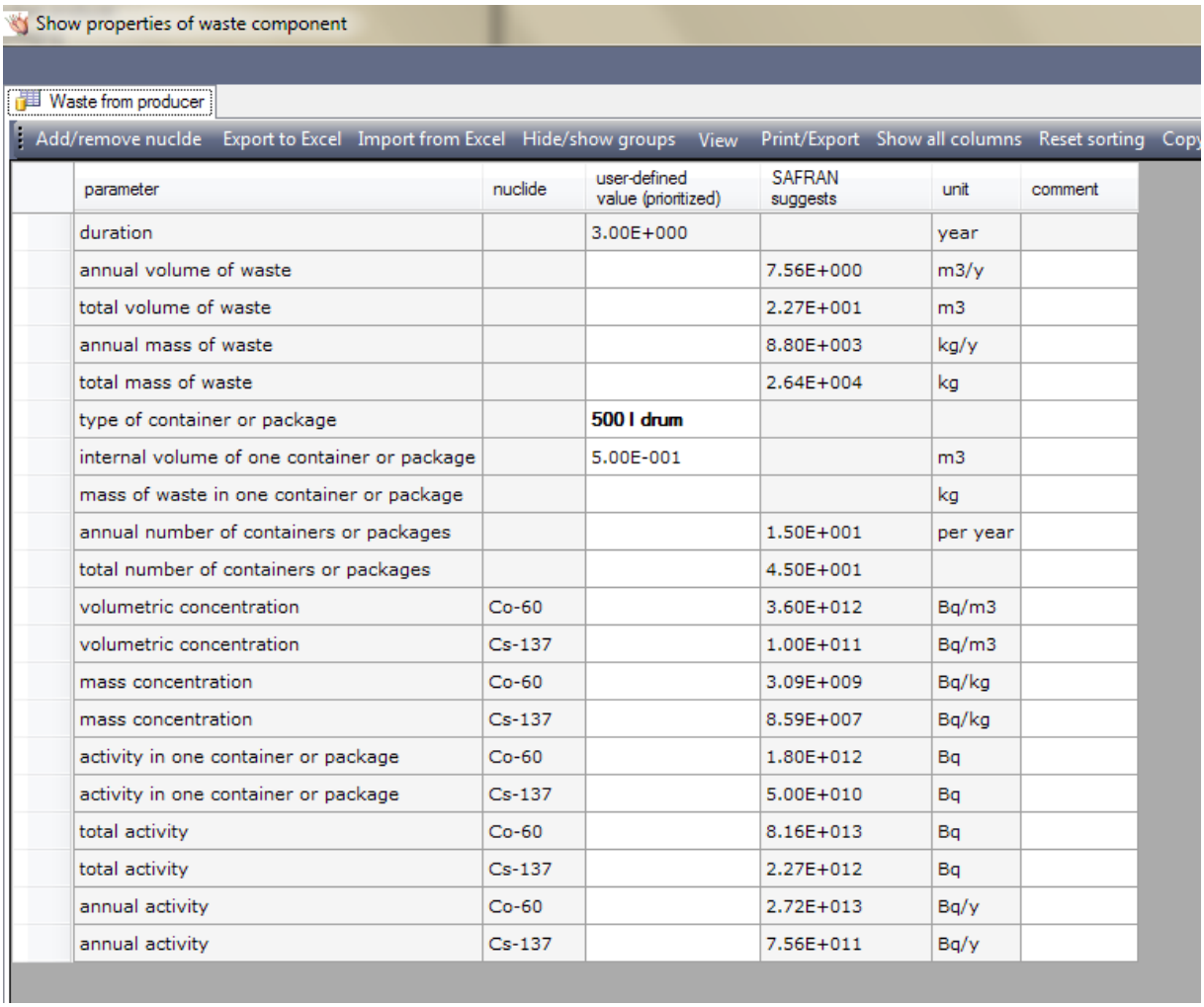
The container/package selection window will appear:



Select “500 l drum” and click OK.

Note the changes in the table - SAFRAN has calculated the number of containers and activity of one container as shown in the picture below[8].

[8] If values will not appear – close the table; press button “Recalculate waste components data” located on the toolbar of Process preview window and then open the table again.



parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration		3.00E+000		year	
annual volume of waste			7.56E+000	m3/y	
total volume of waste			2.27E+001	m3	
annual mass of waste			8.80E+003	kg/y	
total mass of waste			2.64E+004	kg	
type of container or package		**500 l drum**			
internal volume of one container or package		5.00E-001		m3	
mass of waste in one container or package				kg	
annual number of containers or packages			1.50E+001	per year	
total number of containers or packages			4.50E+001		
volumetric concentration	Co-60		3.60E+012	Bq/m3	
volumetric concentration	Cs-137		1.00E+011	Bq/m3	
mass concentration	Co-60		3.09E+009	Bq/kg	
mass concentration	Cs-137		8.59E+007	Bq/kg	
activity in one container or package	Co-60		1.80E+012	Bq	
activity in one container or package	Cs-137		5.00E+010	Bq	
total activity	Co-60		8.16E+013	Bq	
total activity	Cs-137		2.27E+012	Bq	
annual activity	Co-60		2.72E+013	Bq/y	
annual activity	Cs-137		7.56E+011	Bq/y	

Close the table and windows for process and waste stream overview.

SAVING THE FILE:

Save the project.

Tutorial 6. Regulatory Framework

In this tutorial, you will define the regulatory framework which is applicable to your safety assessment.

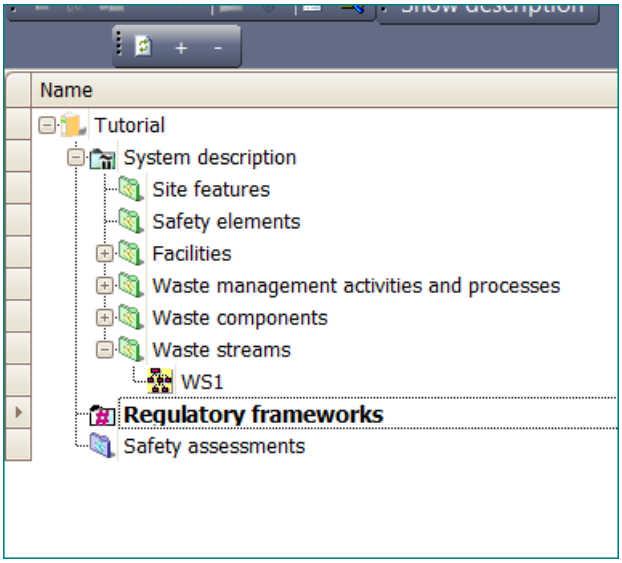
The list of criteria is shown in the Table 5.

Table 5

Situation	Application	Criterion's name	Value	Unit
Normal	Worker	Dose limit to worker	0.02	Sv/y
Normal	Public	Dose limit to public	0.0003	Sv/y
Accidental	Worker	Dose limit to worker	0.001	Sv
Accidental	Public	Dose limit to public	0.001	Sv

The regulatory framework

Locate "*Regulatory frameworks*" in the "***Object explorer (tree view)***" window.

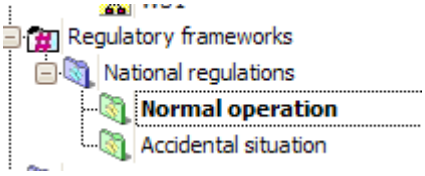


Click on the "**Add regulatory framework**" in the "**Actions**" window (or right-click on the "*Regulatory frameworks*" node and select corresponding command from the context menu).

The new regulatory framework should be named "*National regulations*".

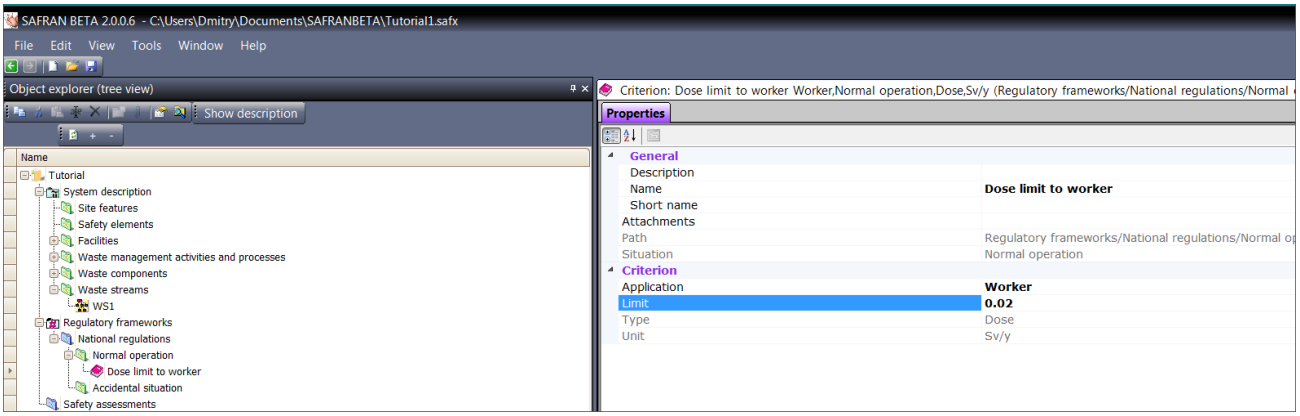
Annual dose limits for normal operation

Locate the "*Normal operation*" folder under the "*National regulations*".

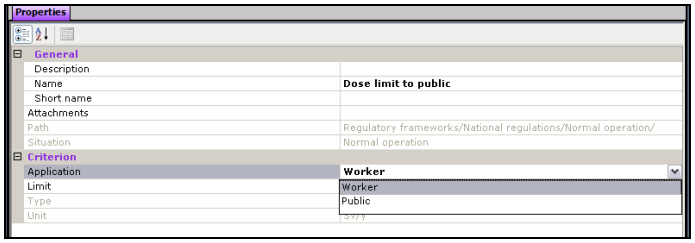


In the "**Actions**" window select "**Add criterion**". Specify the name "*Dose limit to worker*".

In the "Properties" window specify 0.02 as the **limit**. (see first row of the Table 5 shown at the beginning of this tutorial). Notice that unit is already set to Sv/y.



Click again on the "Normal operation" node and select again "**Add criterion**" command. Specify the name and properties for the criterion using second row of the Table 5. Notice that "**Application**" property should be changed from "**Worker**" to "**Public**" as shown in the picture.



Dose limits for accidental situation

By selecting folder "*Accidental situation*" and using "Add criterion" command, add the limits for worker and public specified in the Table 5 for the accidental situation. Don't forget to change the "Application" property for the dose limit for public.

SAVING THE FILE:

Save the project.

Tutorial 7. Safety Assessment.

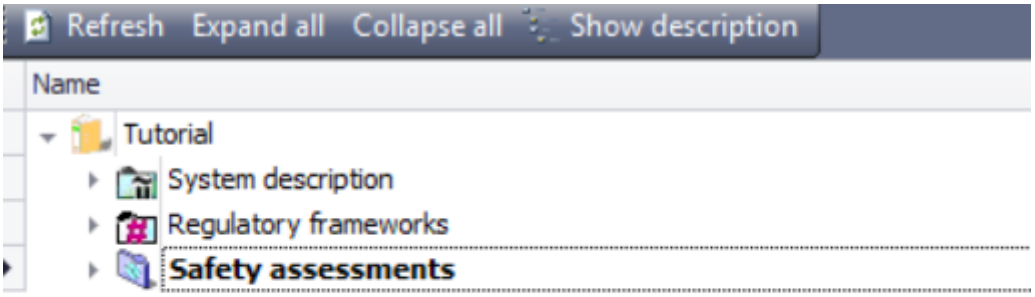
In this tutorial, you will perform the safety assessment.

Safety assessment will be performed for both normal operations and accident conditions. The model is developed by defining:

- the links to the regulatory framework,
- the purpose of the safety assessment, e.g. compliance with regulatory criteria,
- the scope of the assessment defining which facilities, rooms, areas and waste management activities need to be considered the assessment approach (this may include Potential Initiating Events, screening of hazards, compliance with safety requirements),
- the endpoints, e.g. dose to the worker and public,
- the scenarios where those end points could occur, their properties, probabilities etc,
- the impacts that may result,
- the assessment cases for endpoints relevant to each impact.

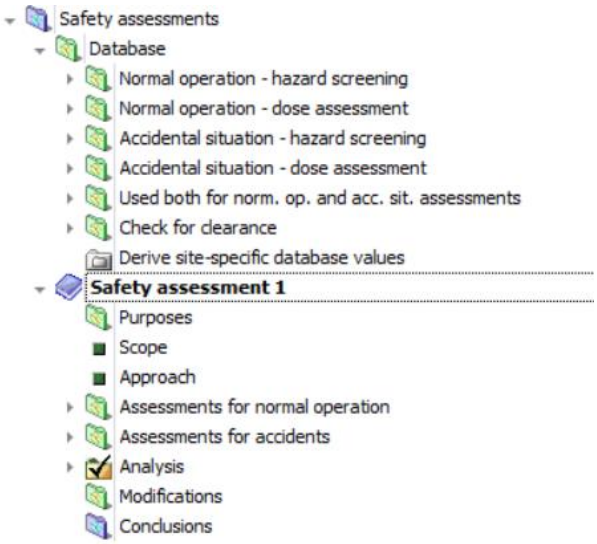
Purposes and scope of the safety assessment

Collapse all branches in the "**Object explorer (tree view)**" window and select the "*Safety assessments*" node.

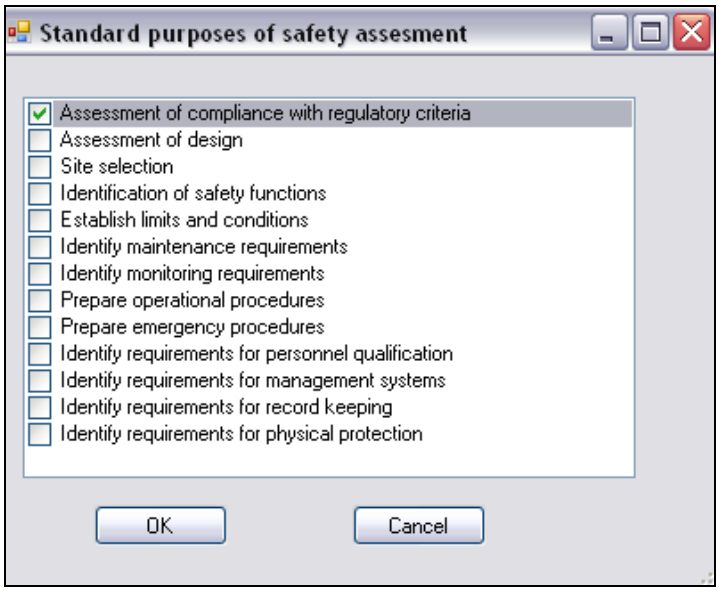


Add the safety assessment "Safety assessment 1".

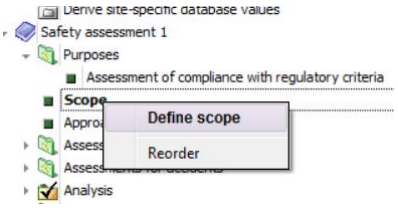
Expand the "Safety assessment 1" node.



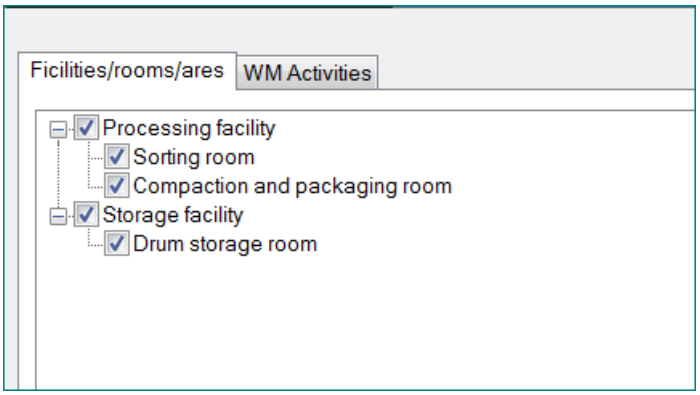
Right-click on the "Purposes" node. Select "*Import standard purposes*". In the window that appears, select "*Assessment of compliance with regulatory criteria*" and confirm by clicking on "OK" button.

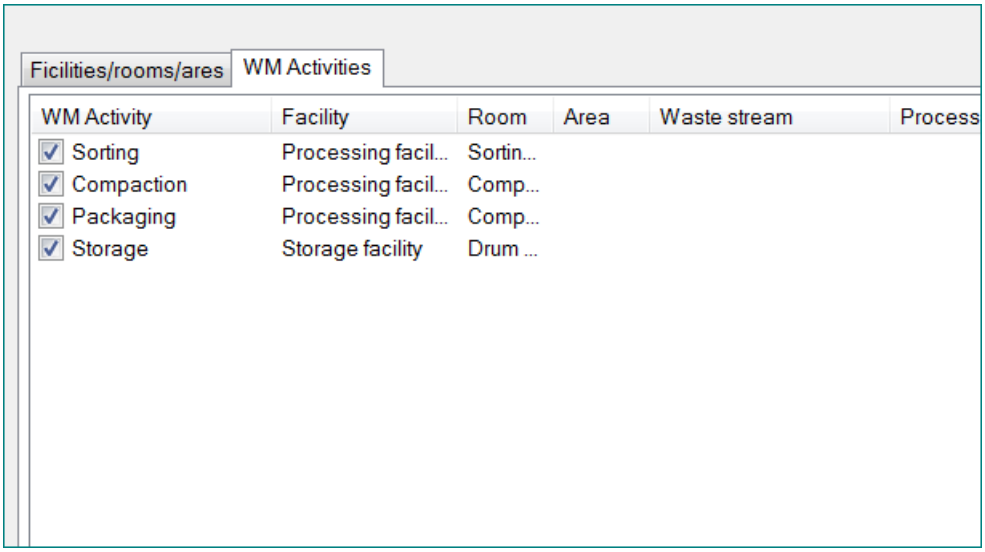


Right-click on the "Safety assessment 1/Scope" and select "Define scope".



Verify that all facilities, rooms and waste management activities are selected as shown in the pictures:



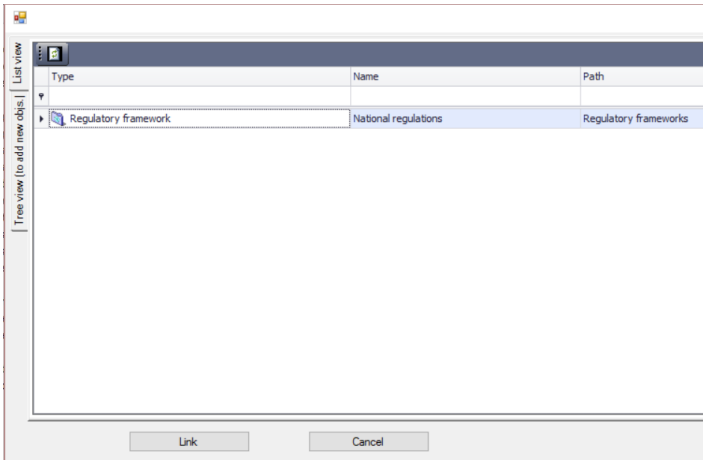


Click “OK”.

Link to the regulatory framework

Select the “Safety assessment 1” node and click “**Link Regulatory framework**” in the “**Actions**” window (or select this command from context menu).

In the window that appears, select “*National regulations*” and click the “**Link**” button.



Assessment for normal operations

Assessment of dose to worker from inhalation and external exposure.

For assessment for normal operations, it is assumed that same worker is involved in all waste management activities (Sorting, Compaction, Packaging, Storage) and spends the following time for each activity:

Table 6

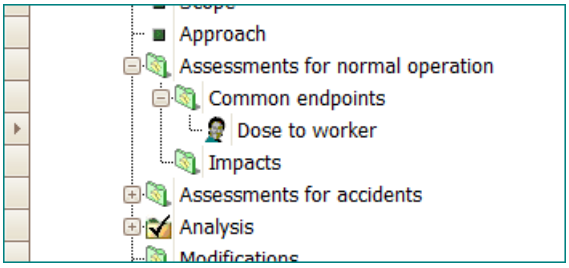
Activity	Working time (hours/year)
Sorting	300
Compaction	200
Packaging	300
Storage	50

Assessment will use data about concentration in air and dose rate entered during Tutorial 2 according to Table 2 of Tutorial 2.

Select the "*Assessment for normal operations/Common endpoints*" node and select "Add endpoint" command.

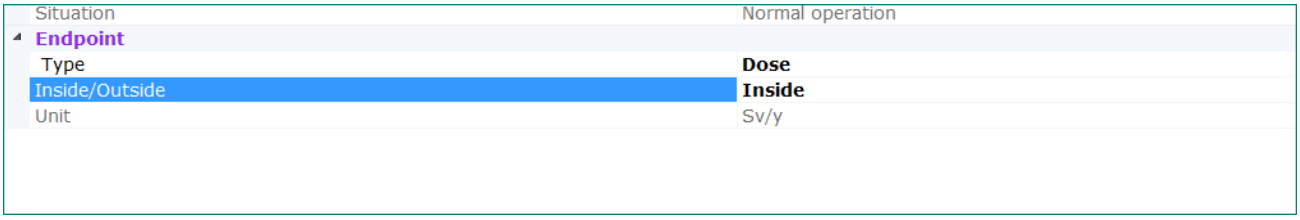
Add the "*Dose to worker*" endpoint.

The message box will appear to remain you that you need to define property "Inside/Outside" for the endpoint.



Set the properties of the endpoint:

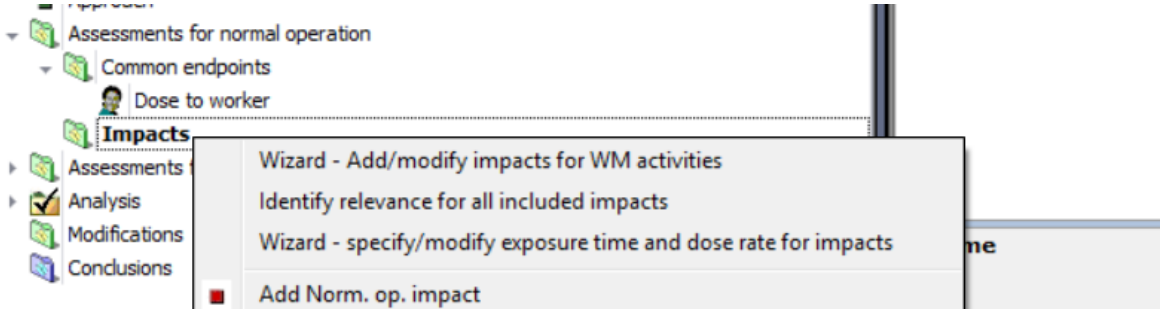
- Type – *Dose*
- Inside/Outside – *Inside*



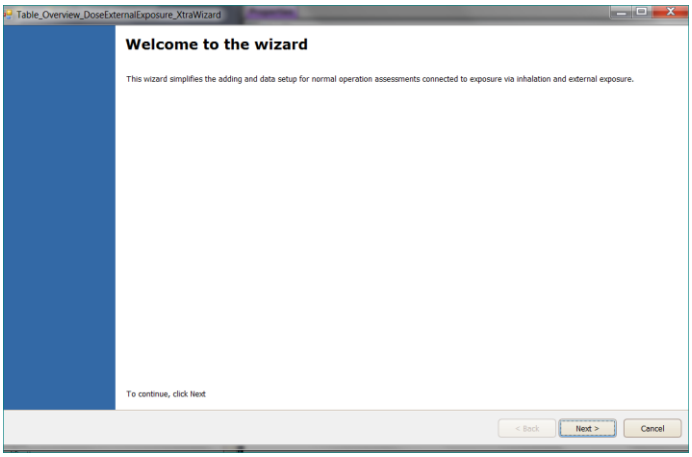
Select the "*Dose to worker*" node and click "**Link criterion**" in the "**Actions**" window.

In the window that appears - select "*Dose limit to worker*" for Normal operation and click the "**Link selected object**" button.

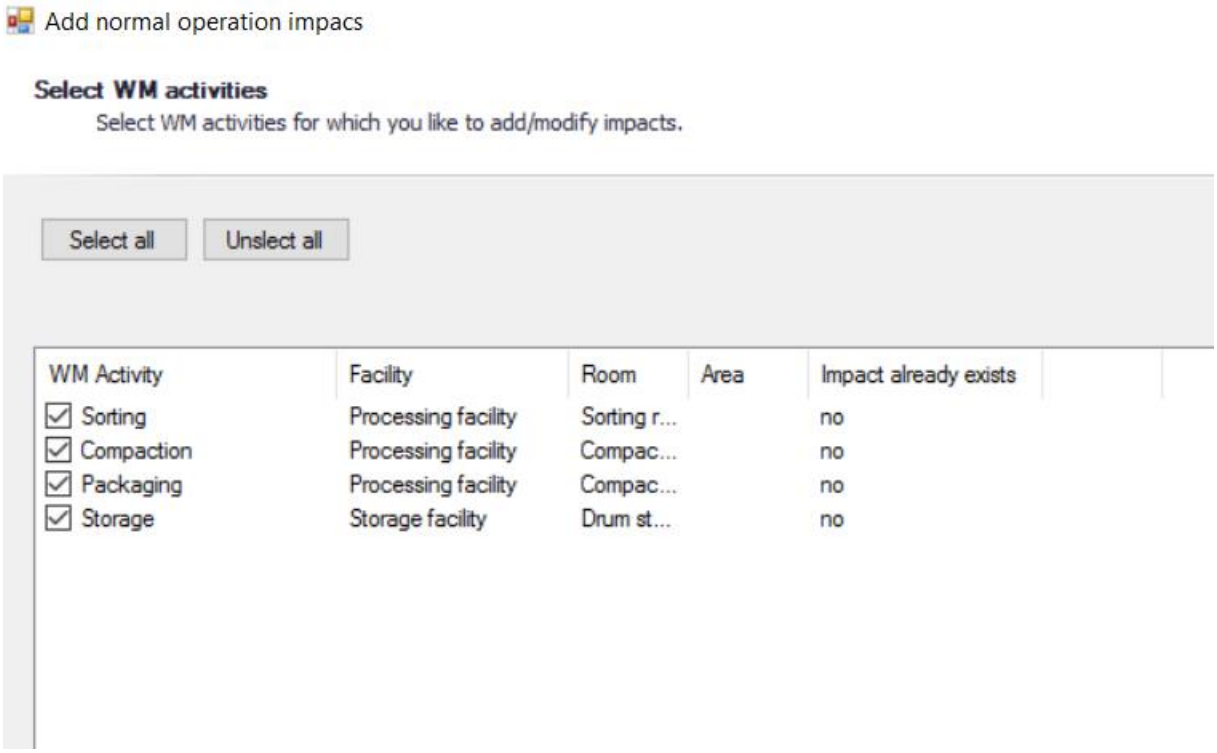
Select the "*Assessment for normal operation/Impacts*" node and select command "Wizard – Add/modify impacts for WM activities".



The wizard will be started.



Click "Next"



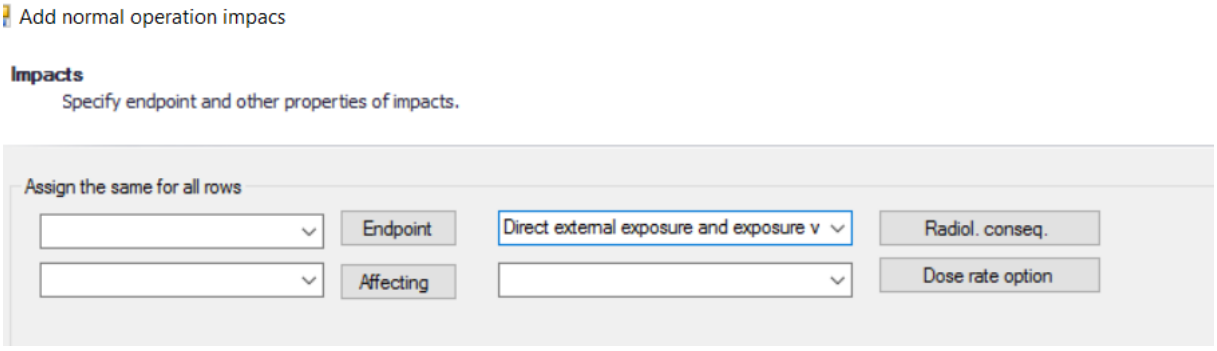
The page with list of all activities will appear. With this page, you can select activities for which you want to make assessment. In your case, you will use default setting when all activities are selected.

Click Next.

Next page allow you to select endpoint, radiological consequences and other options used for assessment for each activity.

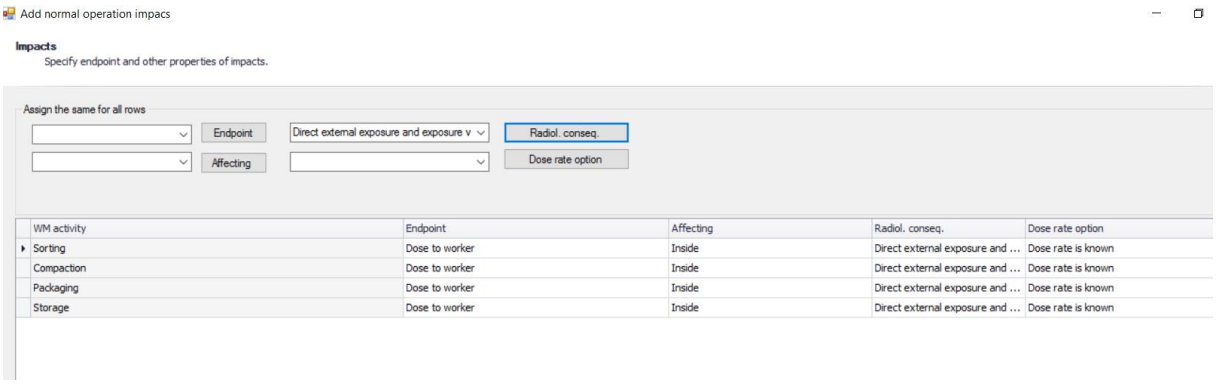
The default radiological consequences for impacts (“Direct external exposure”) need to be changed to the “Direct external exposure and exposure via inhalation”. It is possible to do in each row of the table, but there is also the possibility to change this parameter for all rows simultaneously.

Select “Direct external exposure and exposure via inhalation” in the list located near the button “Radiol. conseq.”



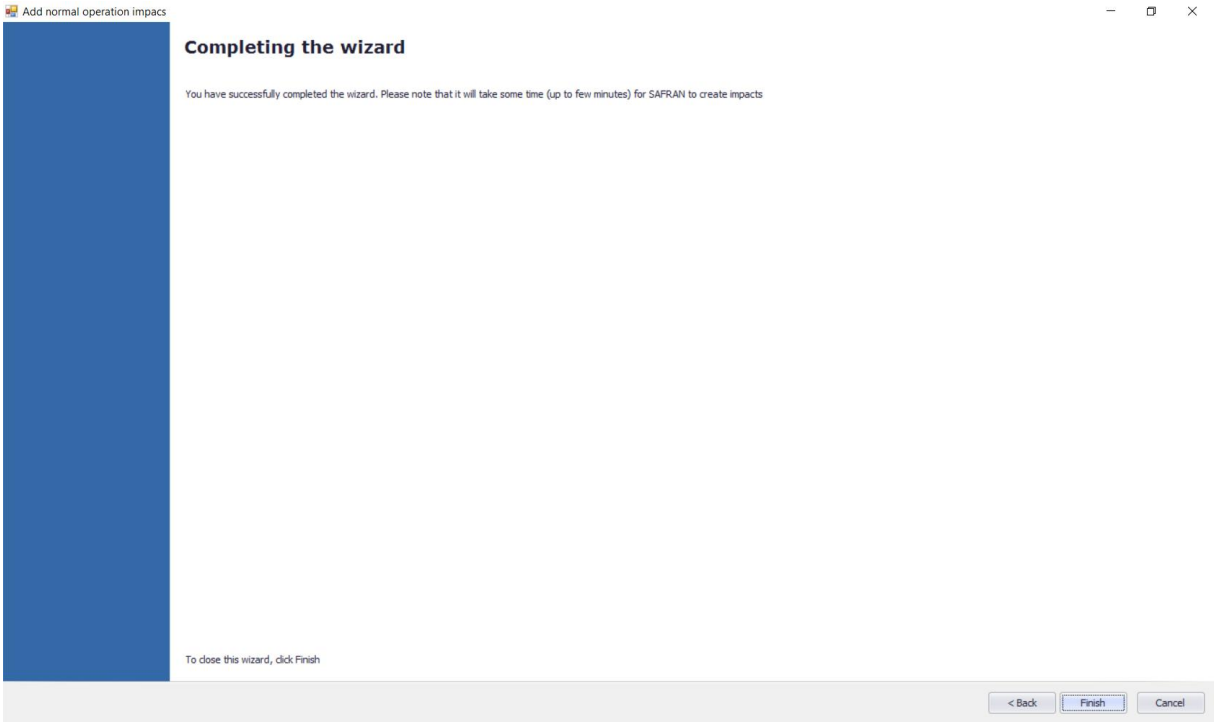
Click on the button “Radiol. conseq”.

Values in the column “Radiol. conseq.” in the table will be modified:



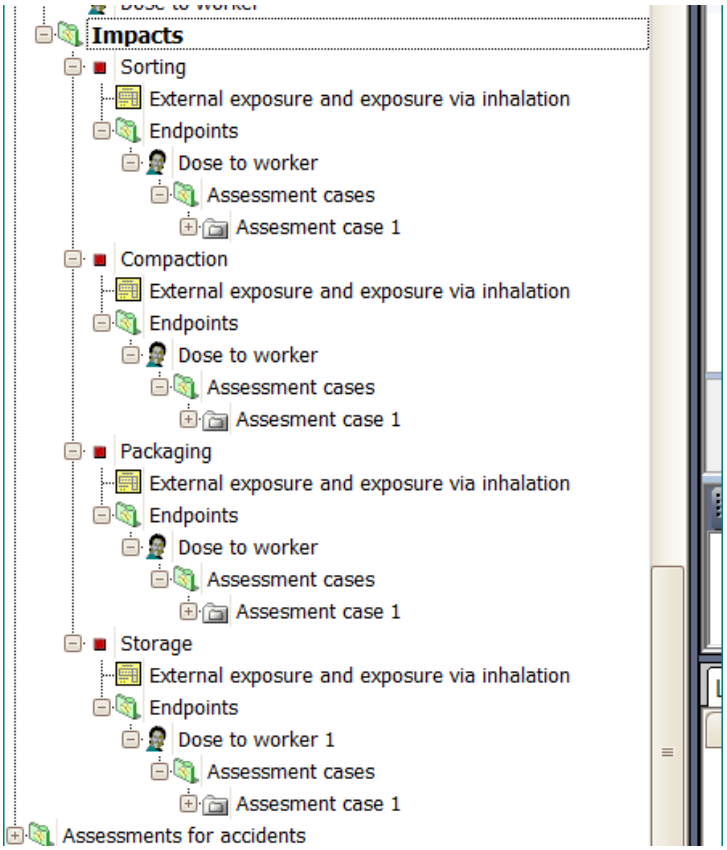
Click Next.

The last page of wizard will appear.

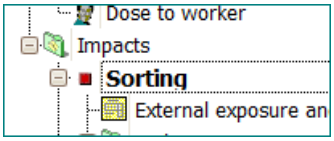


Click “Finish” button. You might need to wait a bit until impacts will be created.

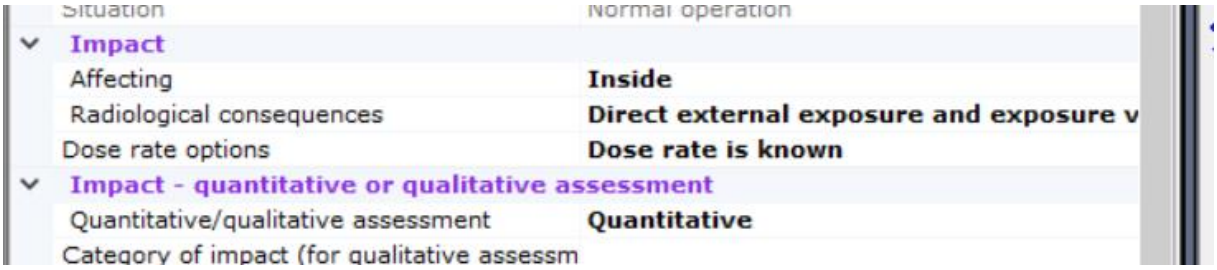
When wizard will finish to create impacts, you will see that 4 impacts are added to Impacts folder.



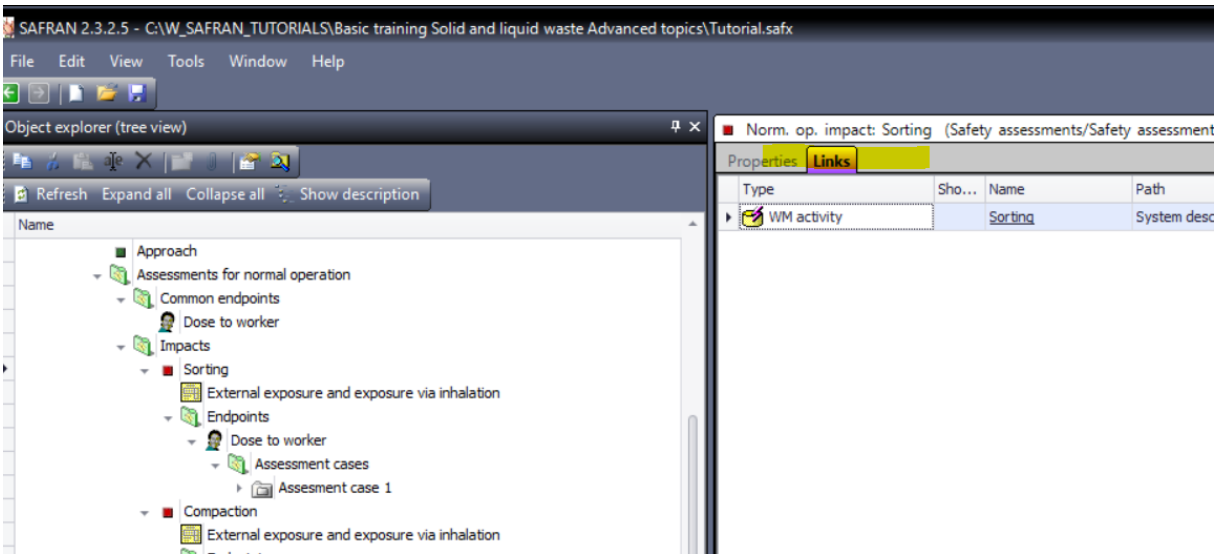
Select impact “Sorting”.



Observe the properties of this impact.



and link established between impact and waste management activity “Sorting”.



Double-click on the node “External exposure and exposure via inhalation” located under “Sorting”.

The following screening table will be shown:

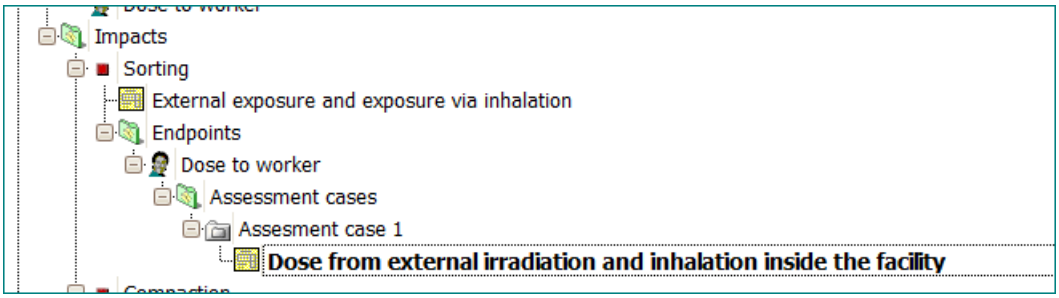
Nuclide	Conc. in air (Bq/...	Inh. dose rate (Sv/h)	Ext dose rate ...	Total dose rat...	Screening dos...	Hazard Quotient...
Co-60	2.80E-002	4.54E-010				
Cs-137	1.70E-002	1.92E-010				
			6.00E-007			
Total		6.47E-010	6.00E-007	6.01E-007	5.00E-008	1.20E+001

Red colour for value in Hazard Quotient shows that detailed dose assessment is required.

Note: If you have another values in the table or if some values are absent, you need to verify that values for release to air and external dose rate were correctly entered for “Sorting room” of “Processing facility” during Tutorial 2.

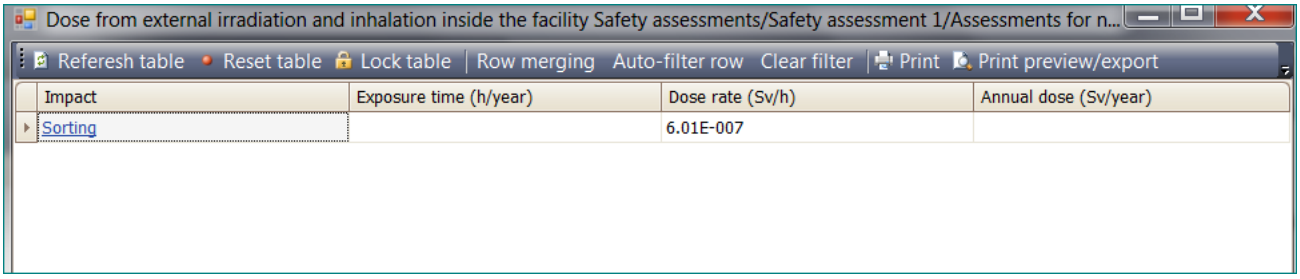
Close the table.

Expand node “Assessment case 1” of “Sorting” impact.



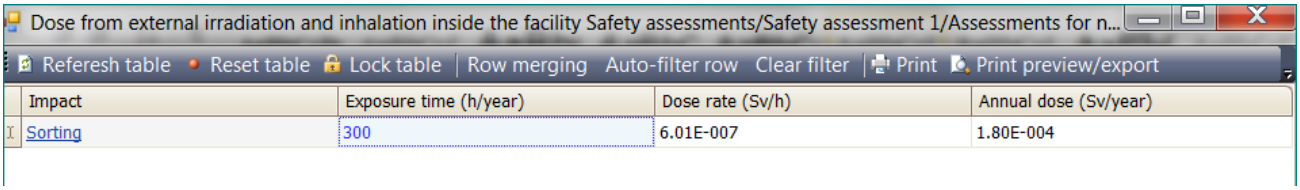
Double-click on “Dose from external irradiation and inhalation inside the facility”.

The table for dose assessment will appear:



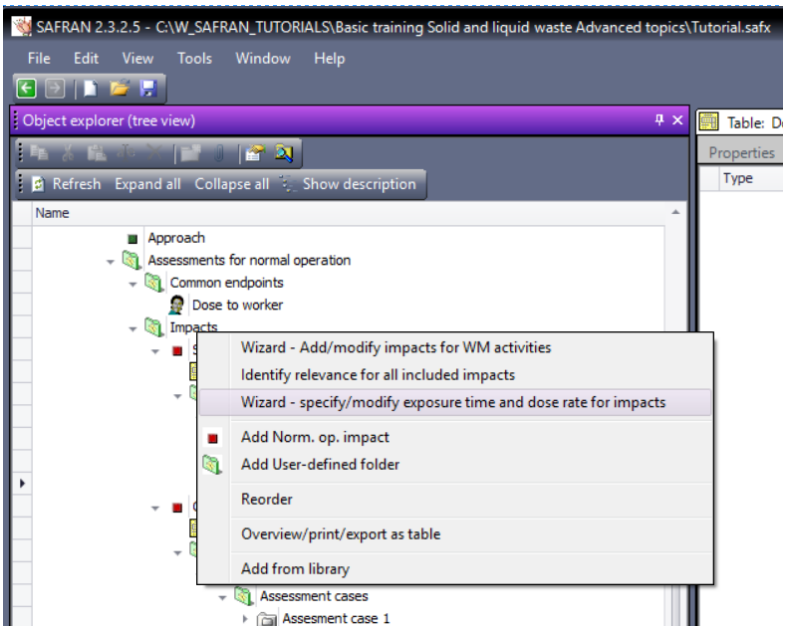
Enter 300 in the column “Exposure time (h/year)” according to Table 6 data.

The annual dose will be calculated:



Assessment of dose from external irradiation and inhalation due to participation in other waste management activities

Click on the node “Impacts” and select command “Wizard – specify/modify exposure time and dose rate for impacts”



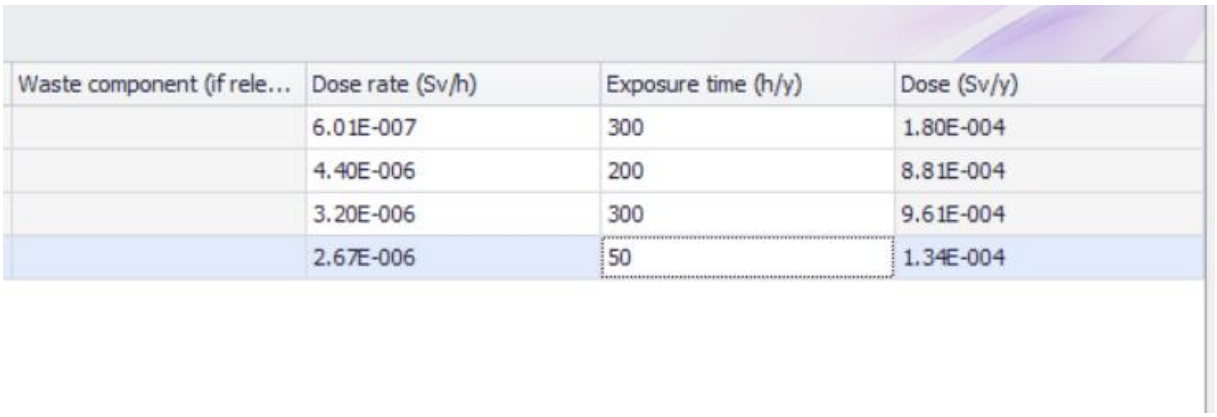
The wizard will appear. Click “Next”

On the second page of the wizard you will see the table showing impacts , dose rates and exposure times.

Impact	Impact's properties	Impact is linked to	Endpoint	Assessment case	Waste component (if rele…	Dose rate (Sv/h)	Exposure time (h/y)	Dose (Sv/y)
Sorting	Inside Direct external exp…	Sorting	Dose to worker	Assesment case 1		6.01E-007	300	1.80E-004
Compaction	Inside Direct external exp…	Compaction	Dose to worker	Assesment case 1		4.40E-006		
Packaging	Inside Direct external exp…	Packaging	Dose to worker	Assesment case 1		3.20E-006		
Storage	Inside Direct external exp…	Storage	Dose to worker	Assesment case 1		2.67E-006		

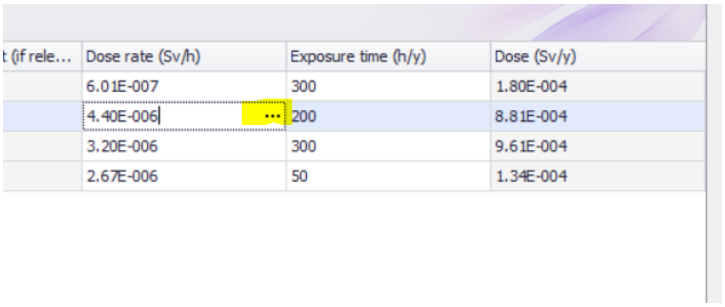
The dose rates for all activities are calculated based on the data provided during completion of Tutorials 3. If some dose rate data in your table are missing (or have different value), please check whether you enter all the data of Table 2 (Tutorial 3).

Provide the exposure time data for Compaction, Packaging and Storage according to Table 6 data.

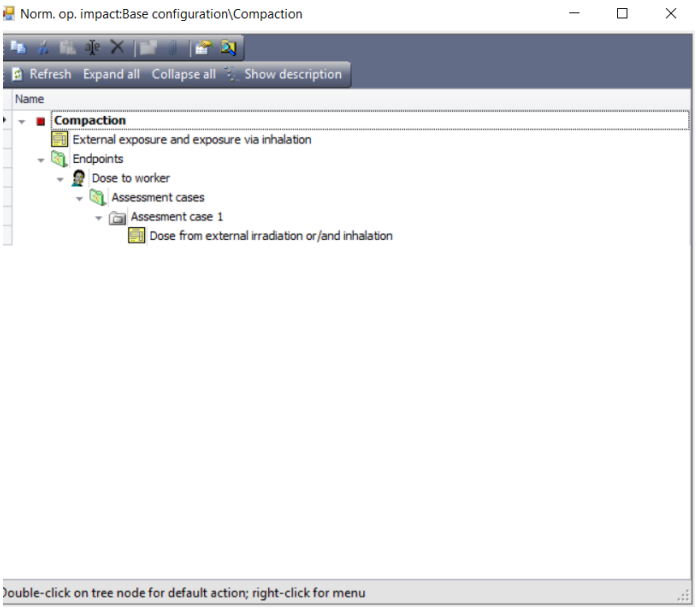


Waste component (if rele...	Dose rate (Sv/h)	Exposure time (h/y)	Dose (Sv/y)
	6.01E-007	300	1.80E-004
	4.40E-006	200	8.81E-004
	3.20E-006	300	9.61E-004
	2.67E-006	50	1.34E-004

To see details about dose rate calculations – select any cell in the column “Dose rate (Sv/h)” and click on the button “…”



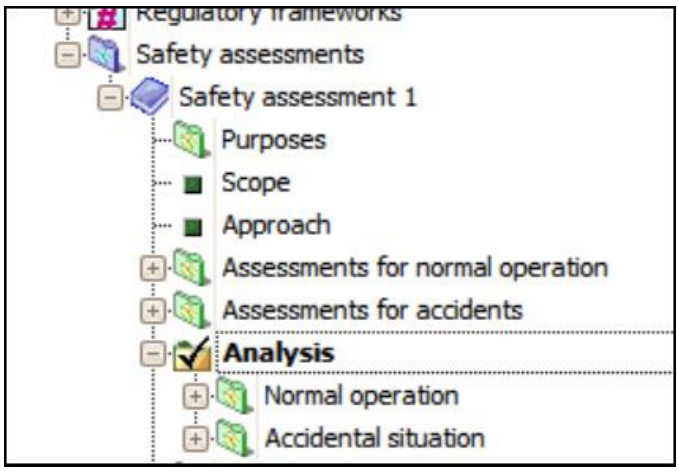
t (if rele...	Dose rate (Sv/h)	Exposure time (h/y)	Dose (Sv/y)
	6.01E-007	300	1.80E-004
	4.40E-006 ...	200	8.81E-004
	3.20E-006	300	9.61E-004
	2.67E-006	50	1.34E-004



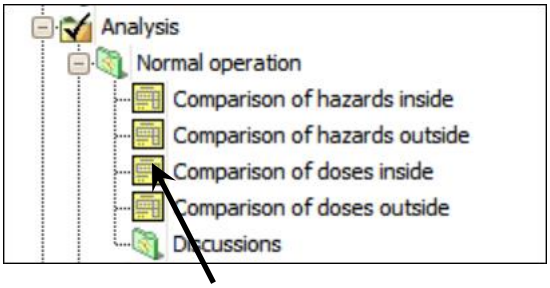
The browser window will appear. This window contains all the calculation tables relevant to impact (as was shown for for impact Sorting a bit earlier in this tutorial).

Analysis

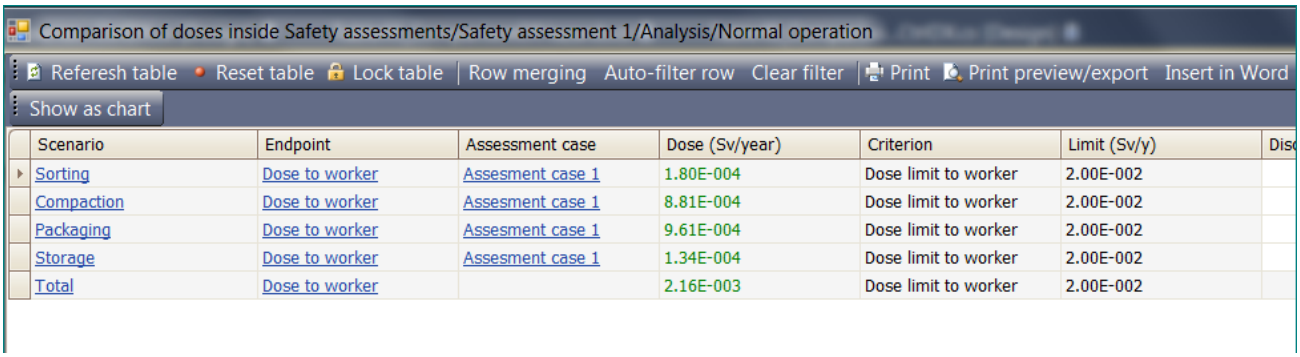
Expand the "*Safety assessment 1/Analysis*" node:



Double-click on the "*Analysis/Normal operation/Comparison of doses inside*":

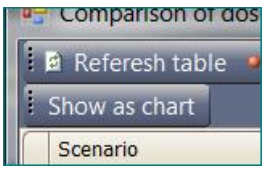


The following table will appear:

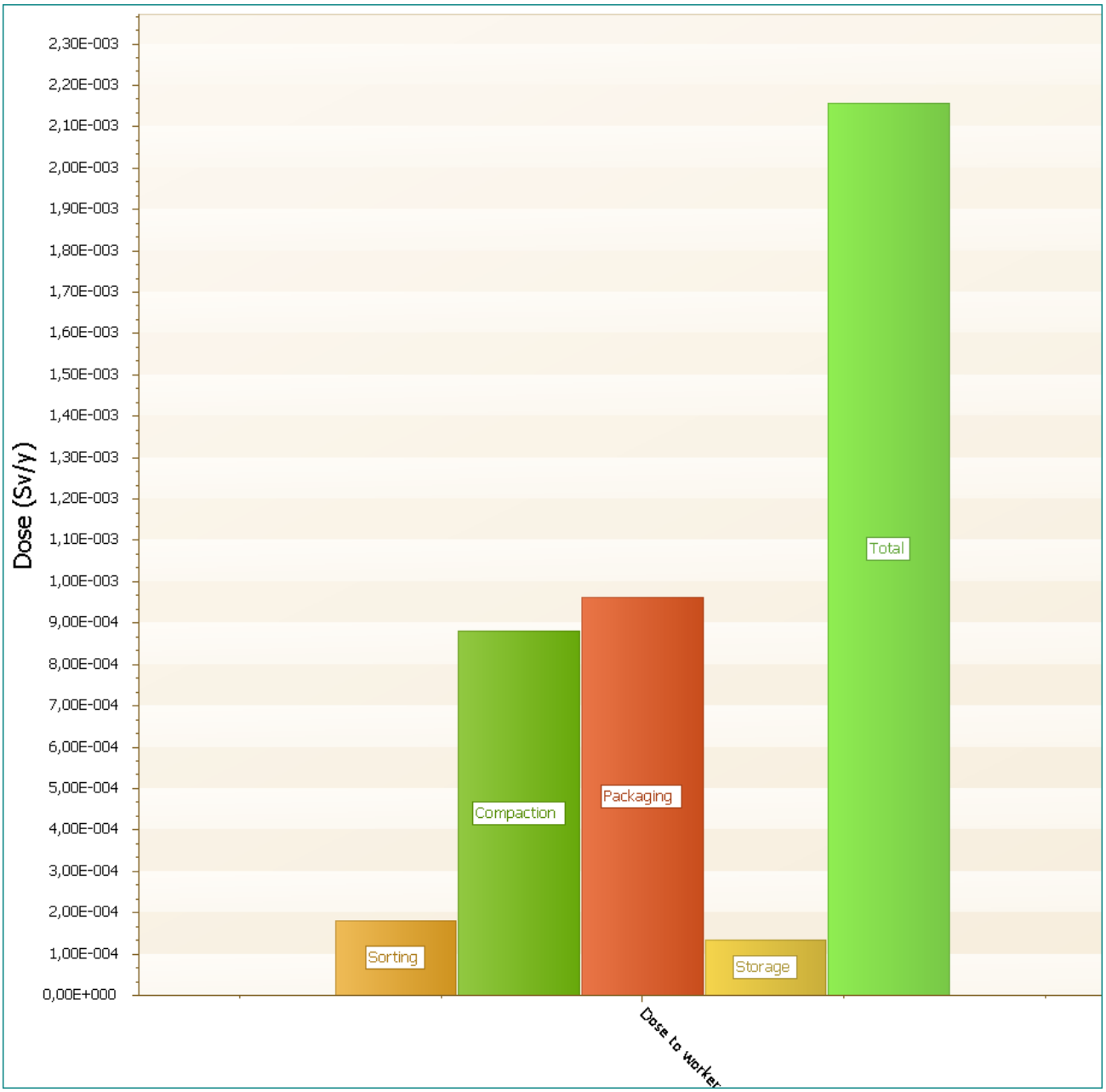


Scenario	Endpoint	Assessment case	Dose (Sv/year)	Criterion	Limit (Sv/y)	Disc
Sorting	Dose to worker	Assesment case 1	1.80E-004	Dose limit to worker	2.00E-002	
Compaction	Dose to worker	Assesment case 1	8.81E-004	Dose limit to worker	2.00E-002	
Packaging	Dose to worker	Assesment case 1	9.61E-004	Dose limit to worker	2.00E-002	
Storage	Dose to worker	Assesment case 1	1.34E-004	Dose limit to worker	2.00E-002	
Total	Dose to worker		2.16E-003	Dose limit to worker	2.00E-002	

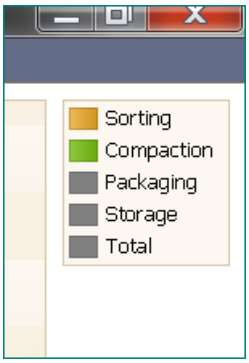
Click the "**Show as chart**" button located on the toolbar.

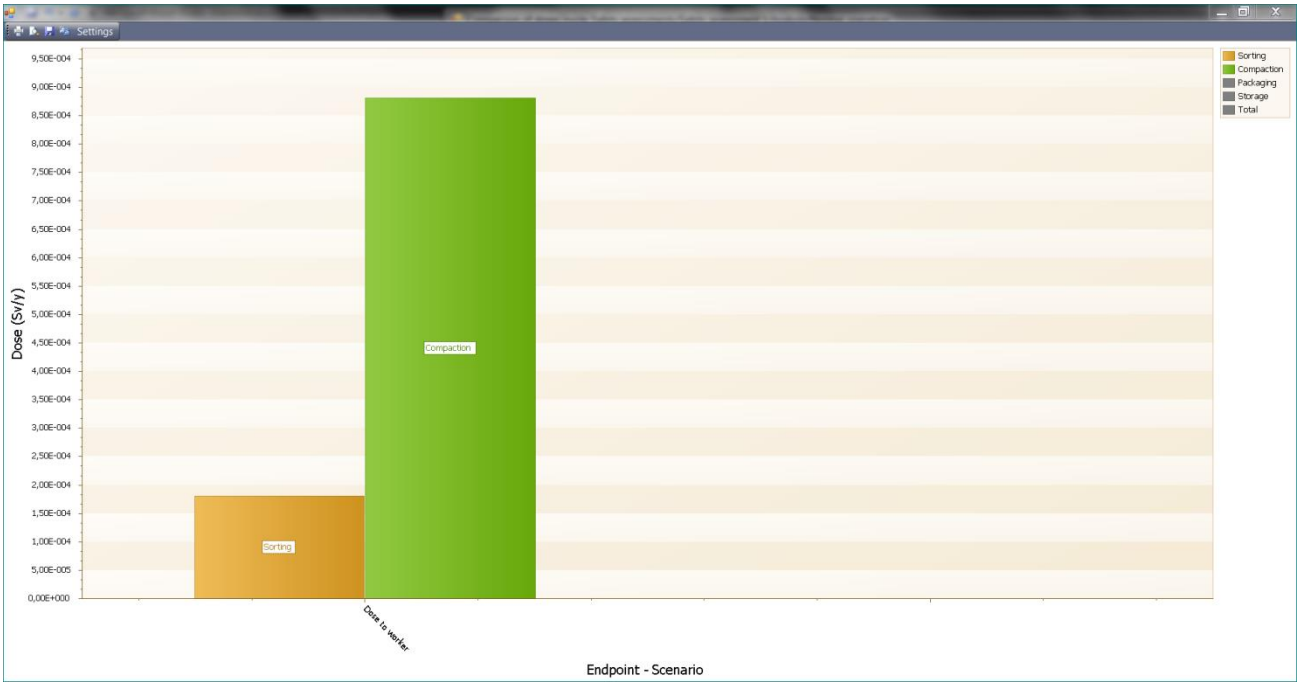


The window will appear showing the same data as chart:


Dose (Sv/y)
2,30E-003
2,20E-003
2,10E-003
2,00E-003
1,90E-003
1,80E-003
1,70E-003
1,60E-003
1,50E-003
1,40E-003
1,30E-003
1,20E-003
1,10E-003
1,00E-003
9,00E-004
8,00E-004
7,00E-004
6,00E-004
5,00E-004
4,00E-004
3,00E-004
2,00E-004
1,00E-004
0,00E+000
Sorting
Compaction
Packaging
Storage
Total

Double-click on the small rectangles shown in the legend to include/exclude a particular result from the chart:

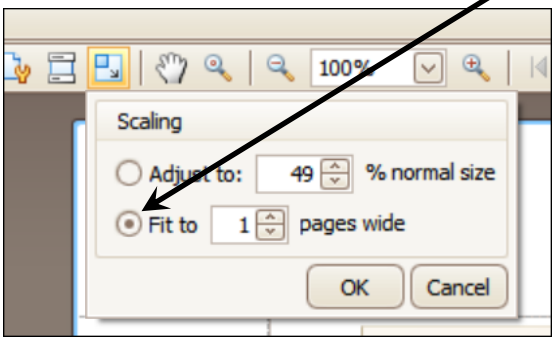




Click on the "**Print preview**" button.

The "**Preview**" window will appear.

Click the "Scale" button and select "**Fit to 1 page wide**".



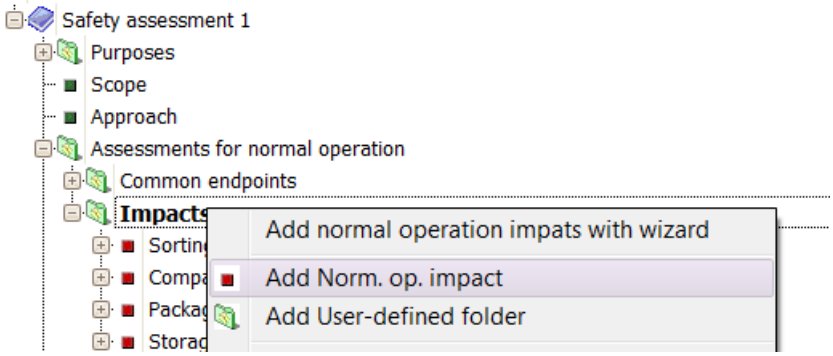
Click Ok.

Click the "**Export document**" button and export the chart as PDF file.

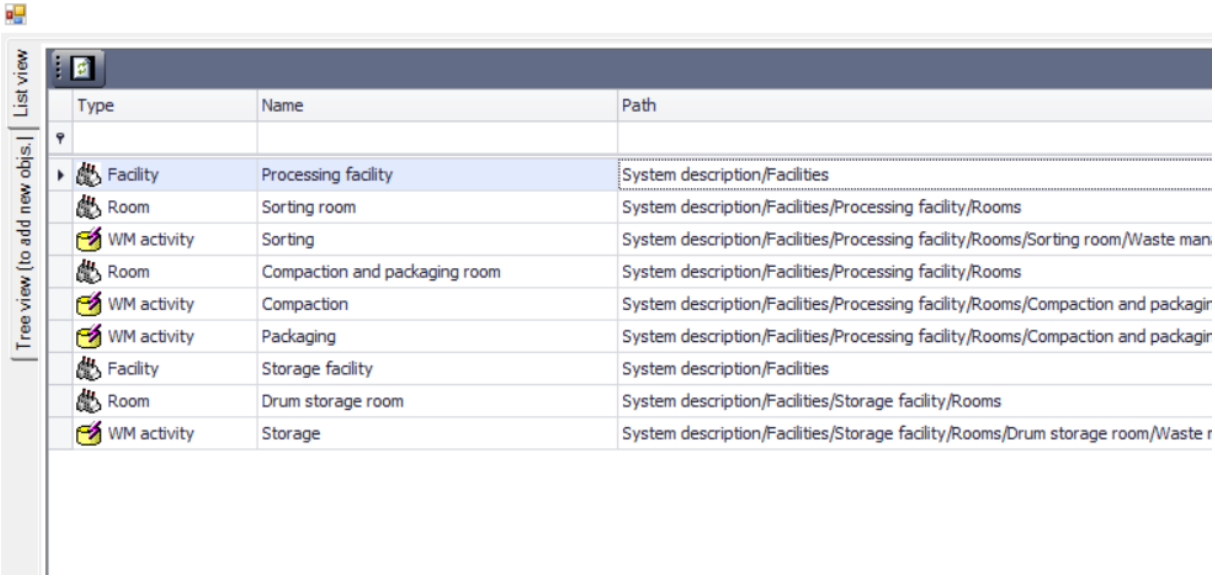
Assessing dose to public due to the normal release from processing facility

Advanced exercise

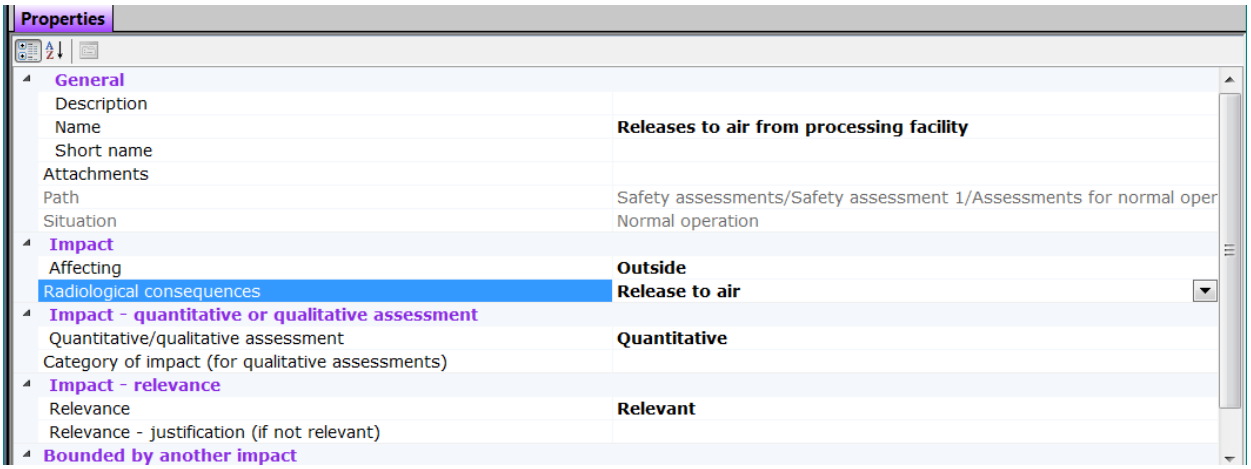
Right-click on the folder "Safety assessment 1/Assessment for normal operation/Impacts" and select command "Add Norm. op. impact".



Give the impact name "*Releases to air from processing facility*". You will be asked if you like to link impact to facility, room, area or activity. Answer "Yes" and link impact to Processing facility via the dialog which will appear.

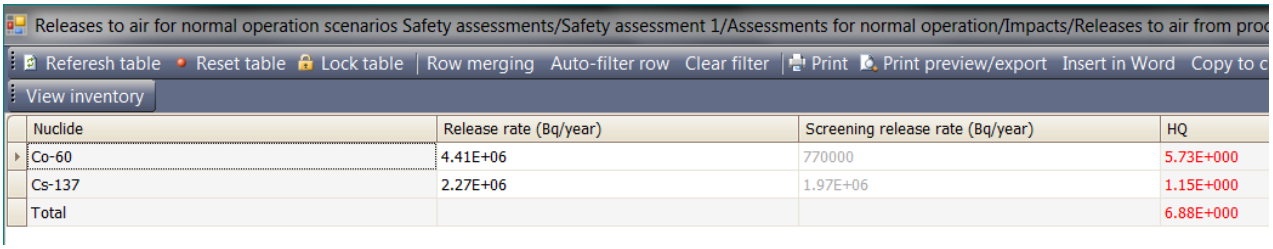


Set the properties of the impact as shown in the picture:



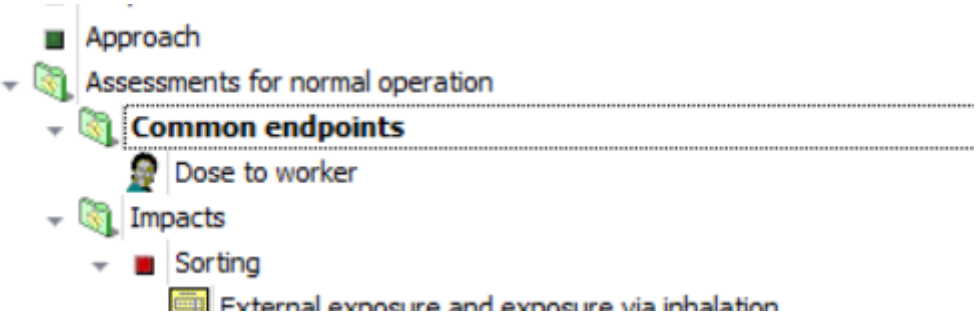
Expand impact node and double-click on the "*Releases to air for normal operation scenarios*":

The following table will be shown:

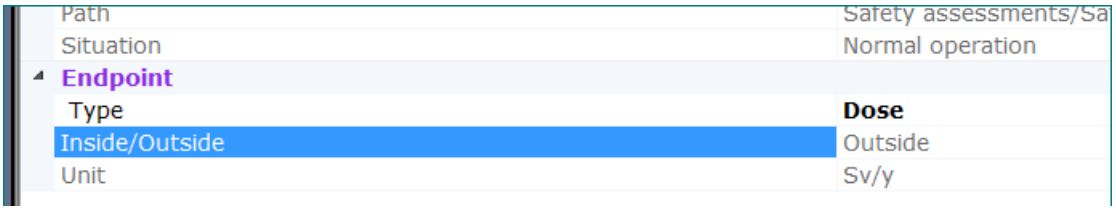


Close the table.

Navigate to the "Assessment for normal operation/Common endpoints".

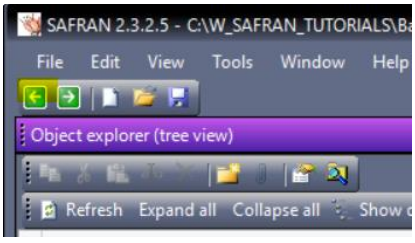


Add new endpoint "Dose to public" with property "Outside".

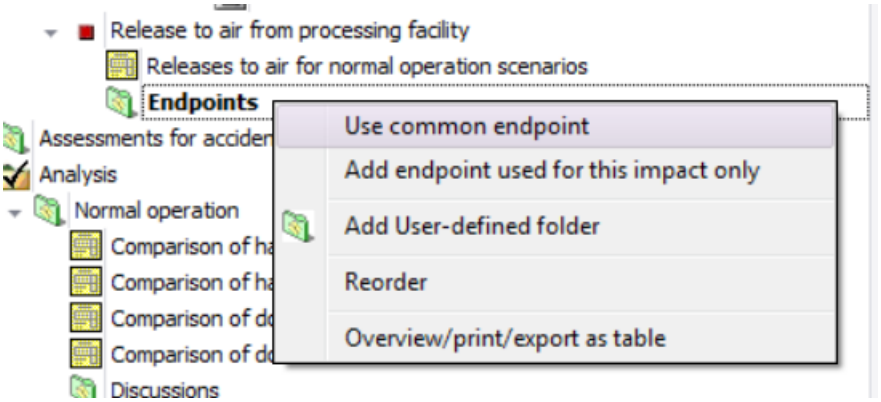


Link this endpoint to criterion “Dose limit to public” (for Normal operation).

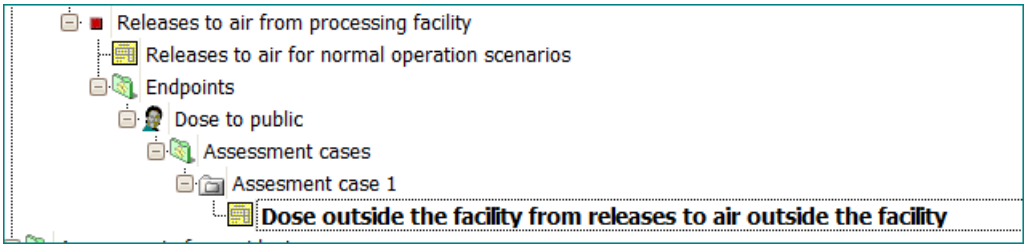
Navigate back to the impact “Releases to air …” (using browser or “Back” button)



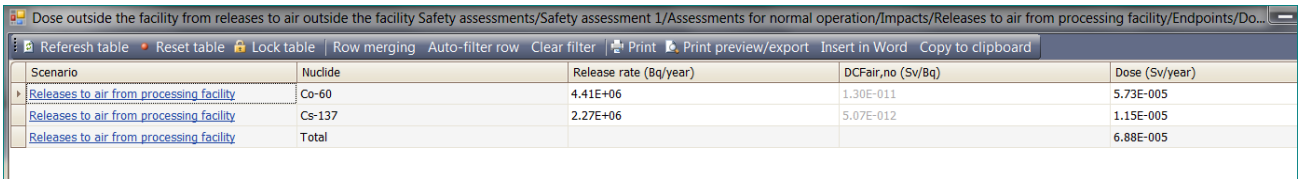
Right-click on Endpoints, select command “Use common endpoint” from the menu and select “Dose to public”.



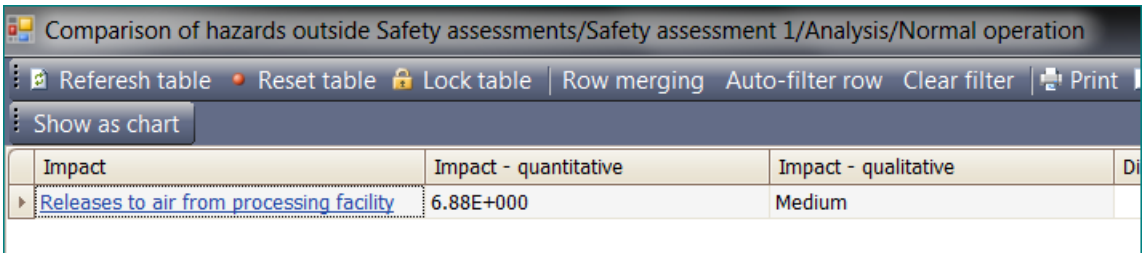
Expand the assessment case created for endpoint and double-click on the “Dose outside the facility from releases to air outside the facility”.

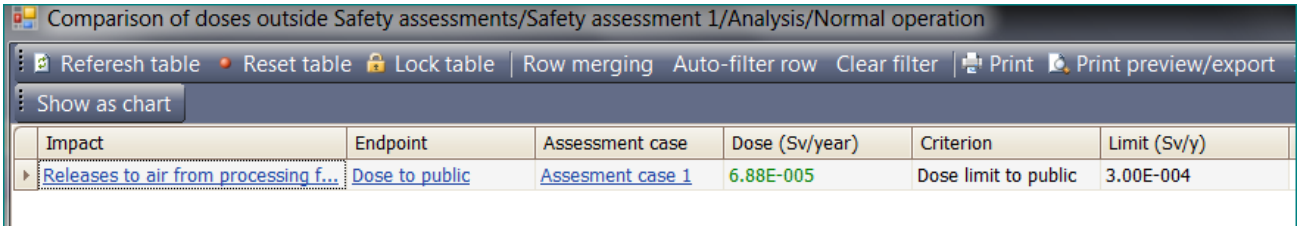


The following table will be shown:



Open the tables “Comparison of hazards outside” and “Comparison of the doses outside” in the Analysis section (in this case they will contain only one impact):



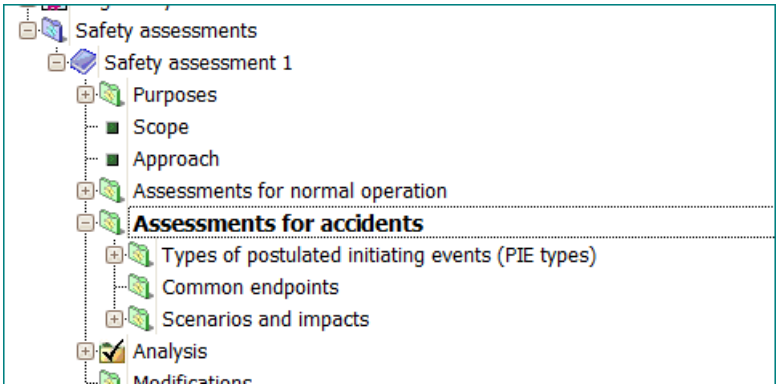


End of advanced exercise

Assessment for accidental situation

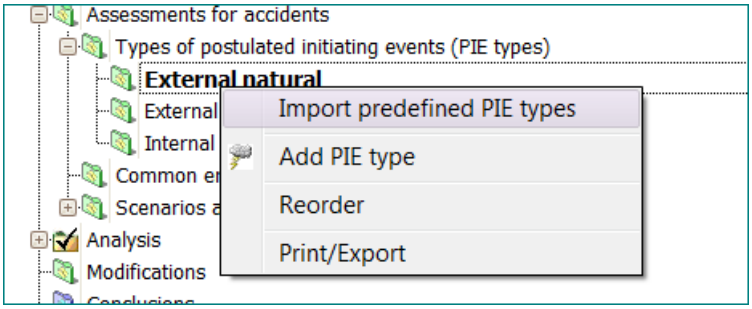
PIE types. Excluding not relevant PIE types.

Expand folder “Assessment for accidents” located in Safety assessment 1.

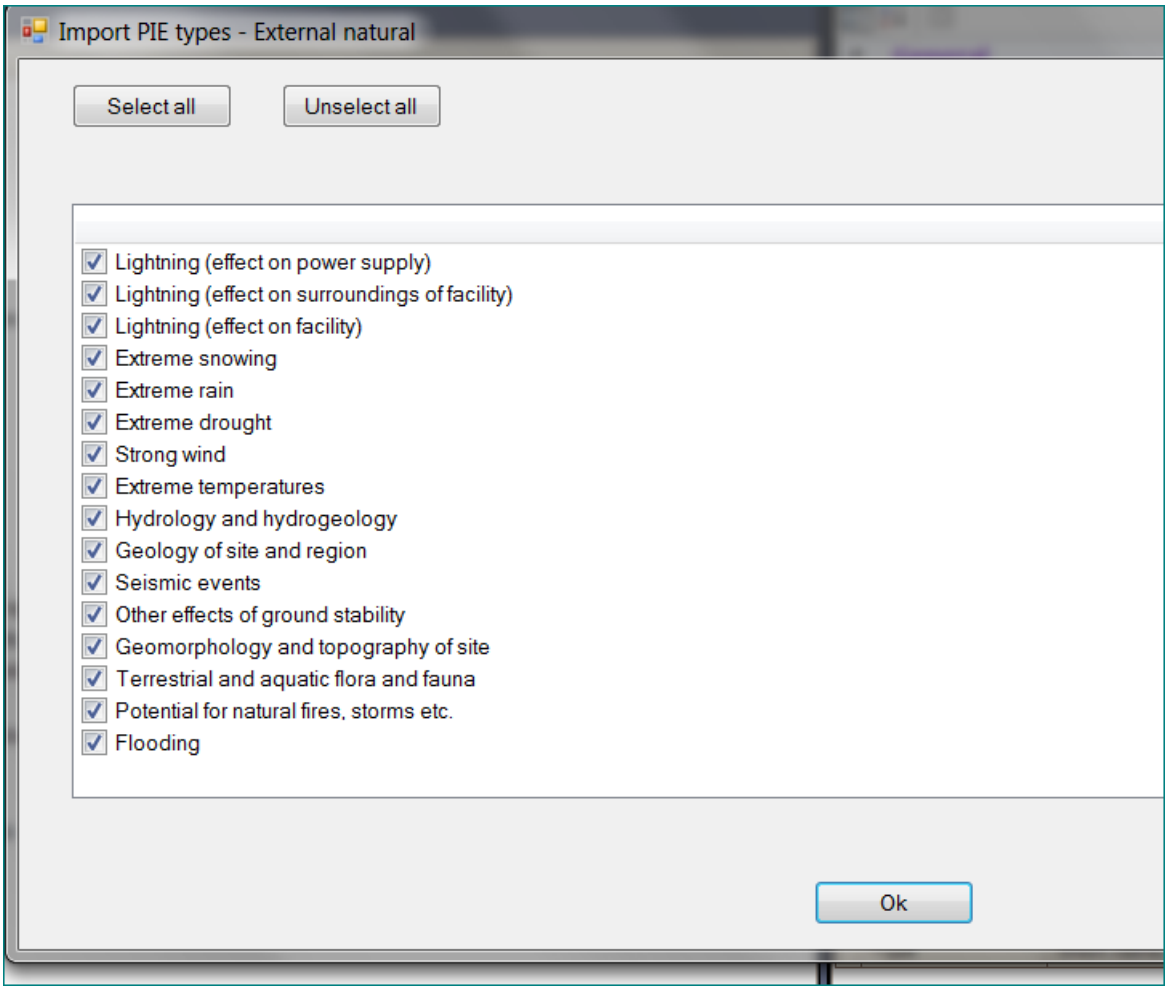


Expand folder “Types of postulated events (PIE types)”.

Right-click on the “External natural” and select “Import predefined PIE types”.

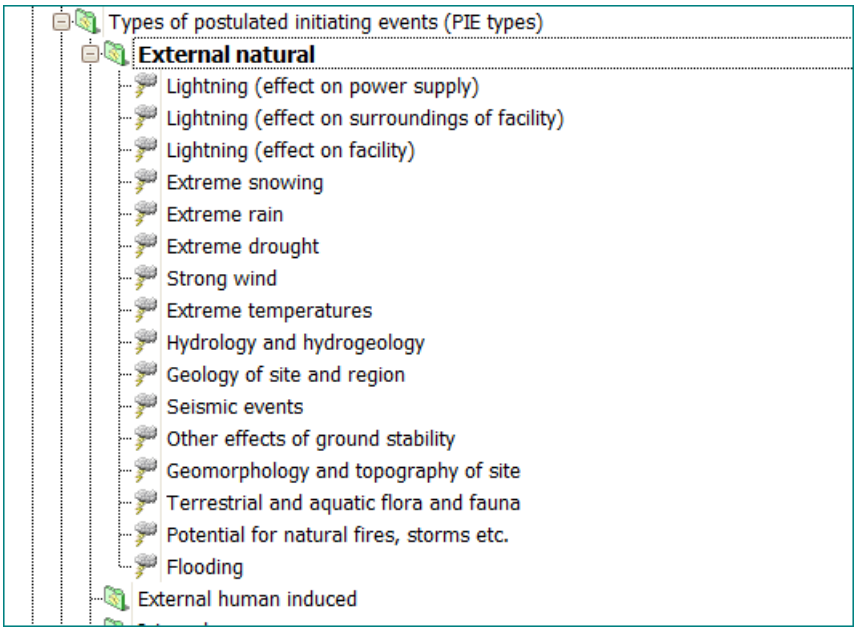


The window showing PIE types (types of postulated initiating events) predefined in SAFRAN will appear.

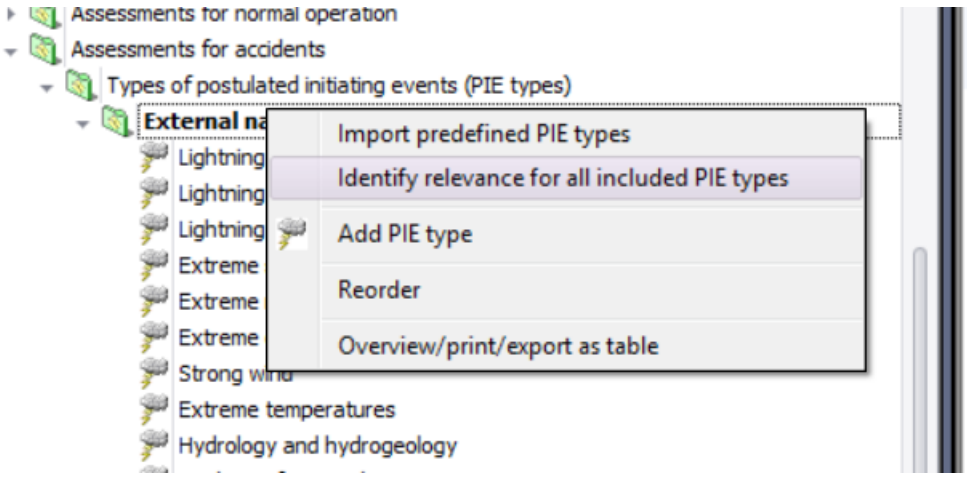


Click OK.

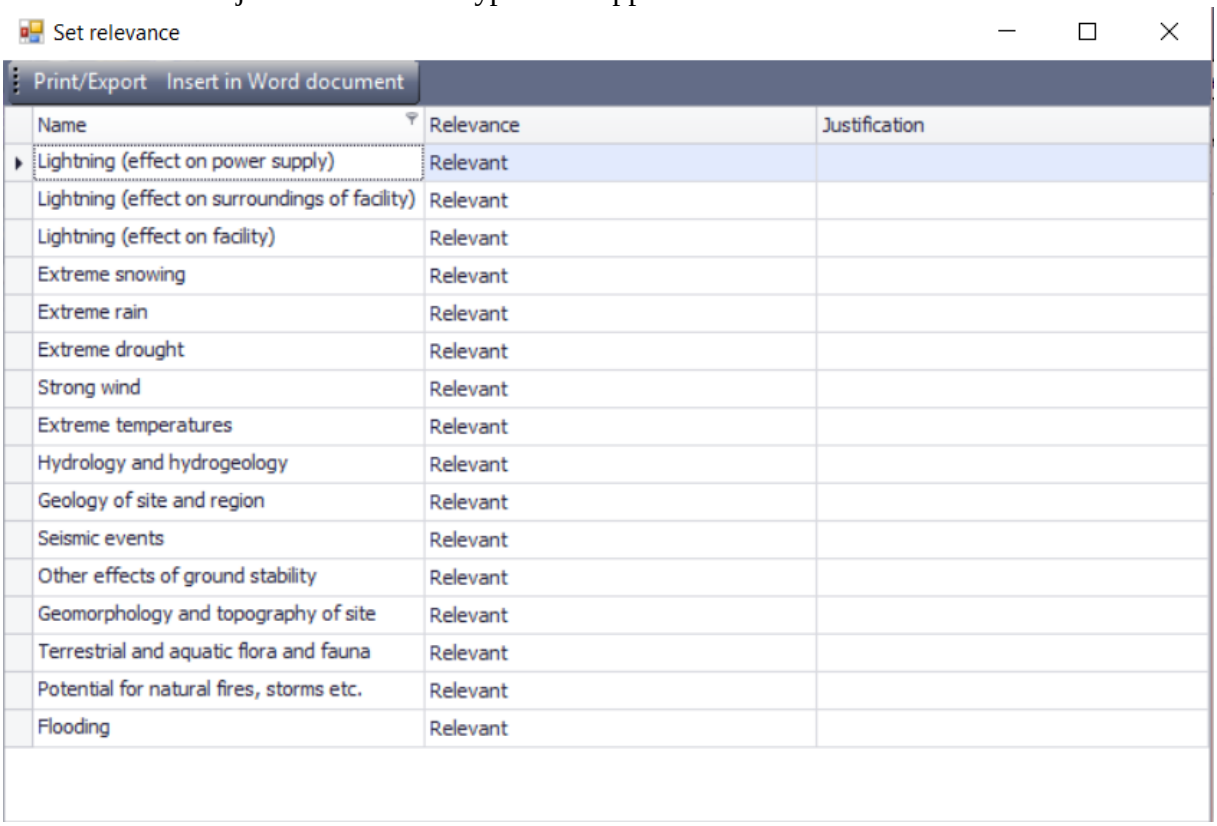
PIE types will be included in project.



Right-click on the ”External natural” and select command ”Identify relevance for all included PIE types”

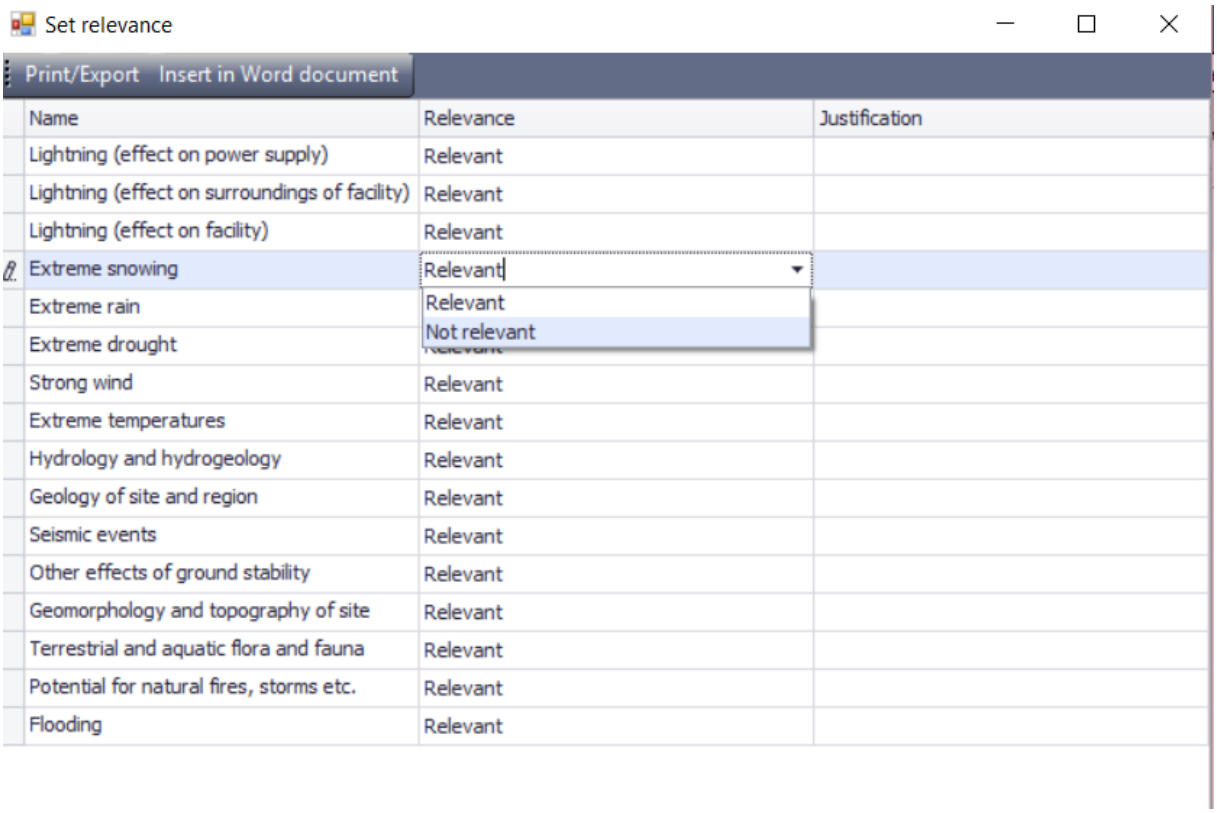


The table with all just included PIE types will appear.



Name	Relevance	Justification
Lightning (effect on power supply)	Relevant	
Lightning (effect on surroundings of facility)	Relevant	
Lightning (effect on facility)	Relevant	
Extreme snowing	Relevant	
Extreme rain	Relevant	
Extreme drought	Relevant	
Strong wind	Relevant	
Extreme temperatures	Relevant	
Hydrology and hydrogeology	Relevant	
Geology of site and region	Relevant	
Seismic events	Relevant	
Other effects of ground stability	Relevant	
Geomorphology and topography of site	Relevant	
Terrestrial and aquatic flora and fauna	Relevant	
Potential for natural fires, storms etc.	Relevant	
Flooding	Relevant	

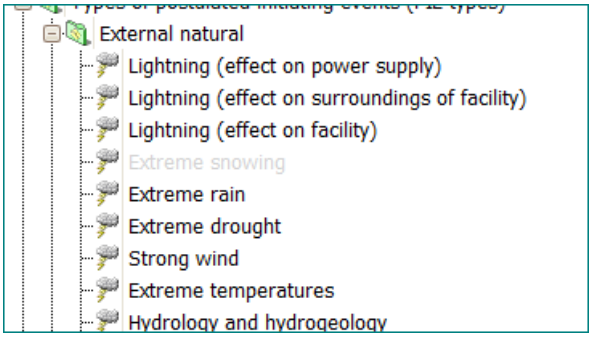
For “Extreme snowing” select “Not relevant”.



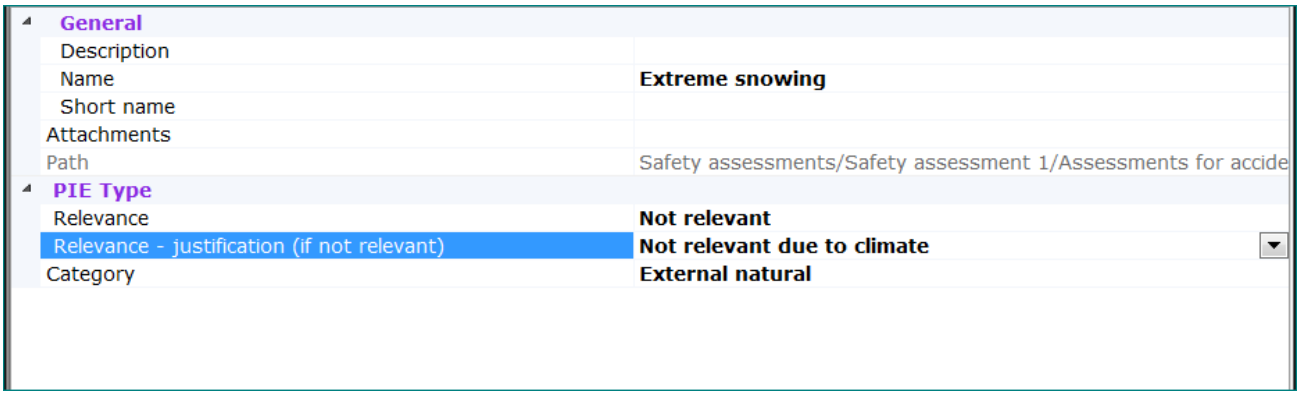
Provide the justification – "Not relevant due to the climate":

Close the table.

Note that node "Extreme snowing" was disabled.

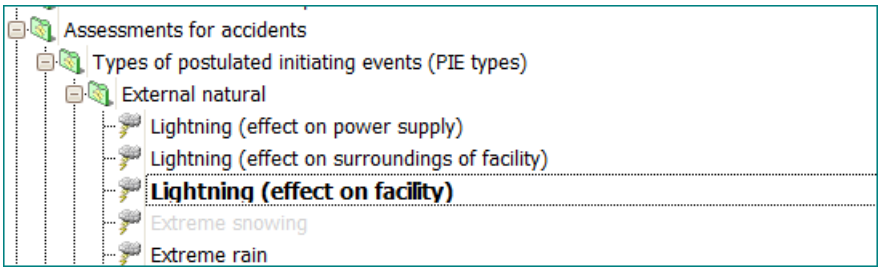


Select "Extreme snowing" node - note that in the window "Properties" the property "Relevance" was changed to "Not relevant" and your justification appears for property "Relevance – justification (if not relevant)".

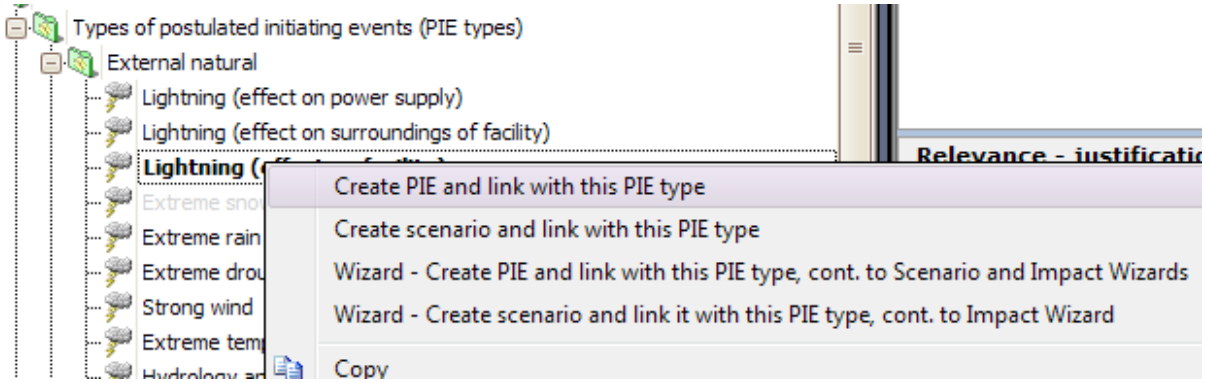


Scenario “Fire in the storage facility”

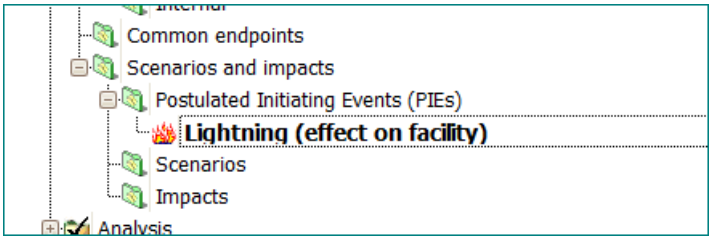
Select PIE type “Lightning (effect on facility)”.



Select in Actions window or in right-click context menu “Create PIE and link with this PIE type”.

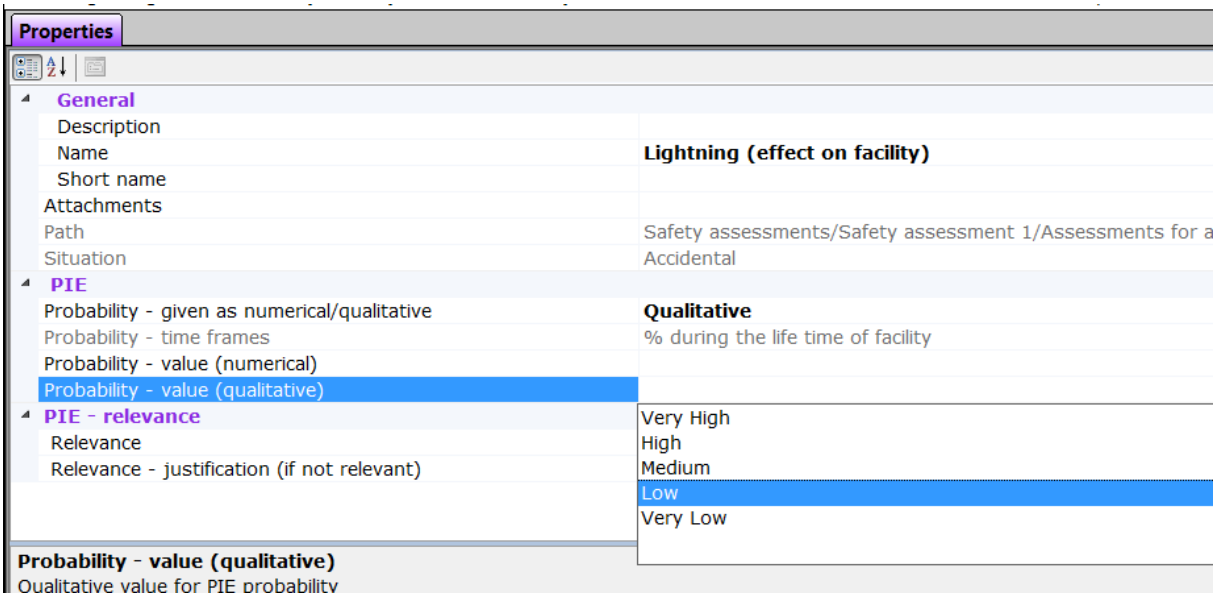


The new PIE (Postulated Initiating Event) with the same name will be added to the folder “Postulated Initiating Events (PIEs)” (under ”Scenarios and impacts”):

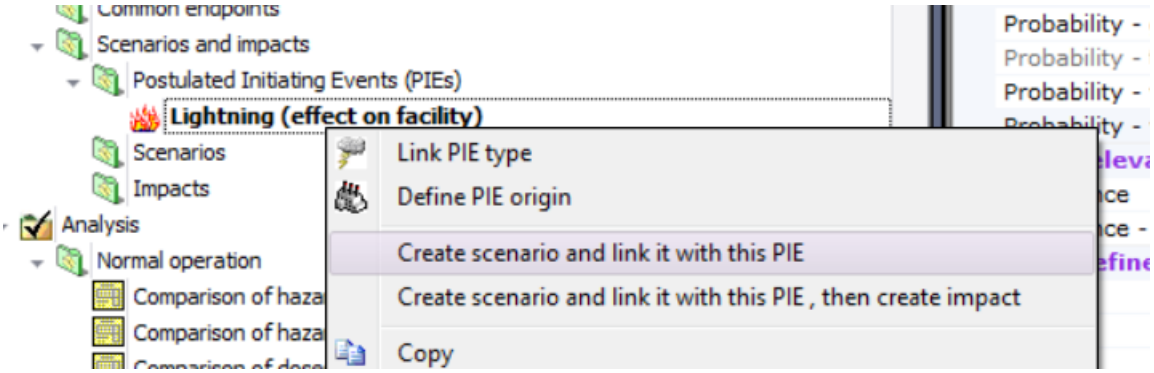


Note that PIE is already linked to the PIE type “Lightning (effect on facility)”.

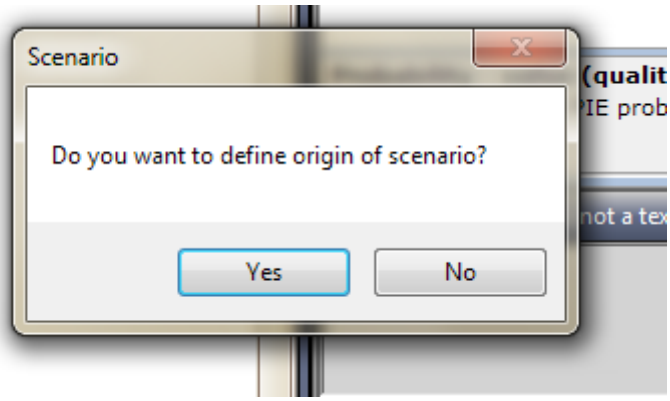
Specify (qualitatively) probability for this PIE as “Low”.



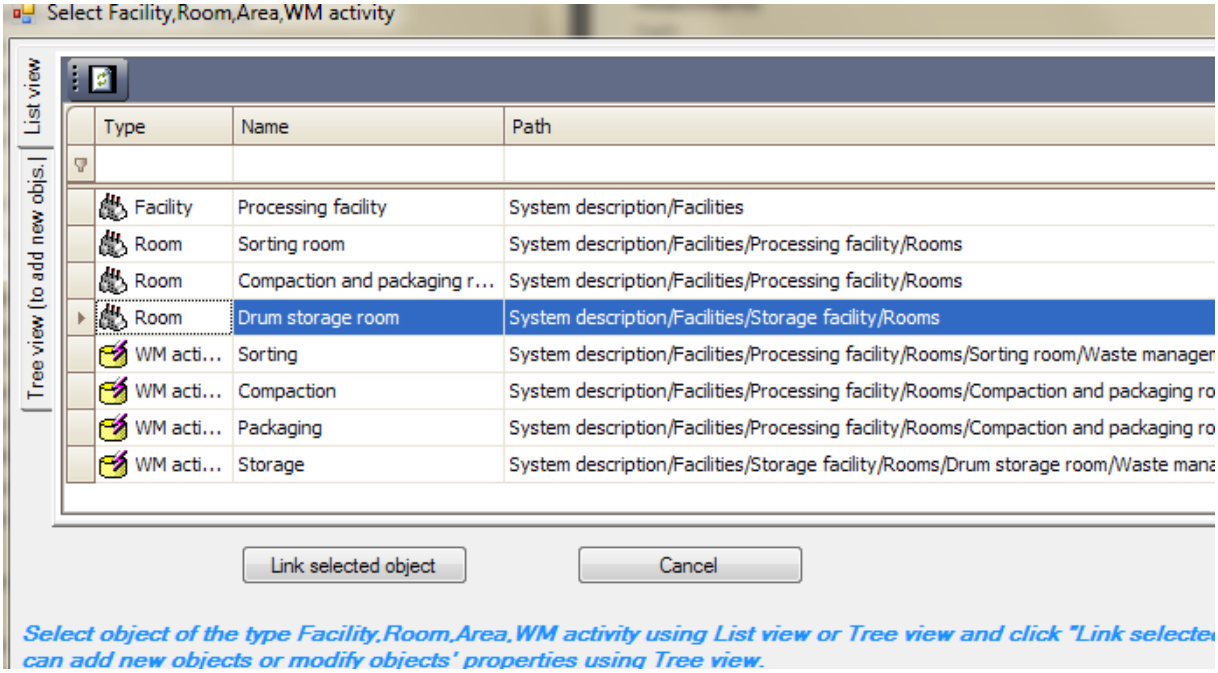
Select for this PIE “Create scenario and link it with this PIE”.



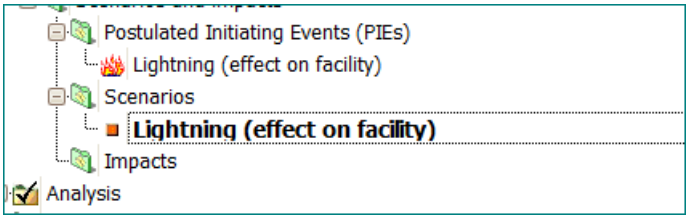
You will be asked whether you like to define origen of scenario.



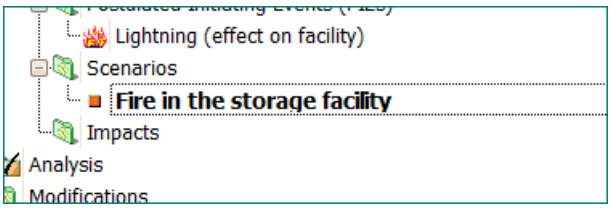
Answer “Yes” and select Drum storage room:



New scenario (linked with this PIE) will be added to folder “Scenarios”.



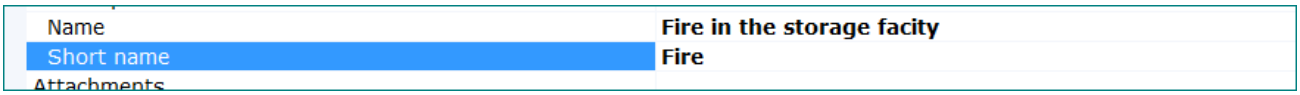
Rename it to “Fire in the storage facility”. (Command “Rename or change description”)



Observe properties of the scenario.

Note that probability for scenario by default is the same as for PIE “Lightning (effect on facility)”.

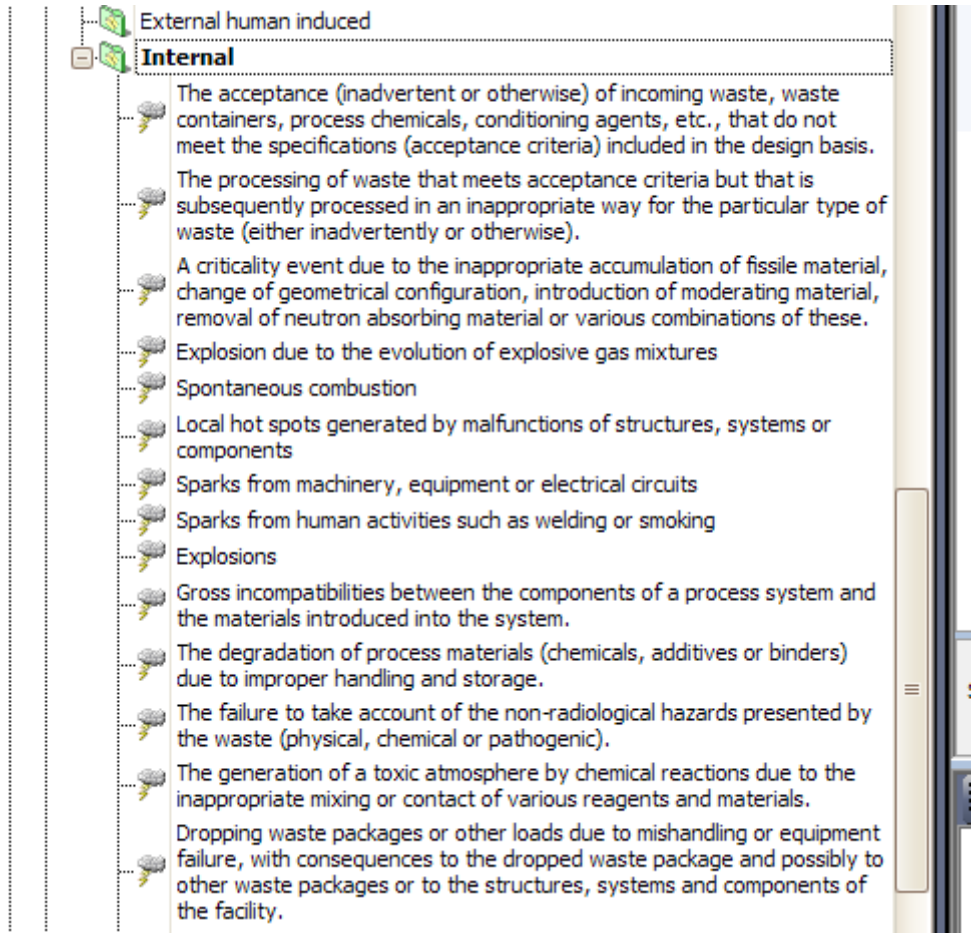
Specify the short name for scenario as “Fire” (short name is convenient for tables and charts).



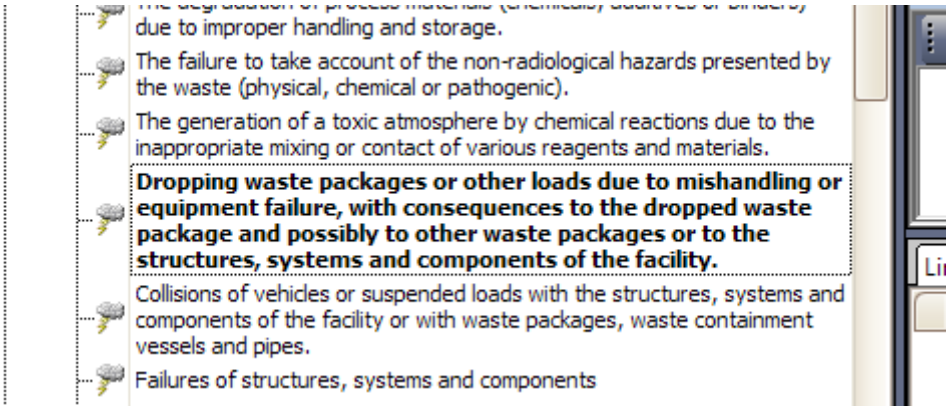
Scenario “Drop of the drum in the Drum storage room”

Right-click to the folder “Internal” for the types of postulated initiating events and select “Import predefined PIE types”.

Import the PIE types proposed by the SAFRAN.



Select PIE type “Dropping waste packages or other loads…”



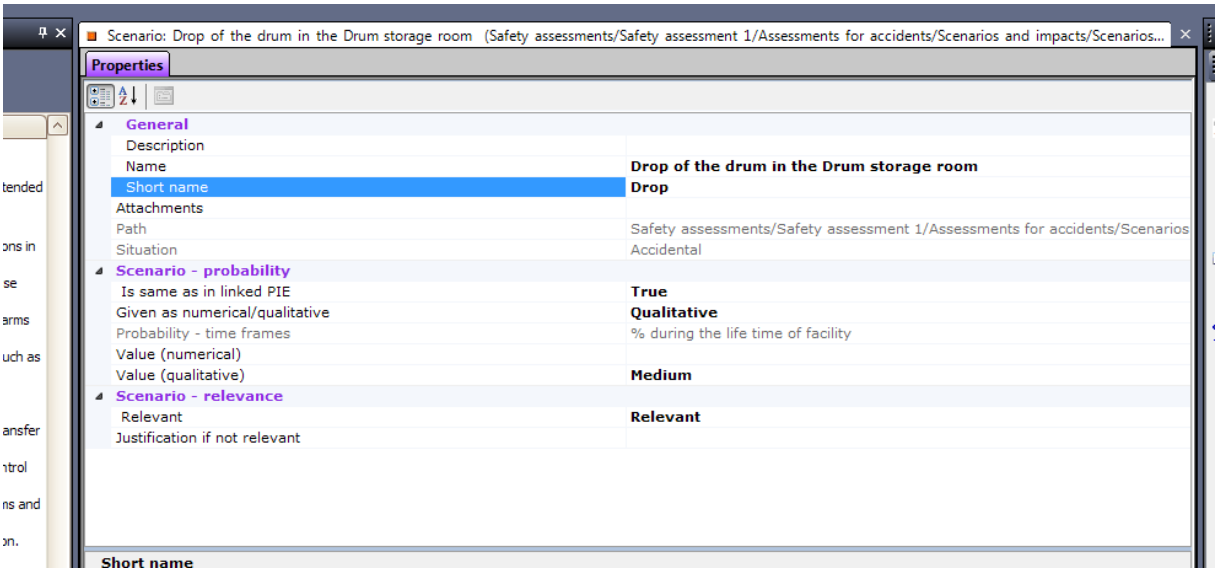
With operations similar to used in previous section – create PIE from this PIE type.

Specify PIE probability as “Medium”.

Create the scenario for this PIE with origen “Drum storage room”;

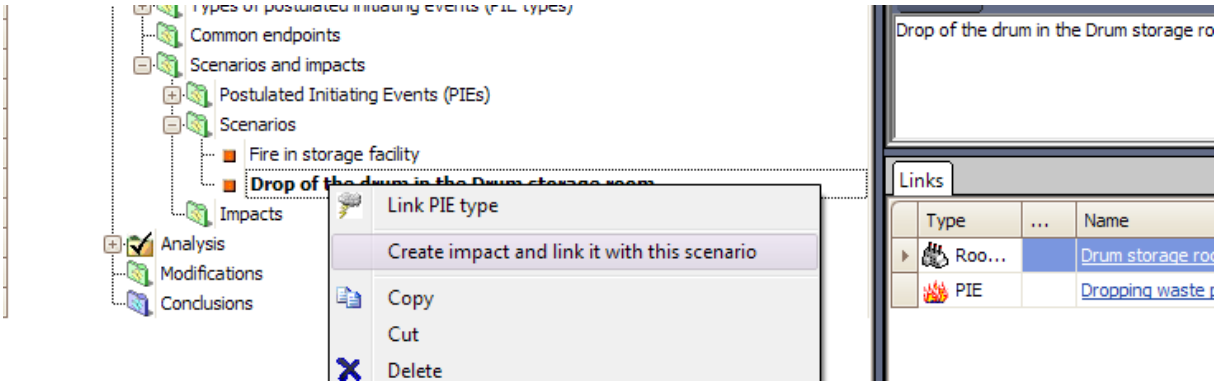
Rename scenario to “Drop of the drum in the Drum storage room” . Specify the short name for scenario as “Drop”.

The properties and links of scenario will be as shown in the picture:

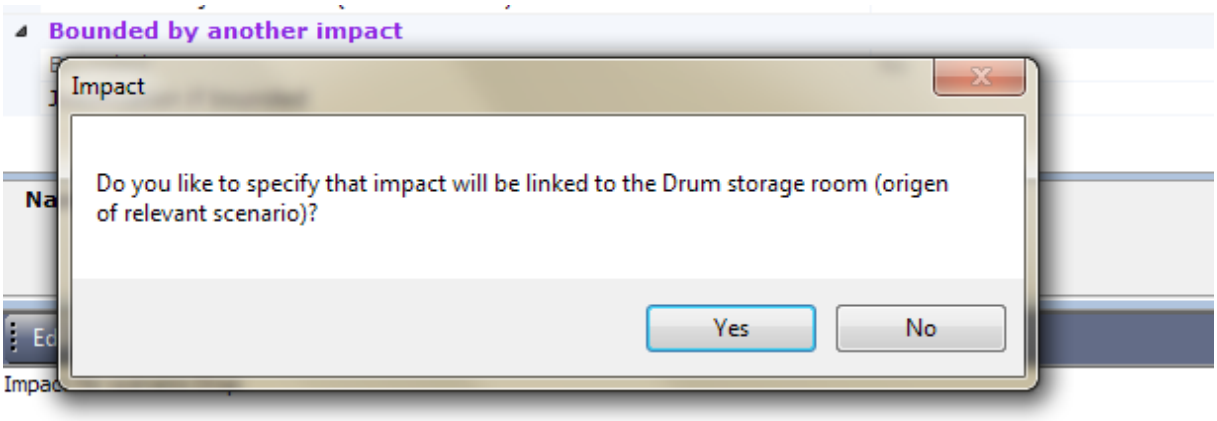


Dose assessment for accidental increase of the external exposure due to drop of the drum

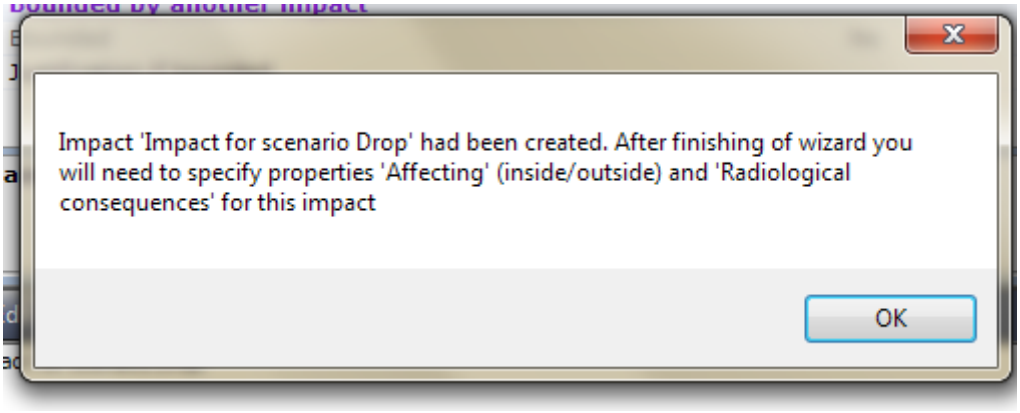
Add impact for this scenario (with command “Create impact and link it with this scenario”).



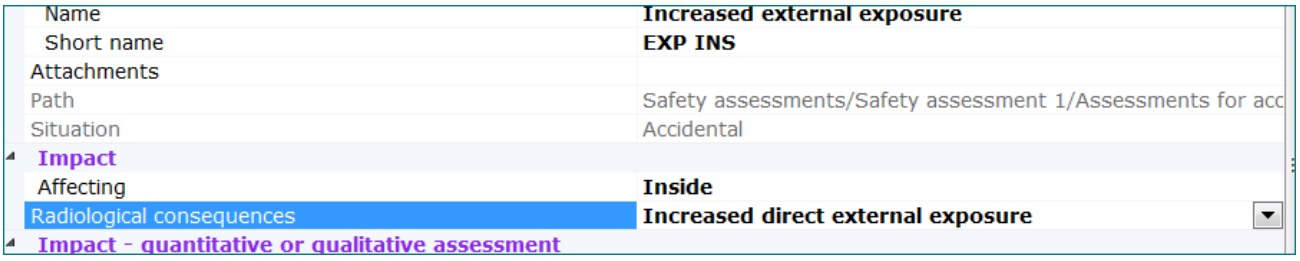
Answer “Yes” to the question whether you like to link impact to the Drum storage room (same room which was defined as origen of the scenario):



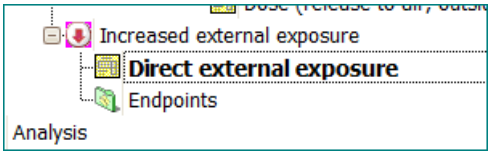
When impact will be created you will get the following message remaining about two most important properties of impact:

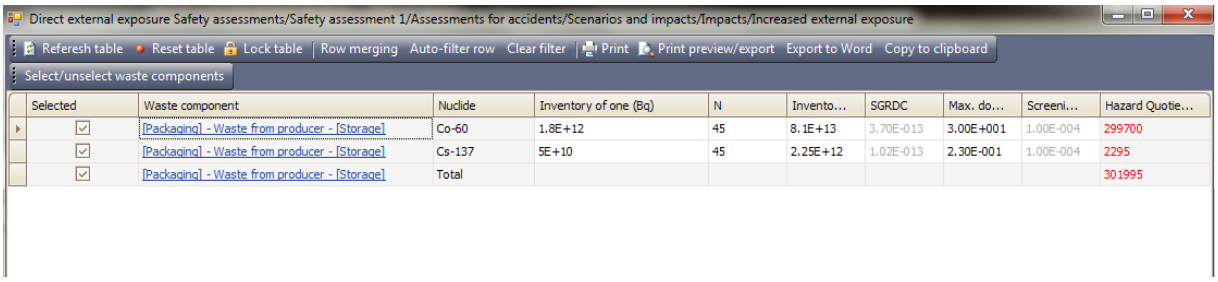


Rename the impact to “Increased external exposure” and set its properties as shown in the picture:

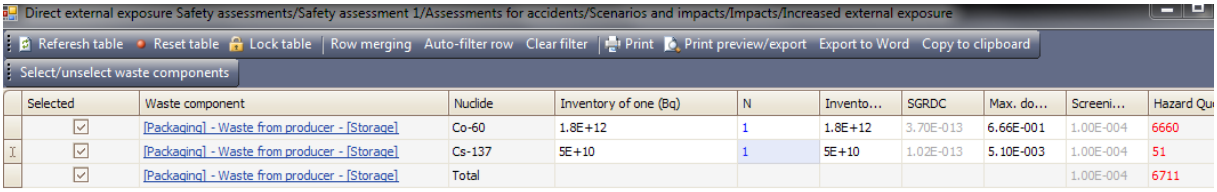


Open the screening table.



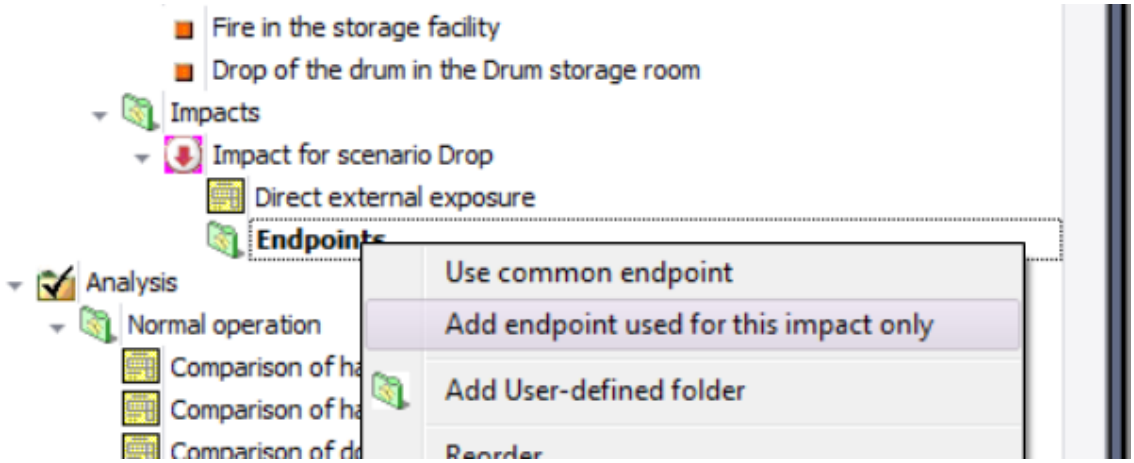


N contains by default total number of containers (45), but for this impact (unlike impacts assessing release due to fire), this should be changed to 1 (only one container is affected).

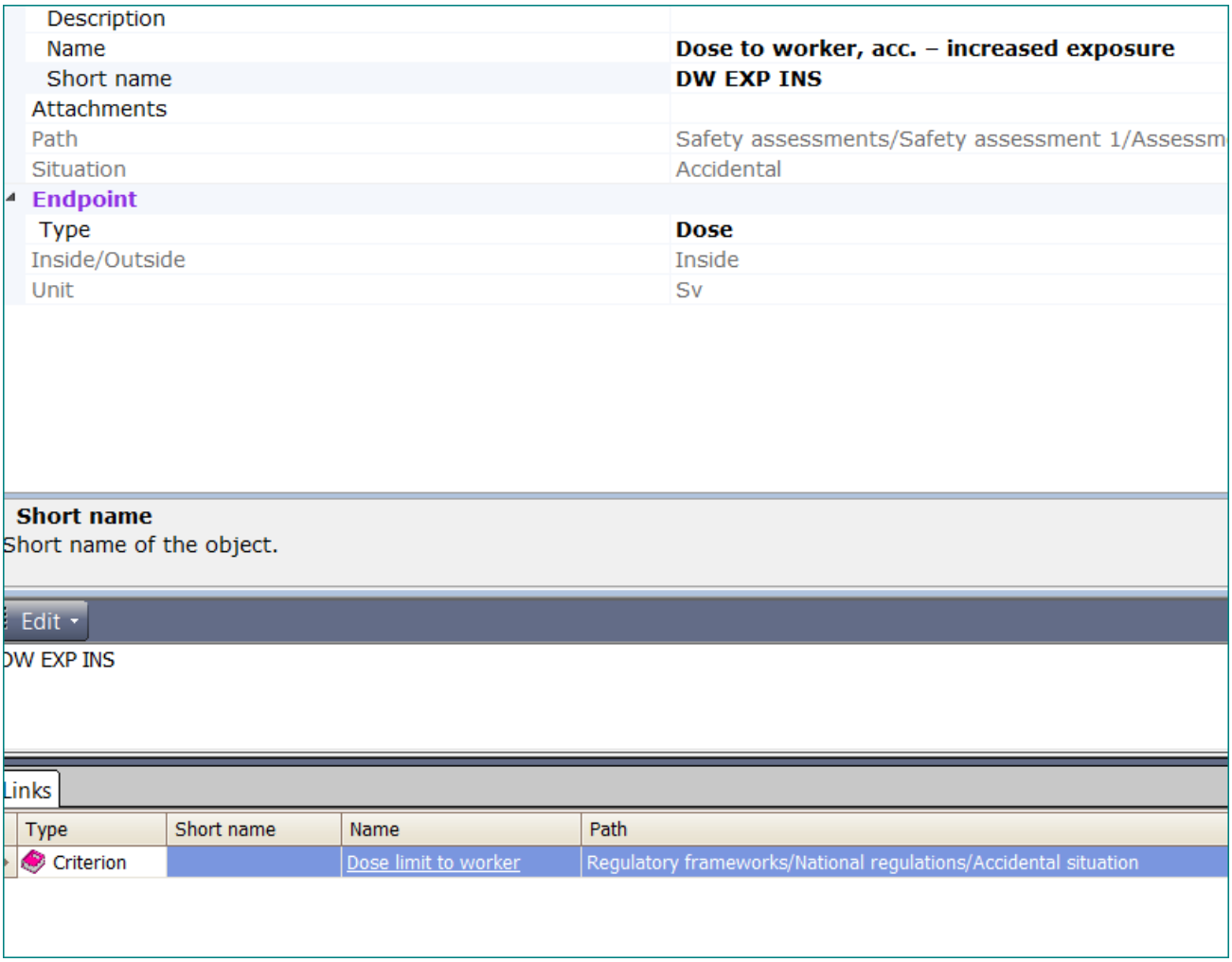


Despite of the change the Hazard Quotient values still show that detailed dose assessment is required.

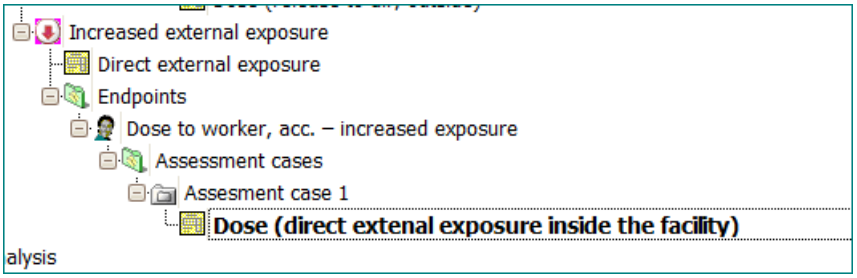
Add endpoint (with "Add endpoint used for this impact only" command).

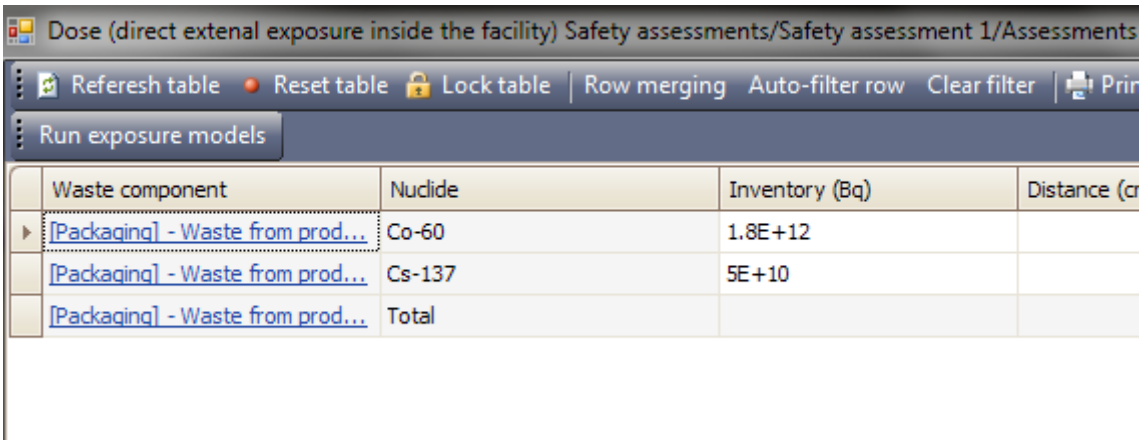


Give endpoint the name "Dose to worker, acc. – increased exposure", give it short name "DW EXP INS" and link it with criterion "Dose limit to worker" for accidental situation.



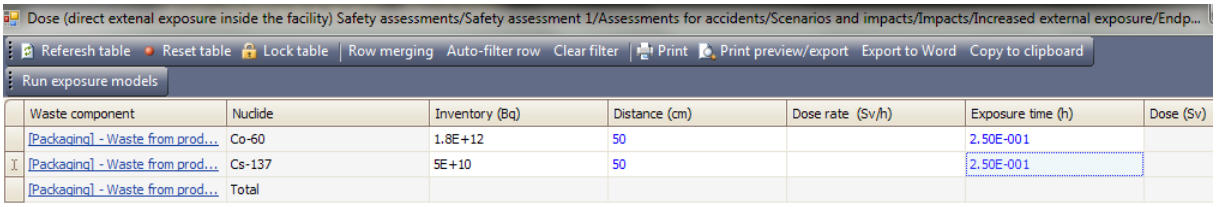
Open table “Dose (direct extenal exposure inside the facility)”.



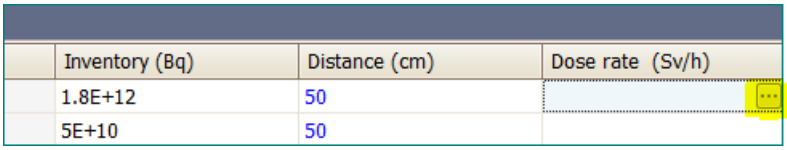


Note that values for inventory are taken from the screening table.

Specify distance (50 cm) and time (0.25h) for worker to fix the sequences of this accident.

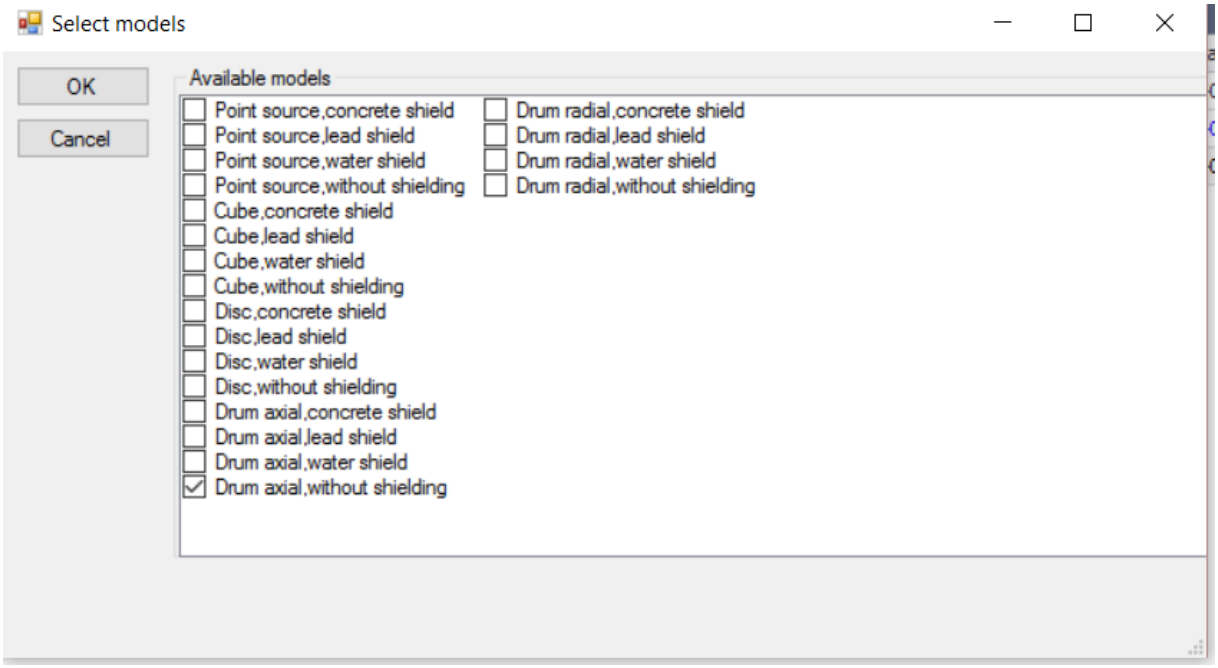


Click on the first row cell in the column “Dose rate” and double-click on the “…” button[9] to select and run one of the available models calculating dose rate for simple geometries.



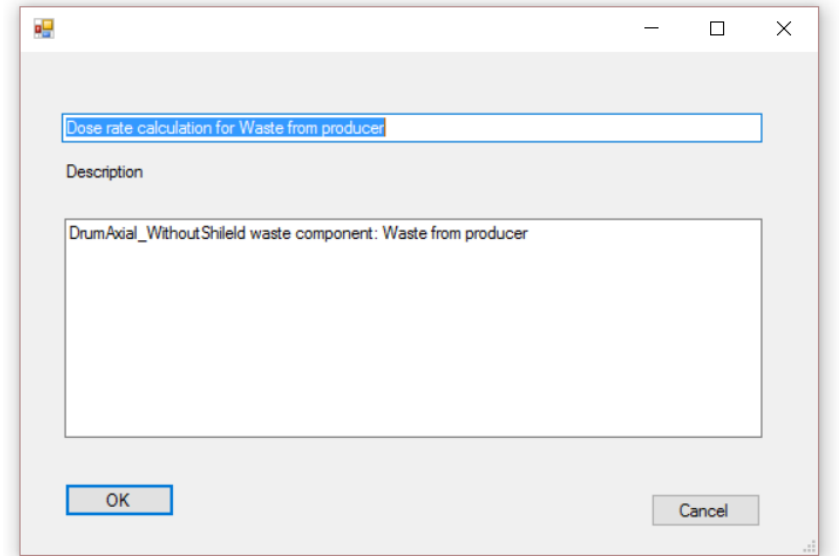
[9] Alternatively you can select the row and press button “Run exposure models” located on toolbar

The model selection dialog box will appear:



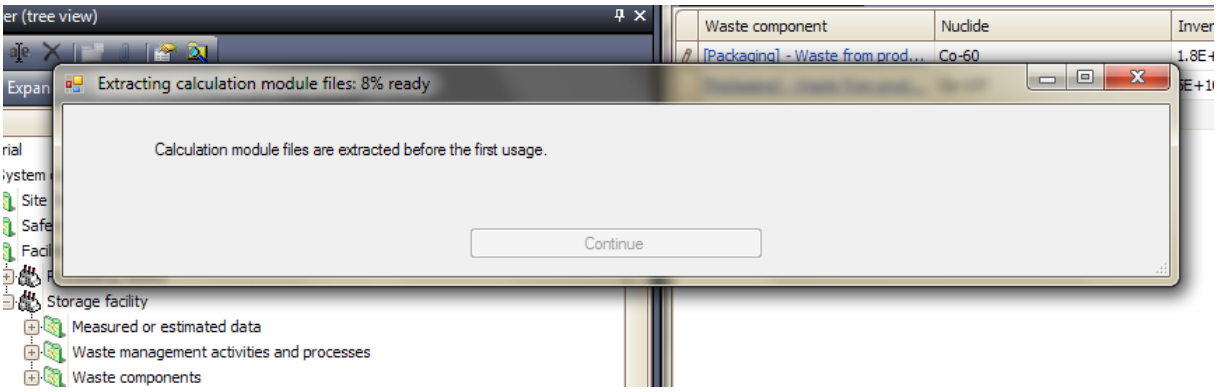
Select “Drum axial, without shiled” in the list and press OK.

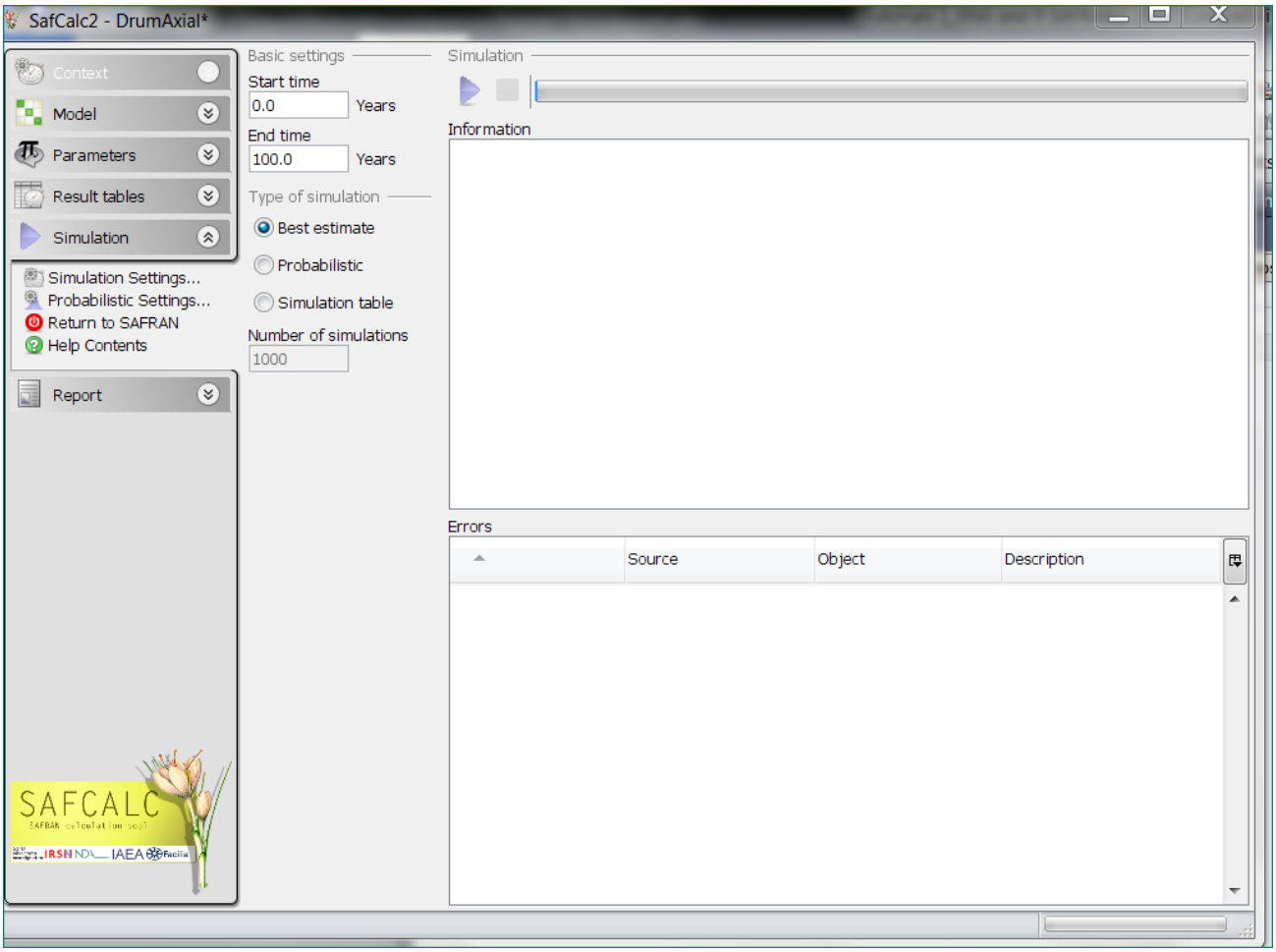
The window with default name and description of calculation will appear.



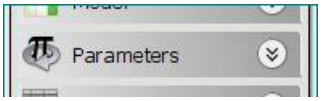
Click OK

The SAFCALC tool will start. You might need to wait a bit until it will be loaded.

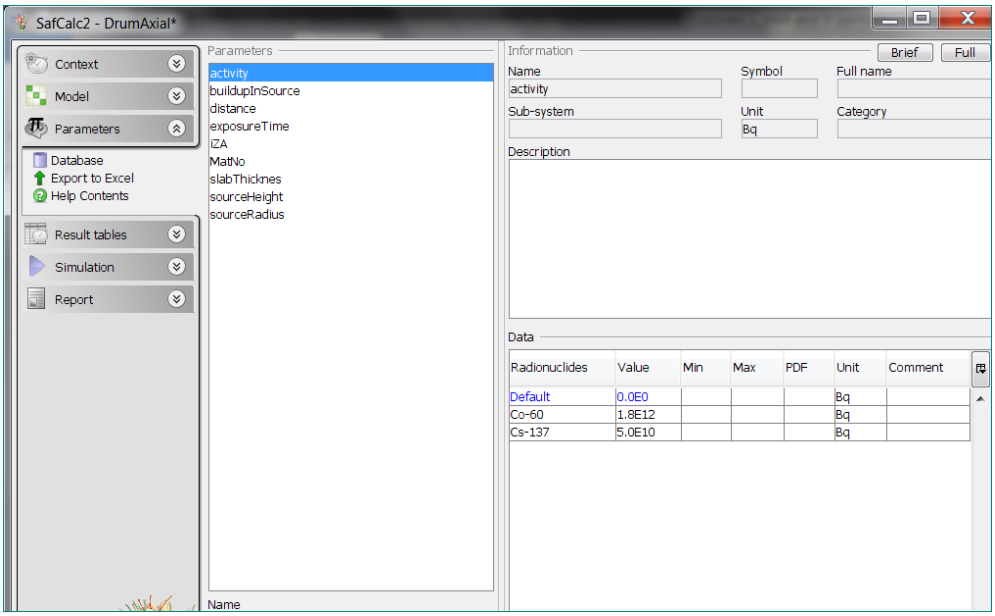




Click on the “Parameters” in the left part of the SAFCALC window.

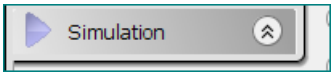


The window will show the list of parameters used by model and their values:



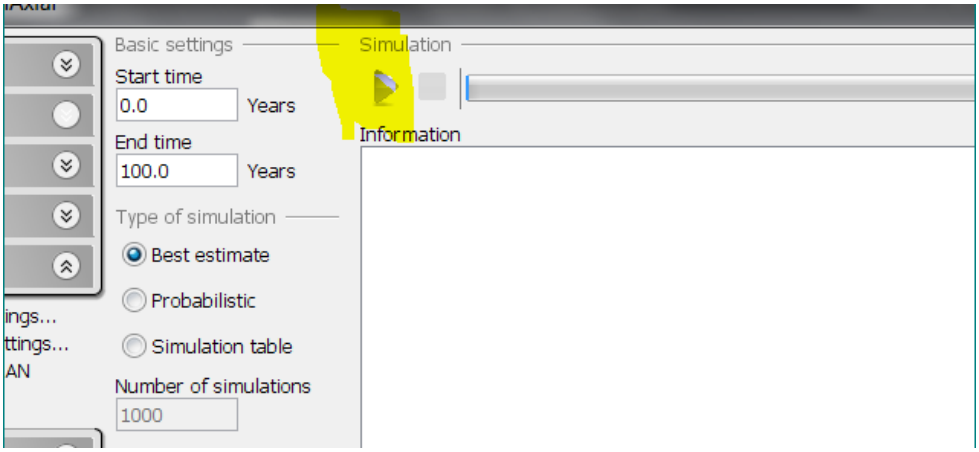
Note that list of nuclides and values for parameter “activity” as well as values for parameters “distance” and “exposureTime” were transfered from the safety assessment table. Other parameters have default values which in real situation might need to be assigned according to the properties specific to the given waste component.

Click on the “Simulation”.

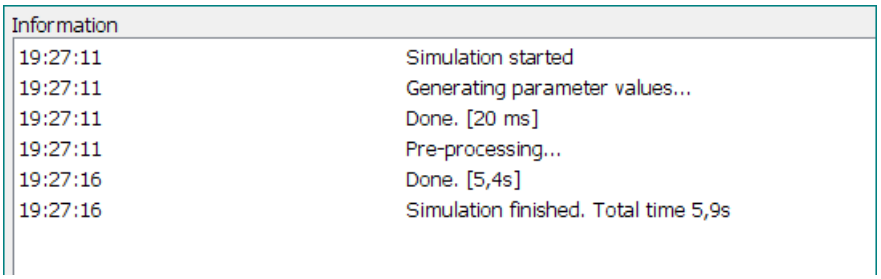


You will return to view which you saw after start of SAFCALC.

Click on the “triangle” button Simulation located on the toolbar.

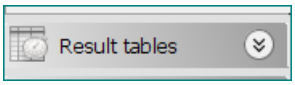


In the Information window, you will see the progress of the simulation

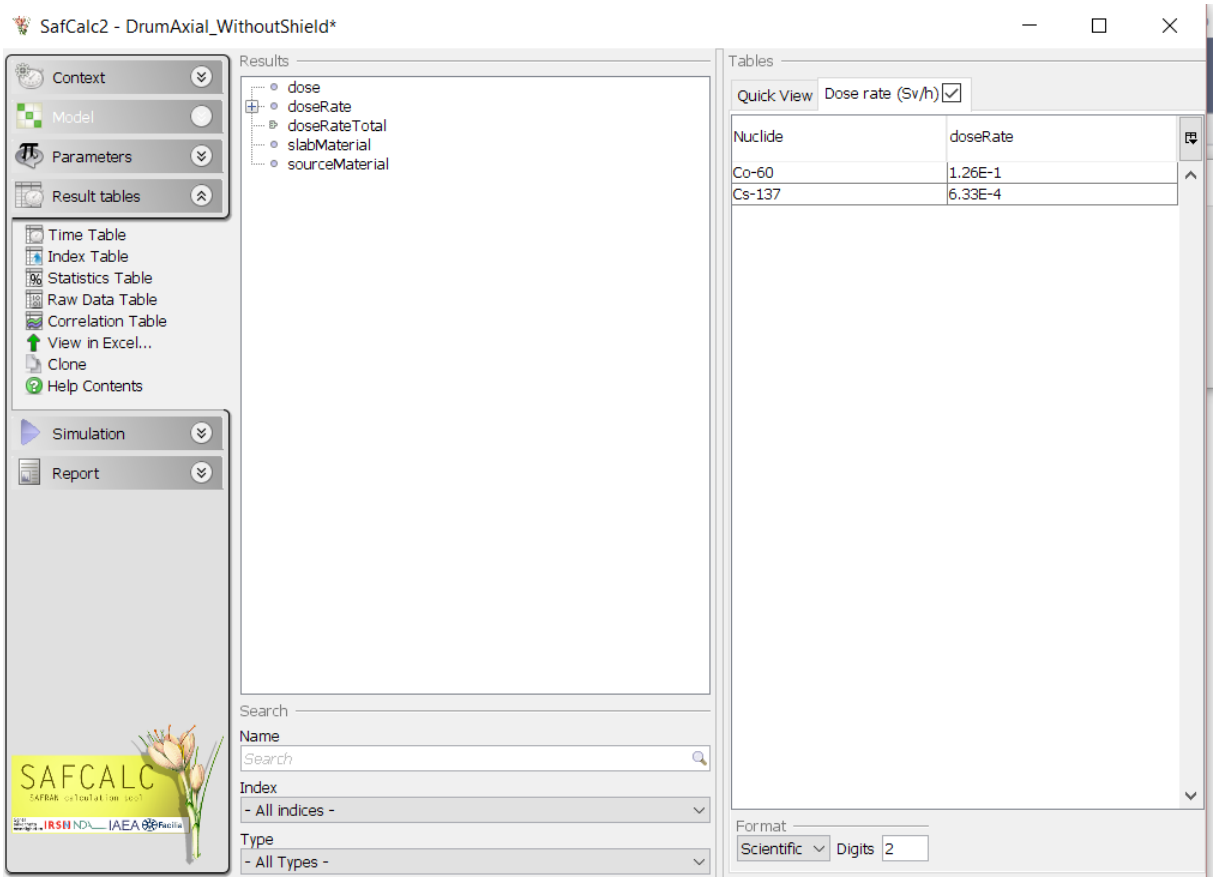


Wait untill simulation will be finished.

Click on the “Result tables”



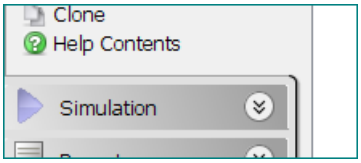
Here you will see the results which will be returened to the assessment table after simulation.



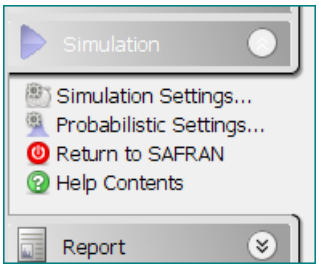
Assure that table “Dose rate” has a check mark in the checkbox located in the header – this is necessary to tell SAFCALC that values from this table need to be “returned” after the simulation[10].

[10] You may create also other tables to observe values of different results.

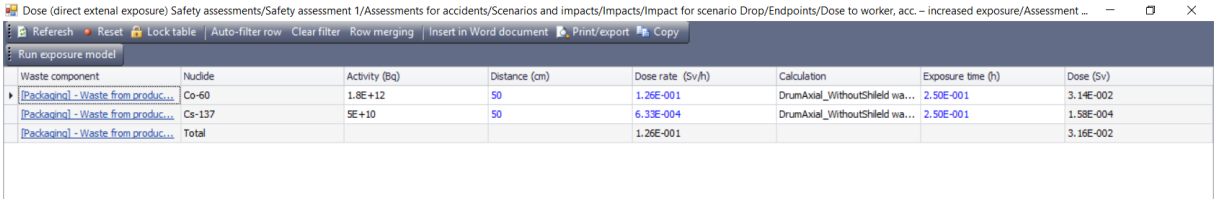
Click on “Simulation”.



Click on the “Return to SAFRAN” under “Simulation”.



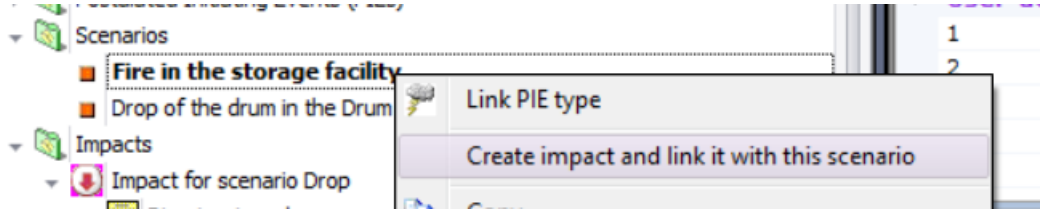
The SAFCALC tool will be closed and (after short waiting time) the dose rate values will be transferred to the safety assessment table and dose will be calculated.



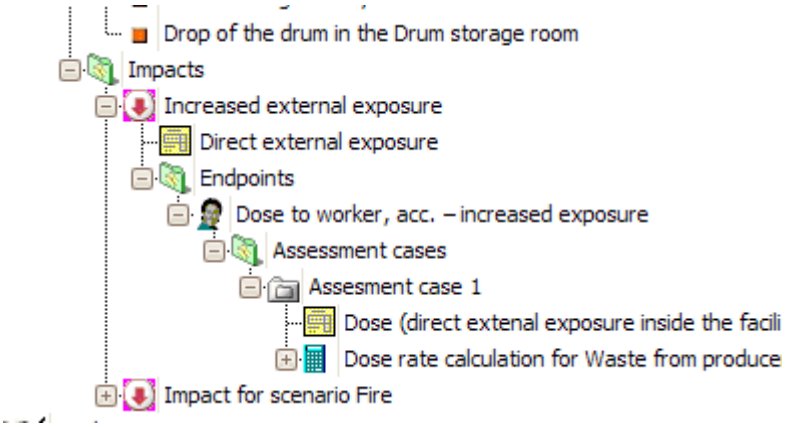
Close the table.

Advanced exercise. Assessment of doses for workers and public due to the accidental release of radionuclides to the air

Select the scenario “Fire in the storage facility” and select for this scenario action “Create impact and link it with this scenario”.

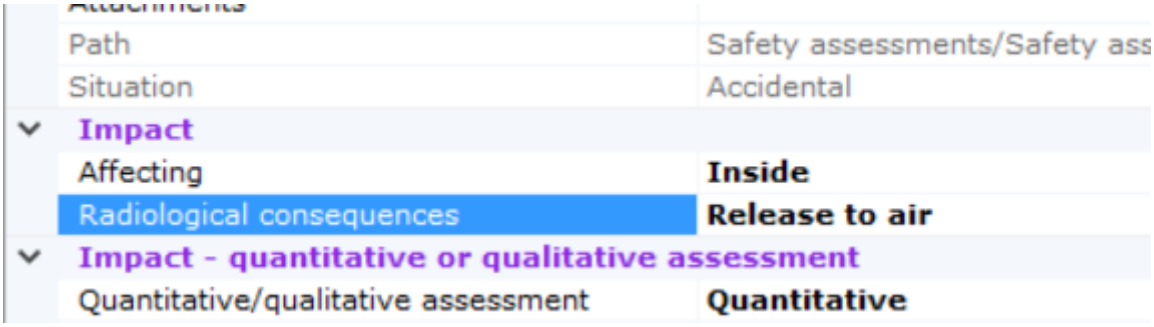


Answer “Yes” to the request to link impact to the Drum storage room. New impact (already linked with this scenario and Drum storage room) will be added to “Impacts” folder.

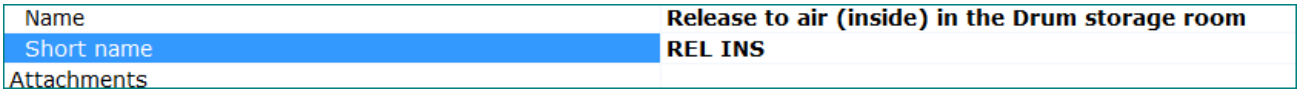


Rename impact to “Release to air (inside) in the Drum storage room”.

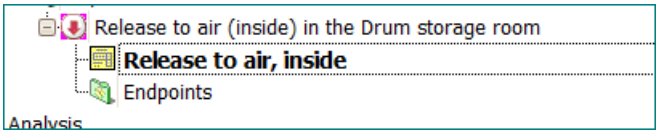
Set the properties of impact as shown in the picture:



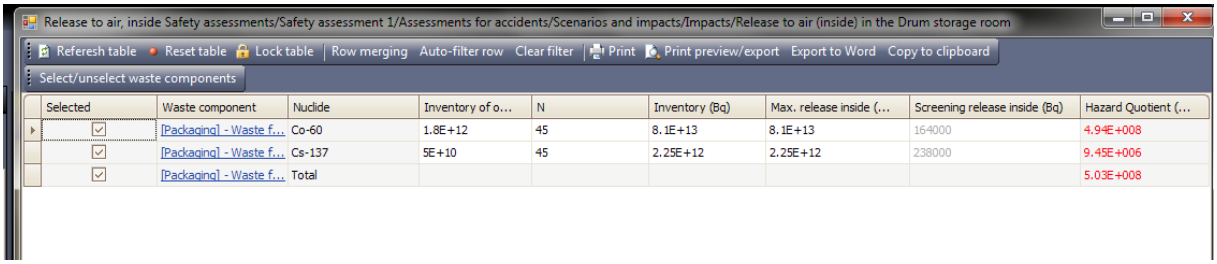
Set the short name for impact as “REL INS”.



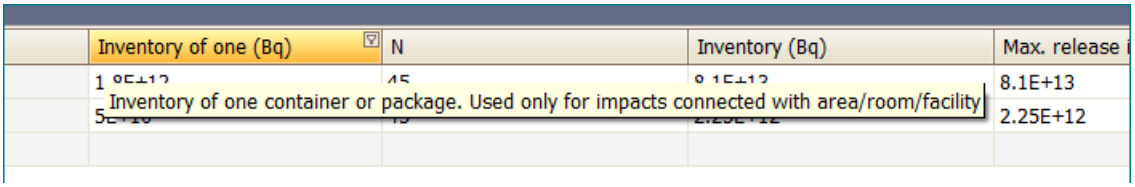
Expand impact node and double-click on the icon for screening table “Release to air, inside”.



The following table will appear:



Tips: To see the meaning of values for each column – hover mouse on column's header, for example:

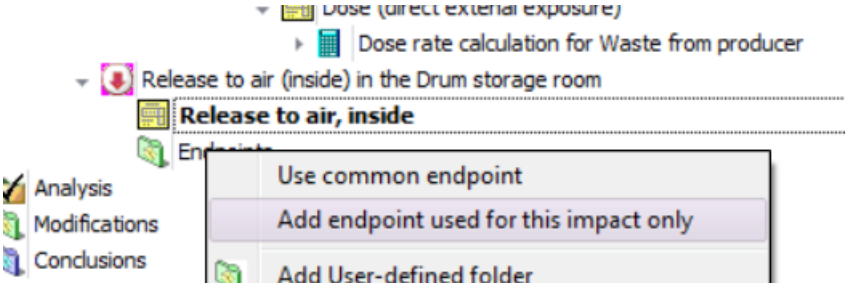


Note that waste component properties are the same as those specified in Tutorial 4.

The values for Hazard Quotient show that more exact dose assessment is required.

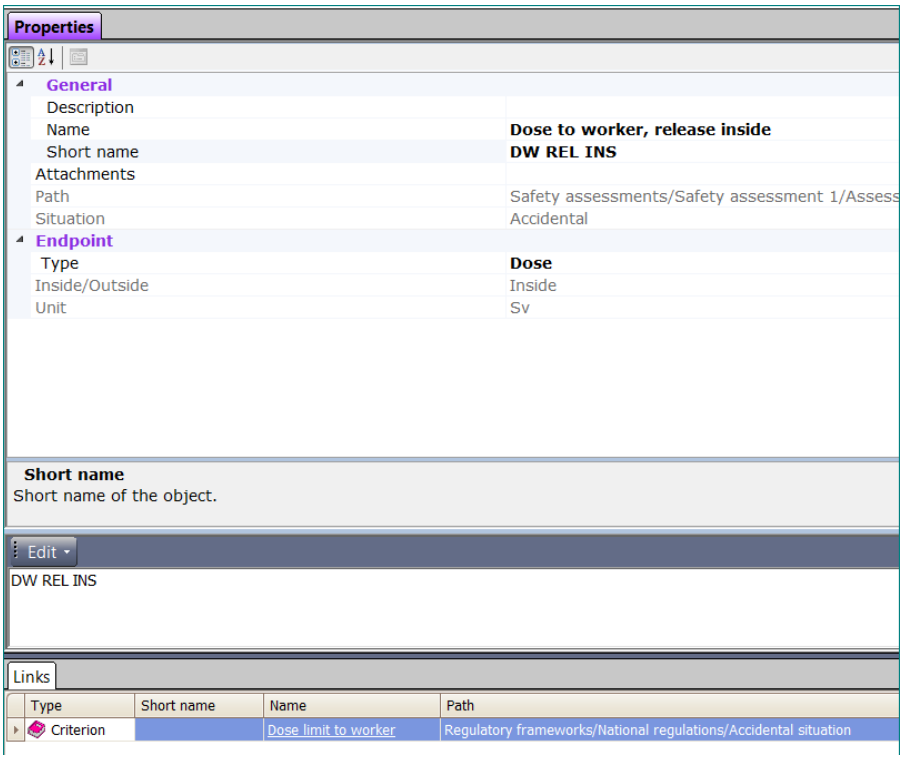
Close the Table.

Right-click on the folder Endpoints and select "Add endpoint user for this impact only".

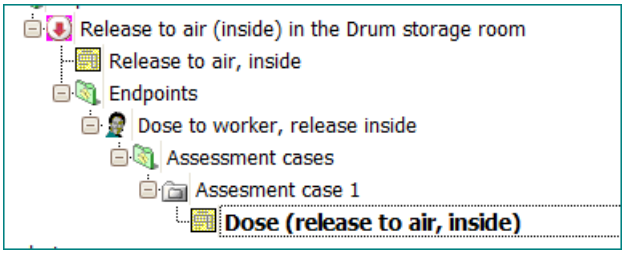


Give to endpoint the name "Dose to worker, release inside", short name "DW REL INS" and link it with criterion "Dose limit to worker" for accidental situation.

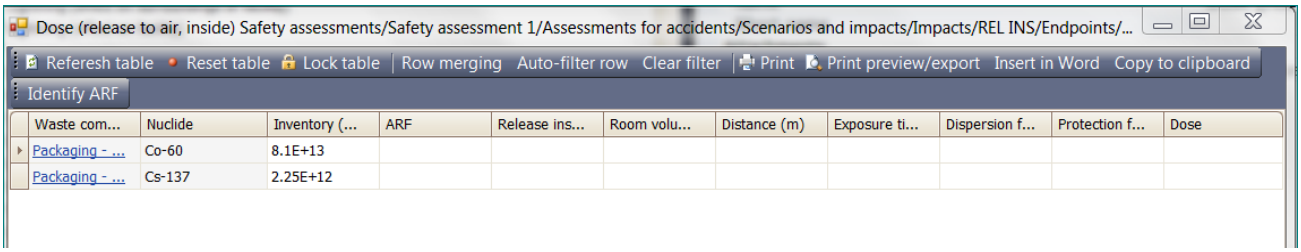
The properties and links of the endpoint finally should look like:



Expand assessment case automatically created for this endpoint and double-click on the icon for the table "Dose (release to air, inside)".



The following table will appear:

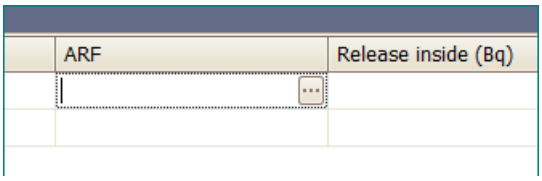


Note that table contains inventory calculated during the screening step.

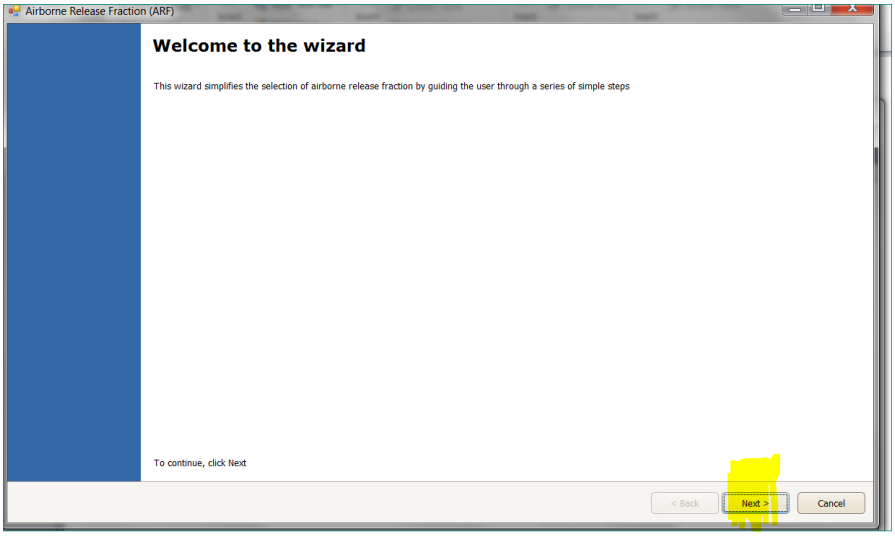
Now you need to identify the ARFs – airborne release fractions for nuclides of waste component.

Click on the first row cell in the column ARF and double click on the "…" button[11].

[11] Alternatively you can select the row and press the button "Identify ARF" located on the toolbar

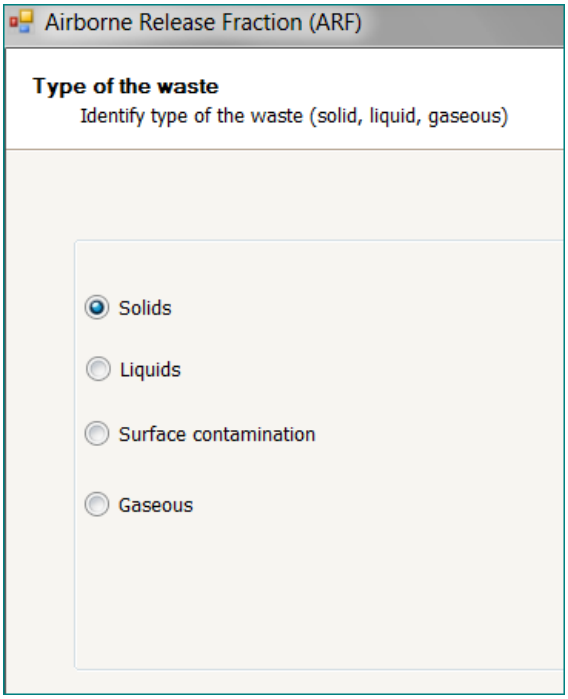


The first page of Wizard will appear:



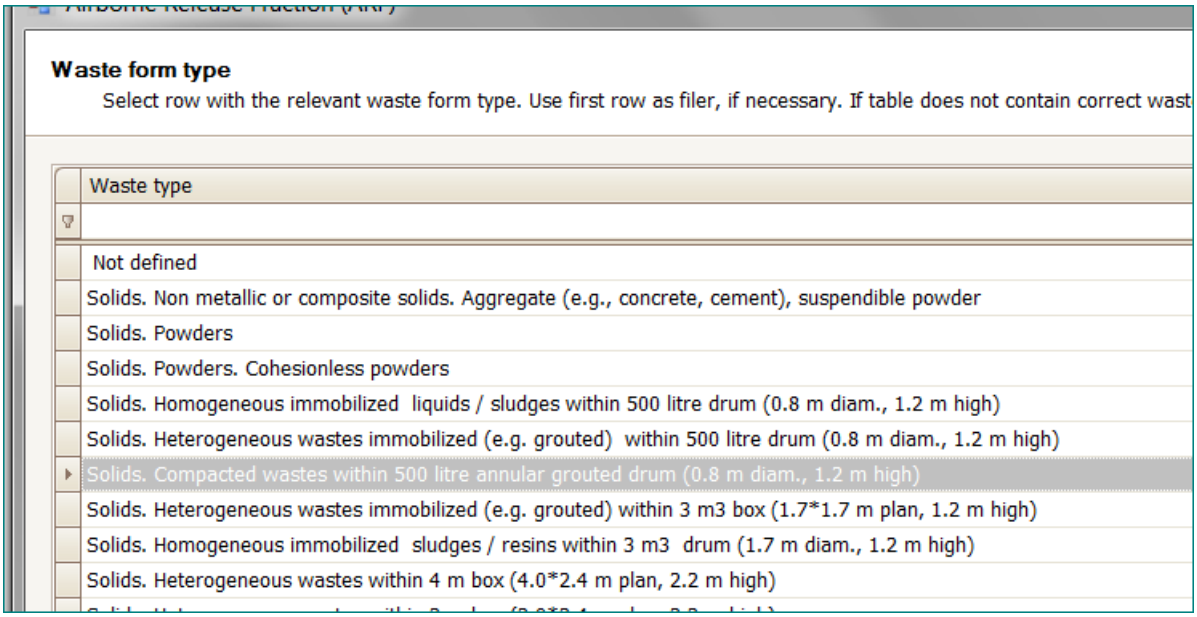
Click Next.

On the second page of wizard select “Solids” as the waste type (the waste type “Solid waste” was selected when defining waste received from producer in Tutorial 3).



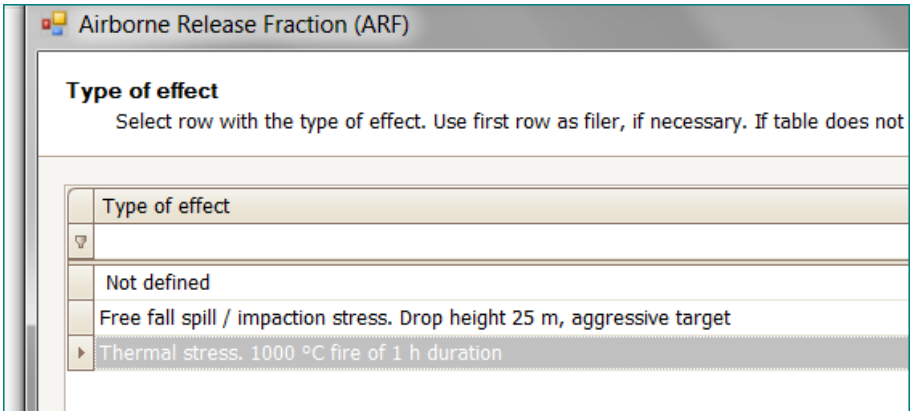
Click Next.

On the “Waste form type” page, select “Solids. Compacted wastes within 500 litre annular grouted drum …” (see Table 4 of Tutorial 4).



Click Next.

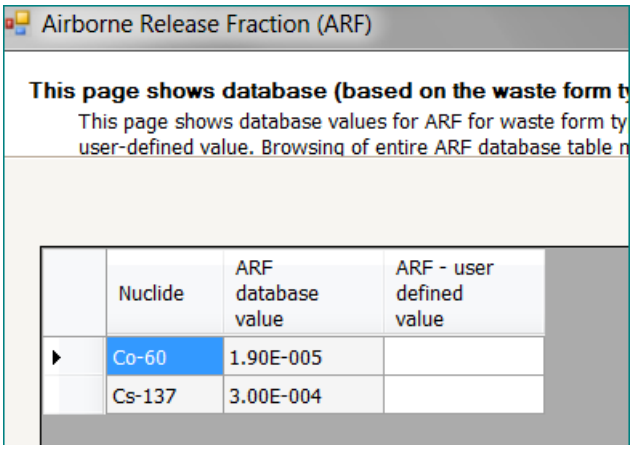
On the page “Type of effect”, select “Thermal stress. 1000 ^{O}C fire 1 h duration”.



Click Next.

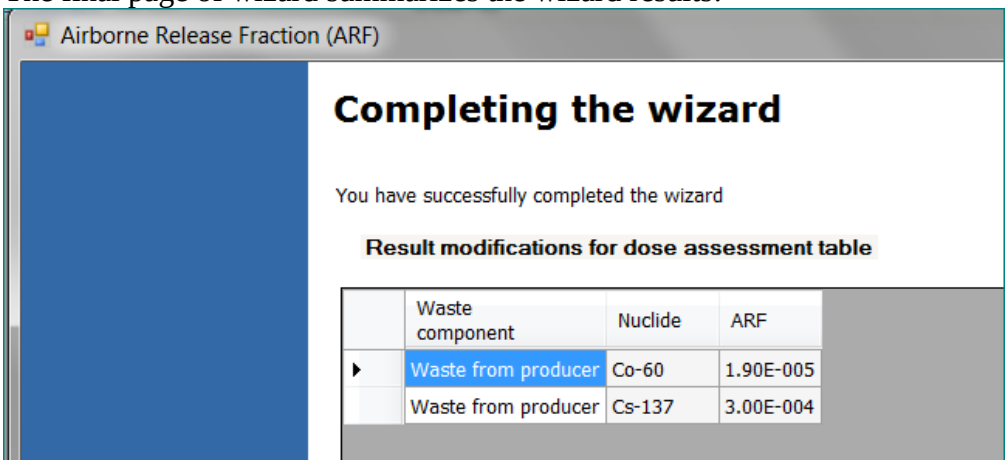
The page which will appear shows you the values of received from database for given nuclide, waste form type and type of effect.

(If necessary, this page also allow you to provide own values)



Click Next.

The final page of wizard summarizes the wizard results:



Click Finish.

The results of wizard will be transferred to the table. (Note: you might need to click on cell in the ARF column of the second row to see the ARF transferred for Cs-137).

Note that Release inside was already calculated based on inventory and ARF values.

Waste component	Nuclide	Inventory (Bq)	ARF	Release inside (Bq)
Packaging - Waste from p...	Co-60	8.1E+13	1.90E-005	1.539E+09
Packaging - Waste from p...	Cs-137	2.25E+12	3.00E-004	6.75E+008

The dose will be calulated based on the pre-calculated dispersion factors stored in the database.[12]

[12] The dispersion factors was pre-calculated for several possible room volume, distance and exposure time values using model for accidental releases inside.

Click in the corresponding cell of first row and select (using combo-boxes) the following values describing Drum storage room and Storage process.

Room volume (m3)	Distance (m)	Exposure time (min)	Dispersion factor (h/m3)
200	2	10	9.74E-004
200	2	10	9.74E-004

Note that data entered for first row are automatically distributed to the second one (they should be the same for all nuclides of the waste component).

Enter 0 as Protection factor (no protection against inhalation).

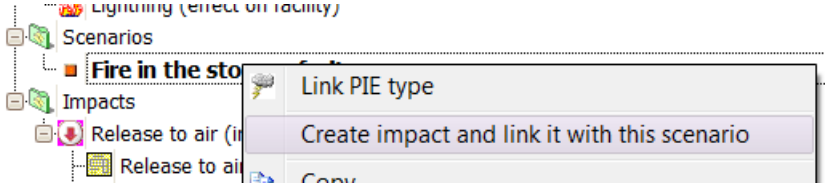
Note that values in the Dose column were calculated.

sure time (min)	Dispersion factor (h/m3)	Protection factor	Dose
	9.74E-004	0	4.39E-002
	9.74E-004	0	1.33E-002

Close the table.

ASSESSMENT OF ACCIDENTAL RELEASE OUTSIDE

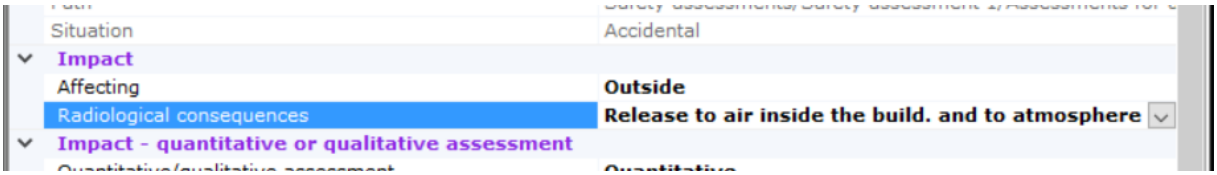
Right-click on the scenario “Fire in storage facility” and select “Create impact and link it with this scenario”. Answer “Yes” to request to link impact with Drum storage room.



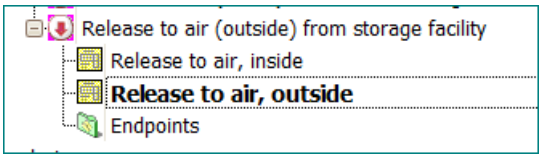
Second impact linked to this scenario will be added.

Rename it to “Release to air (outside) from storage facility”.

Specify the properties “Short name”, “Affecting” and “Radiological consequences” of impact as shown in the picture:



Open tables “Release to air, inside” (it will be the same as in previous impact) and table “Release to air, outside”.

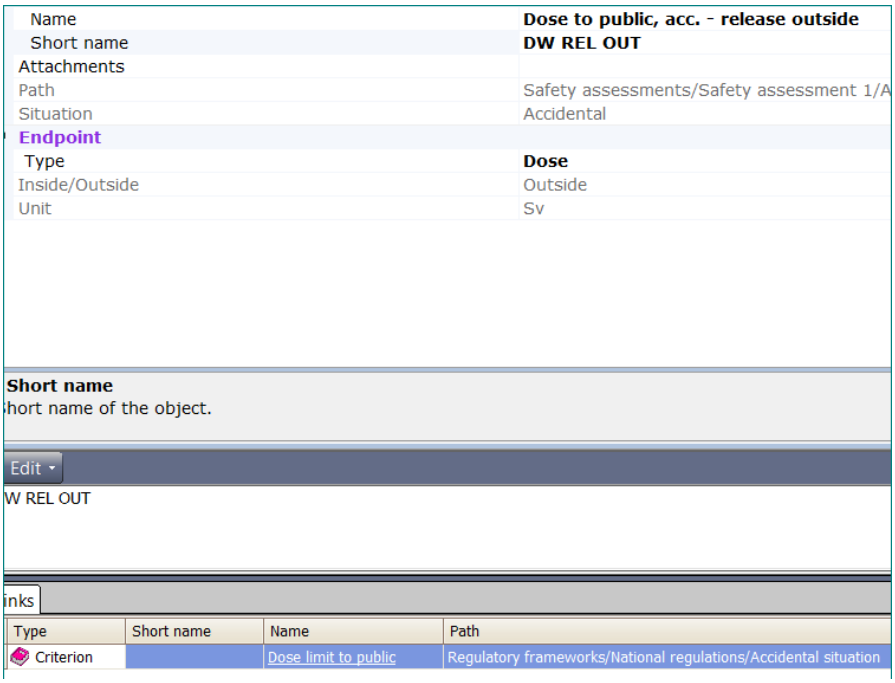


Nuclide	Max. release inside (Bq)	Filtration efficiency	Max. release outside (Bq)	Screening release outside...	Hazard Quotient (HQ)
Co-60	8.1E+13	9.00E-001	8.10E+012	1.02E+08	7.94E+004
Cs-137	2.25E+12	9.00E-001	2.25E+011	6.54E+07	3.44E+003
Total					8.29E+004

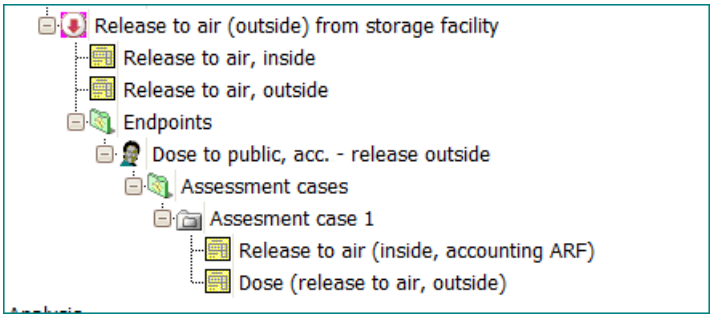
Note that Filtration efficiency data are given for the data for Storage facility according to the Table 2 of Tutorial 2.

The Hazard Quotient value shows that more detailed dose assessment is required.

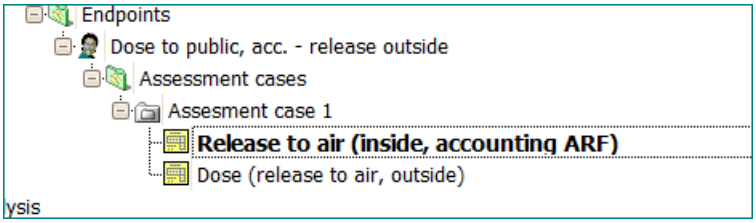
Add endpoint “Dose to public, acc. - release outside”, short name DP REL OUT and link it to the criterion “Dose limit to public” for accidental situation:



Expand “Assessment case 1” created for this endpoint:



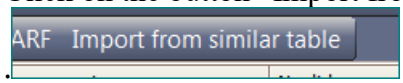
Open table “Release to air (inside, accounting ARF)”.



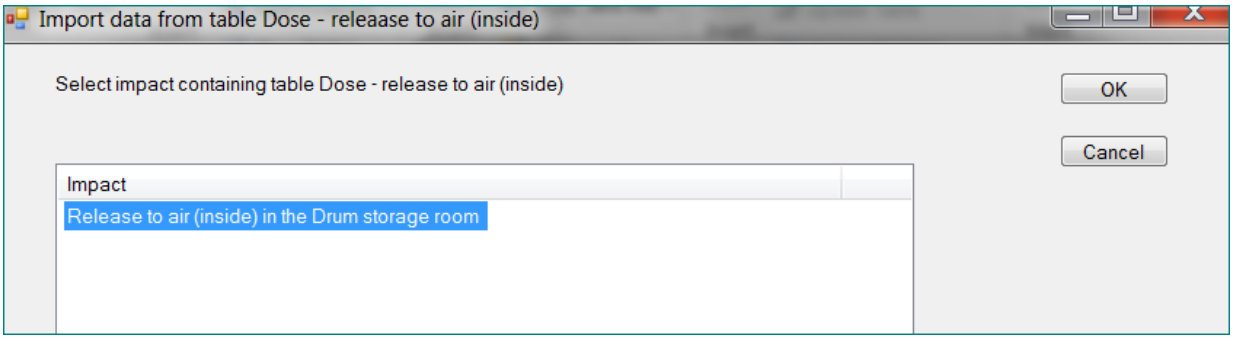
The following table will be shown:

Note that this table and its data are similar to the first part (up to “Release inside”) table “Dose to air (inside)” in previous impact.

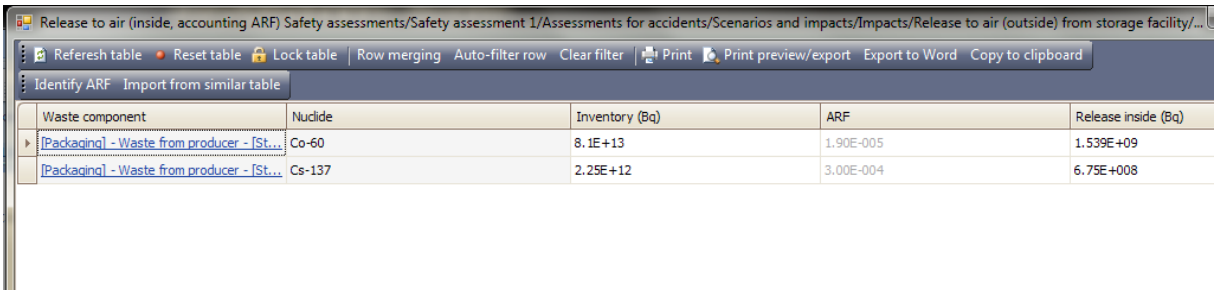
Click on the button “Import from similar table”, located on the toolbar.



Select the impact containing table from which data will be imported.

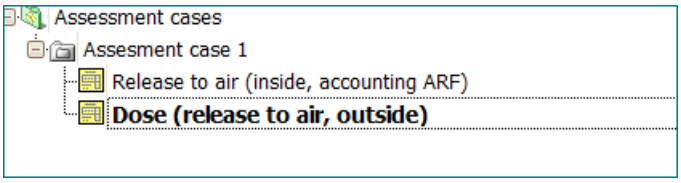


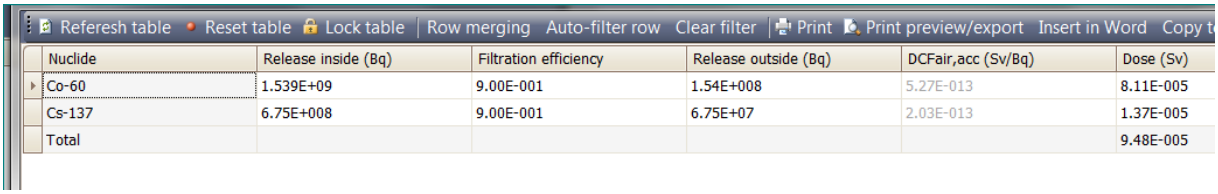
Click OK and observe the changes in the table.



Close the table.

Open table “Dose (release to air, outside)”.





Nuclide	Release inside (Bq)	Filtration efficiency	Release outside (Bq)	DCFair,acc (Sv/Bq)	Dose (Sv)
Co-60	1.539E+09	9.00E-001	1.54E+008	5.27E-013	8.11E-005
Cs-137	6.75E+008	9.00E-001	6.75E+07	2.03E-013	1.37E-005
Total					9.48E-005

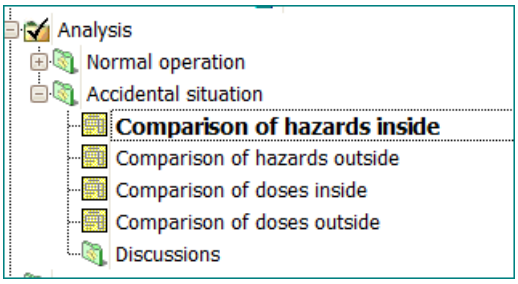
Note that this table use filtration efficiency to calculate dose obtained from System description (similarly to the screening table).

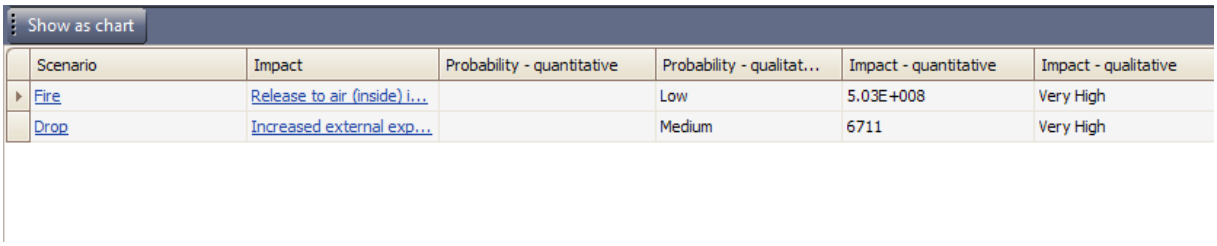
Close the table.

End of advanced exercise

Analysis

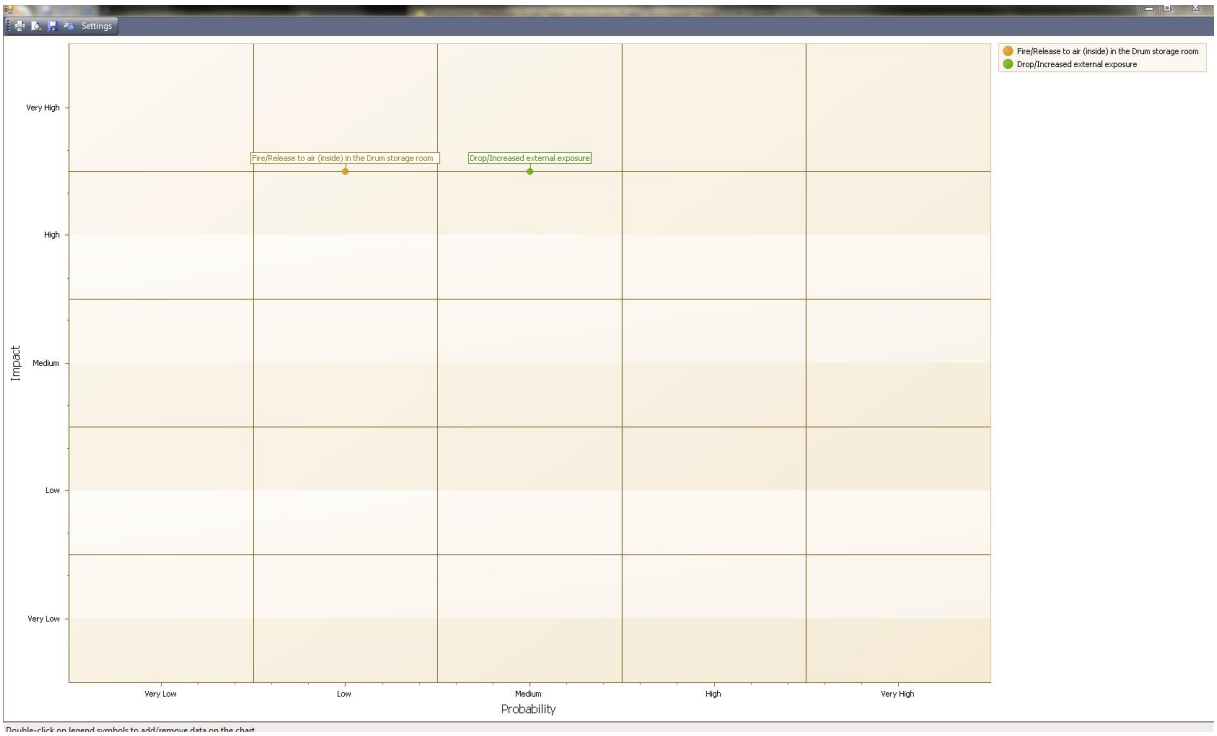
Open table “Analysis/Accidental situation/Comparison of hazards inside”.





Scenario	Impact	Probability - quantitative	Probability - qualitat...	Impact - quantitative	Impact - qualitative
Fire	Release to air (inside) i...		Low	5.03E+008	Very High
Drop	Increased external exp...		Medium	6711	Very High

Click button “Show as chart”. The Probability/Impact matrix will be shown.



Close chart and table.

Open table “Comparison of doses inside”.

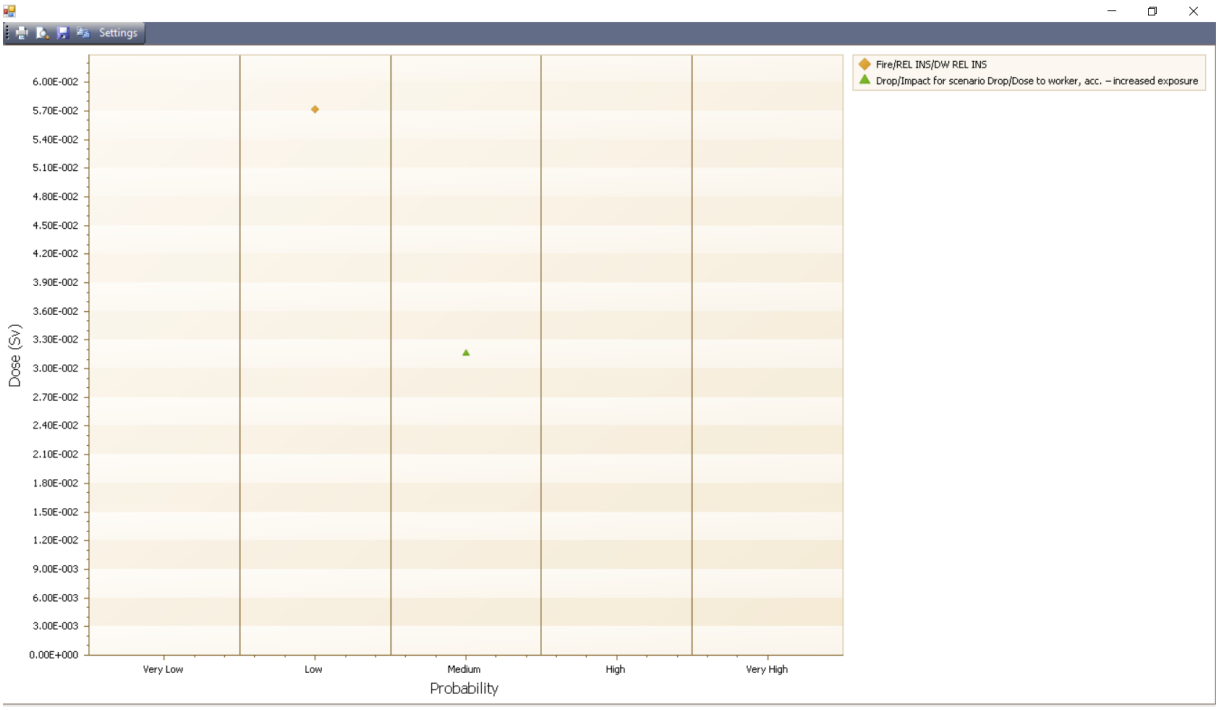
Comparison of doses inside Safety assessments/Safety assessment 1/Analysis/Accidental situation

Referesh | Reset | Lock table | Auto-filter row | Clear filter | Row merging | Insert in Word document | Print/export | Copy

Show as chart

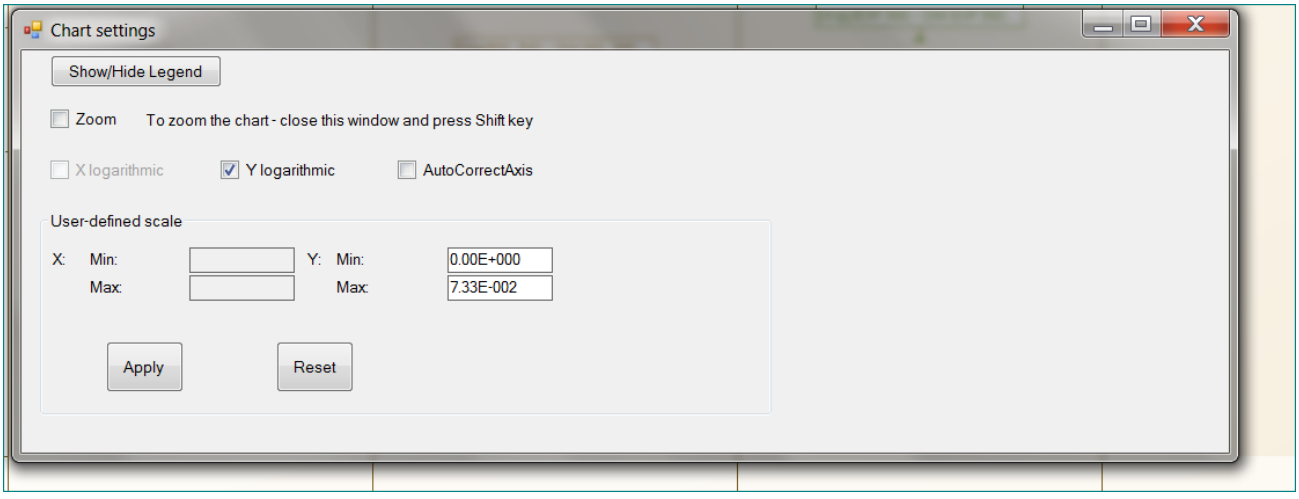
Scenario	Impact	Probability - quantitative	Probability - qualita...	Endpoint	Case	Dose (Sv)	Criterion	Limit (Sv)	Discus
Fire	REL INS		Low	DW REL INS	Assesment case 1	5.71E-002	Dose limit to worker	1.00E-003	
Drop	Impact for scenario ...		Medium	Dose to worker, acc...	Assesment case 1	3.16E-002	Dose limit to worker	1.00E-003	

Click “Show as chart” – the Probability/Dose matrix will be shown.



Click on the “Settings” button located in the chart’s toolbar.

Select “Y logarithmic” option as shown in the picture.



The chart view will be modified.

Close the “Chart settings” dialog box, the chart and the table.

SAVING THE FILE:

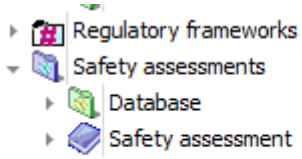
Save the project.

Tutorial 8. Database

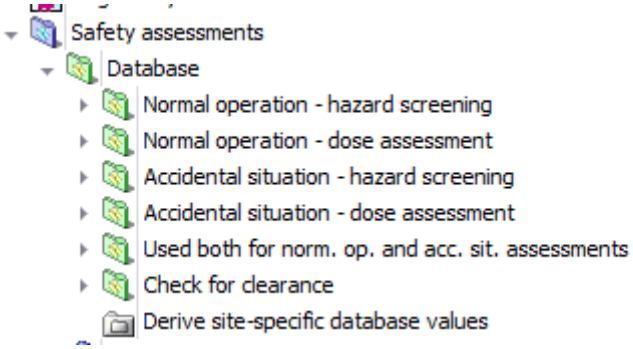
Overview of the database.

Database contains the values used during the safety assessment. The values are taken from the IAEA documents or pre-calculated (accounting conservative conditions) with the SAFRAN calculation (SAFCALC) models.

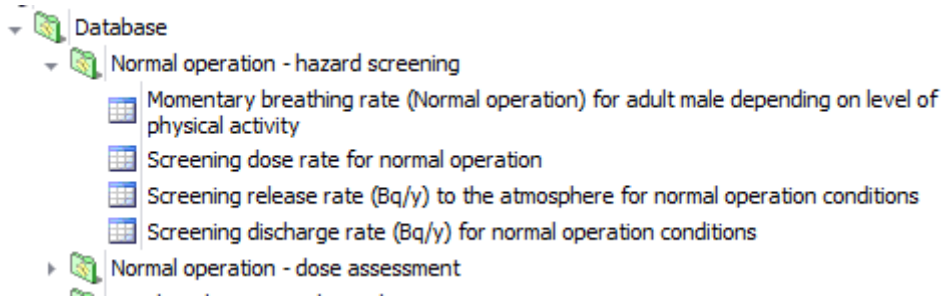
Expand node “Database” (located under “Safety assessments”)



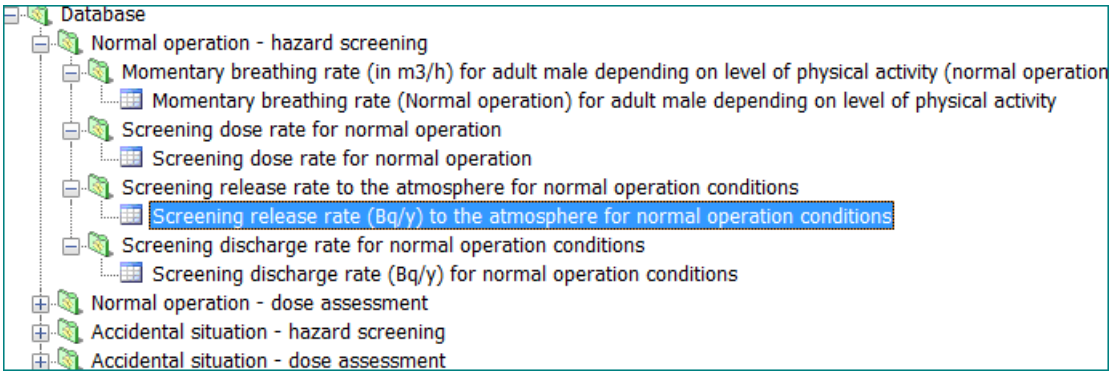
and observe the categories of the database tables.



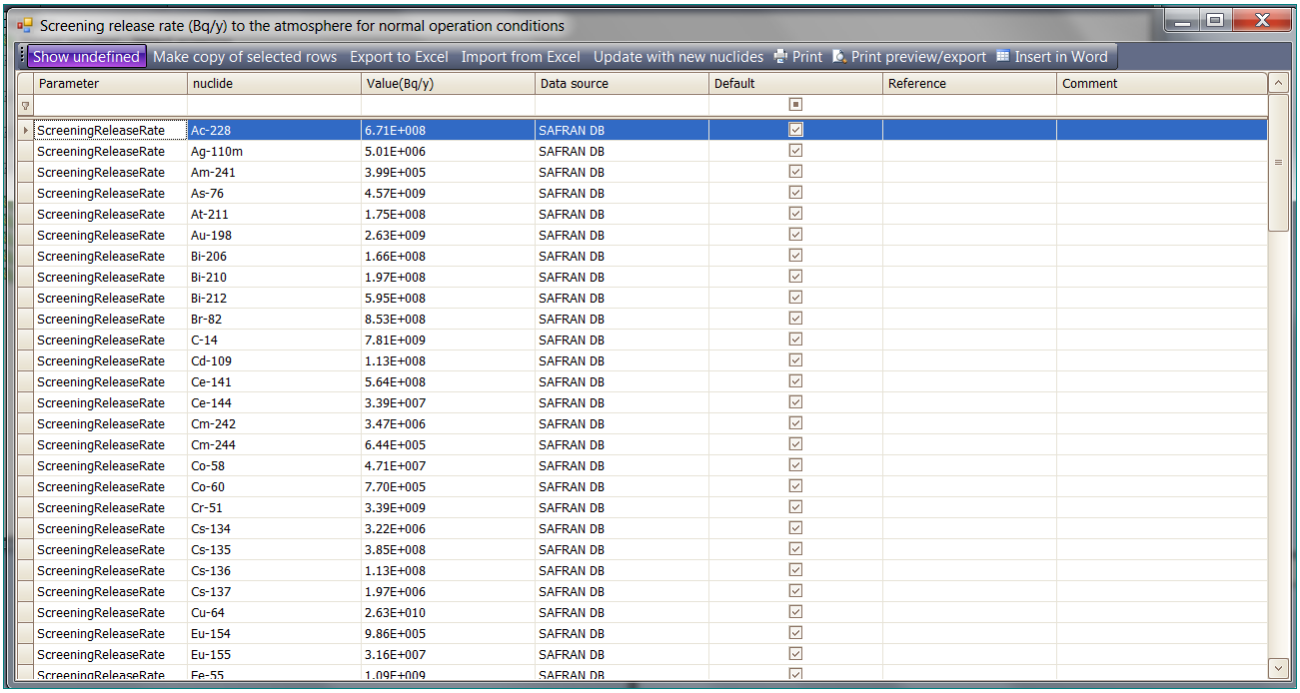
Expand node “Normal operation – hazard screening”. You will see the tables containing the values used in hazard screening for normal operation assessments (see Tutorial 6).



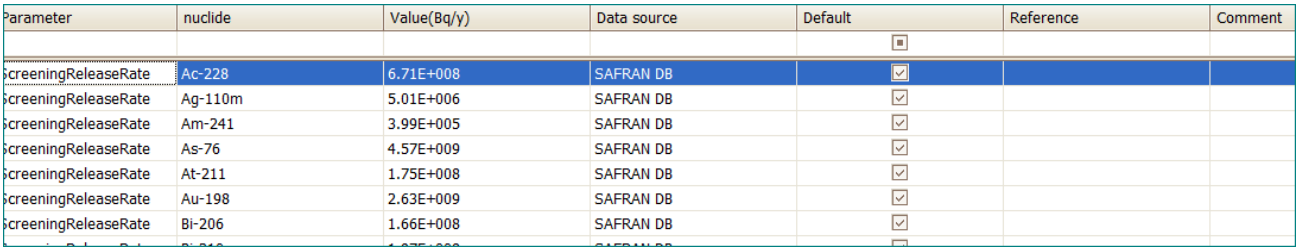
Double-click on the icon for table “Screening release rate …”



The table will appear:



Observe the structure of each row of the table.

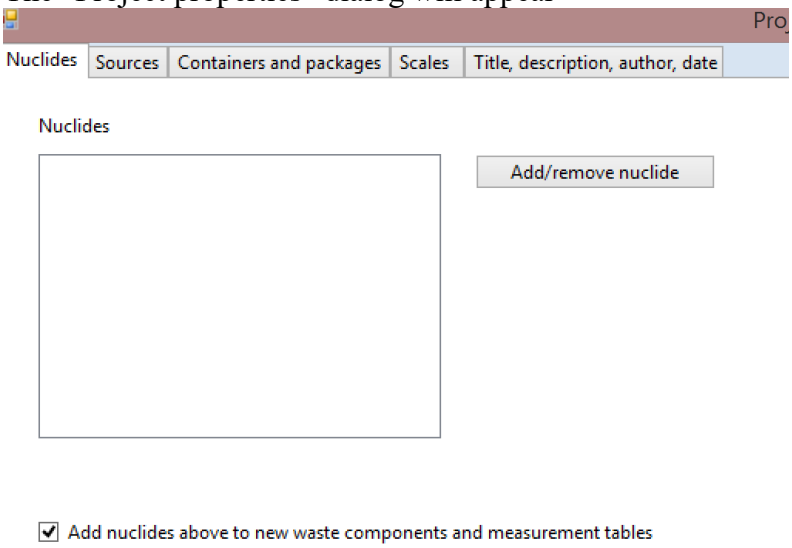


Note that, in addtion to the column “parameter”, “nuclide”, “value”,”reference”, “comment”, it contains two more cells “Data source” (can have values “SAFRAN DB” and “user”) and “Default”. These two columns are relevant to the possibility to add user-defined site-specific values to the table. Important feature for database table that it can contain several values for the same nuclide. Only one value for given nuclide can be marked as “Default” – this value SAFRAN assessment table receives from database when query value (in this case screening release rate for the given nuclide) .

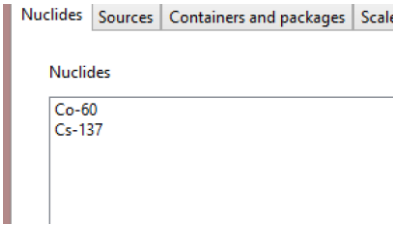
Tutorial 9. Sealed sources – system description

Start SAFRAN
Create new SAFRAN project with the title “Sealed sources” and save it with the same name

The “Project properties” dialog will appear



In the “Nuclides” tab – click “Add/remove nuclide” and select Co-60 and Cs-137



Select tab “Sources” and (using the button “Add row”) enter the following information:

Source	Description	Nuclide	A1	Date	NT
Irradiator	In their working shield, Cat I	Cs-137	2.60E+13	Date of the exercise	10
Radiotherapy sources	In their working shield, Cat I	Co-60	7.40E+13	Date of the exercise	10

Select tab “Containers and packages”. Enter the following information:

Container	Description
Bare source	Source without shielding
Working shield for high activity sources	Depleted Uranium and lead

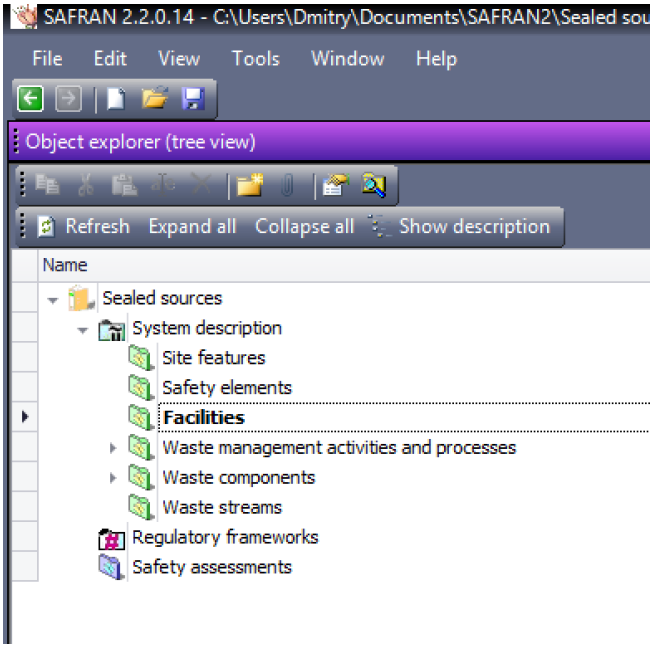
Capsule large	Stainless steel, typical dimensions 152mm long and inside diameter 48mm, thickness 4mm
Long term storage shield for high activity sources	It can contain several capsules

Column “Internal volume” can be left empty – its data are required only for containers of solid or liquid waste.

Close dialog “Project properties”

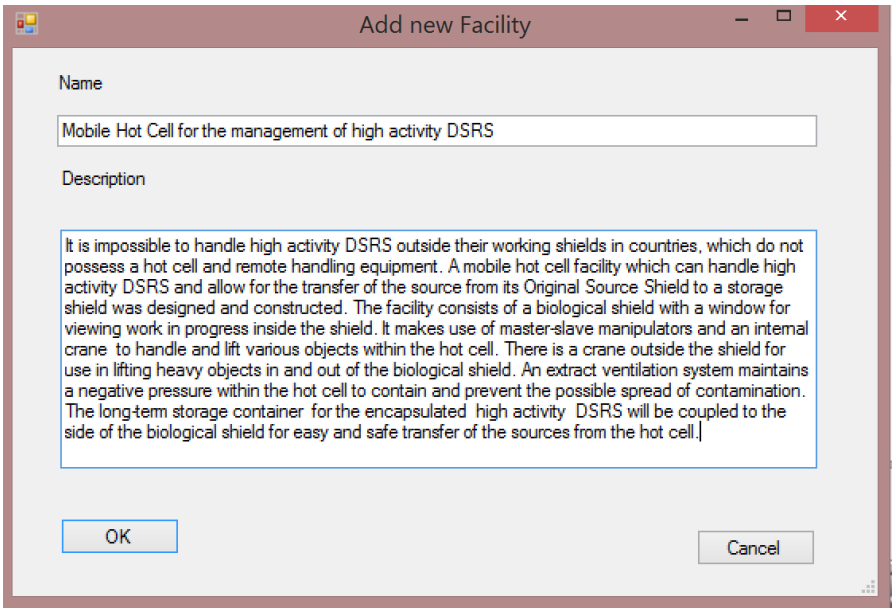
Create facility “Mobile Hot Cell for the management of high activity DSRS” with the following steps:

Expand node “Facilities”

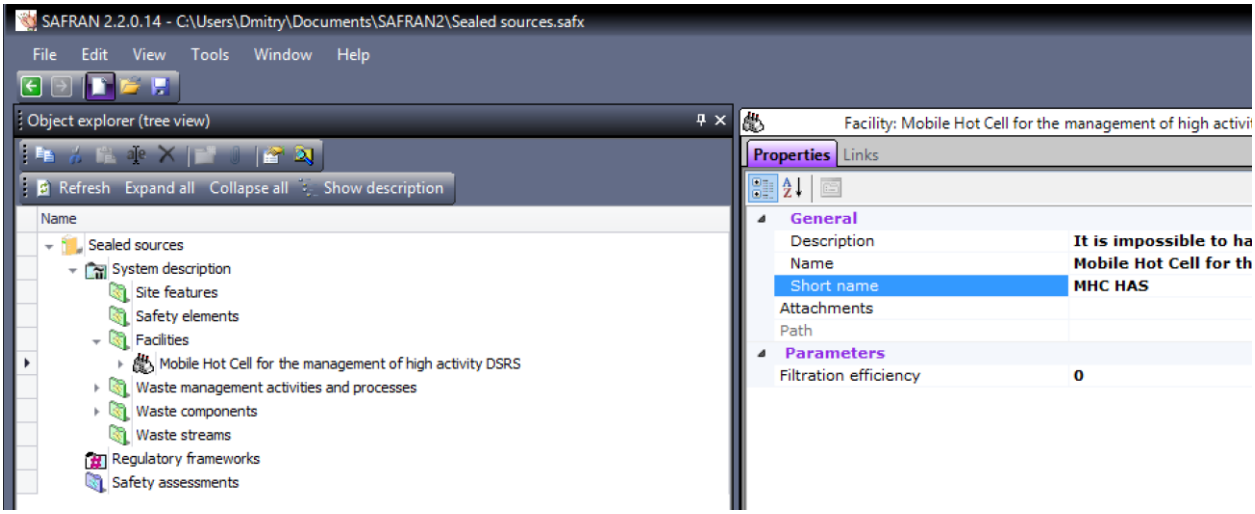


Righ-click on the node and select “Add Facility”.

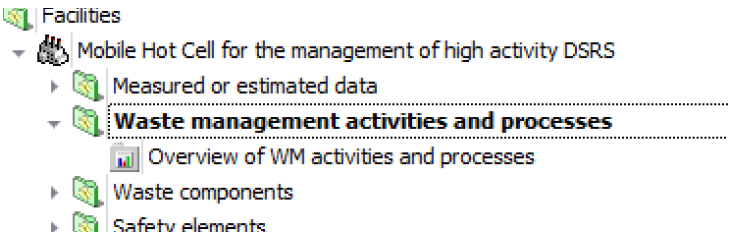
In the dialog which will appear – enter “Mobile Hot Cell for the management of high activity DSRS” in the field “Name”. The example in the picture below contains also description, while providing description is optional.



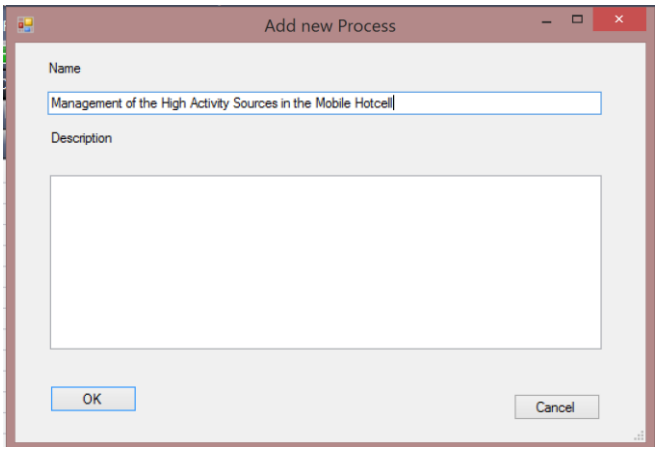
Place “MHC HAS” as a short name for this facility



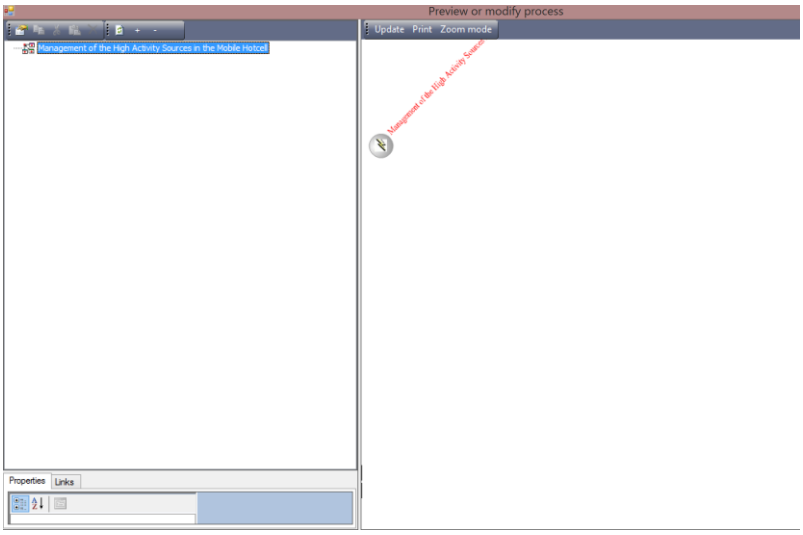
Expand node “Waste management activities and processes”



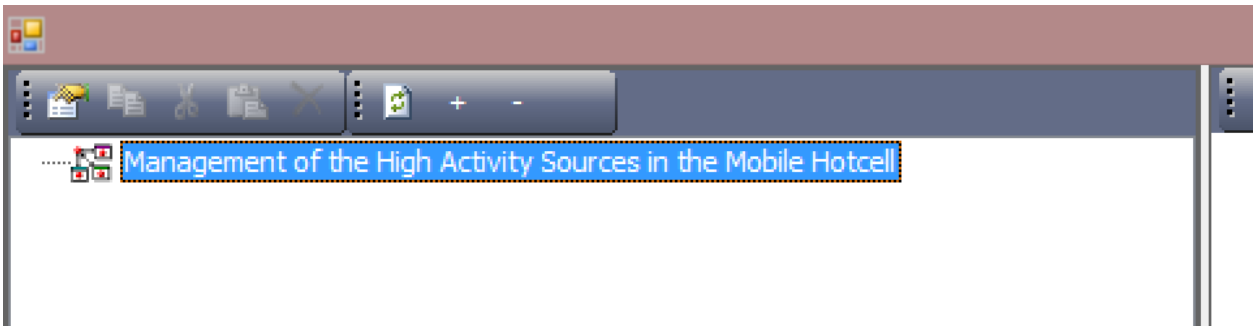
Right-click on it select “Add process” and give the process name “Management of the High Activity Sources in the Mobile Hotcell”



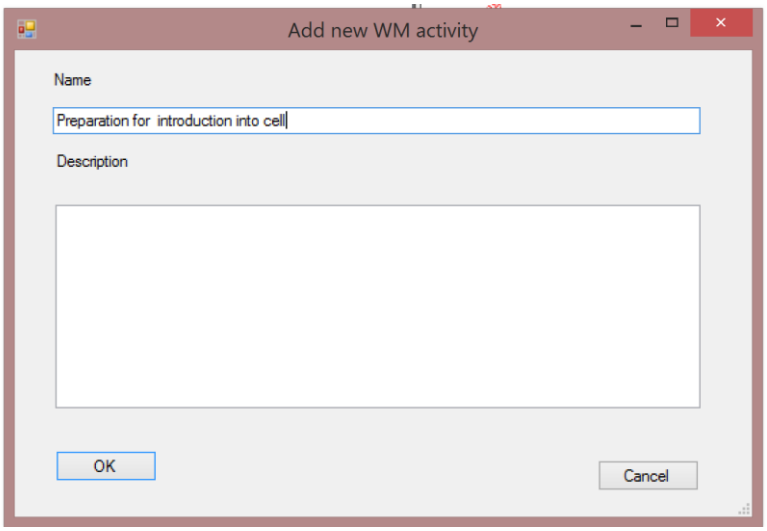
Double-click on the process node – the process diagram window will appear:



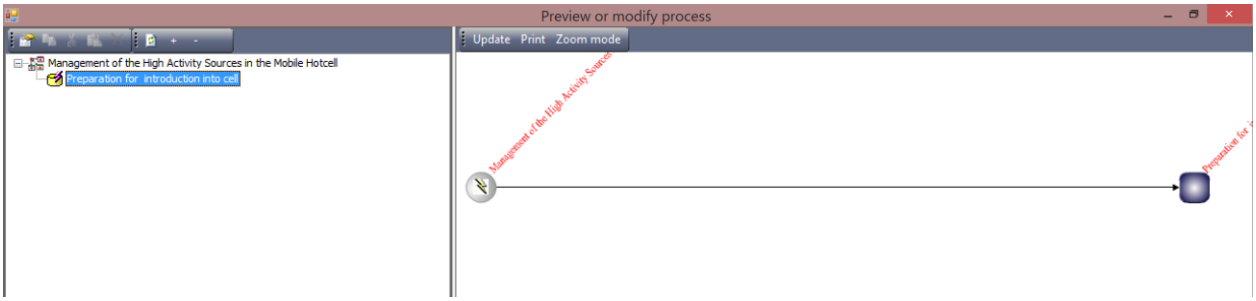
Right-click on the node “Management of the High Activity Sources in the Mobile Hotcell”



select “Add new activity” and give it name “Preparation for introduction into cell”



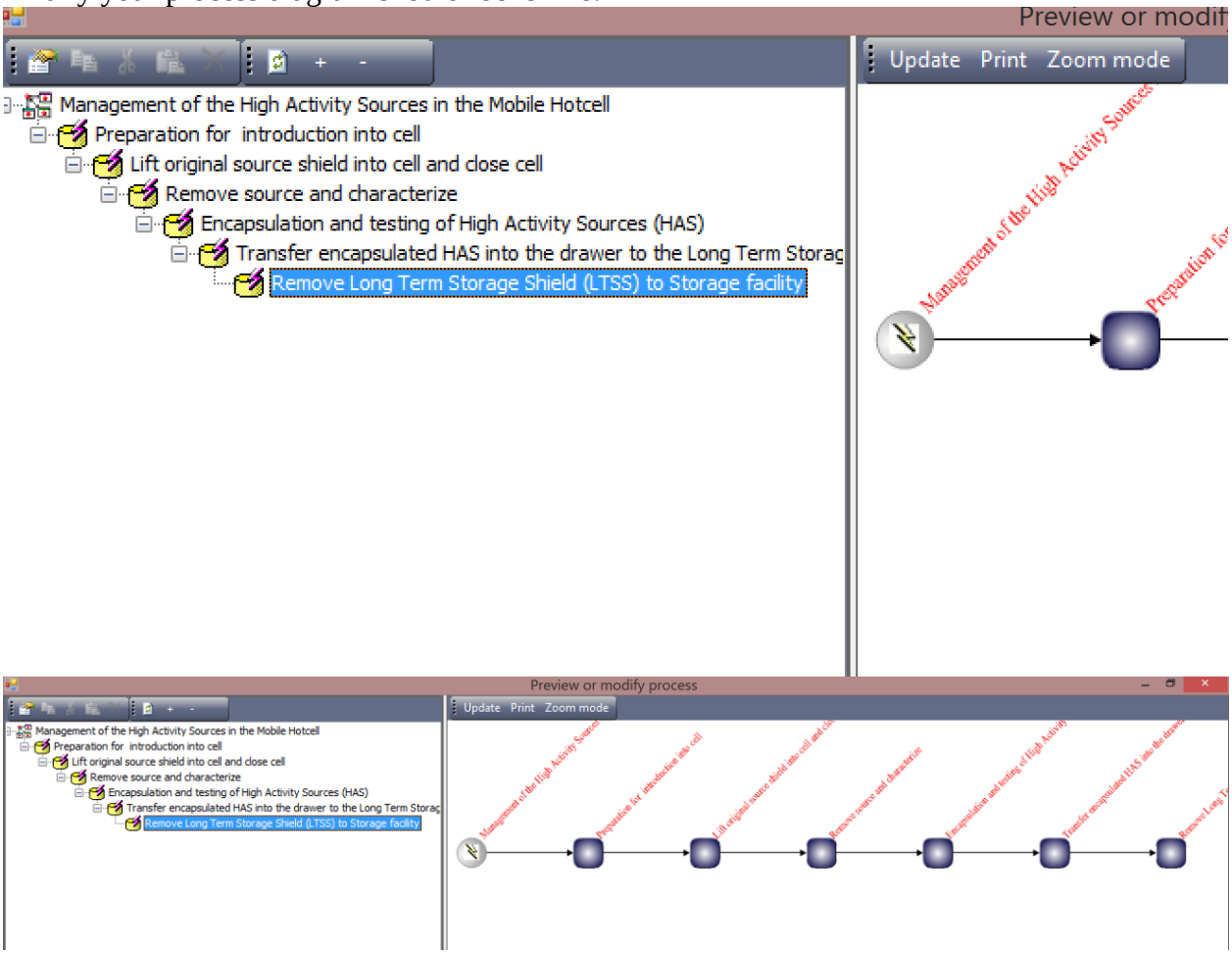
The process diagram will change:



Right-click on the node “Preparation for introduction into cell” and add new activity “Lift original source shield into cell and close cell”
Continue to add activities according to the table below:

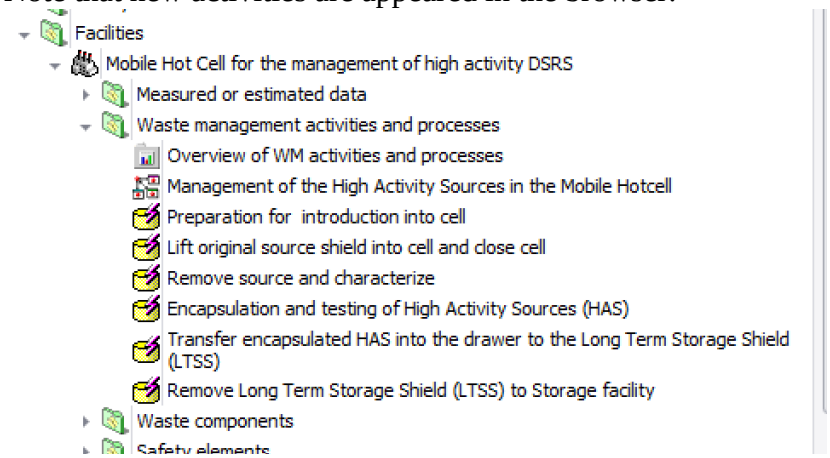
Activity
Preparation for introduction into cell
Lift original source shield into cell and close cell
Remove source and characterize
Encapsulation and testing of High Activity Sources (HAS)
Transfer encapsulated HAS into the drawer to the Long Term Storage Shield (LTSS)
Remove Long Term Storage Shield (LTSS) to Storage facility

Finally your process diagram should looks like:



Close the process diagram window.

Note that new activities are appeared in the browser:

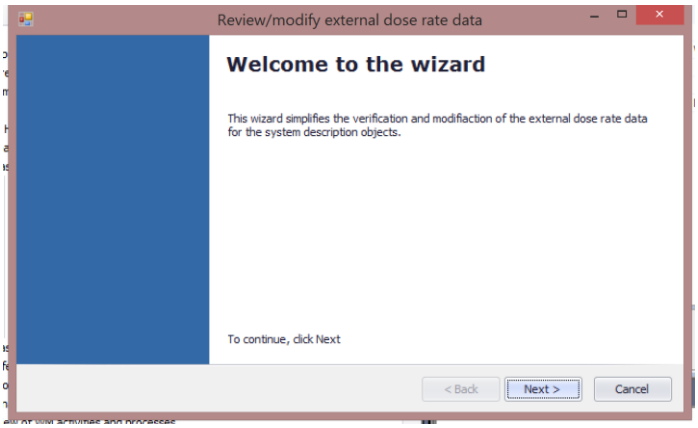


For tutorial purposes we assume that external exposure dose rate to worker for some of the activities is known from measurements (while for other is will be estimated depending on the sources involved):

Activity	External exposure dose rate Sv/h
Preparation for introduction into cell	
Lift original source shield into cell and close cell	
Remove source and characterize	2.2E-05
Encapsulation and testing of High Activity Sources (HAS)	4.1E-05
Transfer encapsulated HAS into the drawer to the Long Term Storage Shield (LTSS)	
Remove Long Term Storage Shield (LTSS) to Storage facility	

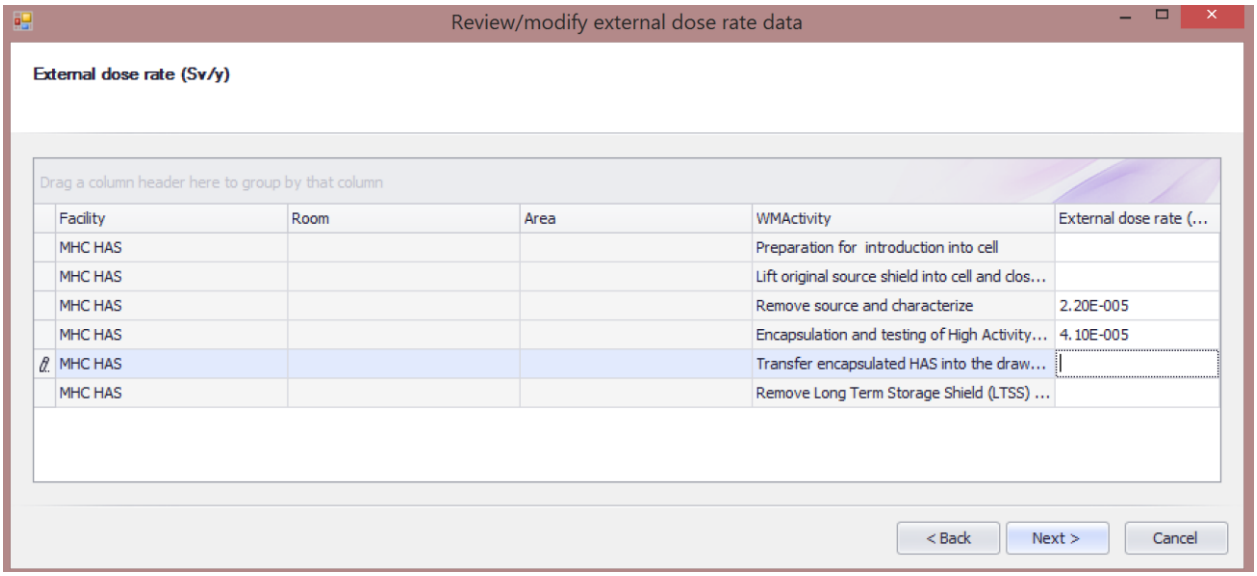
Right-click on the node “Waste management activities and processes” and select “Verify/modify external dose rate data”

The wizard will appear



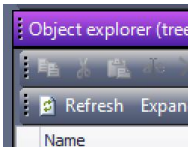
Click “Next”

Enter data according to the table above

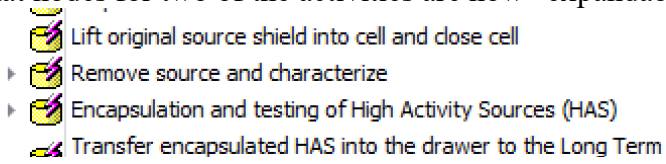


Click “Next” and then “Finish”

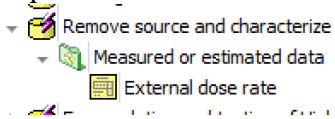
Click on the “Refresh” button located on the toolbar of the browser



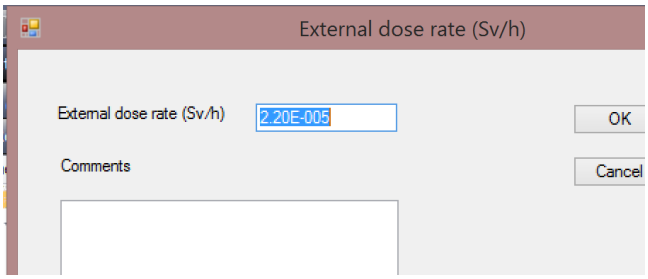
Note that nodes for two of the activities are now “expandable”



Expand node “Remove source and characterize”



Double-click on the “External dose rate” to see the alternative way to enter/modify external dose rate data.

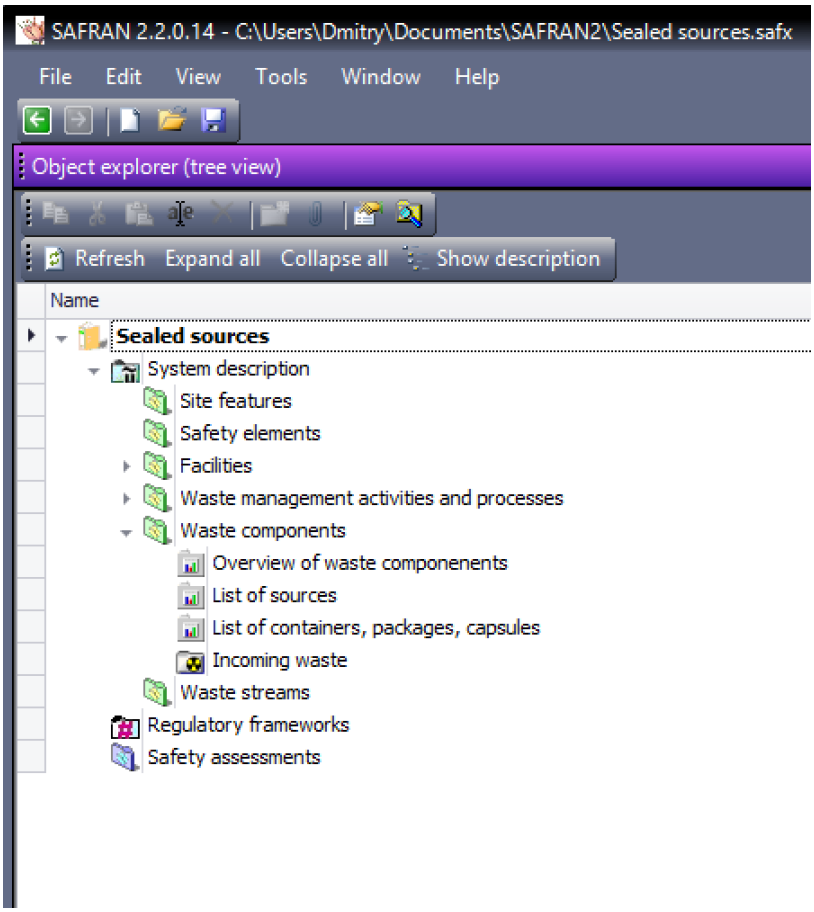


Click Ok or Cancel

For simplicity we assume that there are no radionuclides present in the air (which means that concentration in the air for all nuclides is equal to 0 and all the doses to worker under normal operation are obtained because of the external exposure). If you like later in your safety assessment to account dose from inhalation for the assessments of the type 'Direct external exposure and exposure via inhalation' you need to specify concentration in the air for the facility or for individual waste management activities (See Tutorial 3, pp. 26 -27)

Waste components

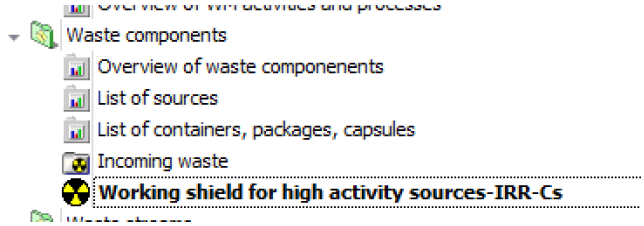
Collapse the "Facilities" node and expand node "Waste components" located under the "System description" folder:



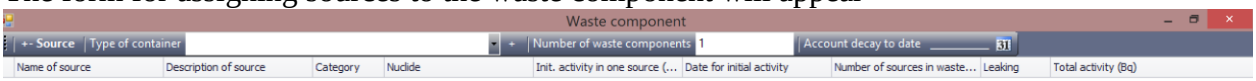
Right click on the node "Waste components" and select "Add waste component with type 'Sealed sources'"

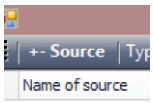
Give the new waste component name "Working shield for high activity sources-RT-Co"

Double-click on the waste component node



The form for assigning sources to the waste component will appear

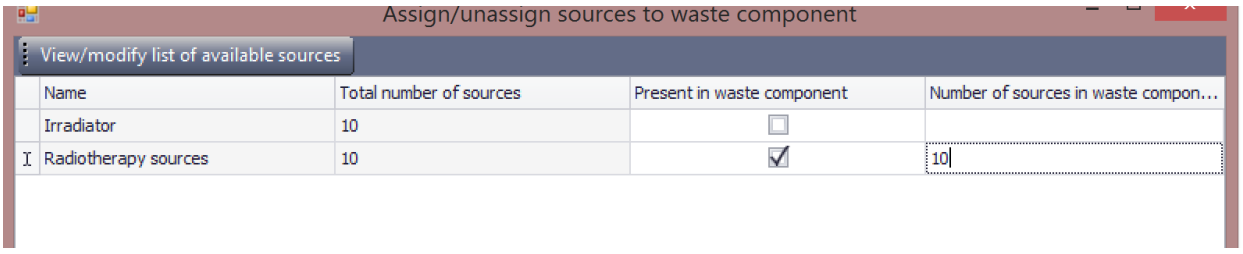


Click on the "+-Source" button 

In the dialog which will appear – check the checkbox in the column "Present in waste component" for "Irradiator"

Click in the next column "Number of sources in the waste component"

System will suggest you 10 (the total number of sources).



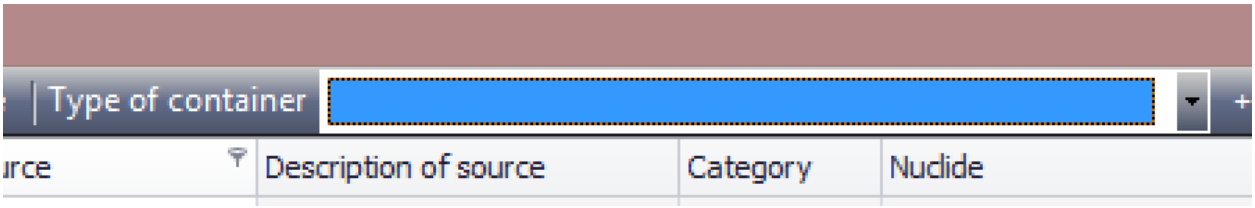
But one waste component will contain only one source – change 10 to 1

Close the sources selection dialog

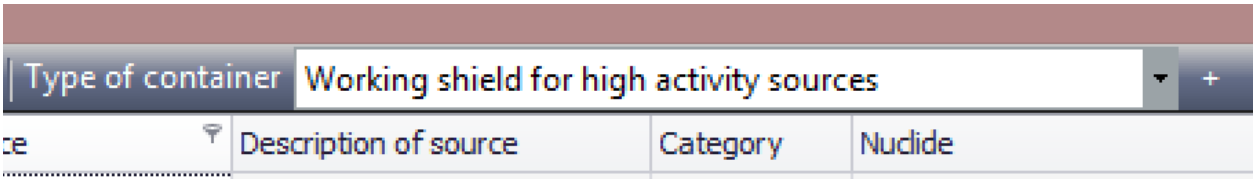
Now the form for waste component will looks like:

(the date for initial activity will be different, but it is not important unless you are accounting decay, to have exactly the same picture you need to change date of source activity measurement to 2014-04-03 in the Project properties)

Expand combo-box located near the label “Type of container”

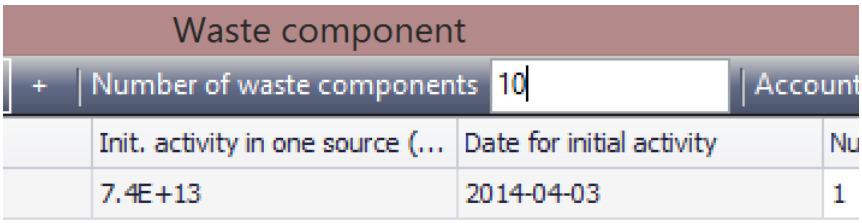


Select “Working shield for high activity sources”



Because the total number of radiotherapy sources is 10 we will have 10 waste components arriving to the Hot Cell facility.

Change the number of waste components to 10



Finally the waste component description will looks like:

Now the description of this waste component is completed.

Please note that form also allows you to account decrease of activity due to decay ("Account decay to date" control located on the toolbar).

Close the waste component form.

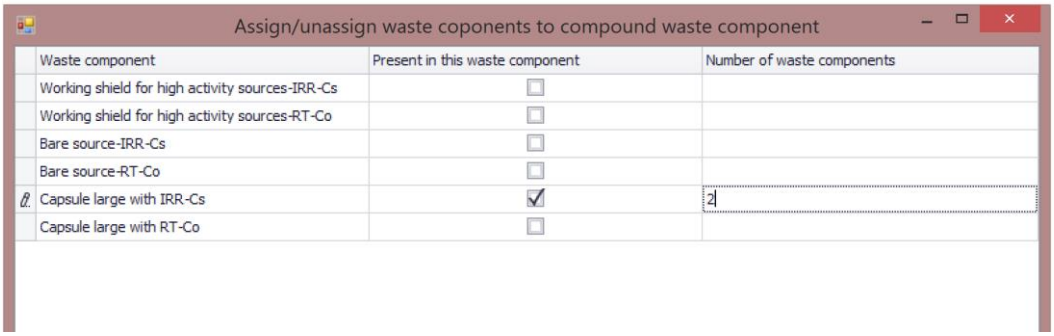
Add and describe other waste components according to the table below:

Waste component	Contain source(s)	Number of sources in the waste component	Type of container	Number of waste components
Working shield for high activity sources-IRR-Cs	Irradiator	1	Working shield for high activity sources	10
Working shield for high activity sources-RT-Co (already added)	Radiotherapy sources	1	Working shield for high activity sources	10
Bare source-IRR-Cs	Irradiator	1	Bare source	10
Bare source-RT-Co	Radiotherapy sources	1	Bare source	10
Capsule large with IRR-Cs	Irradiator	5	Capsule large	2
Capsule large with RT-Co	Radiotherapy sources	3	Capsule large	3

We will also add two more waste components representing long terms storage shields for the capsules above.

These waste components will be of the specific type – “waste components containing other waste components” (in some SAFRAN forms and menus they are also referred as “compound” waste components)
Right-click on the “Waste components node” and select “Add waste components containing other waste components with type ‘sealed sources’”. Give the new component name “Long term storage shield for high activity sources-Cs”.

Adding of the waste components to the “compound” waste component is similar to adding sources to the other waste components. To add waste component – use button “+-Waste component” located on the toolbar



Define properties of the “Long term storage shield for high activity sources-Cs” and add relevant component for Co-60 sources based on the table below.

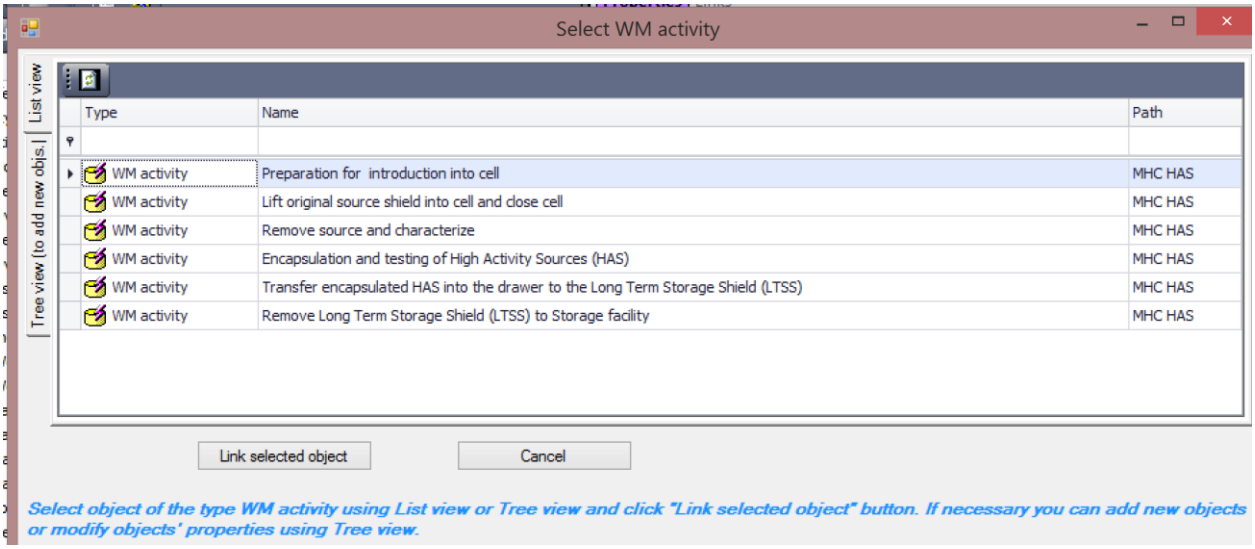
Compound waste component	Contains waste component(s)	Number of the included waste components	Type of container	Number of the compound waste components
Long term storage shield for high activity sources-Cs	Capsule large with IRR-Cs	2	Long term storage shield for high activity sources	1
Long term storage shield for high activity sources-Co	Capsule large with RT-Co	2	Long term storage shield for high activity sources	2

Linking waste components to the waste management activities

Right-click on the waste component “Working shield for high activity sources-IRR-Cs” and

select “Link WM activity” from the menu.

The window allowing you to select WM activity from the list will appear.



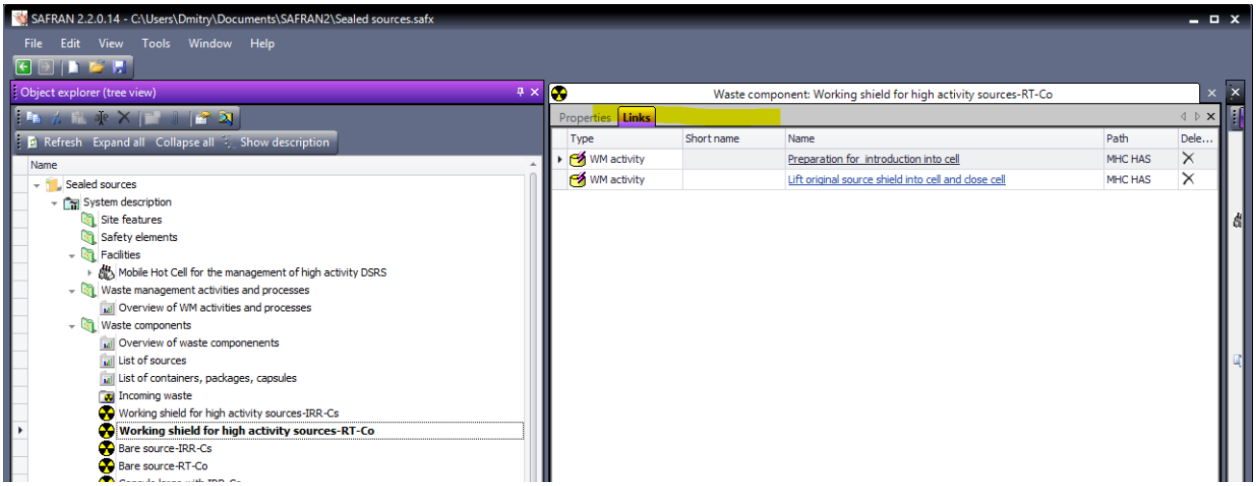
Select row “Preparation for introduction into cell” and click button “Link selected object”

Repeat the operation again and link this waste component also with the operation “Lift original source shield into cell and close cell”

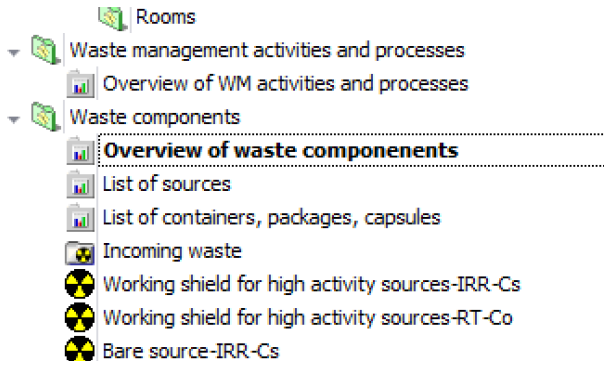
Link other waste components with the WM activities according to the table below.

Waste component	Activities
Working shield for high activity sources-IRR-Cs	Preparation for introduction into cell Lift original source shield into cell and close cell
Working shield for high activity sources-RT-Co	Preparation for introduction into cell Lift original source shield into cell and close cell
Bare source-IRR-Cs	Remove source and characterize Encapsulation and testing of High Activity Sources (HAS)
Bare source-RT-Co	Remove source and characterize Encapsulation and testing of High Activity Sources (HAS)
Capsule large with IRR-Cs	Encapsulation and testing of High Activity Sources (HAS) Transfer encapsulated HAS into the drawer to the Long Term Storage Shield (LTSS)
Capsule large with RT-Co	Encapsulation and testing of High Activity Sources (HAS) Transfer encapsulated HAS into the drawer to the Long Term Storage Shield (LTSS)
Long term storage shield for high activity sources-Cs	Remove Long Term Storage Shield (LTSS) to Storage facility
Long term storage shield for high activity sources-Co	Remove Long Term Storage Shield (LTSS) to Storage facility

You can preview the links to each waste component by selecting the “Links” tab of the “Properties and links” panel located in the middle of the window.



The other useful way to control linking between waste components and activities is to double-click on the node “Overview of waste components”.



If everything is linked correctly the table which will appear will remain the table just shown above (actually the table above was received by exporting of the “Overview of waste components” to Excel)

Save the project

Tutorial 10. Sealed sources – assessment for normal operation

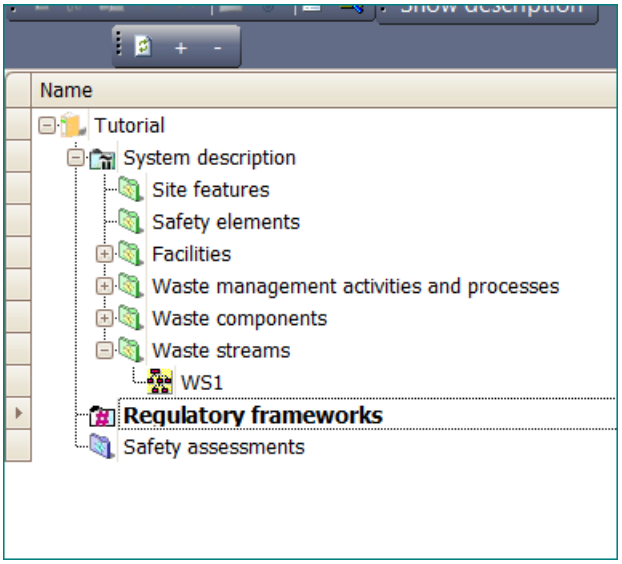
Regulatory framework

You will define the regulatory framework which is applicable to your safety assessment.

The list of criteria is shown in the table below:

Situation	Application	Criterion's name	Value	Unit
Normal	Worker	Dose limit to worker	0.02	Sv/y
Normal	Public	Dose limit to public	0.0003	Sv/y

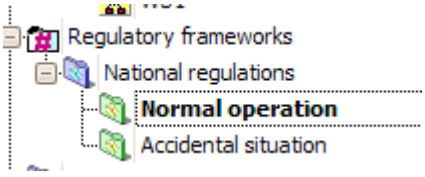
Locate "*Regulatory frameworks*" in the "***Object explorer (tree view)***" window.



Click on the "**Add regulatory framework**" in the "**Actions**" window (or right-click on the "*Regulatory frameworks*" node and select corresponding command from the context menu).

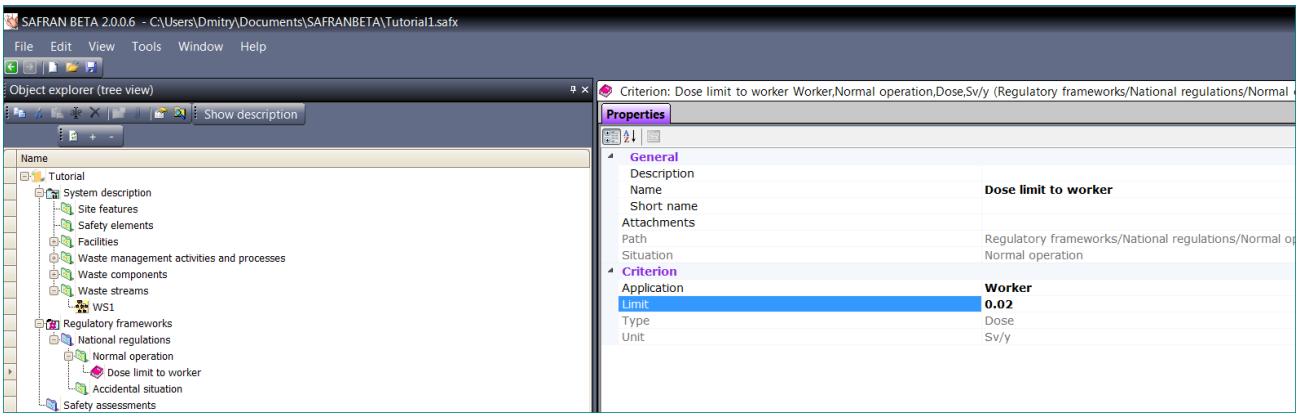
The new regulatory framework should be named "*National regulations*".

Locate the "*Normal operation*" folder under the "*National regulations*".

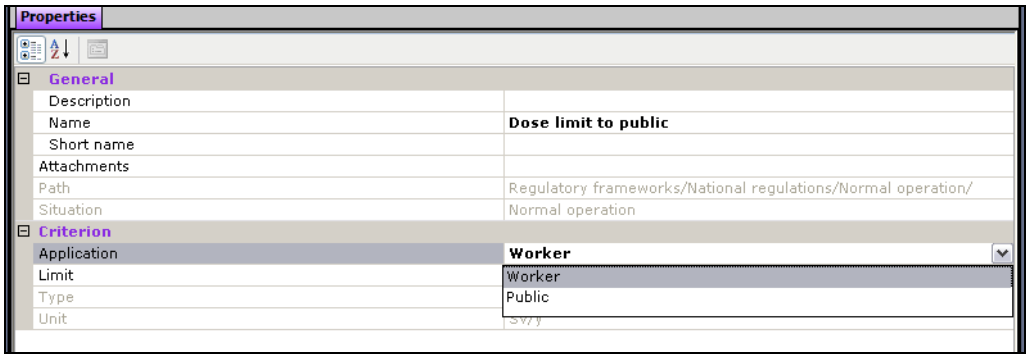


In the "**Actions**" window select "**Add criterion**". Specify the name "*Dose limit to worker*".

In the "Properties" window specify 0.02 as the **limit**. (see first row of the Table 5 shown at the beginning of this tutorial). Notice that unit is already set to Sv/y.



Click again on the "Normal operation" node and select again "**Add criterion**" command. Specify the name and properties for the criterion using second row of the table shown at the beginning of this section. Notice that "**Application**" property should be changed from "**Worker**" to "**Public**" as shown in the picture.



Safety assessment

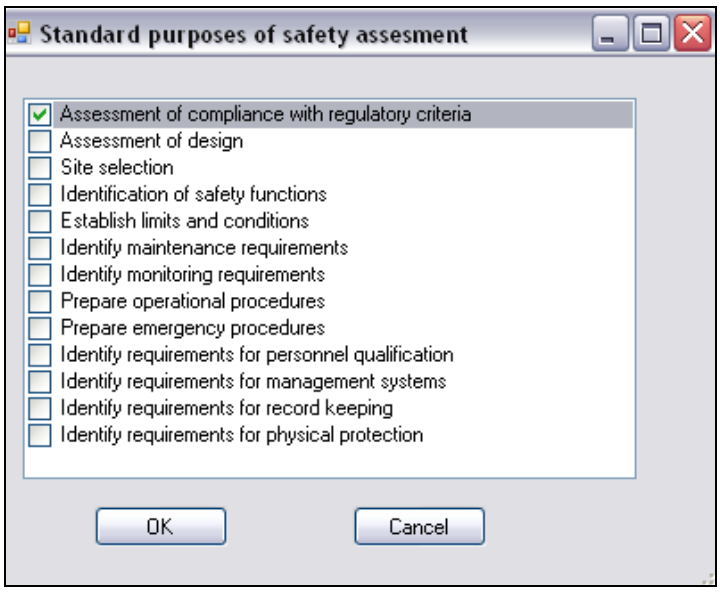
In this tutorial we will exercise in the assessment of impacts of the type 'External exposure' for normal operation as the most demonstrative case for the sealed sources. For other types of normal operation impacts (such as assessing dose to public due to the routine releases outside facility) and for assessments relevant to the accidental situation, please follow the Tutorial 7 sections "Advanced exercise: Assessing dose to public due to the normal release from processing facility", "Assessment for accidental situation" (general section describing PIE types, PIEs, scenarios etc.), "Dose assessment for accidental increase of the external exposure due to drop of the drum" and "Advanced exercise. Assessment of doses for workers and public due to the accidental release of radionuclides to the air".

In the "**Object explorer (tree view)**" window select the "*Safety assessments*" node.

Add the safety assessment "Safety assessment 1".

Expand the "Safety assessment 1" node.

Right-click on the "Purposes" node. Select "*Import standard purposes*". In the window that appears, select "*Assessment of compliance with regulatory criteria*" and confirm by clicking on "OK" button.

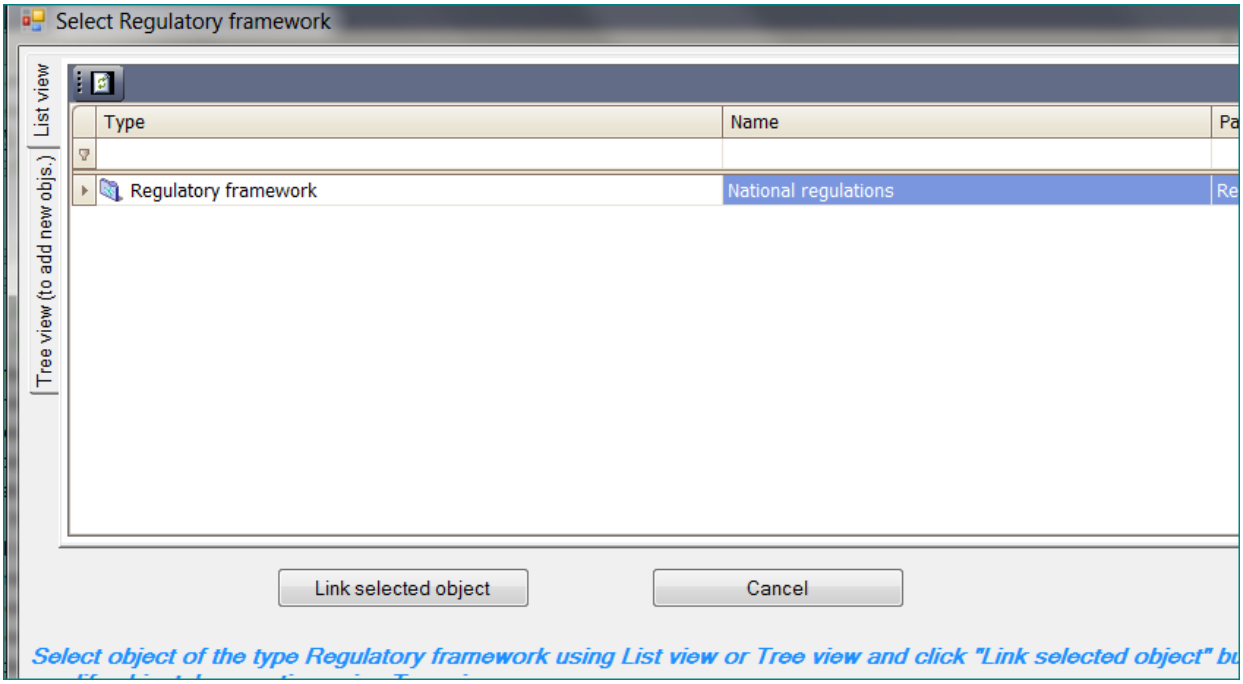


Scope automatically includes all the facilities, rooms, areas and WM activities defined in the system description. You need to change it if you like to exclude some facilities, rooms, areas or activities from the assessment. You can review the scope by right-click on the "Safety assessment 1/Scope" and select "Defile scope".

Link to the regulatory framework

Select the "Safety assessment 1" node and click "**Link Regulatory framework**" in the "**Actions**" window (or select this command from context menu).

In the window that appears, select "*National regulations*" and click the "**Link selected object**" button.



Assessment for impacts relevant to the external exposure under normal operation.

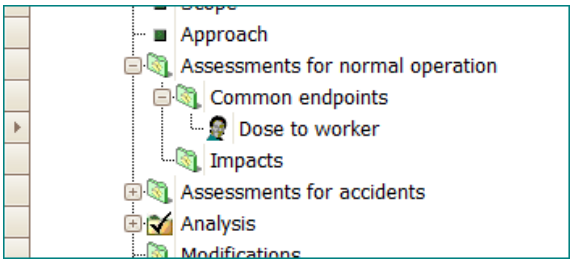
For assessment for normal operations, it is assumed that same worker is involved in all waste management activities and spends the following time for each activity[13]:

Table 10.1

Activity	External exposure dose rate Sv/h	Working time hours/per year
Preparation for introduction into cell	Will be estimated based on the waste components inventory	20
Lift original source shield into cell and close cell	Will be estimated based on the waste components inventory	10
Remove source and characterize	2.2E-05 (entered during the system configuration description)	25
Encapsulation and testing of High Activity Sources (HAS)	4.1E-05 (entered during the system configuration description)	30
Transfer encapsulated HAS into the drawer to the Long Term Storage Shield (LTSS)	Will be estimated based on the waste components inventory	5
Remove Long Term Storage Shield (LTSS) to Storage facility	Will be estimated based on the waste components inventory	10

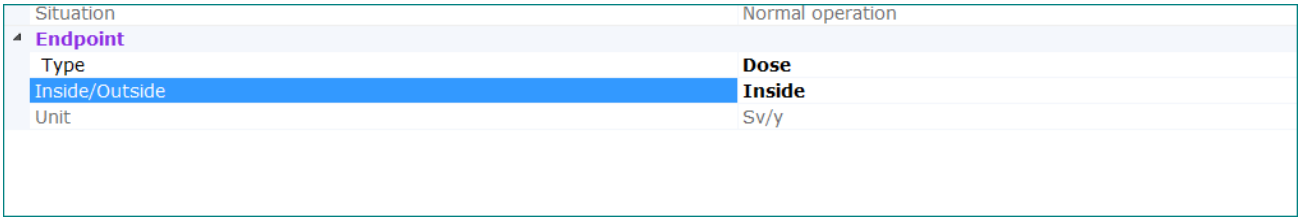
[13] During the description of the system configuration we assumed that for the WM activities which take place inside the cell dose rate for external exposure is known from the measurements. For other WM activities we will estimate it based on the inventory and shield characteristics of the waste components. For simplicity we also assumed that there are no radionuclides present in the air (which means that concentration in the air for all nuclides is equal to 0 and there is no doses from inhalation under normal operation). If you like to account dose from inhalation for the assessments of the type 'Direct external exposure and exposure via inhalation' you need to specify concentration in the air for the facility or for individual waste management activities (See Tutorial 3, pp. 26 -27)

Select the "*Assessment for normal operations/Common endpoints*" node and select "Add endpoint" command.
Common endpoint will be used in all assessments and will "accumulate" all the doses calculated in these assessments.
Add the "*Dose to worker*" endpoint.



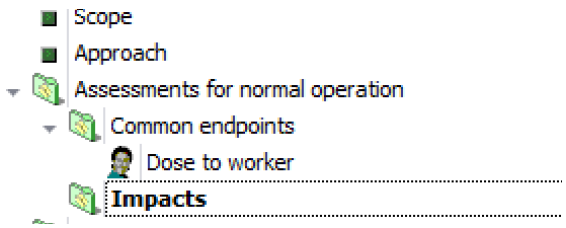
Set the properties of the endpoint:

- Type – *Dose*
- Inside/Outside – *Inside*

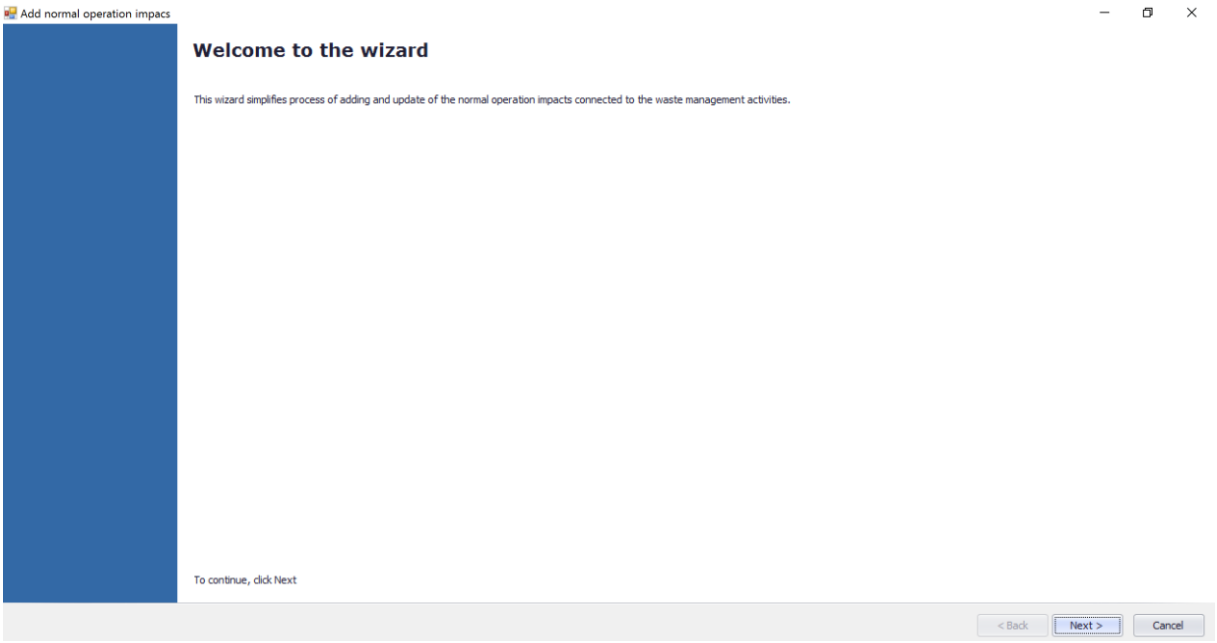


Select the "*Dose to worker*" node and click "**Link criterion**" in the "**Actions**" window. In the window that appears - select "*Dose limit to worker*" for Normal operation and click the "**Link selected object**" button.

Select the "*Assessment for normal operation/Impacts*" node and select command "Wizard / Add/modify impacts for WM activities".

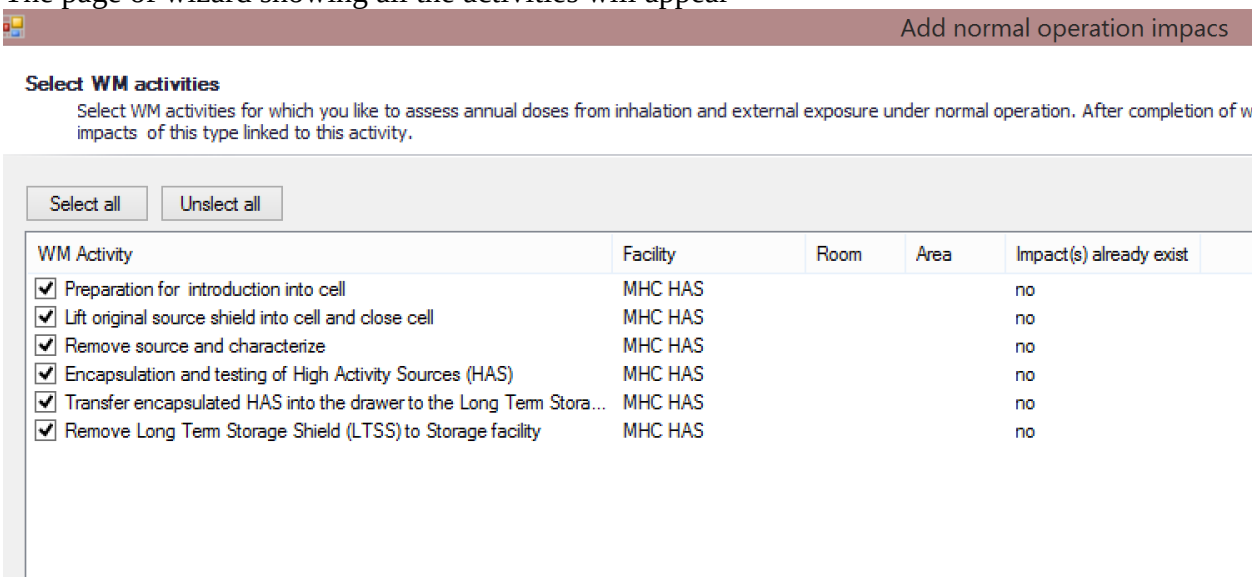


The wizard will be started.



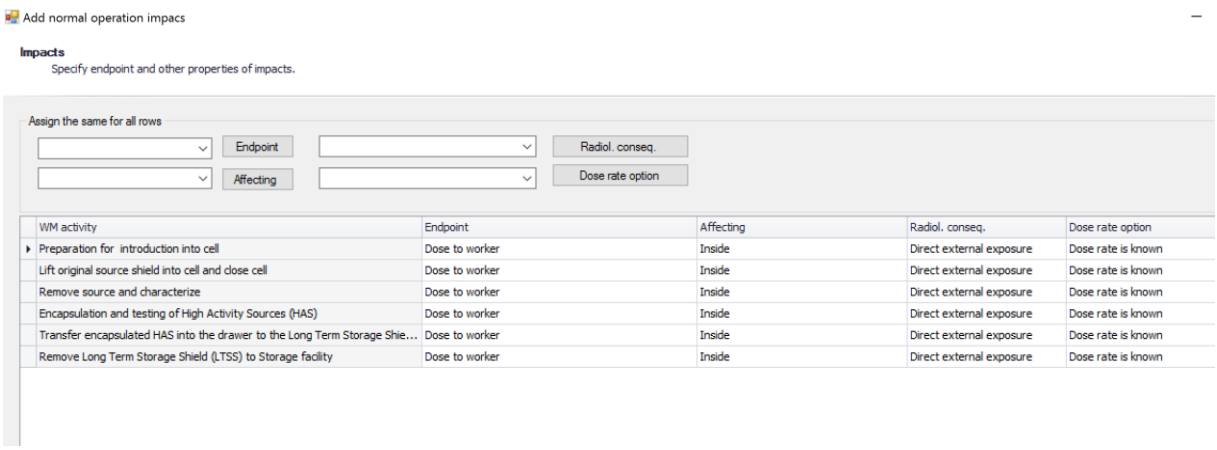
Click “Next”

The page of wizard showing all the activities will appear



Select all the activities (if not selected) and click the “Next” button.

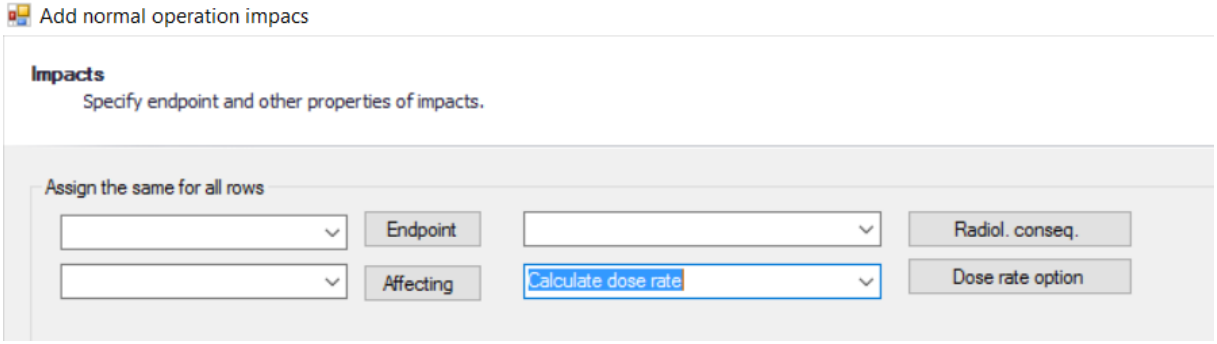
Next page will contain the table defining by default the endpoint “Dose to worker” and radiological consequences “Direct external exposure” for all impacts.



WM activity	Endpoint	Affecting	Radiol. conseq.	Dose rate option
Preparation for introduction into cell	Dose to worker	Inside	Direct external exposure	Dose rate is known
Lift original source shield into cell and close cell	Dose to worker	Inside	Direct external exposure	Dose rate is known
Remove source and characterize	Dose to worker	Inside	Direct external exposure	Dose rate is known
Encapsulation and testing of High Activity Sources (HAS)	Dose to worker	Inside	Direct external exposure	Dose rate is known
Transfer encapsulated HAS into the drawer to the Long Term Storage Shie...	Dose to worker	Inside	Direct external exposure	Dose rate is known
Remove Long Term Storage Shield (LTSS) to Storage facility	Dose to worker	Inside	Direct external exposure	Dose rate is known

The dose rate associated with each waste management activity by default is assumed to be known in advance (column “Dose rate option”). According to the description of waste management activities in the Table 10.1 this is true only for two activities – “Remove source and characterize” and “Encapsulation and testing of High Activity Sources (HAS)”. For all other activities the dose rate will be calculated based on the waste components’ radionuclide inventory and container properties.

Select “Calculate dose rate” in the list located near the ”Dose rate option” button and click “Dose rate option” button.

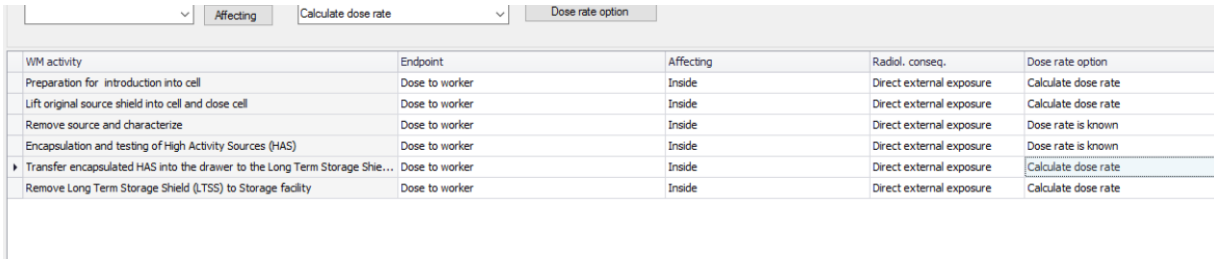


This will assign option “Calculate dose rate” to all rows.

WM activity	Endpoint	Affecting	Radiol. conseq.	Dose rate option
Preparation for introduction into cell	Dose to worker	Inside	Direct external exposure	Calculate dose rate
Lift original source shield into cell and close cell	Dose to worker	Inside	Direct external exposure	Calculate dose rate
Remove source and characterize	Dose to worker	Inside	Direct external exposure	Calculate dose rate
Encapsulation and testing of High Activity Sources (HAS)	Dose to worker	Inside	Direct external exposure	Calculate dose rate
Transfer encapsulated HAS into the drawer to the Long Term Storage Shie...	Dose to worker	Inside	Direct external exposure	Calculate dose rate
Remove Long Term Storage Shield (LTSS) to Storage facility	Dose to worker	Inside	Direct external exposure	Calculate dose rate

Change value in the “Dose rate option” column for “Remove source and characterize” and “Encapsulation and testing of High Activity Sources (HAS)” by selection in the list available after click in the corresponding cell.

Finally the table should look like:



WM activity	Endpoint	Affecting	Radiol. conseq.	Dose rate option
Preparation for introduction into cell	Dose to worker	Inside	Direct external exposure	Calculate dose rate
Lift original source shield into cell and close cell	Dose to worker	Inside	Direct external exposure	Calculate dose rate
Remove source and characterize	Dose to worker	Inside	Direct external exposure	Dose rate is known
Encapsulation and testing of High Activity Sources (HAS)	Dose to worker	Inside	Direct external exposure	Dose rate is known
Transfer encapsulated HAS into the drawer to the Long Term Storage Shie...	Dose to worker	Inside	Direct external exposure	Calculate dose rate
Remove Long Term Storage Shield (LTSS) to Storage facility	Dose to worker	Inside	Direct external exposure	Calculate dose rate

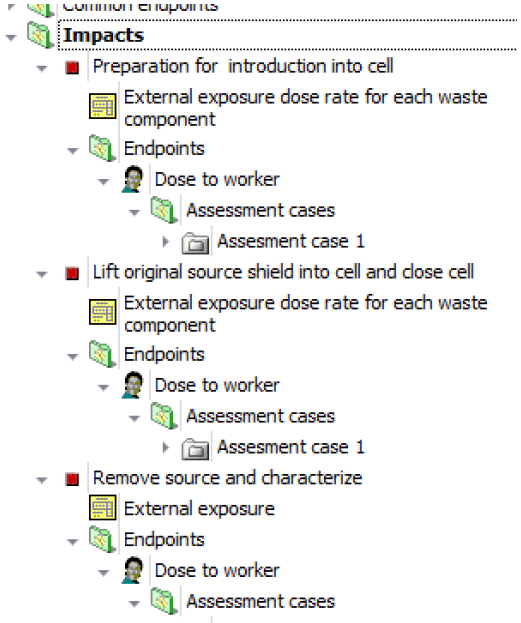
The values in the last column are:

	Dose rate option
'e	Calculate dose rate
'e	Calculate dose rate
'e	Dose rate is known
'e	Dose rate is known
'e	Calculate dose rate
'e	Calculate dose rate

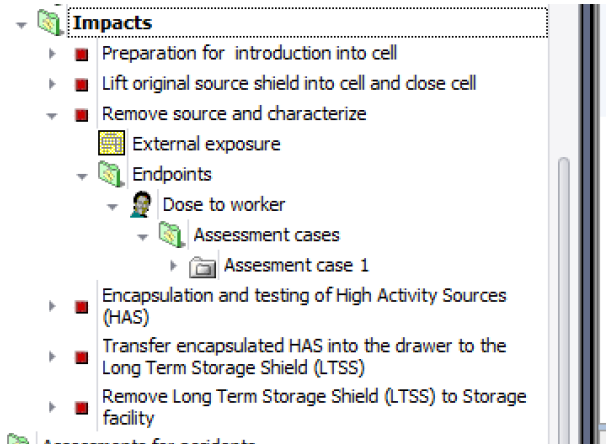
Click on the “Next” button

On the next page click button “Finish”. You might need to wait a bit until all impacts will be created.

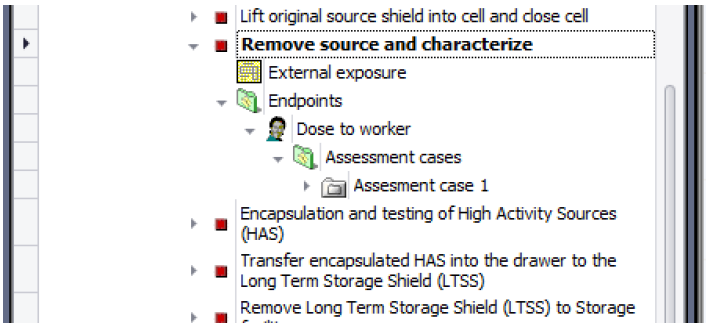
The new impacts will be added in the “Impacts” folder.



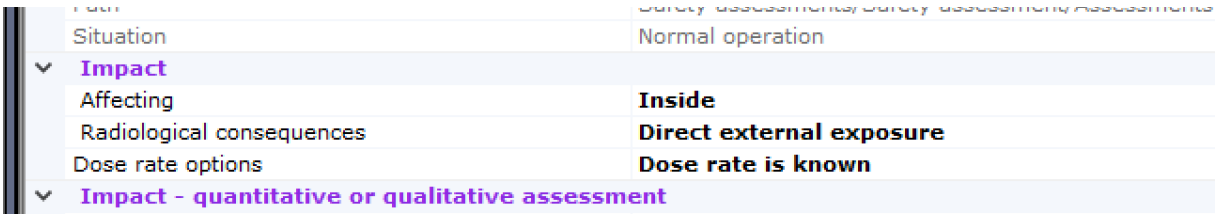
Collapse all impact objects except on the node “Remove source and characterize” – first of impacts where external dose rate associated with activity is known in advance.



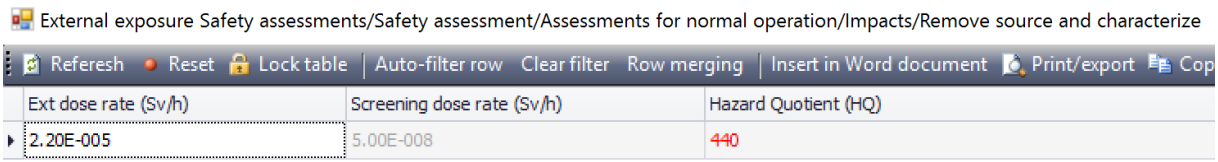
Select “Remove source and characterize”



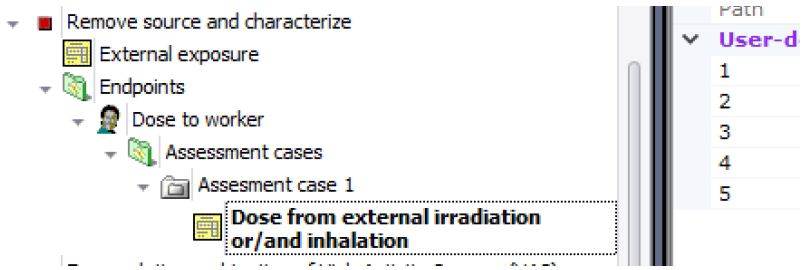
Observe the properties of this impact:



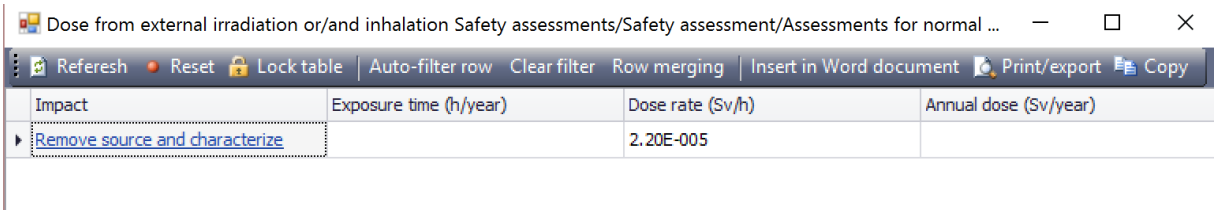
Double-click on the table “External exposure”.



Red color for value in Hazard Quotient shows that detailed dose assessment is required.
Expand the node “Assessment case 1” and double-click on the table “Dose from external irradiation or/and inhalation”

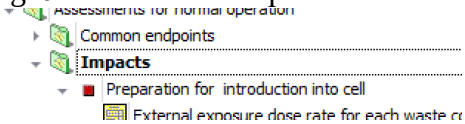


The dose rate value is taken from the table “External exposure”.



To calculate annual activity the exposure time associated with waste management activity “Remove source and characterize” have to be specified. According to the table of activities it is 25 hours/year. It is possible to enter it directly in the table “Dose from external radiation…” but the other possibility is to define all the exposure times associated with all activities with wizard.

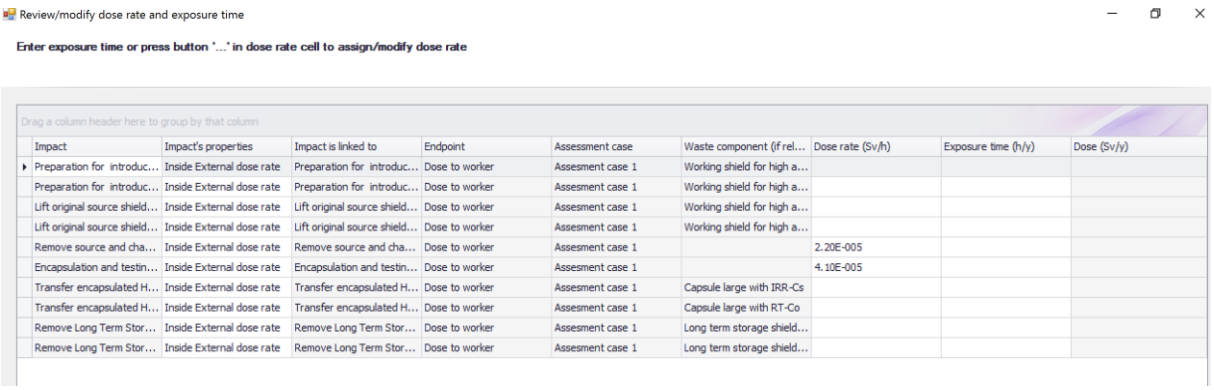
Right-click on the “Impacts” node



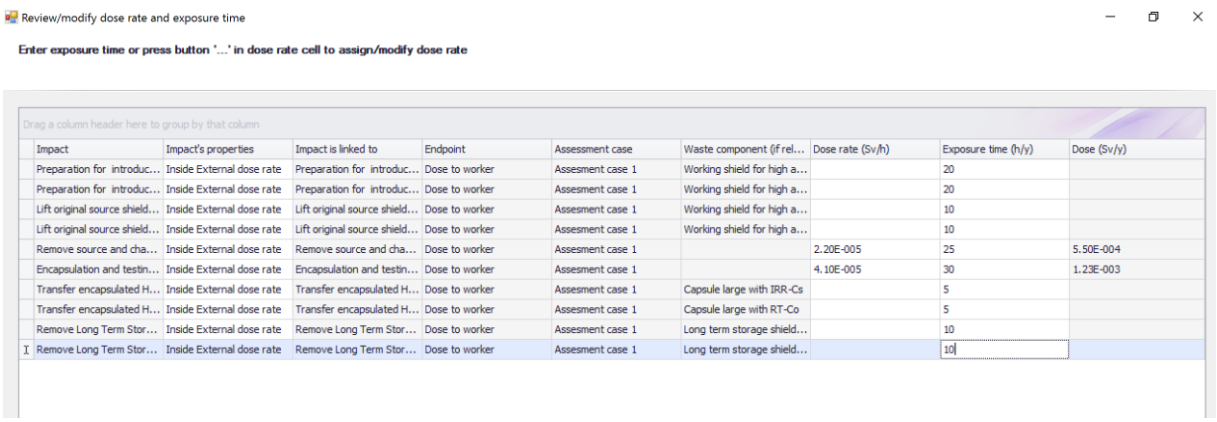
and select the command “Wizard – specify/modify exposure time and dose rate for impacts”.

Click “Next” on the first page of the wizard.

The table on the next page will look like:

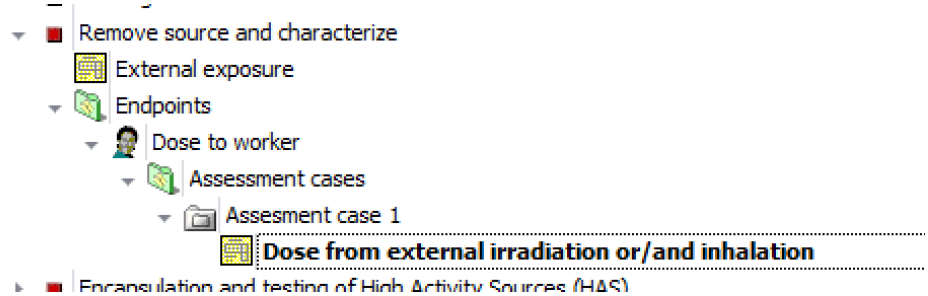


Enter in the column “Exposure time (h/y)” the exposure time associated with each activity according to the Table 10.1[14].

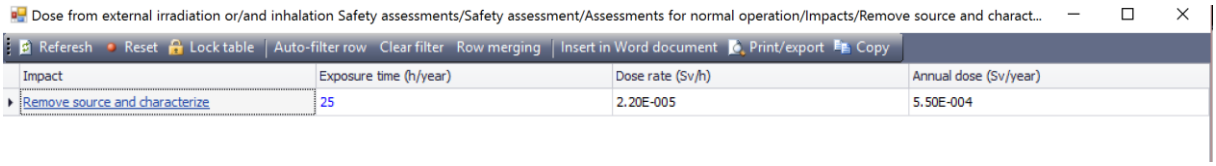


Click “Next” and then (on the next page), “Finish”

Double-click again on the table “Dose from external irradiation or/and inhalation…” for the impact “Remove source and characterize”.

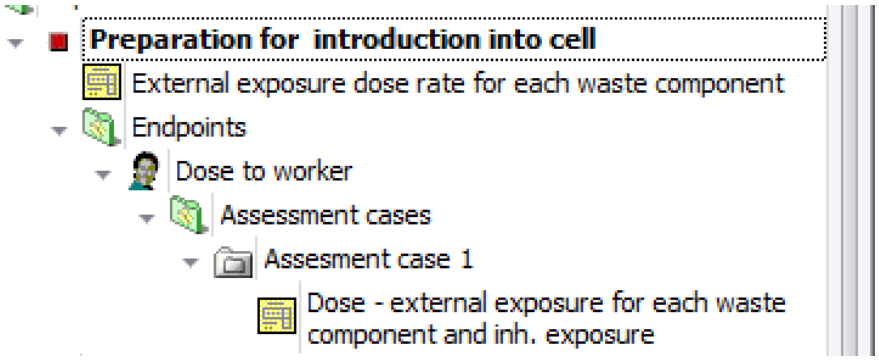


Note that exposure time is now appeared in the table and the annual dose is calculated.

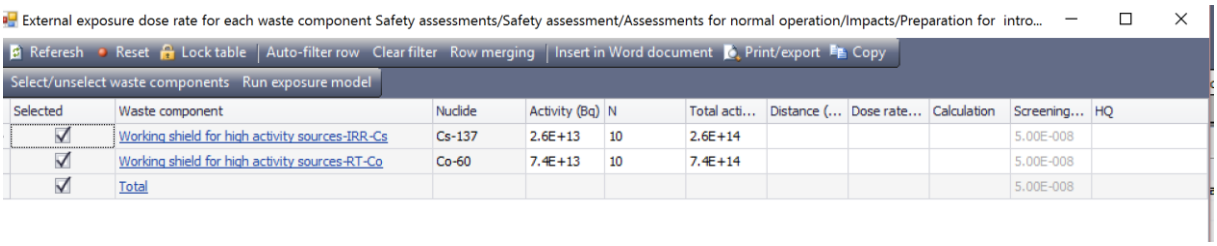


Select and expand the impact “Preparation for introduction into cell” – the first of the impacts, where it was selected to estimate dose rate for external exposure for each waste component individually.

[14] Note that while for simplicity Table 10.1 specifies one exposure time for each activity it is possible to specify different exposure time for each waste component involved.



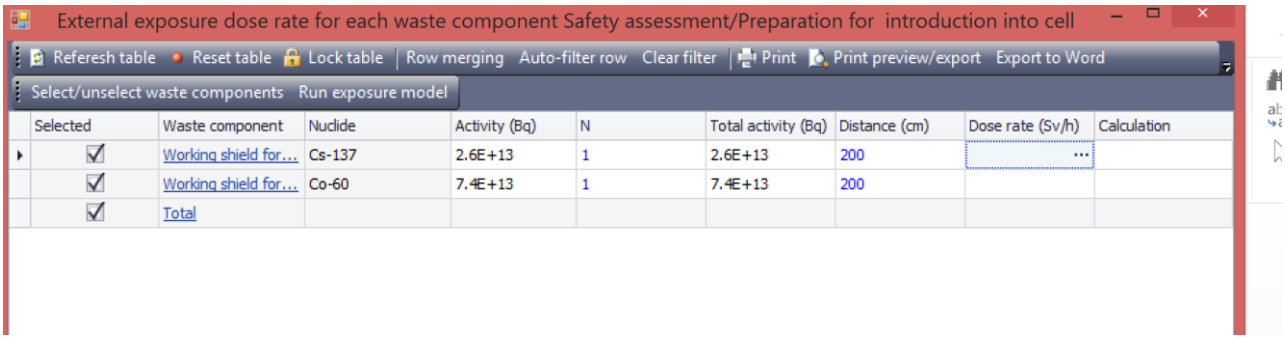
Double-click on the table “External exposure dose rate for each waste component”.



Note that by default the number of the waste components shown in the table is 10 (all waste components).

Change this number to 1 (assuming that it is only one waste component at the time).

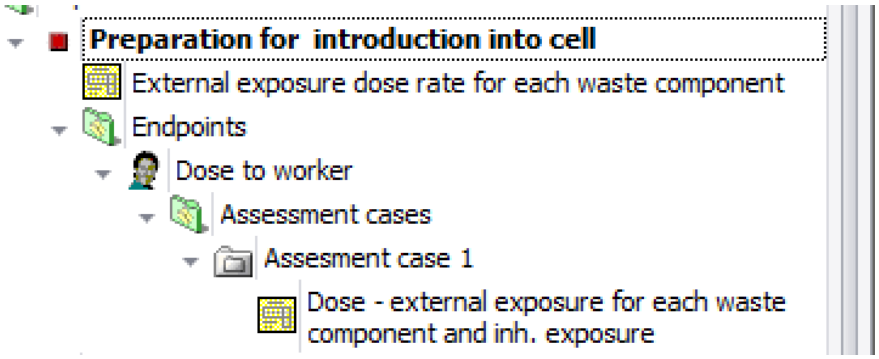
Specify the distance to the source (200 cm)



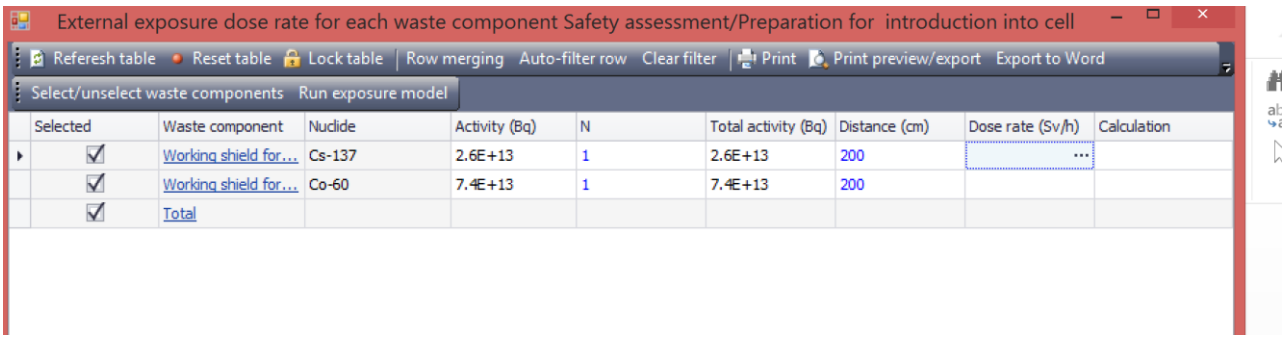
In the next tutorial the dose rates for waste components enumerated in this table be calculated using the SAFCALC tool and SAFRAN exposure models (see Annex III to the IAEA SADRWMS Methodology document).

Tutorial 11. Dose rate estimation for normal operation with SAFRAN exposure models

If necessary - open the project created for Tutorial 10 and double click on the table “External exposure dose rate” of the normal operation impact “Preparation for introduction into cell”

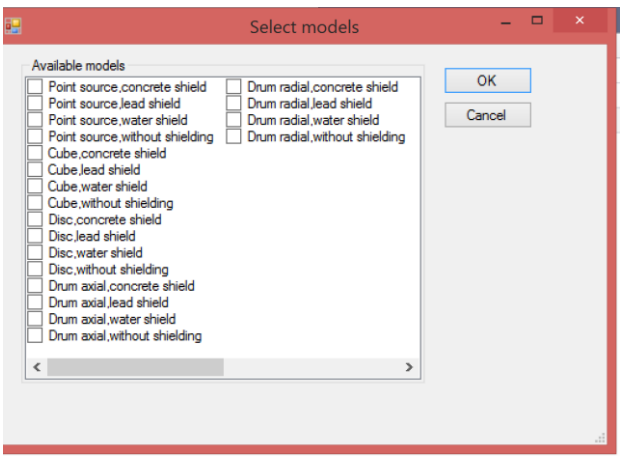


Click in the cell “Dose rate (Sv/h)” of the first row (Cs-137 source)

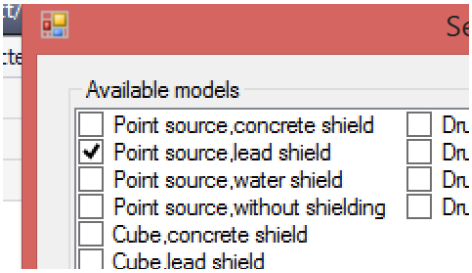


Click on the “Run exposure model” located on the toolbar or double-click on the “…” button appearing in the right part of the cell.

The model selection window will appear

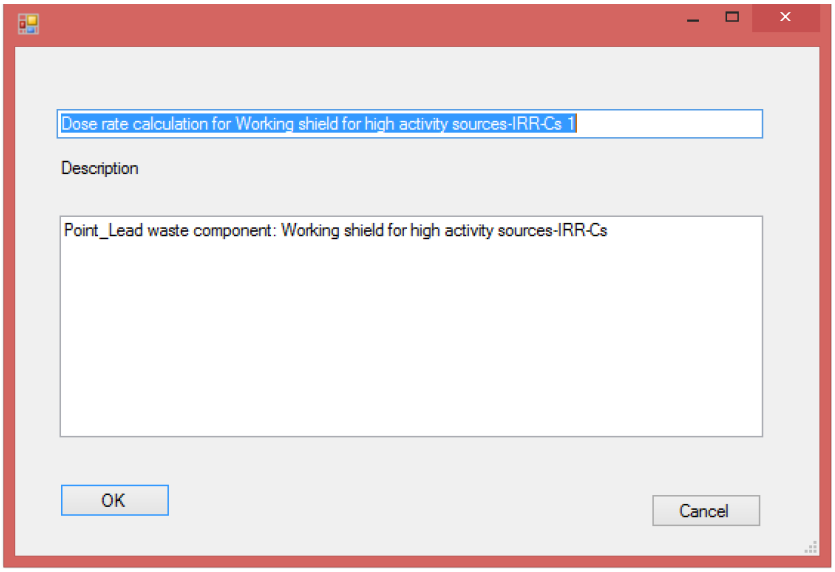


Select “Point source, lead shield”



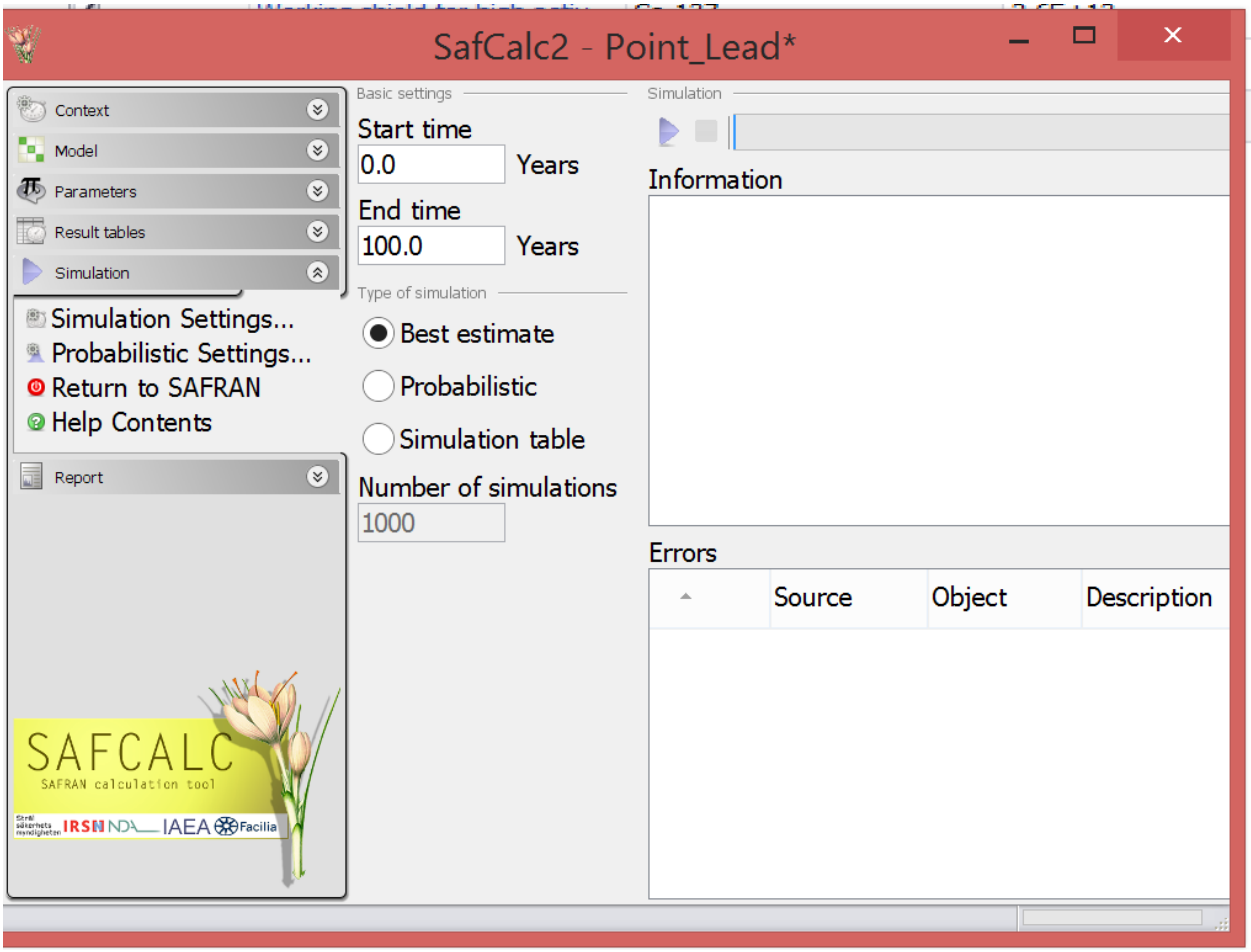
Click OK

The dialog allowing you to change the name and description of the calculation will appear:

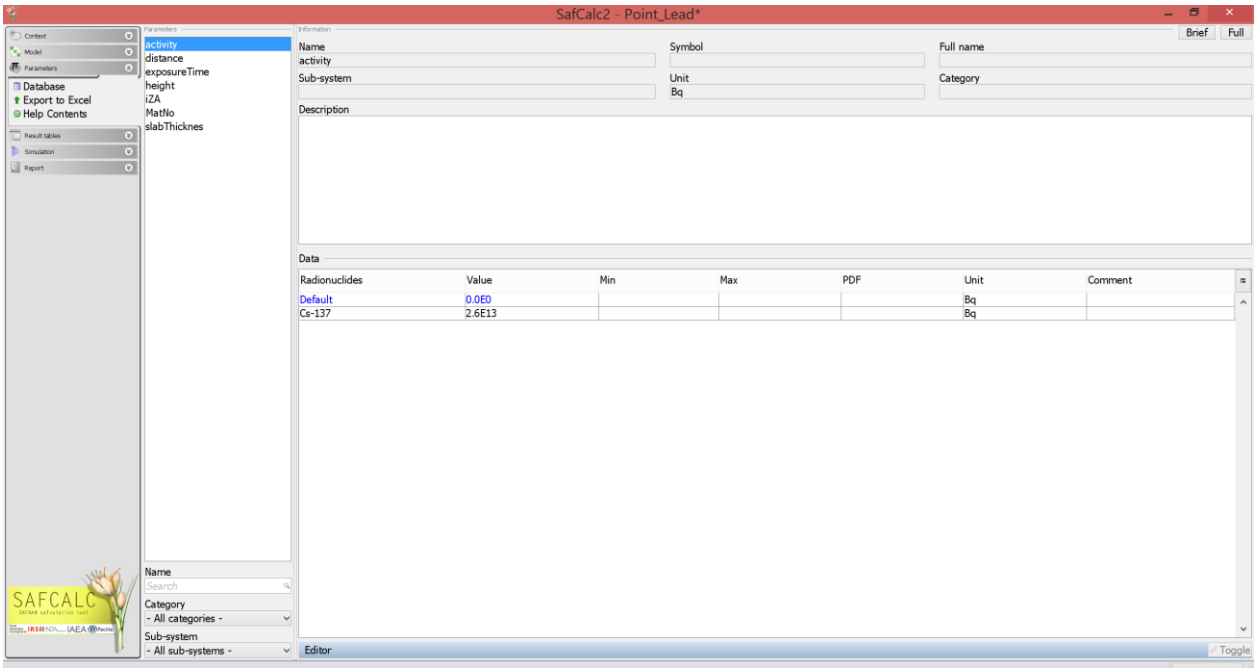


Click OK

The SafCalc2 window will appear



Maximize it and select the “Parameters” tab

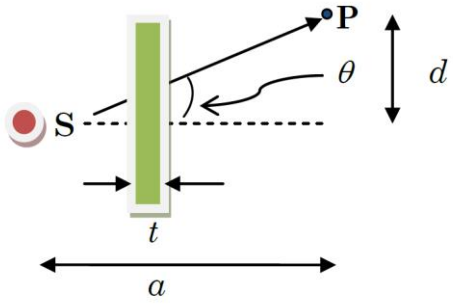


There is a list of parameters including “activity”, “distance”, “height” and “slabThicknes”.

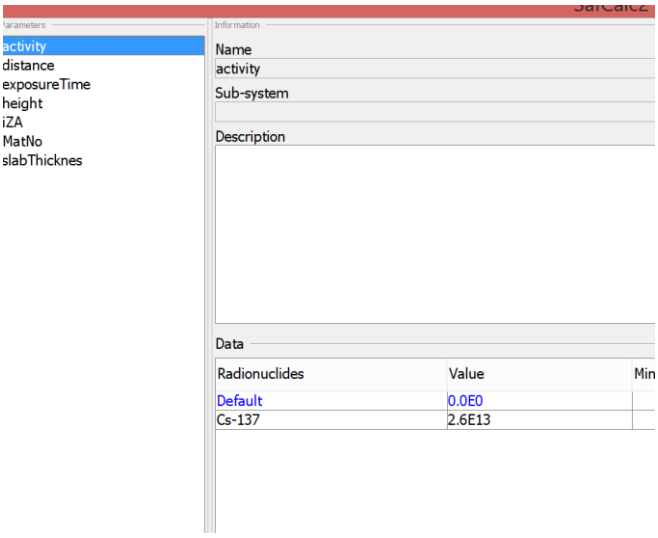
Below is the corresponding picture from the Annex 3 of SADRWMS Methodology Guide

2 Dose rates for different geometries

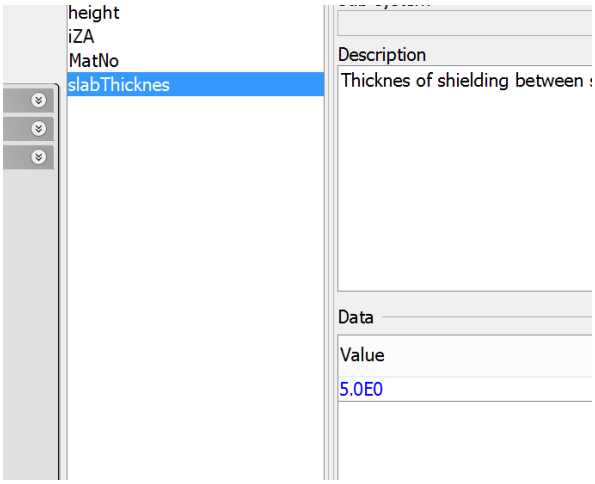
2.1 Point source



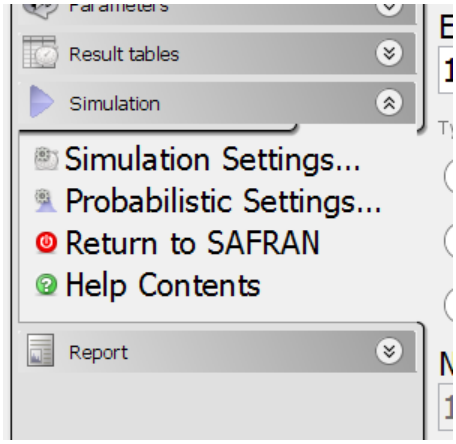
Note that “activity” and “distance” are already initialized with the values from the safety assessment table:



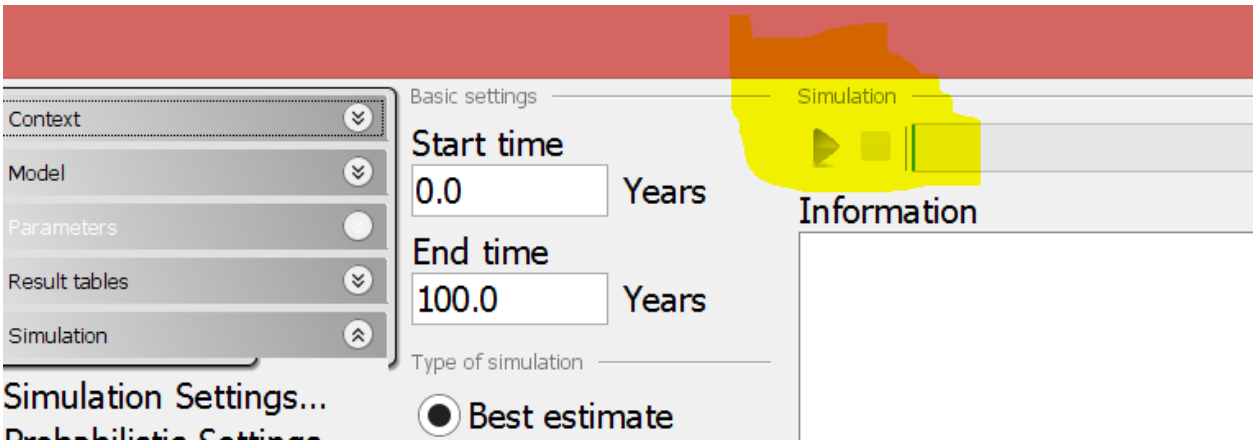
Left 0 for “height” and specify 5 (5 cm) for “slabThicknes” and press Enter.



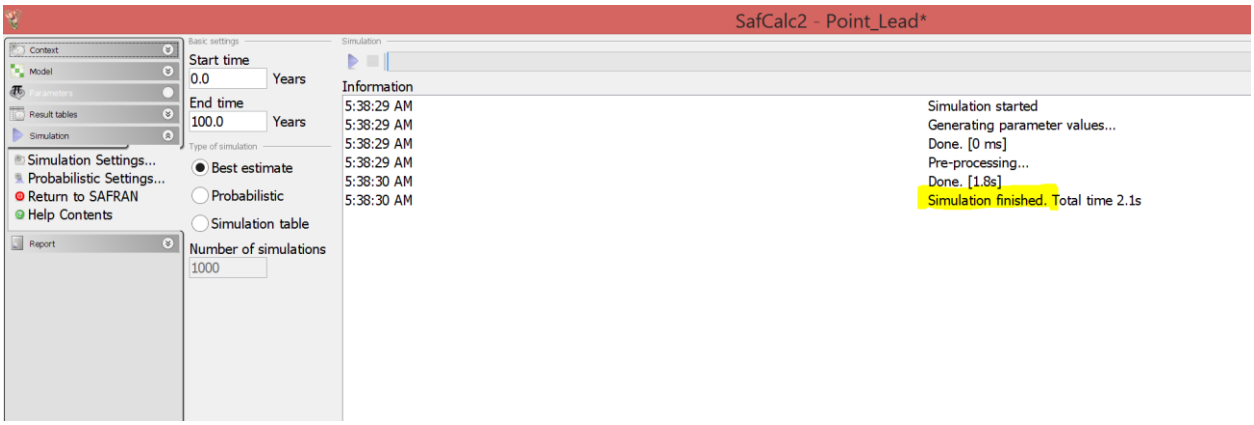
Click on the “Simulation” tab:



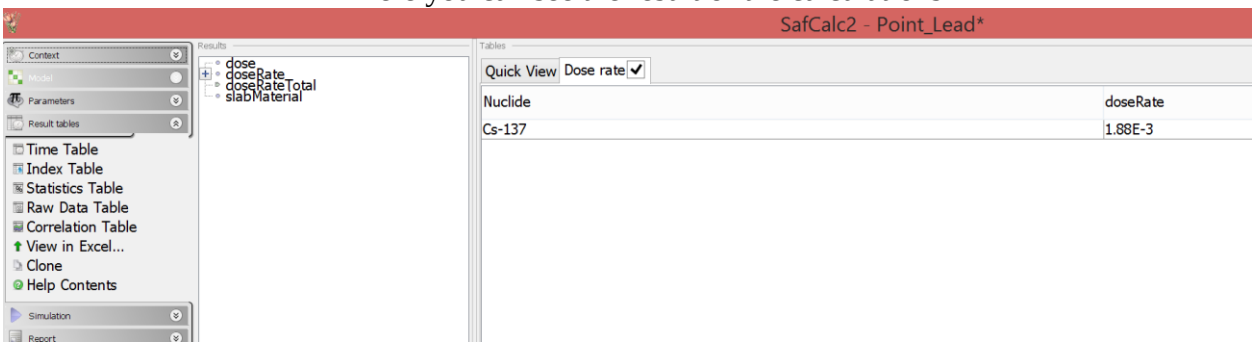
Click on the “Simulation” button located in the upper part of the window:



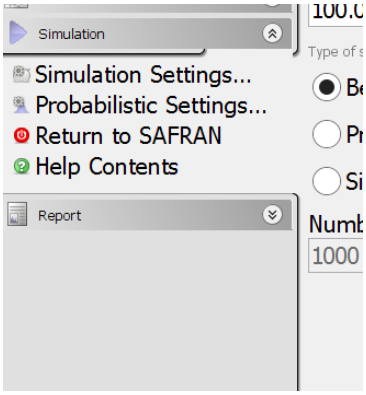
Wait until simulation will be finished



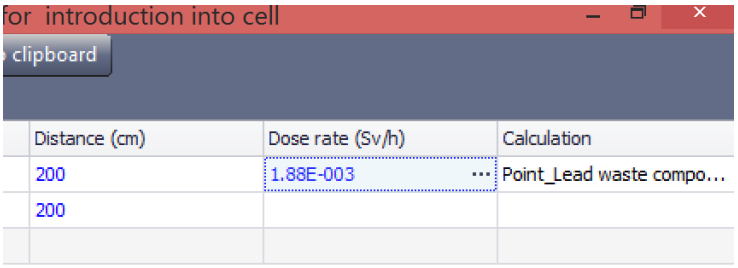
Select “Result tables” tab – here you can see the result of the calculations



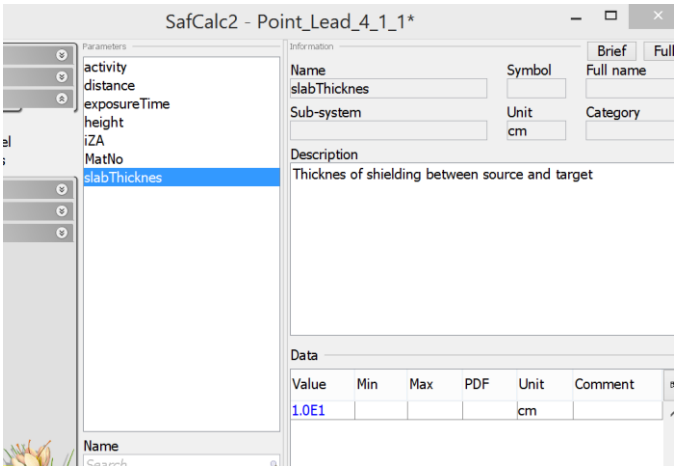
Click on the button “Return to SAFRAN” located on the “Simulation” tab



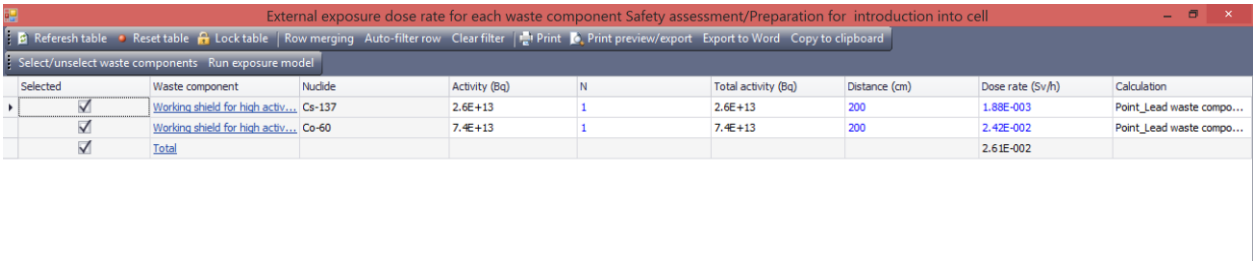
Note that result was transferred into the assessment table:



Do the similar calculations (with the same parameters) for the Co-60 source, but input 10 cm as thickness of the shield:

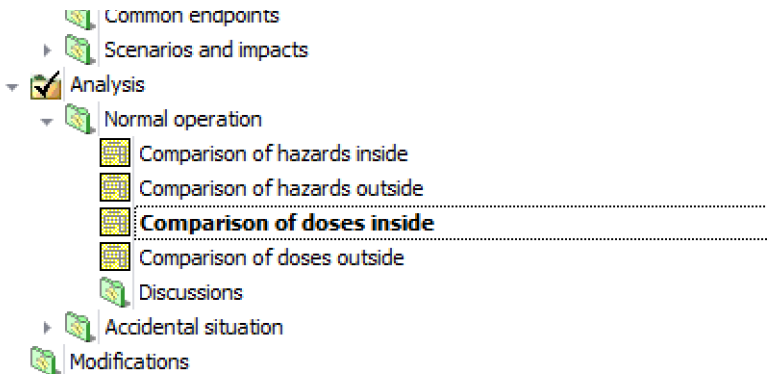


The final assessment table will looks like:



Tutorial 12. Advanced analysis of safety assessment results. Discussion object. Modified/new safety elements.

Open the table “Comparison of the doses inside” located in the “Analysis” folder



Comparison of doses inside Safety assessments/Safety assessment/Analysis/Normal operation

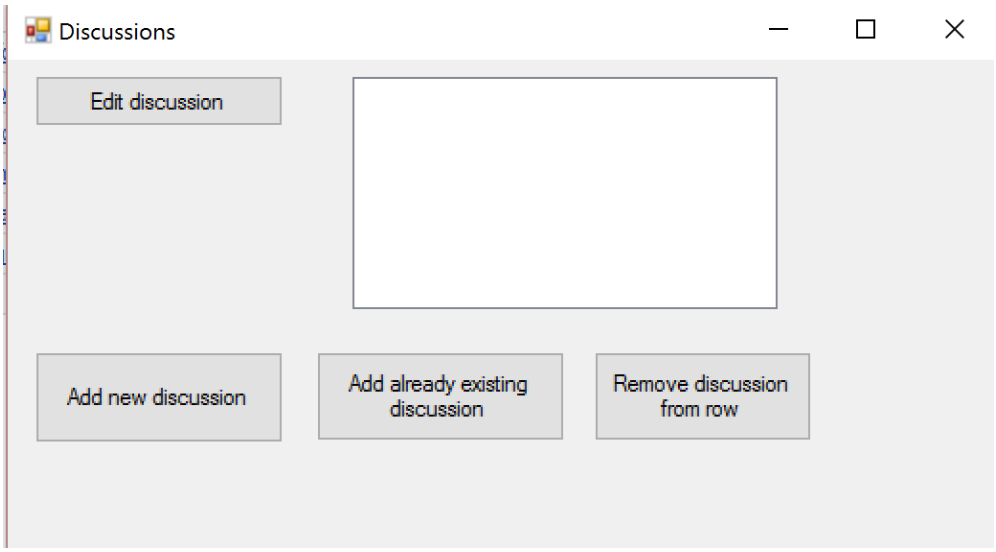
Referesh | Reset | Lock table | Auto-filter row | Clear filter | Row merging | Insert in Word document | Print/export | Copy

Show as chart

Impact	Endpoint	Assessment case	Dose (Sv/year)	Criterion	Limit (Sv/y)
Preparation for introduction into...	Dose to worker	(+)Assesment case 1	5.22E-001	Worker	2.00E-002
Lift original source shield into cell...	Dose to worker	(+)Assesment case 1		Worker	2.00E-002
Remove source and characterize	Dose to worker	(+)Assesment case 1	5.50E-004	Worker	2.00E-002
Encapsulation and testing of Hig...	Dose to worker	(+)Assesment case 1	1.23E-003	Worker	2.00E-002
Transfer encapsulated HAS into ...	Dose to worker	(+)Assesment case 1		Worker	2.00E-002
Remove Long Term Storage Shie...	Dose to worker	(+)Assesment case 1		Worker	2.00E-002
Total	Dose to worker		5.24E-001	Worker	2.00E-002

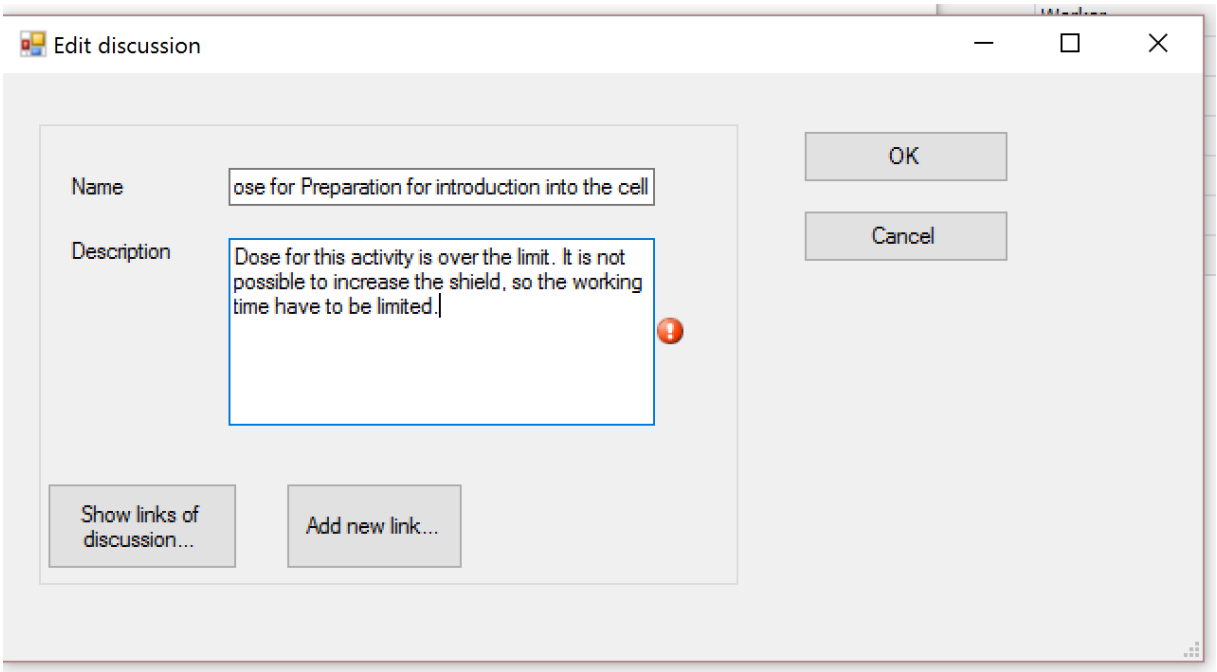
Note that dose for the operation “Preparation for the introduction into the cell” is over the limit

Click on the “Discussion” cell. The “Discussions” dialog will appear.



Click “Add new discussion”

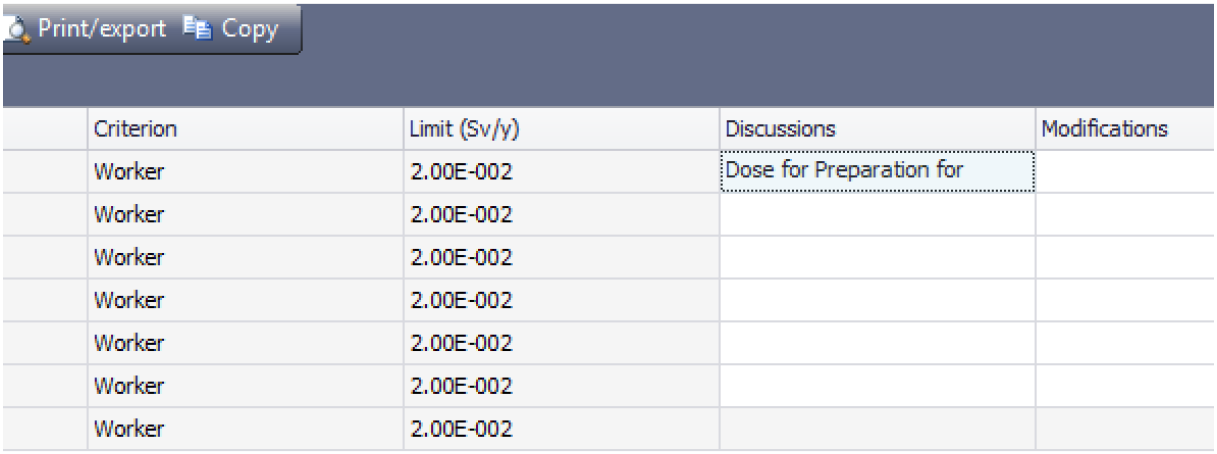
Enter name “Dose for Preparation for introduction into the cell” and description of the discussion.



Click Ok button.

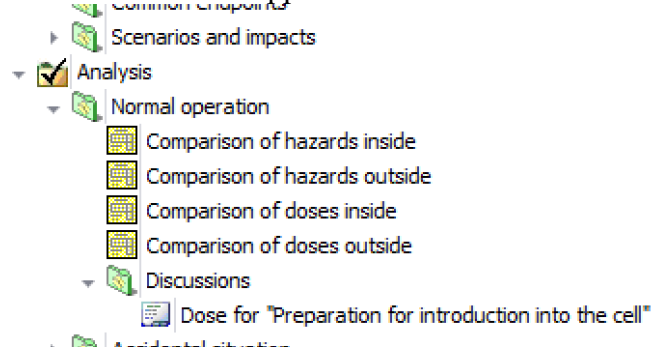
Close the “Discussions” dialog.

The discussion’s name will appear in the analysis table:



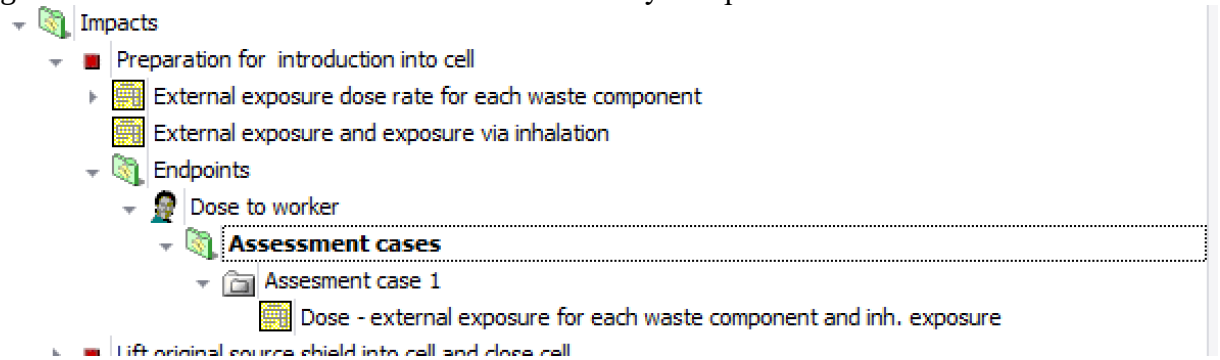
Close the analysis table.

Note that discussion appears also in the folder “Discussions”

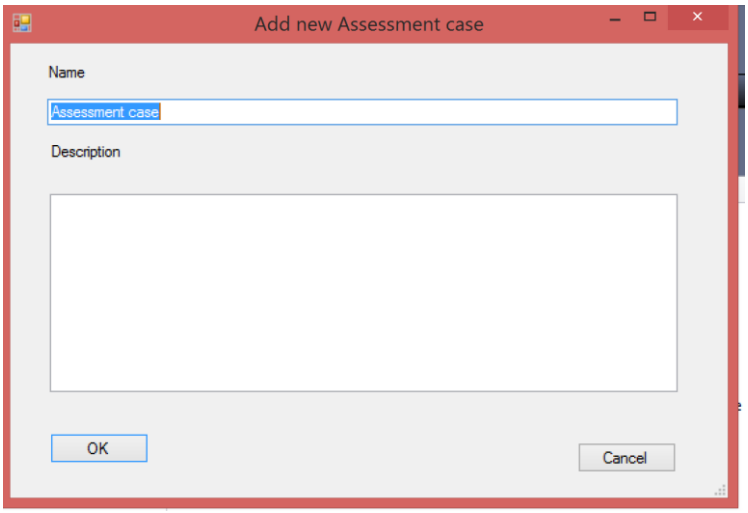


Now you need to make additional assessments to estimate maximum allowed working time

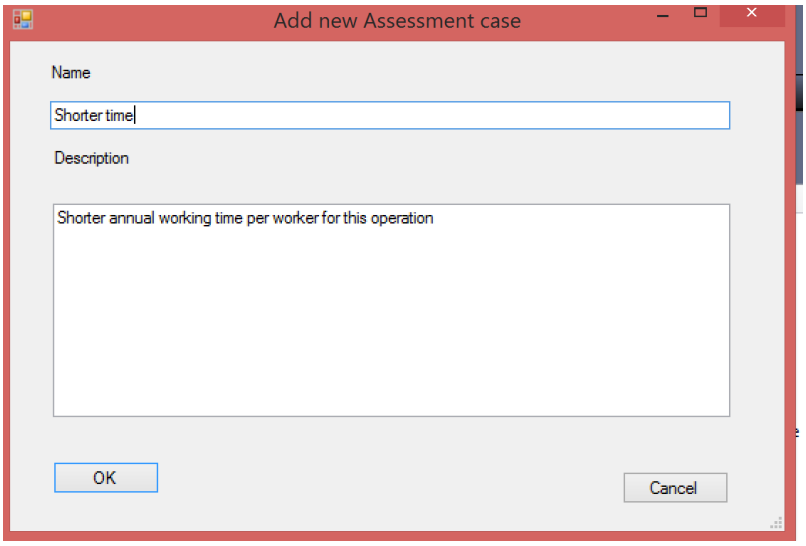
Right-click on the “Assessment cases” for the activity “Preparation for introduction into cell”



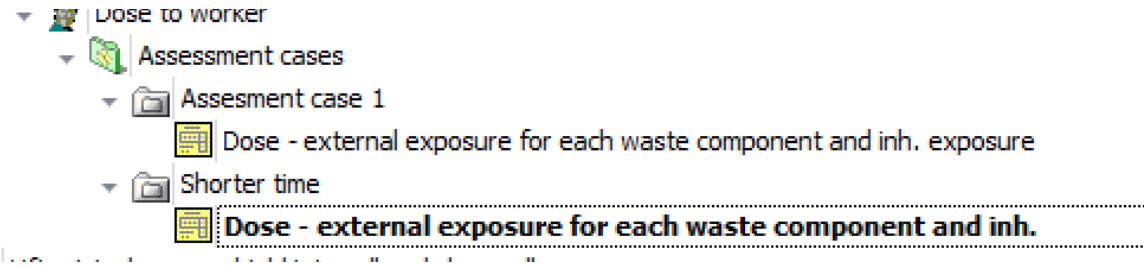
Select “Add assessment” case

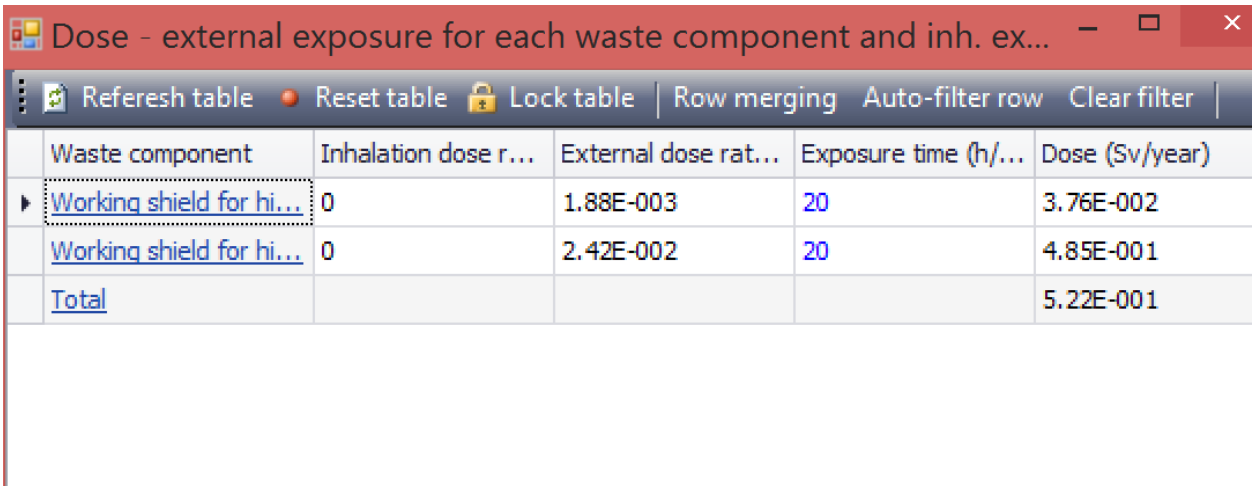


Give for the case the name “Shorter time” and description “Shorter annual working time per worker for this operation”

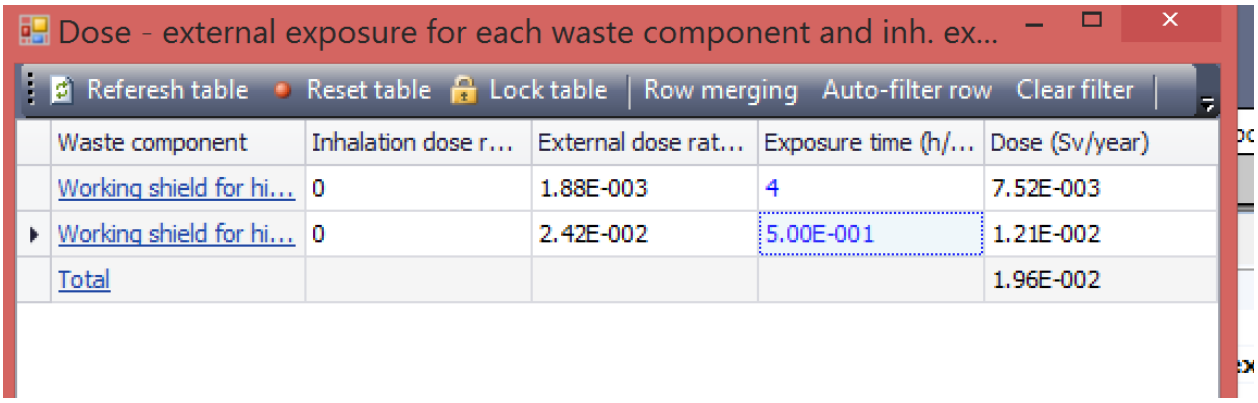


Double-click on the table “Dose – external exposure …” for this assessment case

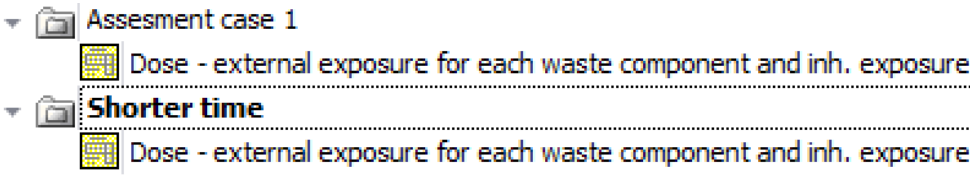




Try different combination of exposure time. Finally put 4 and 0.5 as exposure times for Cs and Co sources respective

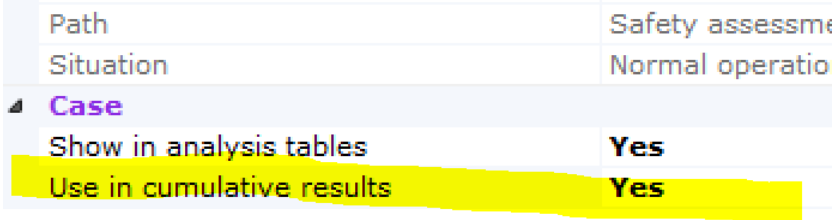


Click on the assessment case node



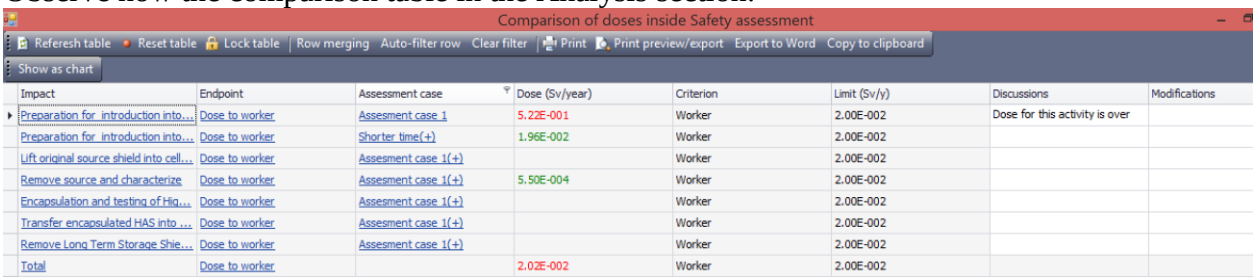
ft original source shield into cell and close cell

Select the properties of this assessment case and set “yes” for the “Use in cumulative results” parameter:



SAFRAN will warn you that now the results of this assessment case will be used for the calculation of the total dose to worker.

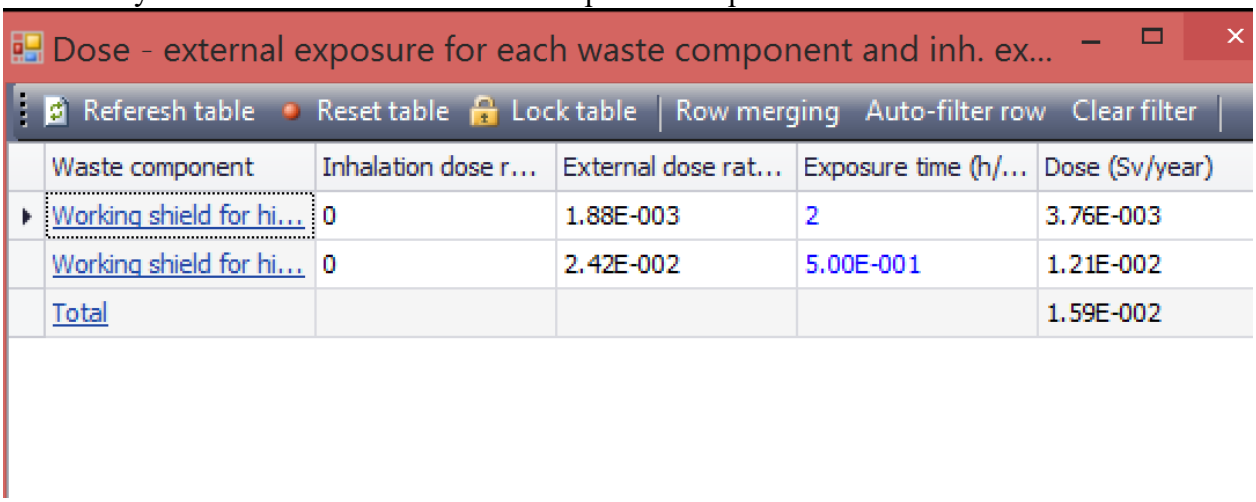
Observe now the comparison table in the Analysis section:



Impact	Endpoint	Assessment case	Dose (Sv/year)	Criterion	Limit (Sv/y)	Discussions	Modifications
Preparation for introduction into...	Dose to worker	Assesment case 1	5.22E-001	Worker	2.00E-002	Dose for this activity is over	
Preparation for introduction into...	Dose to worker	Shorter time(+)	1.96E-002	Worker	2.00E-002		
Lift original source shield into cell...	Dose to worker	Assesment case 1(+)		Worker	2.00E-002		
Remove source and characterize	Dose to worker	Assesment case 1(+)	5.50E-004	Worker	2.00E-002		
Encapsulation and testing of Hig...	Dose to worker	Assesment case 1(+)		Worker	2.00E-002		
Transfer encapsulated HAS into ...	Dose to worker	Assesment case 1(+)		Worker	2.00E-002		
Remove Long Term Storage Shie...	Dose to worker	Assesment case 1(+)		Worker	2.00E-002		
Total	Dose to worker		2.02E-002	Worker	2.00E-002		

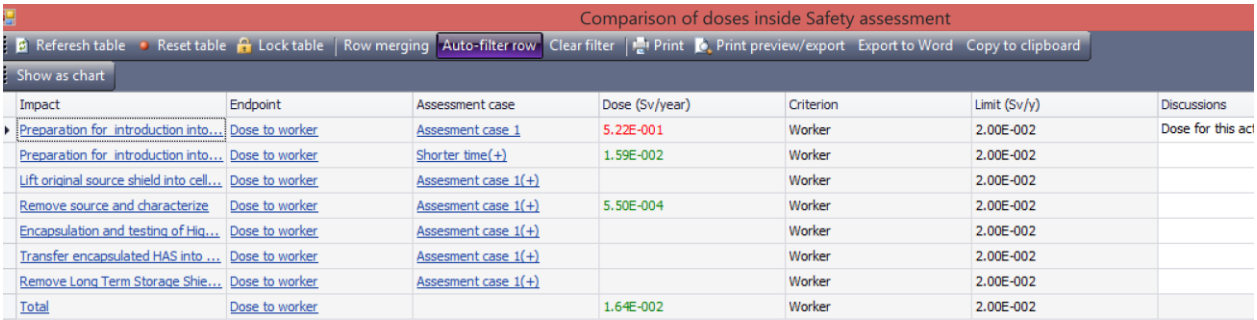
While dose for the “Preparation ….” operation is now under the limit, the total dose is still a bit higher than the limit.

We will try to decrease more the time of “Preparation” operation:



Waste component	Inhalation dose r...	External dose rat...	Exposure time (h/...	Dose (Sv/year)
Working shield for hi...	0	1.88E-003	2	3.76E-003
Working shield for hi...	0	2.42E-002	5.00E-001	1.21E-002
Total				1.59E-002

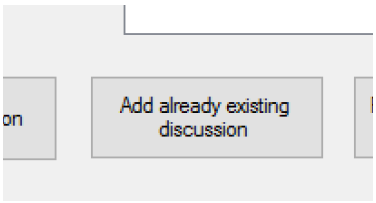
Now the Analysis table looks like:

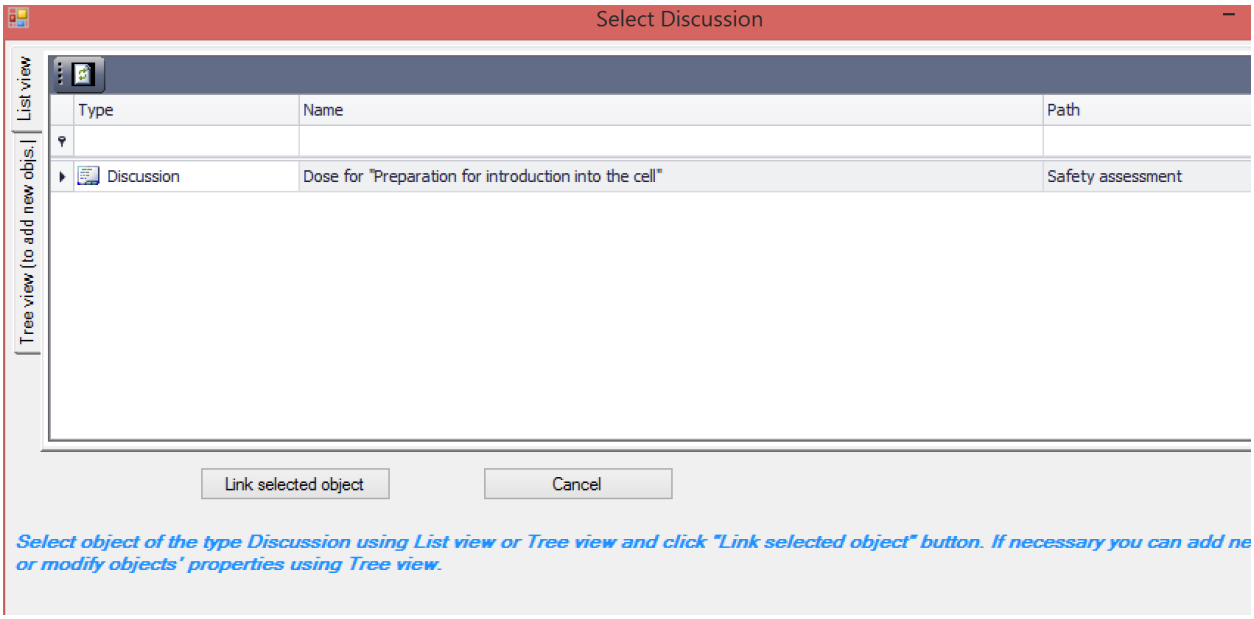


Impact	Endpoint	Assessment case	Dose (Sv/year)	Criterion	Limit (Sv/y)	Discussions
Preparation for introduction into...	Dose to worker	Assesment case 1	5.22E-001	Worker	2.00E-002	Dose for this act
Preparation for introduction into...	Dose to worker	Shorter time(+)	1.59E-002	Worker	2.00E-002	
Lift original source shield into cell...	Dose to worker	Assesment case 1(+)		Worker	2.00E-002	
Remove source and characterize	Dose to worker	Assesment case 1(+)	5.50E-004	Worker	2.00E-002	
Encapsulation and testing of Hig...	Dose to worker	Assesment case 1(+)		Worker	2.00E-002	
Transfer encapsulated HAS into ...	Dose to worker	Assesment case 1(+)		Worker	2.00E-002	
Remove Long Term Storage Shie...	Dose to worker	Assesment case 1(+)		Worker	2.00E-002	
Total	Dose to worker		1.64E-002	Worker	2.00E-002	

Click on the column “Discussions” for the second row of the table (with the results of new assessment)

The “Discussions dialog will appear”. Click on the button “Add already existing discussion”





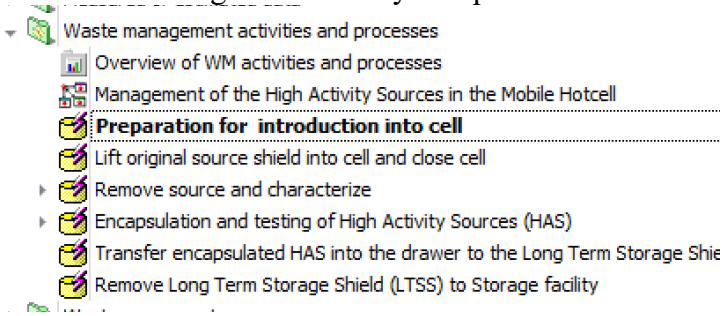
Select row “Dose for “Preparation into the cell” and click “Link”.

Close the “Discussions” dialog. The link to discussion will be added to the analysis table.

Close the analysis table.

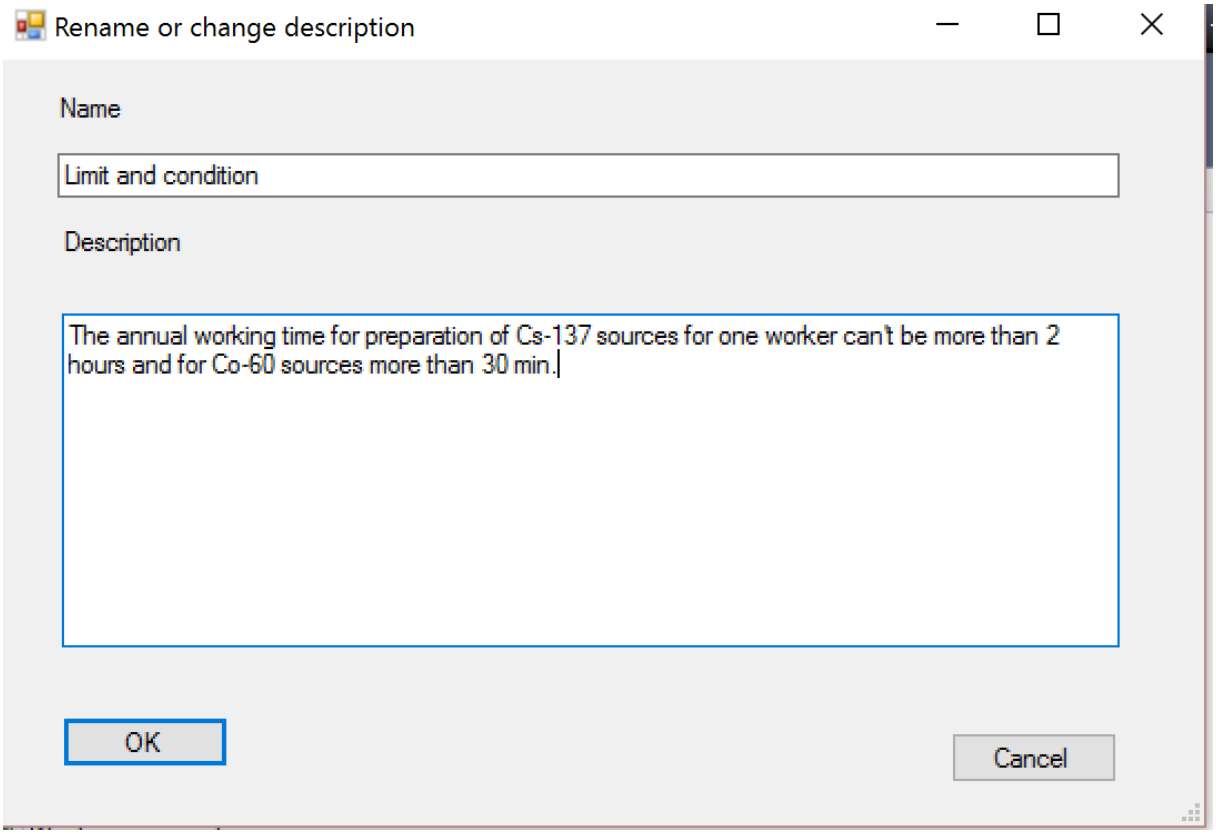
Now you will create the new safety element for the waste management activity “Preperation for introduction into cell” based on the results of analysis.

Select the waste management activity “Preparation …” in the system description



Right-click on it and select “Add limit and condition”

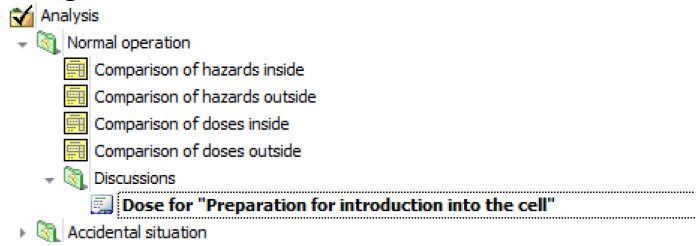
Put the description:



Click OK

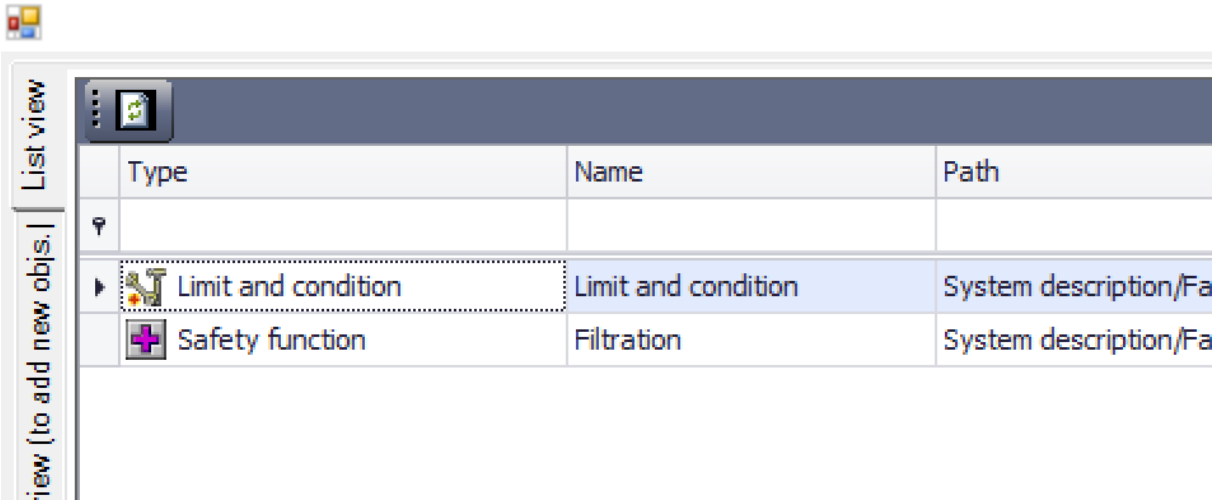
The “Limit and condition” object will be added to the waste management activity.

Navigate to the discussion we created earlier



Right-click on it and select “Link to objects”

Link the discussion with the “Limit and condition” object.

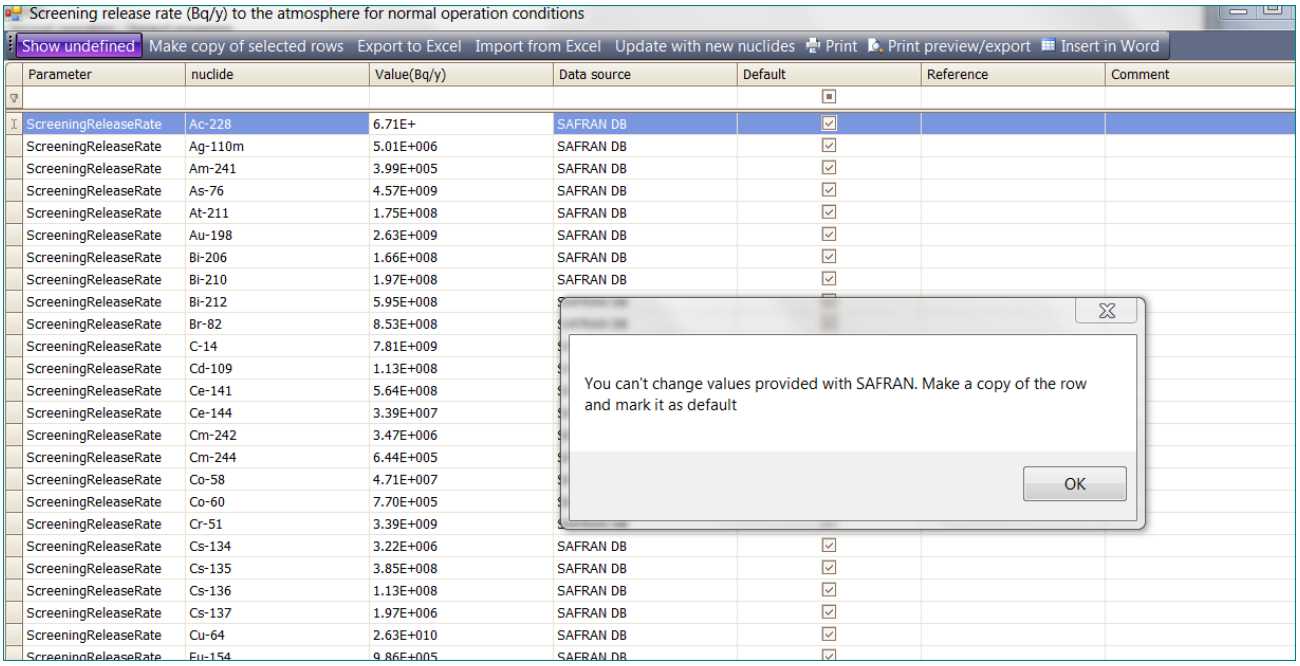


In this tutorial we performed the analysis of the assessment for normal operation and derived new safety element. For simplicity of tutorial this was done using discussions. The more appropriate way is to use modifications and alternative configurations. See SAFRAN on-line User Guide for details.

Tutorial 13. Database – advanced topics

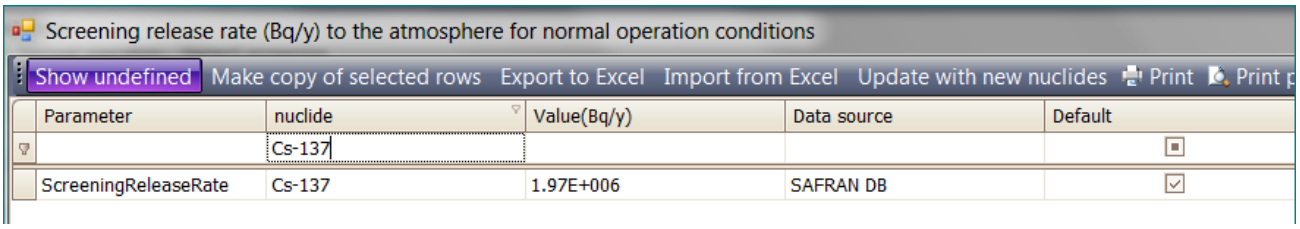
Advanced exercise. Adding user-defined values to database by copying of the rows

Column “Data source” identifies whether row contains data from database distributed with SAFRAN or user-defined value. It is not possible to change the value marked as “SAFRAN DB”. Try to change it for Ac-228. You will be able to change value in the “Value” cell, but when leaving the cell, you will get the error message asking you to make a copy of the row before making changes.



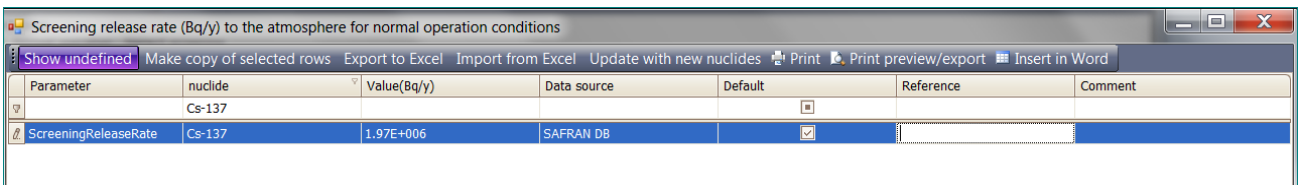
Parameter	nuclide	Value(Bq/y)	Data source	Default	Reference	Comment
ScreeningReleaseRate	Ac-228	6.71E+	SAFRAN DB	☑		
ScreeningReleaseRate	Ag-110m	5.01E+006	SAFRAN DB	☑		
ScreeningReleaseRate	Am-241	3.99E+005	SAFRAN DB	☑		
ScreeningReleaseRate	As-76	4.57E+009	SAFRAN DB	☑		
ScreeningReleaseRate	At-211	1.75E+008	SAFRAN DB	☑		
ScreeningReleaseRate	Au-198	2.63E+009	SAFRAN DB	☑		
ScreeningReleaseRate	Bi-206	1.66E+008	SAFRAN DB	☑		
ScreeningReleaseRate	Bi-210	1.97E+008	SAFRAN DB	☑		
ScreeningReleaseRate	Bi-212	5.95E+008				
ScreeningReleaseRate	Br-82	8.53E+008				
ScreeningReleaseRate	C-14	7.81E+009				
ScreeningReleaseRate	Cd-109	1.13E+008				
ScreeningReleaseRate	Ce-141	5.64E+008				
ScreeningReleaseRate	Ce-144	3.39E+007				
ScreeningReleaseRate	Cm-242	3.47E+006				
ScreeningReleaseRate	Cm-244	6.44E+005				
ScreeningReleaseRate	Co-58	4.71E+007				
ScreeningReleaseRate	Co-60	7.70E+005				
ScreeningReleaseRate	Cr-51	3.39E+009				
ScreeningReleaseRate	Cs-134	3.22E+006	SAFRAN DB	☑		
ScreeningReleaseRate	Cs-135	3.85E+008	SAFRAN DB	☑		
ScreeningReleaseRate	Cs-136	1.13E+008	SAFRAN DB	☑		
ScreeningReleaseRate	Cs-137	1.97E+006	SAFRAN DB	☑		
ScreeningReleaseRate	Cu-64	2.63E+010	SAFRAN DB	☑		
ScreeningReleaseRate	Eu-154	9.86E+005	SAFRAN DB	☑		

Now we will add the user-defined value for Cs-137. To easy find corresponding row in the table – write Cs-137 in the column “nuclide” of the first – filter row of the table.



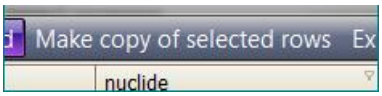
Parameter	nuclide	Value(Bq/y)	Data source	Default
	Cs-137			☐
ScreeningReleaseRate	Cs-137	1.97E+006	SAFRAN DB	☑

Click somewhere in the row to select it.

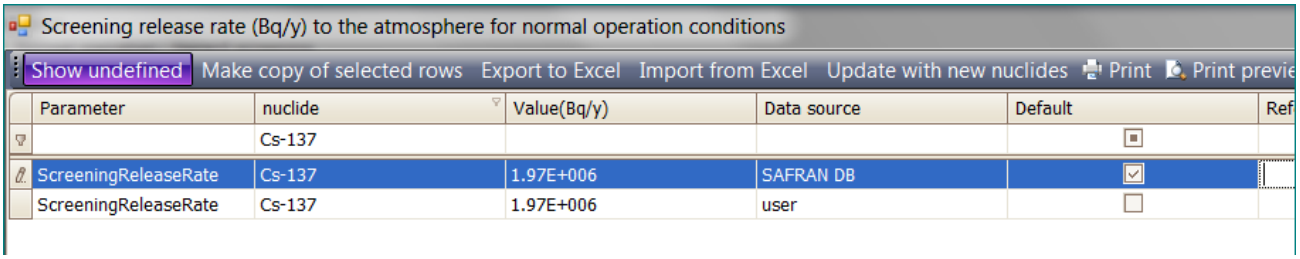


Parameter	nuclide	Value(Bq/y)	Data source	Default	Reference	Comment
	Cs-137			☐		
ScreeningReleaseRate	Cs-137	1.97E+006	SAFRAN DB	☑		

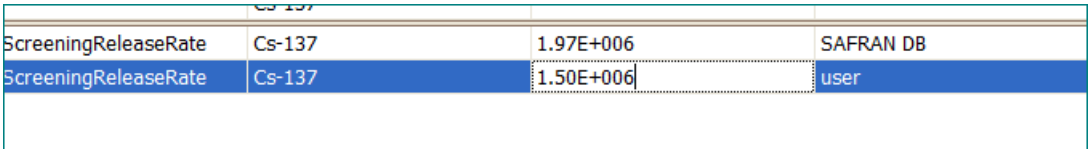
Click button ”Make copy of the selected rows” located on the toolbar.



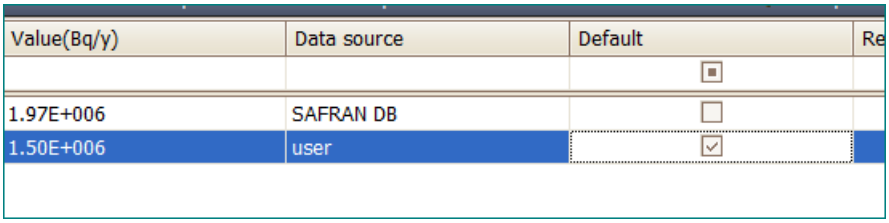
New row for Cs-137 will be added to the table. Note that this row has “user” in the “Data source” column and therefore it is possible to change the value in this row.



Change the value for this row to 1.5E+06.



Finally, mark this row as “Default”.



Note that next time when you will open relevant hazard screening table, SAFRAN will change the value for screening release to this new value. To avoid this in already finalized assessments, you need to use possibility to “lock” assessment table or assessment provided by SAFRAN.

Remove the Cs-137 from the filter row. Now you again see the entire table. New row is located at the end of the table.

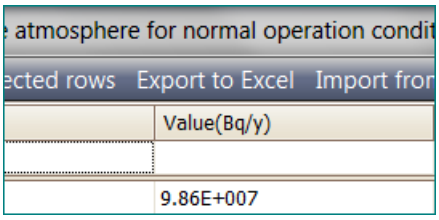
Note that it is possible to select and copy several rows simultaneously.

End of advanced exercise

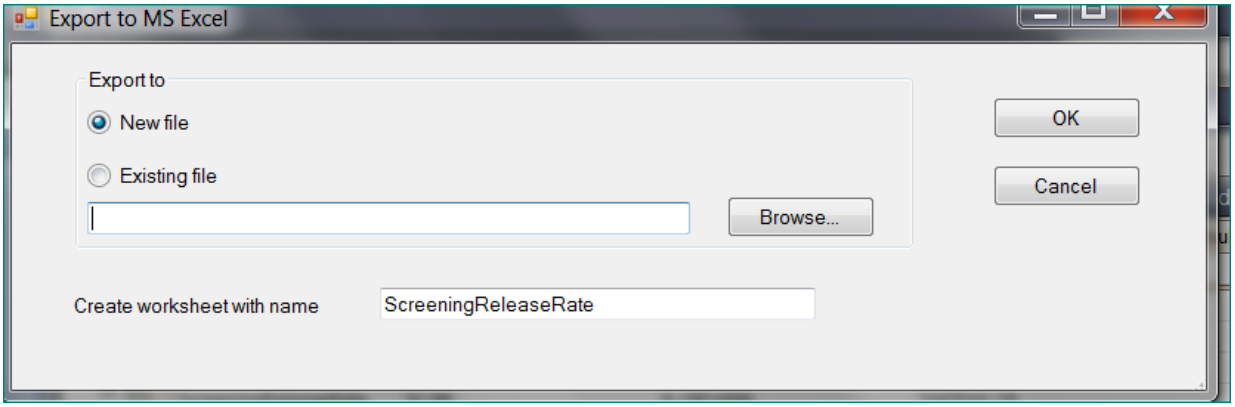
Advanced exercise. Adding user-defined values to database by importing data from Excel

For adding user-defined values for large amount of nuclides or for importing values calculated by external models (including models distributed with SAFRAN), import from Excel can be convenient.

Click button “Export to Excel” located on the toolbar of the table.

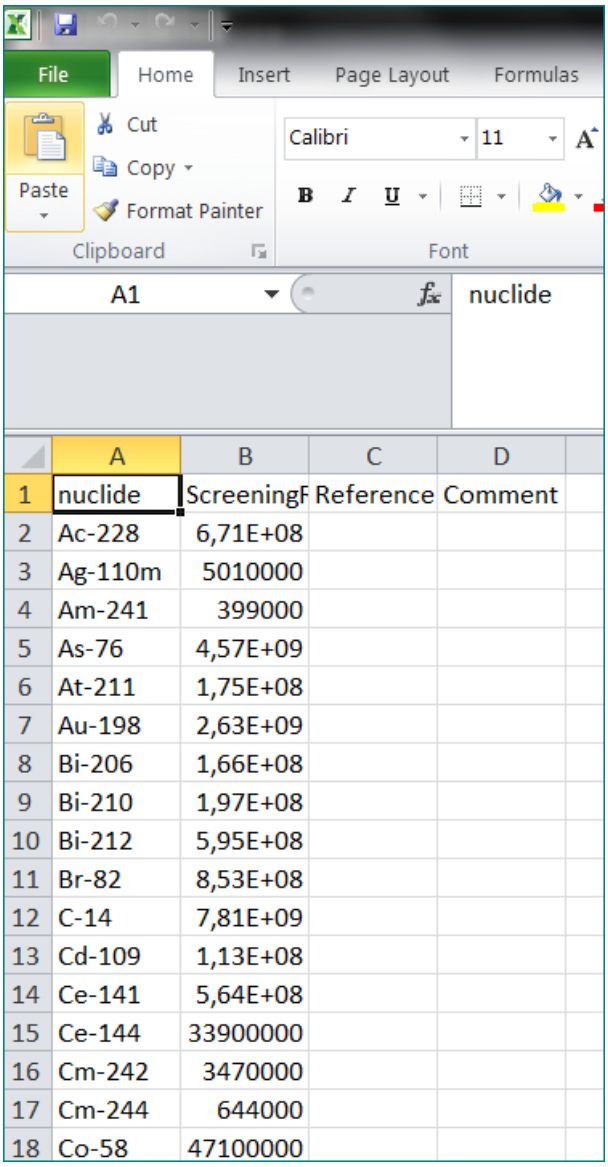


The dialog box “Export to Excel” will appear:



Click OK.

Data from the table will be exported to new Excel file, worksheet “ScreeningReleaseRate”.



	A	B	C	D
1	nuclide	ScreeningF	Reference	Comment
2	Ac-228	6,71E+08		
3	Ag-110m	5010000		
4	Am-241	399000		
5	As-76	4,57E+09		
6	At-211	1,75E+08		
7	Au-198	2,63E+09		
8	Bi-206	1,66E+08		
9	Bi-210	1,97E+08		
10	Bi-212	5,95E+08		
11	Br-82	8,53E+08		
12	C-14	7,81E+09		
13	Cd-109	1,13E+08		
14	Ce-141	5,64E+08		
15	Ce-144	33900000		
16	Cm-242	3470000		
17	Cm-244	644000		
18	Co-58	47100000		

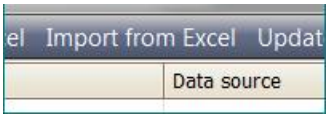
Change the values for first 3 nuclides.

1	nuclide	ScreeningRe	Reference
2	Ac-228	681000000	
3	Ag-110m	5110000	
4	Am-241	409000	
5	As-76	4,57E+09	

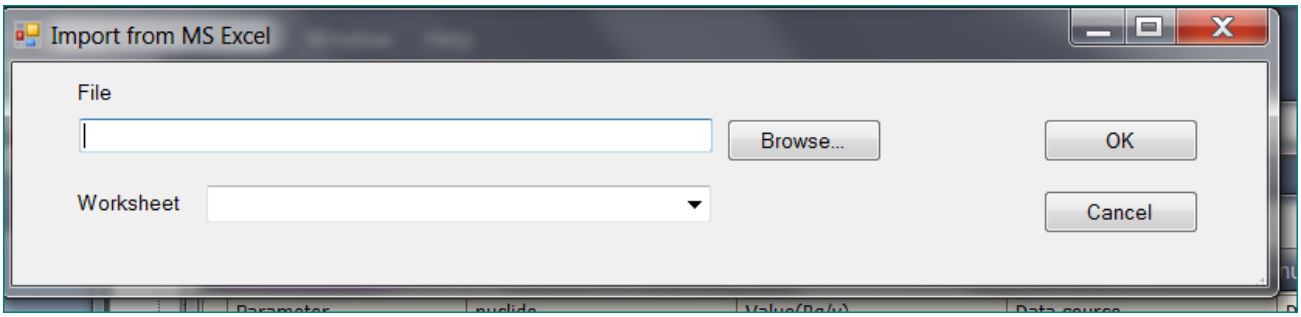
Save the Excel file as Test.xls or Test.xlsx file (both Excel 97-2003 and Excel 2007-2010 formats are allowed).

Close Excel file.

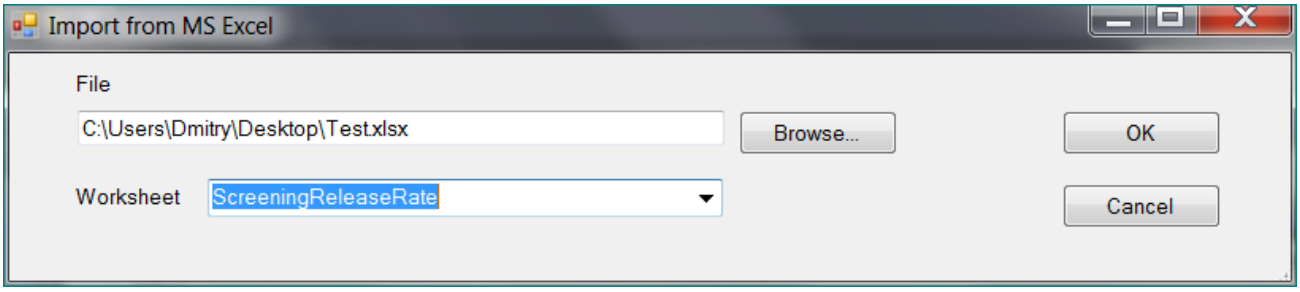
Click on the button “Import from Excel” located on the table’s toolbar.



The “Import from MS Excel” dialog box will appear.



Select the Excel file and worksheet “ScreeningReleaseRate”.

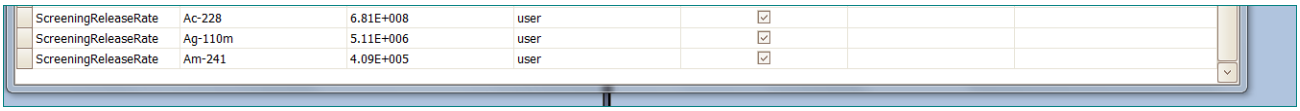


Click OK.

When import will be finished, you will get the message telling that 3 rows were added to the table. (On import SAFRAN checks whether the value provided in Excel file for given nuclide is different from the value already present in database and import only modified rows).

Scroll to the end of the table.

You will find 3 new rows with the values you specified in the Excel file.



ScreeningReleaseRate	Ac-228	6.81E+008	user	☑		
ScreeningReleaseRate	Ag-110m	5.11E+006	user	☑		
ScreeningReleaseRate	Am-241	4.09E+005	user	☑		

Note that rows were already marked as default.
End of advanced exercise

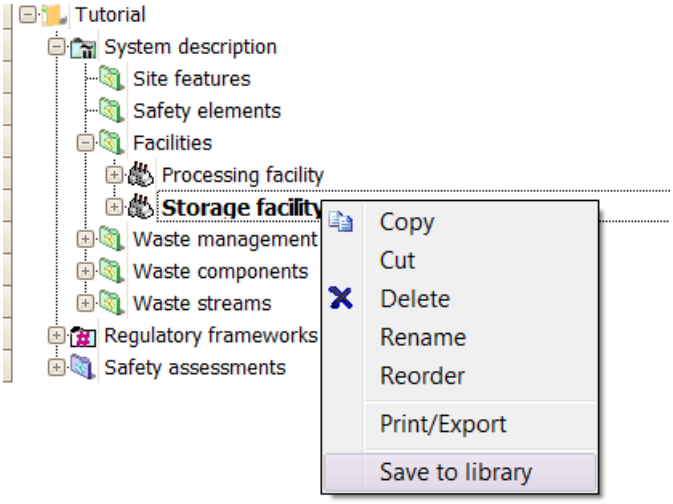
Close the database table and database window.

Tutorial 14. Reuse library objects

Intension of the library is to keep the set of "standard" facilities, processes, waste management activities, scenarios and even entire assessments. Users then can easy retrieve them in the projects and modify properties if necessary.

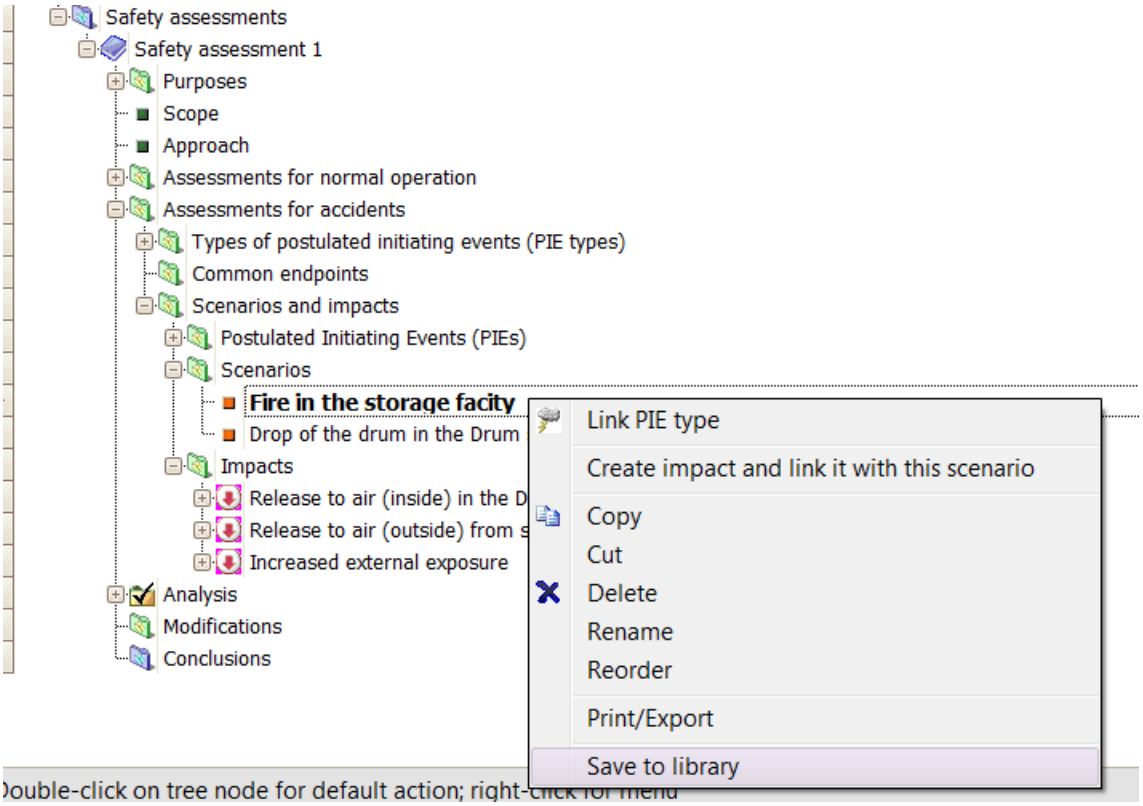
Saving objects to the library[15]

Right-click on the "Storage facility" and select "Save to library".

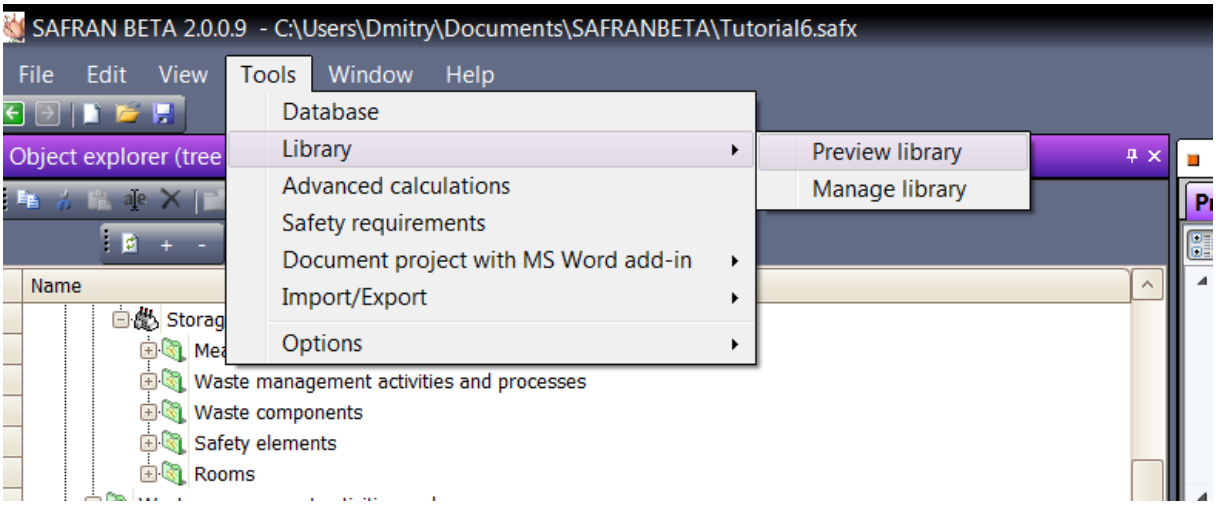


Right-click on the accidental scenarios "Fire in the storage facility" and select "Save to library".

[15] This step will be normally performed only by creators of the library. Here it is included in order to have some content in the library.

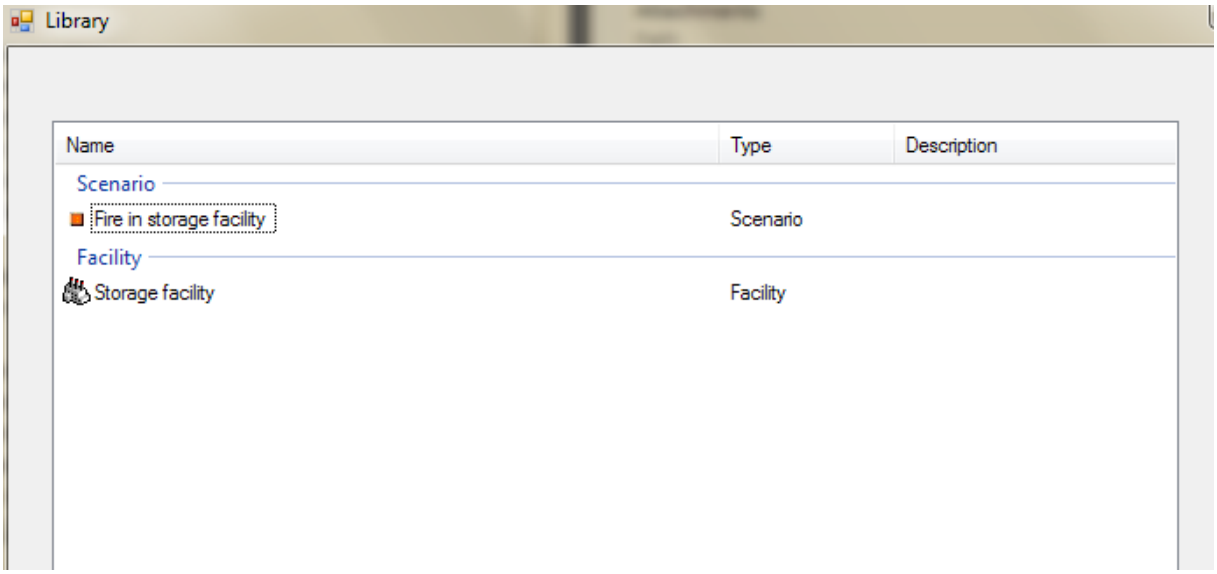


Select from the main menu, Tools/Library/Preview library.



The "Library" window will appear[16].

[16] In this tutorial the library distributed with SAFRAN was initially empty. If library already contains some objects they will be shown.



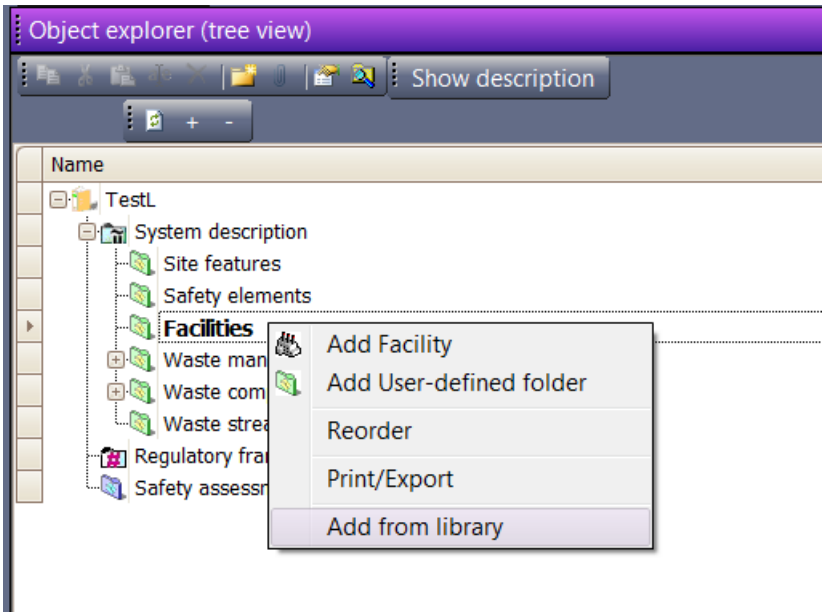
Note that “Storage facility” and scenario “Fire in the storage facility” are saved in the library.

Close the library window and close project.

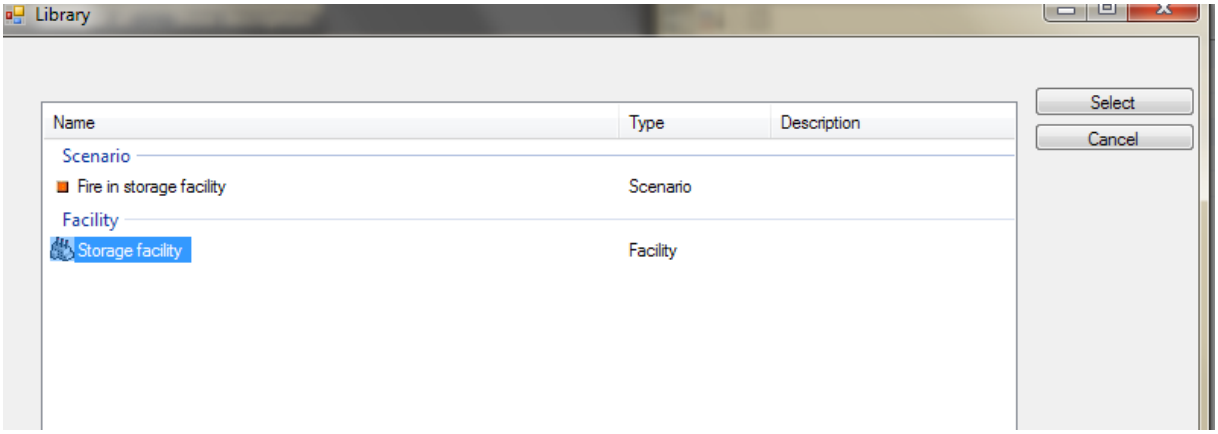
Reusing of the library objects

Create new SAFRAN project TestL.

Expand folder Facilities and select command “Add from library”.

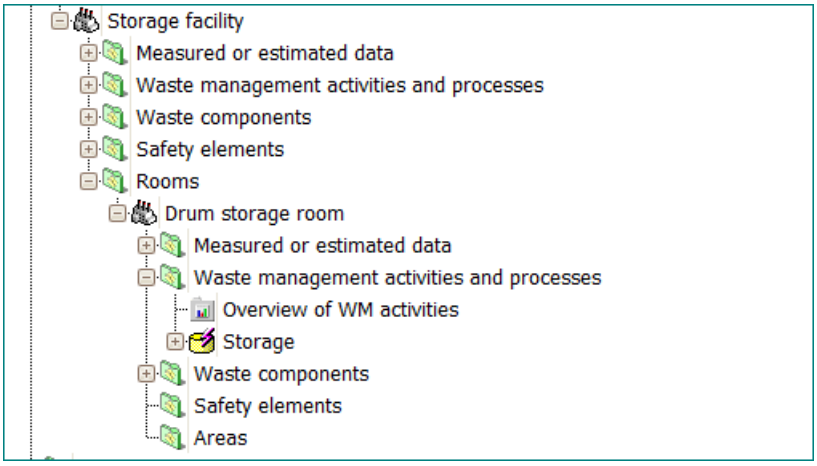


The window “Library” will appear. Select “Storage facility” and click button “Select”:



The libarry object “Storage facility” will be added to the “Facilities”.

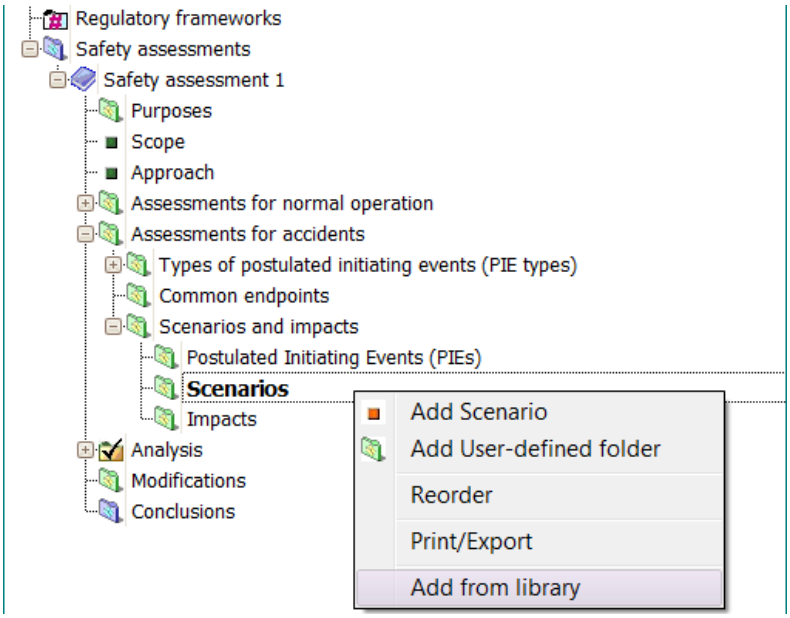
Expand node “Storage facility”.



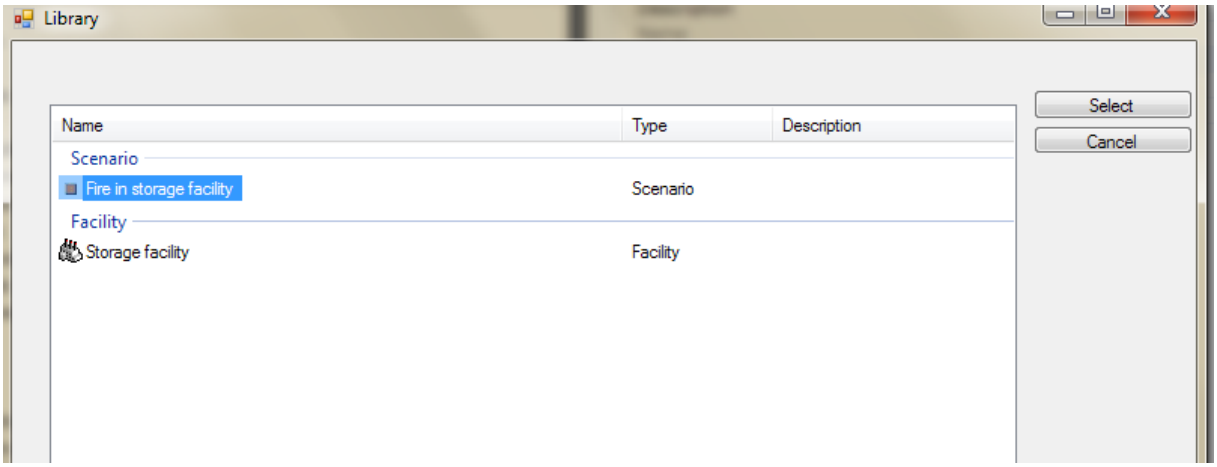
Observe that it already contains “Storage room” and waste management activity “Storage”.

Add safety assessment to your project.

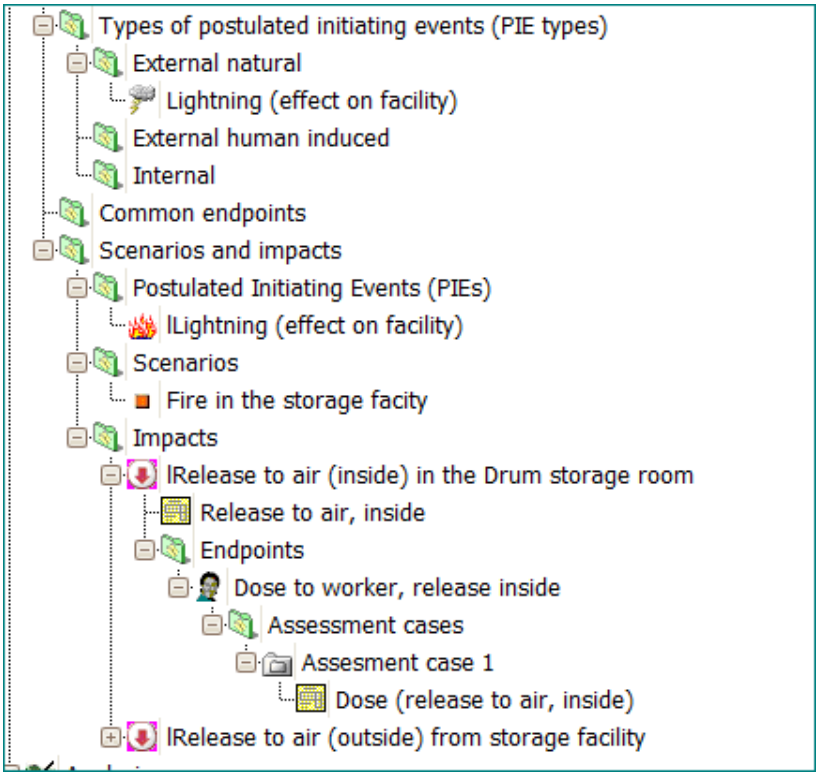
Expand for new safety assessment the folder “Assessment for accidents/Scenarios and impacts/Scenarios” and select “Add from library” command.



In the window “Library” which will appear, select scenario “Fire in storage facility”.

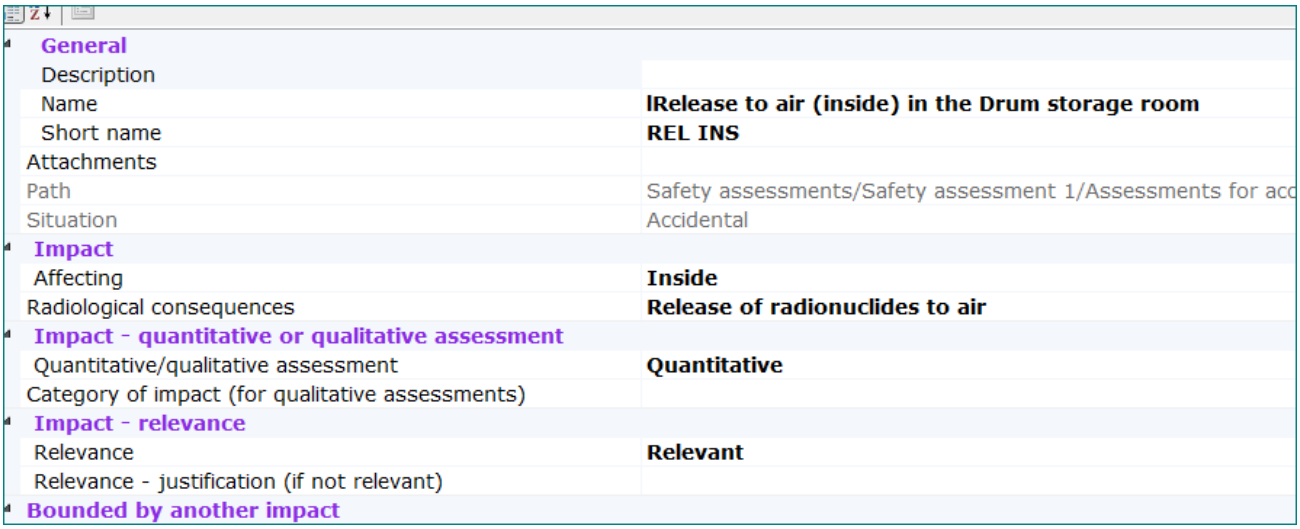


After adding scenario from library – observe changes in project:



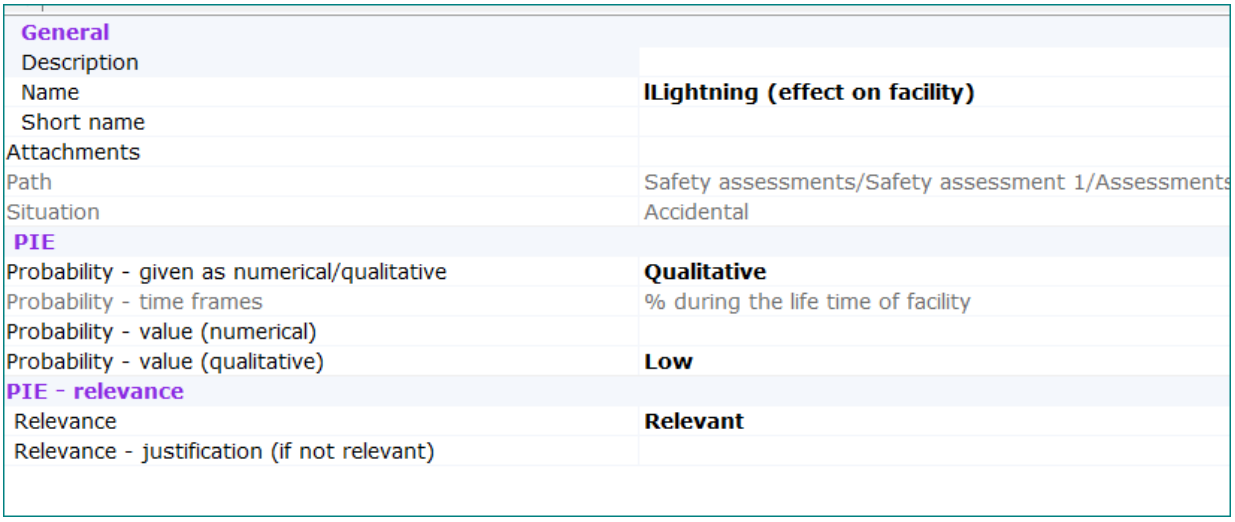
Note that not only scenario, but also relevant PIE type, PIE and impacts with screening and dose assessment were added.

Click on one of impacts – you see that library preserve its properties.



General	
Description	
Name	**lRelease to air (inside) in the Drum storage room**
Short name	**REL INS**
Attachments	
Path	Safety assessments/Safety assessment 1/Assessments for acc
Situation	Accidental
Impact	
Affecting	**Inside**
Radiological consequences	**Release of radionuclides to air**
Impact - quantitative or qualitative assessment	
Quantitative/qualitative assessment	**Quantitative**
Category of impact (for qualitative assessments)	
Impact - relevance	
Relevance	**Relevant**
Relevance - justification (if not relevant)	
Bounded by another impact	

Same is for PIE – the probability was kept.



General	
Description	
Name	**lLightning (effect on facility)**
Short name	
Attachments	
Path	Safety assessments/Safety assessment 1/Assessments
Situation	Accidental
PIE	
Probability - given as numerical/qualitative	**Qualitative**
Probability - time frames	% during the life time of facility
Probability - value (numerical)	
Probability - value (qualitative)	**Low**
PIE - relevance	
Relevance	**Relevant**
Relevance - justification (if not relevant)	

In the same time, observe that screening and dose assessment tables for impacts are so far empty – the information about waste components need to be provided and impacts need to be linked to the relevant facility/room/area or activity.

SAVING THE FILE:

Save the project.

Tutorial 15. Complex waste streams. Check for clearance.

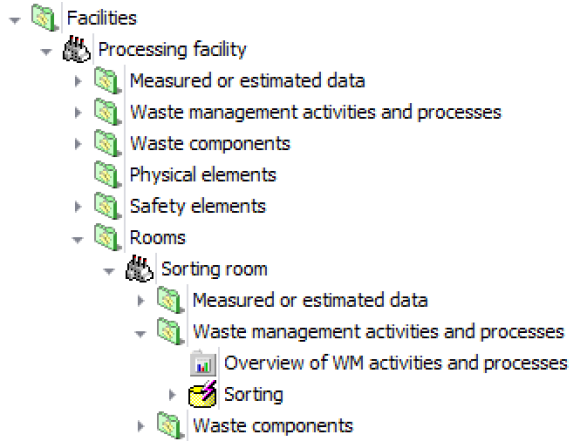
Advanced exercise

Open Tutorial.safx project created in earlier tutorials. Save it as TutorialAdvStream.safx (using File->Save as… command)

In this tutorial, the waste stream will be extended by including additional branch describing the fate of non-compactable components appeared after sorting. For non-compactable components, check for clearance will be performed and then the waste which can't be cleared will be packaged and stored in the Drum storage room of the Storage facility.

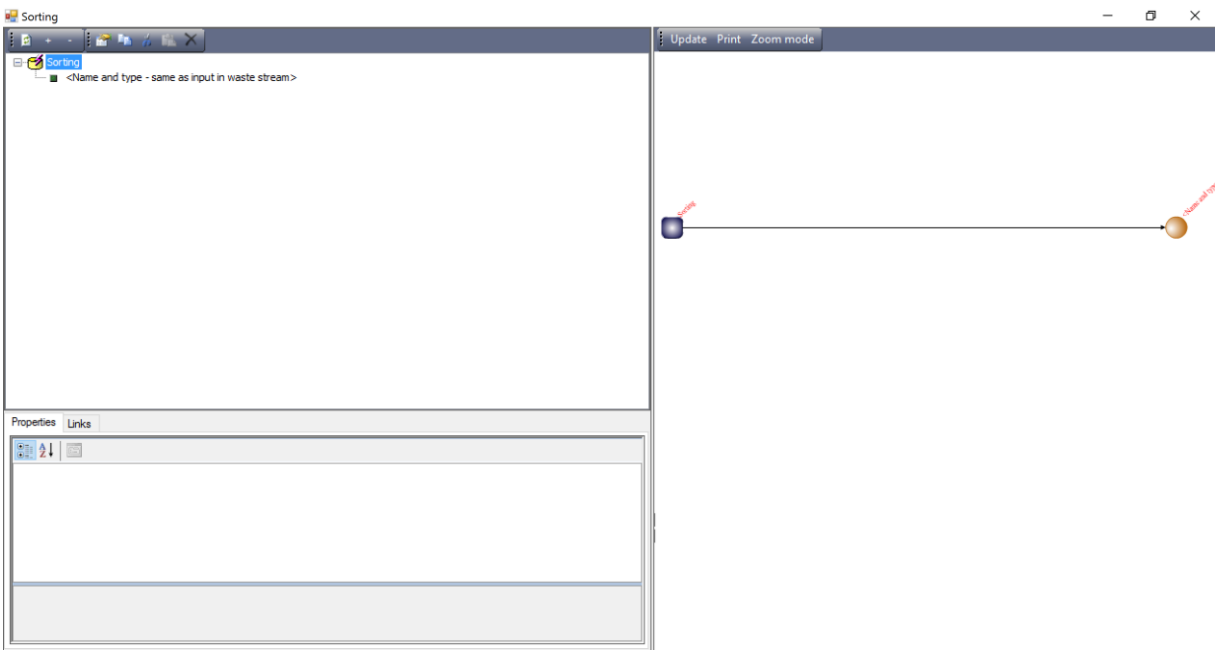
Define several outputs for the same waste management activity

Expand node for waste management activity "Sorting" which take place in the Sorting room of the Processing facility.



Right-click on "Sorting" and select "Manage output(s)" command

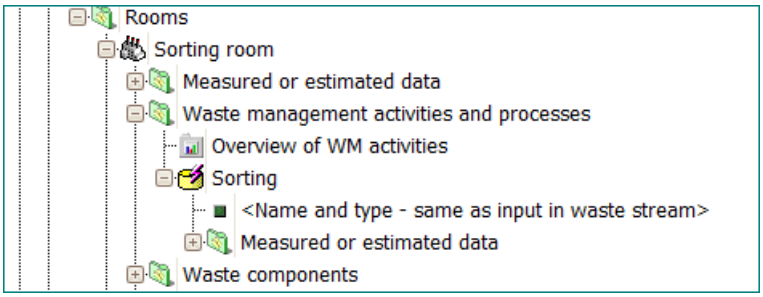
The window for managemet of the outputs of waste management activcity will appear



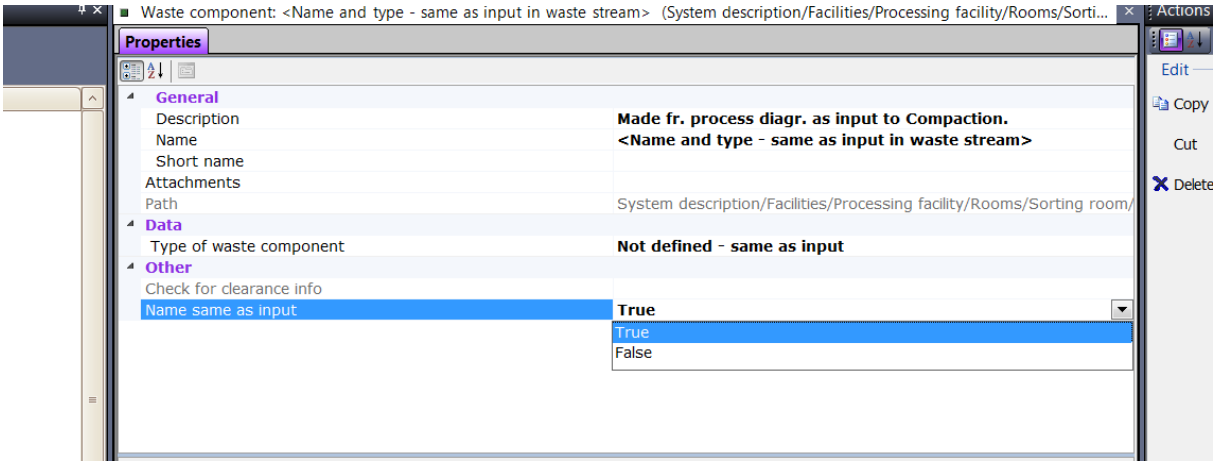
Further screen-dumps in this tutorial are created with older version of SAFRAN in which outputs was located directly in the object's tree. In the newer versions you always need to call window for the management of outputs to see the part of the tree relevant to outputs.

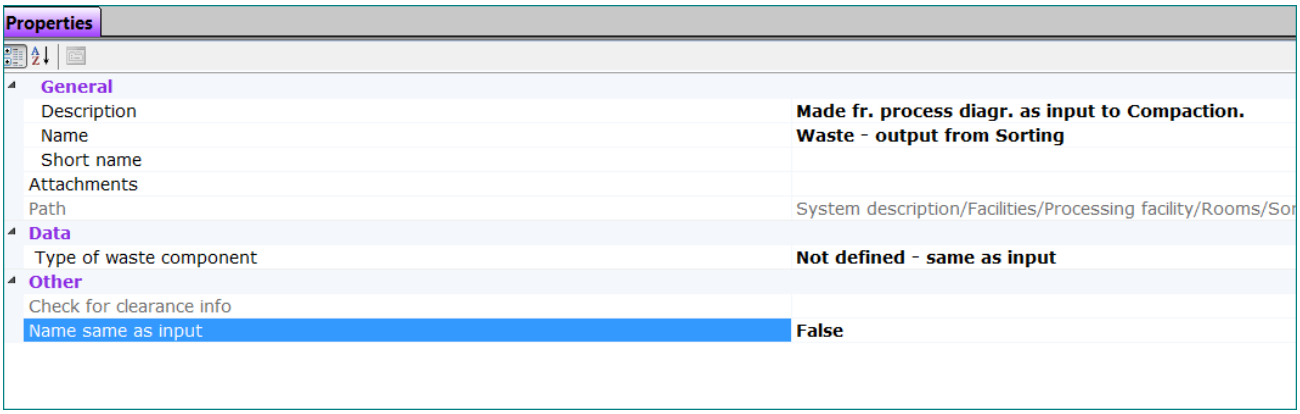
We will add new output to Sorting which will correspond to the non-compactable waste, but before we will rename the current output to the "Compactable waste".

Select output <Name and type – same as input in the stream>



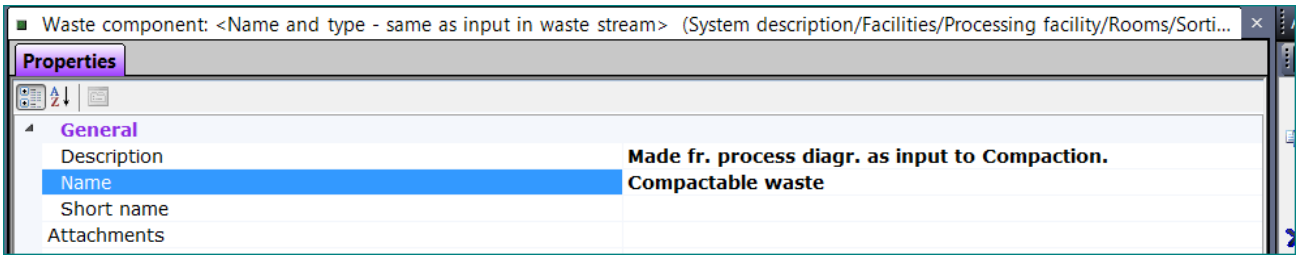
In the Properties window – change the property "Name same as input" to "False"



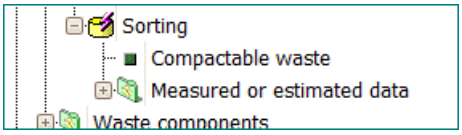


Note that name of output was automatically modified to “Waste – output from Sorting”.

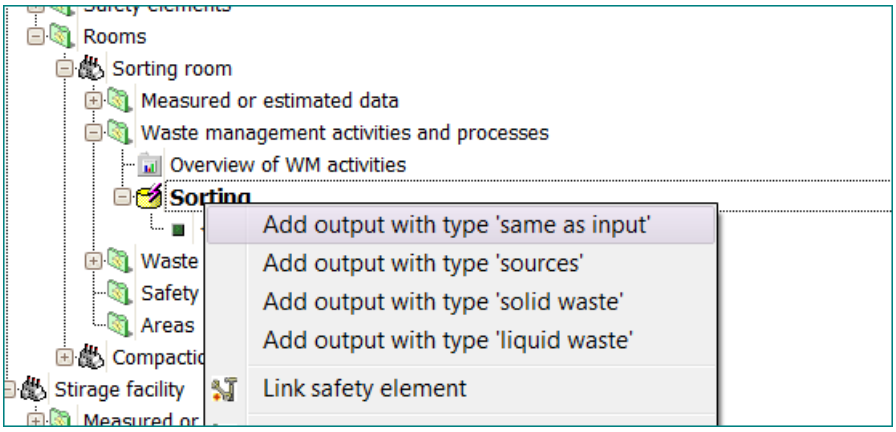
Change the property “Name” to “Compactable waste”.



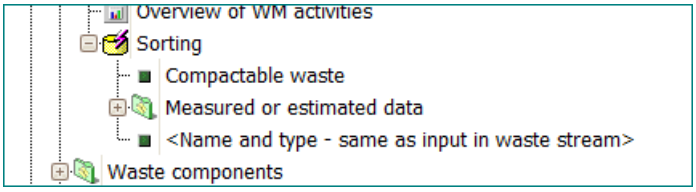
Note that name was also changed in the browser window.



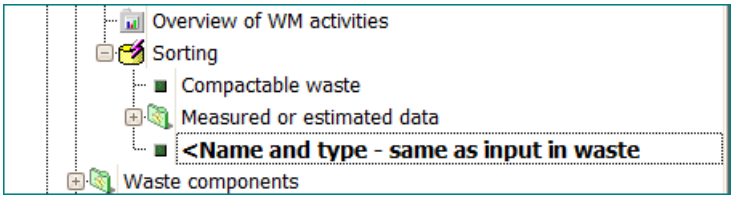
Right-click on Sorting and select from the menu “Add output with type ‘same as input’”.



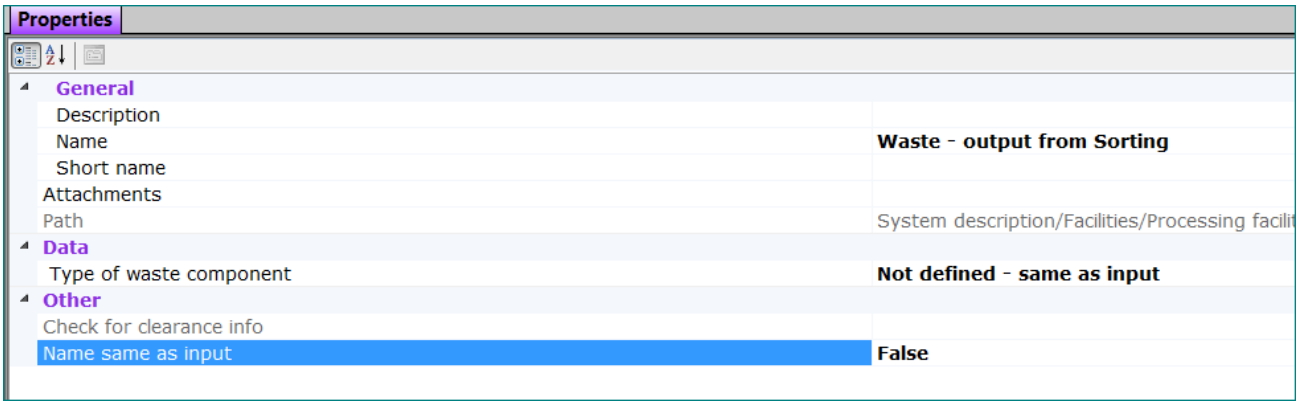
The new output will be added to Sorting:



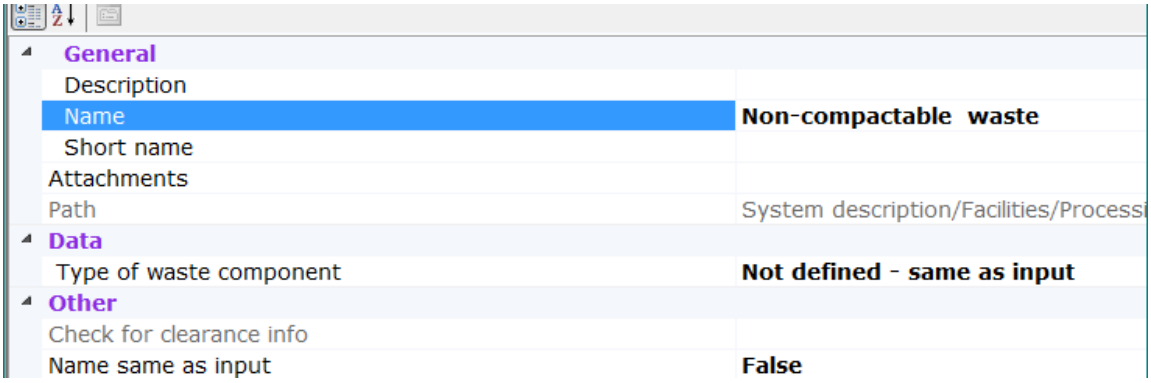
Select this output.

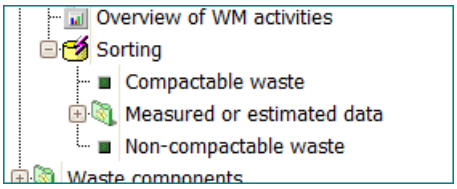


Change the property “Name same as input” to False:



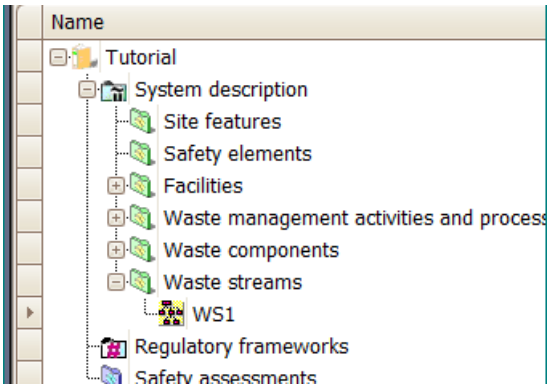
Change for the property Name to “Non-compactable waste”.

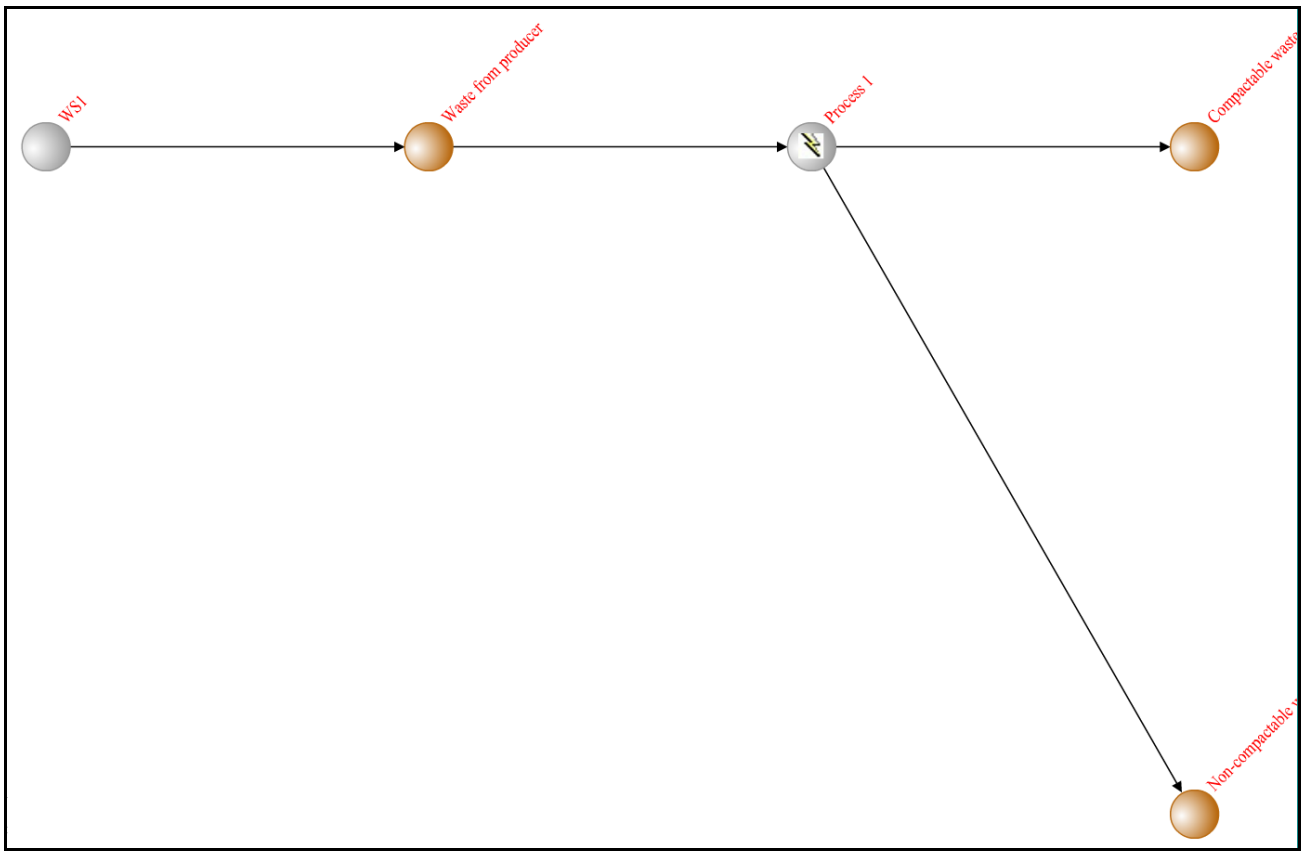




Review the changes in the waste stream

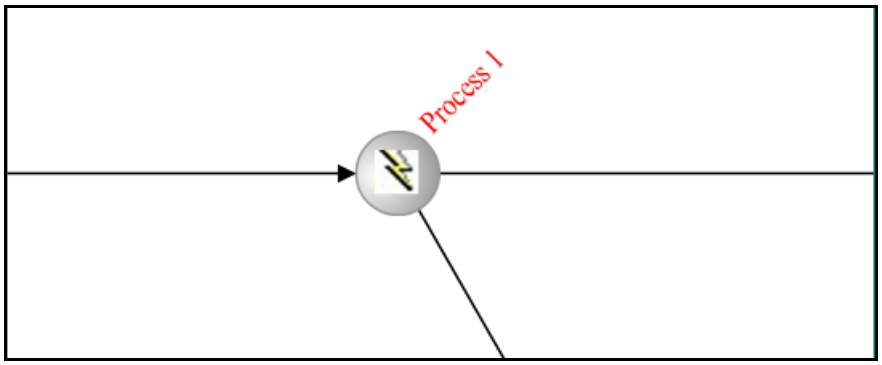
Double-click on the WS1 node to open waste stream created in Tutorial 4.

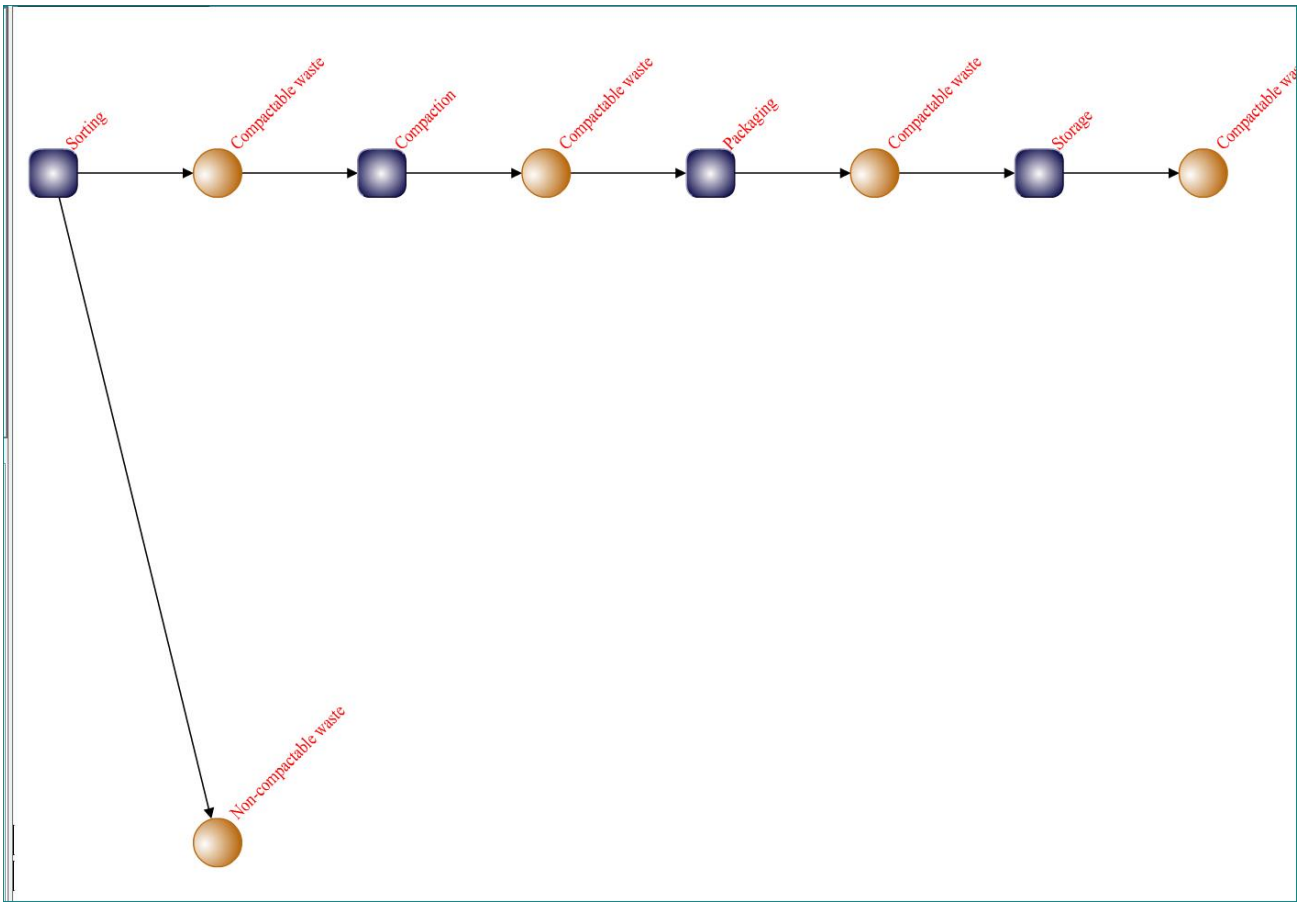




The stream was modified in comparison with Tutorial 4. Now it has two outputs from Process 1 – “Compactable waste” and “Non-compactable waste”.

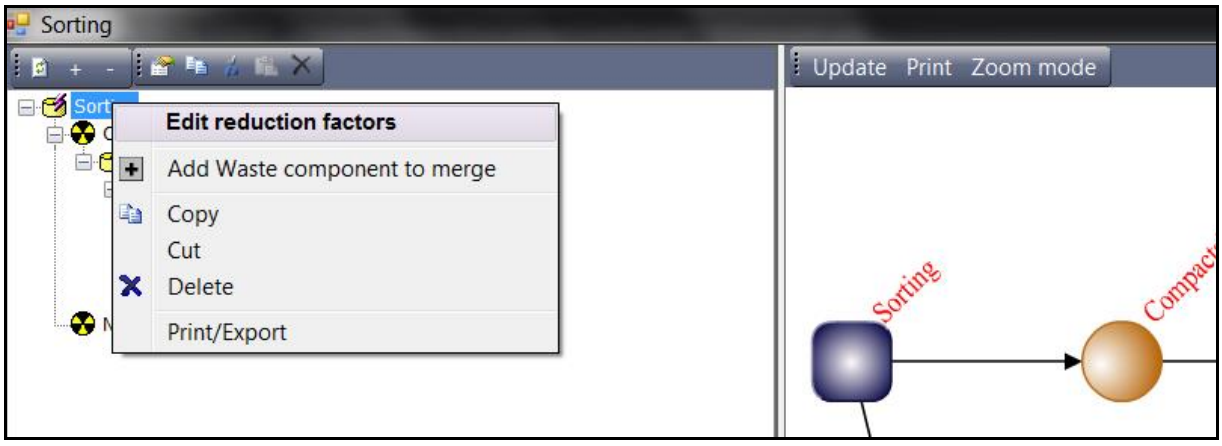
Click on the circle “Process 1”. Now you can see in details how application of Process 1 in stream was modified.

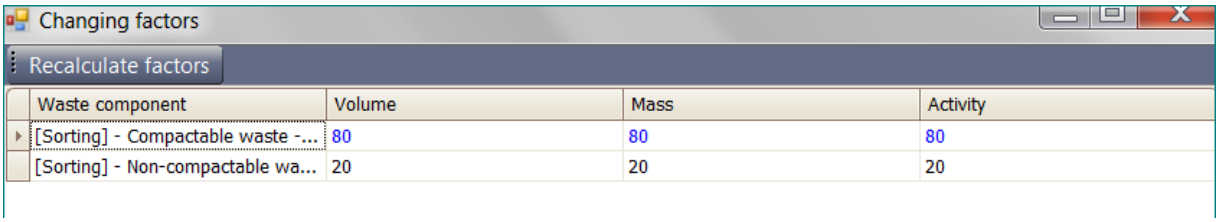




Because a second output was added to the sorting activity, it is necessary to verify that reduction factors for Sorting are correct (see Tutorial 4).

Right-click on the “Sorting” in the browser window and select “Edit reduction factors” from the menu.

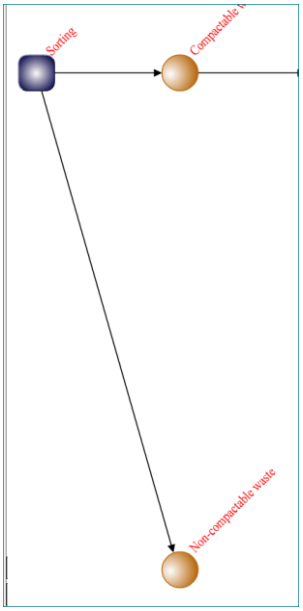




You can see that reduction factors are still correct and correspond to the Table 4 of Tutorial 4.

Close the table.

Click on the circle “Non-compactable waste”.



The table with its properties will appear. Note that the properties of the waste correspond to the properties of incoming “Waste from producer” (see Tutorial 3) and reduction factors (20%).

The values calculated by SAFRAN for mass concentration will be used to perform “check for clearance” later in this tutorial.

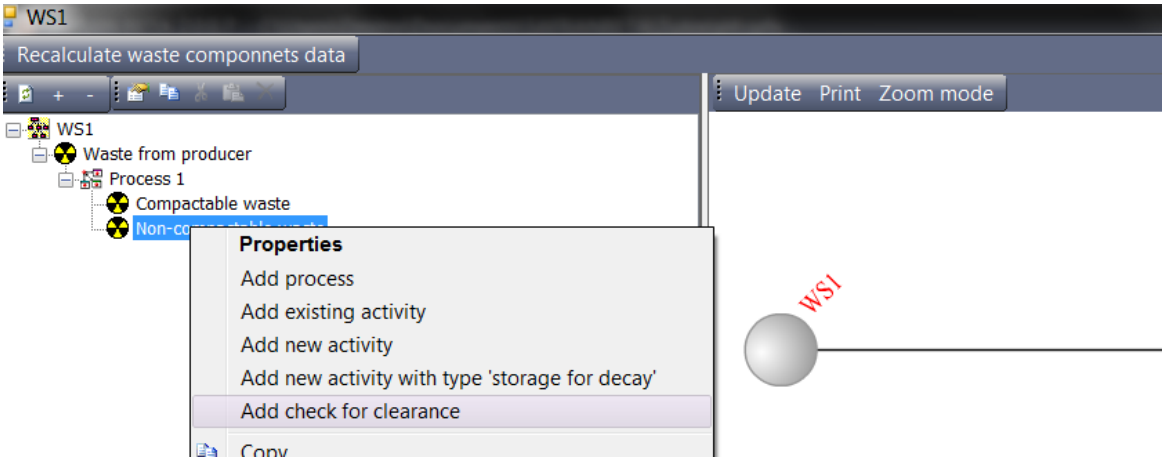
Close the table.

Close the window showing process and return to the general waste stream overview window.

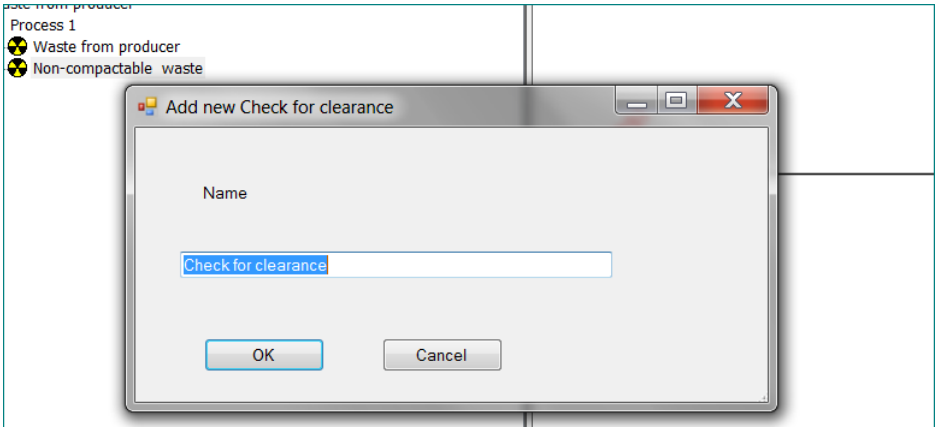
Now you will define the the chain of activities for non-compactable waste consisting of check for clearance and packaging and storage for the waste which cannot be cleared.

Add “check for clearance” activity to the waste stream

Right-click on the “Non-compactable waste” in the object’s browser and select from menu “Add check for clearance”.

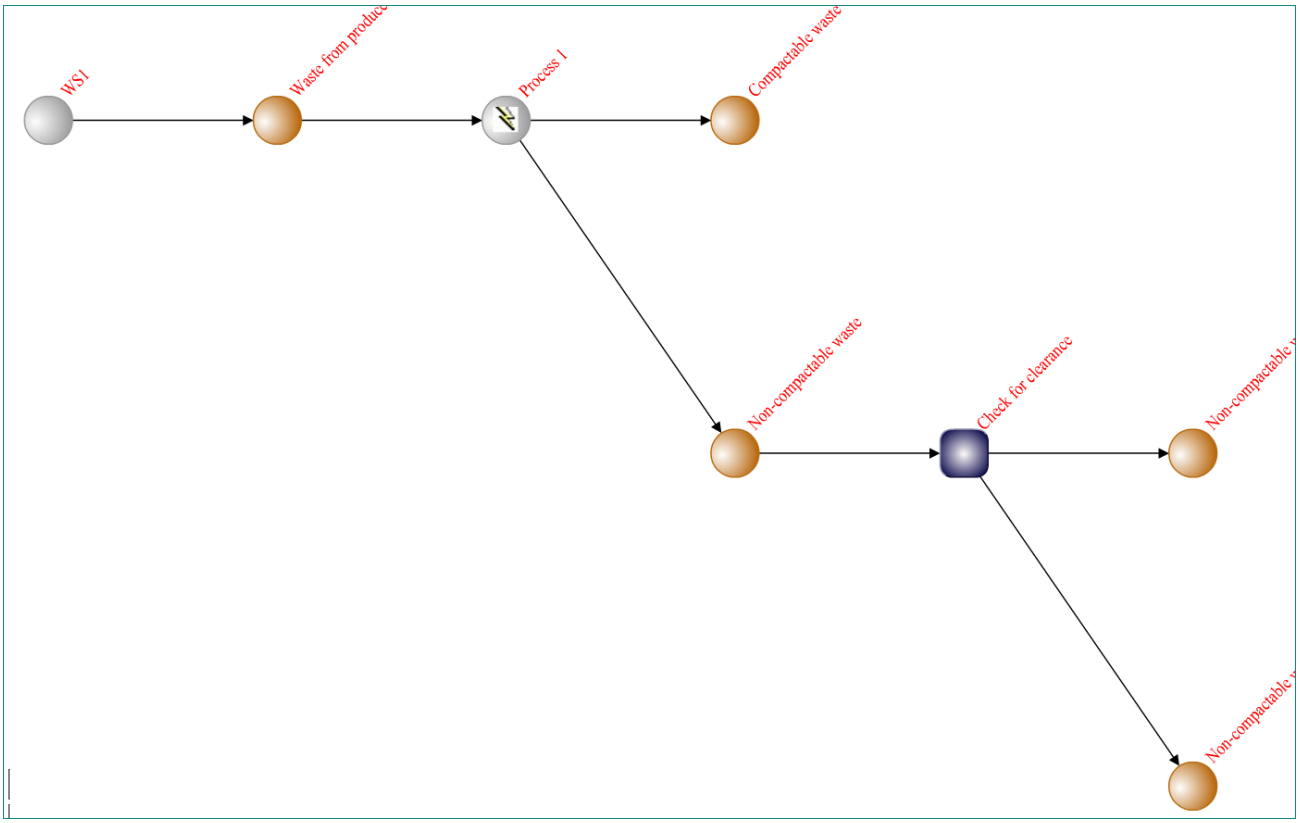


A dialog box will appear:

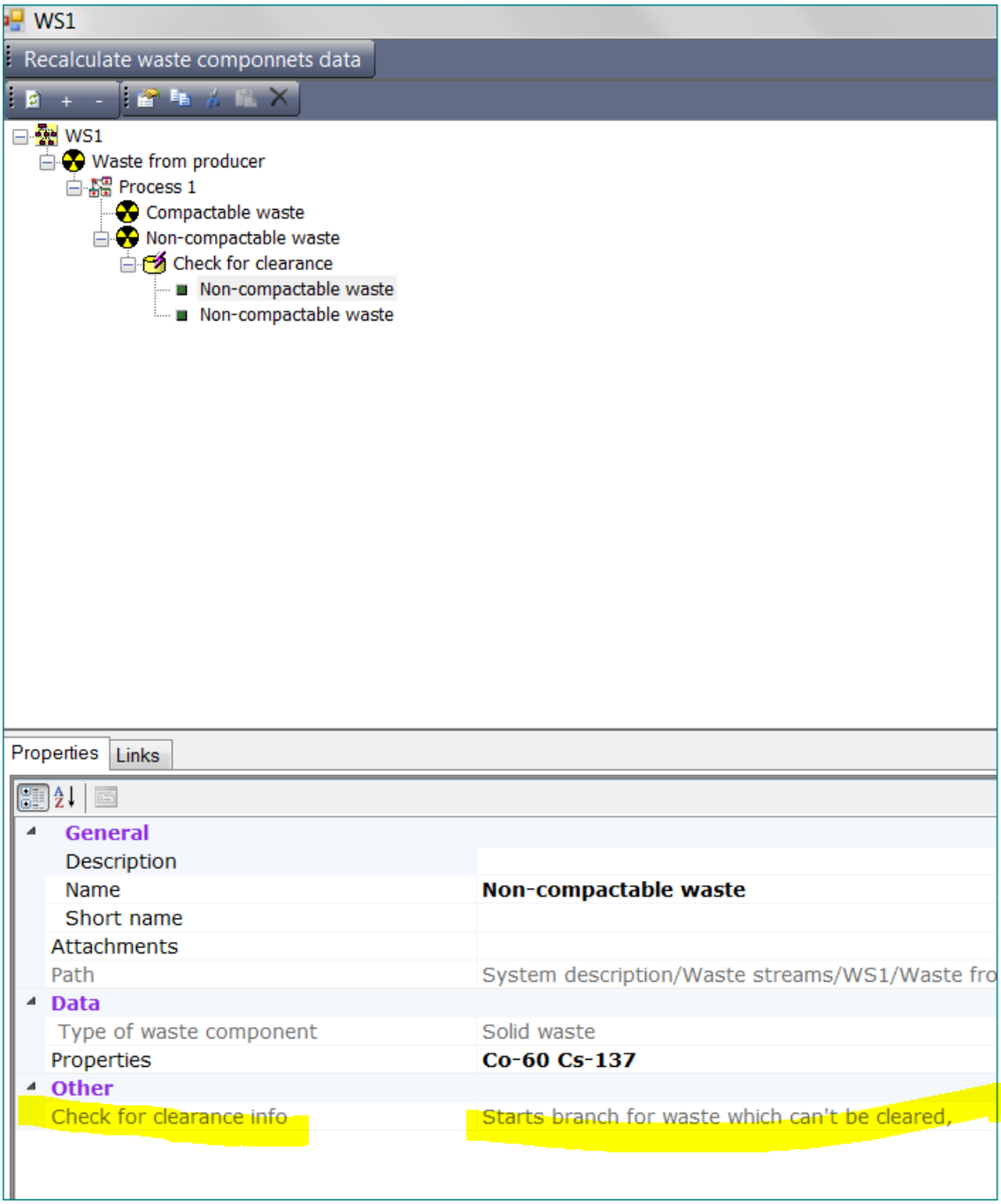


Leave the default name “Check for clearance” and click OK.

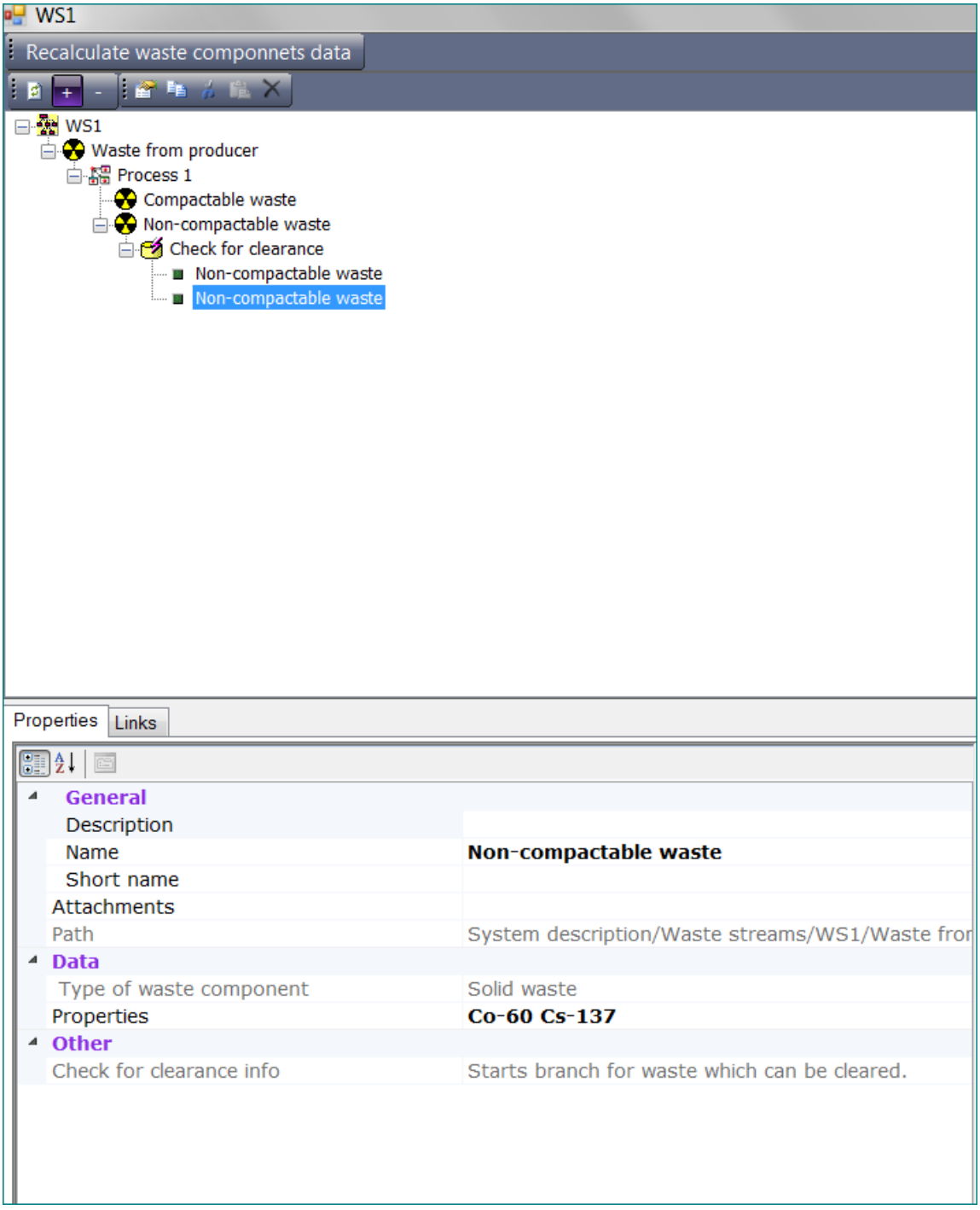
Note the changes in the browser and graphical stream presentation – the new activity “Check for clearance” was added with two outputs.


WS1
Waste from produce
Process 1
Compactable waste
Non-compactable waste
Check for clearance
Non-compactable w
Non-compactable w

First of the outputs starts branch for waste which can't be cleared – to see this, expand the "Check for clearance" in the browser, select this output and review the read-only property "Check for clearance info" located in the lower left part of the screen.

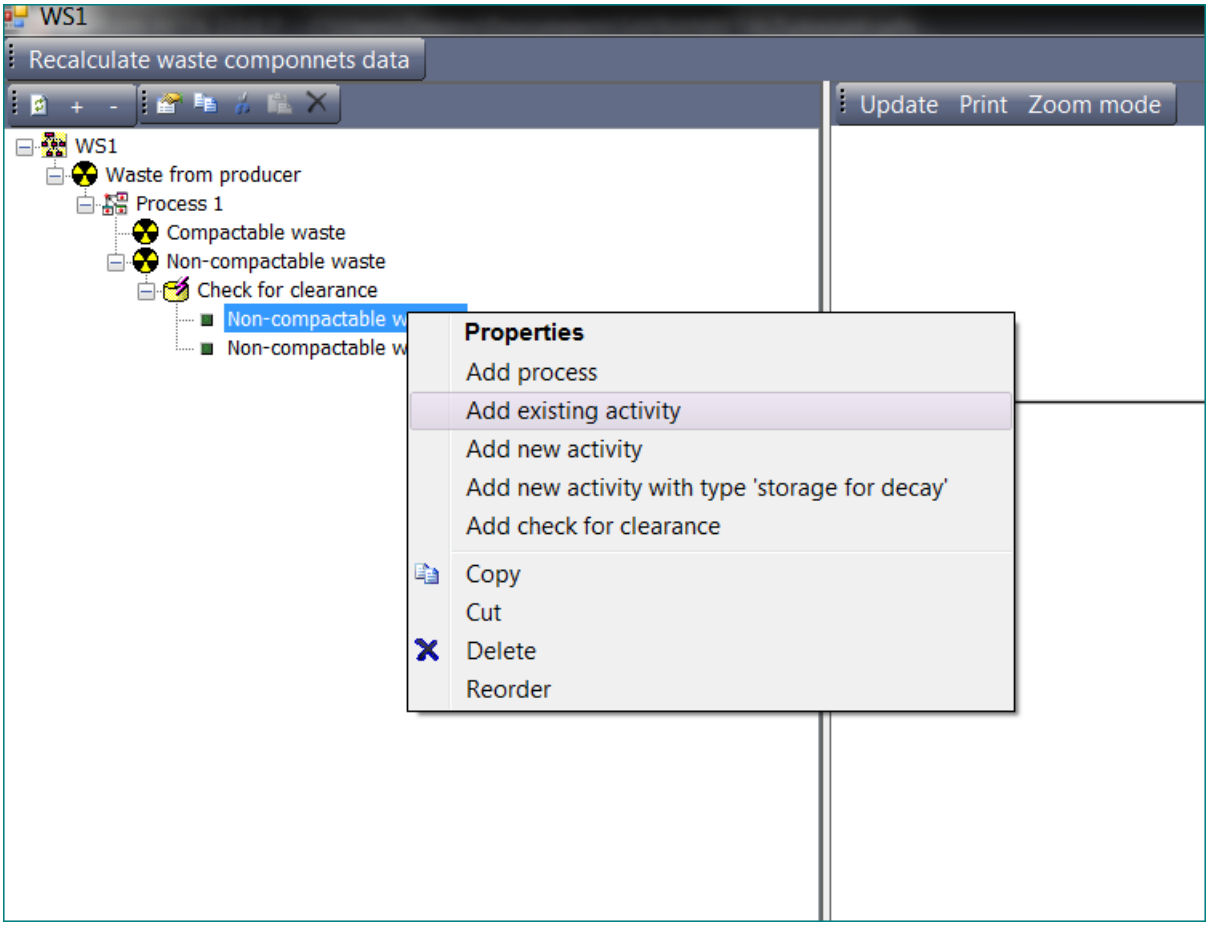


The second output starts the branch for waste which can be cleared.

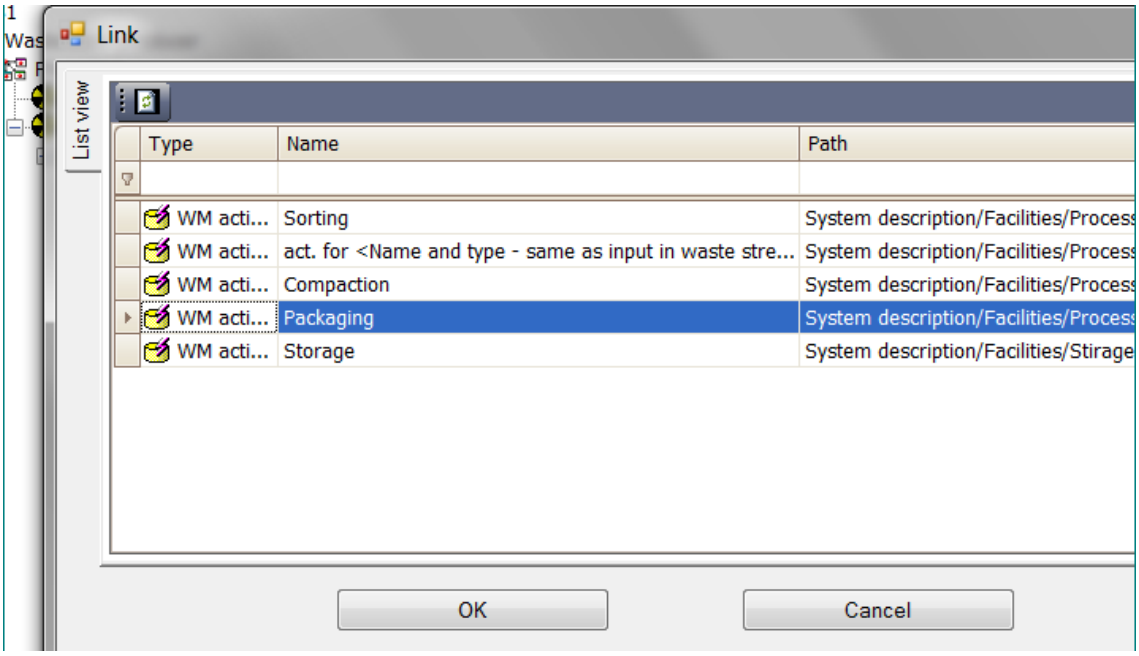


Now the stream for “waste which can’t be cleared” will be developed with Packaging.

Right-click first output and select from the menu “Add existing activity”.

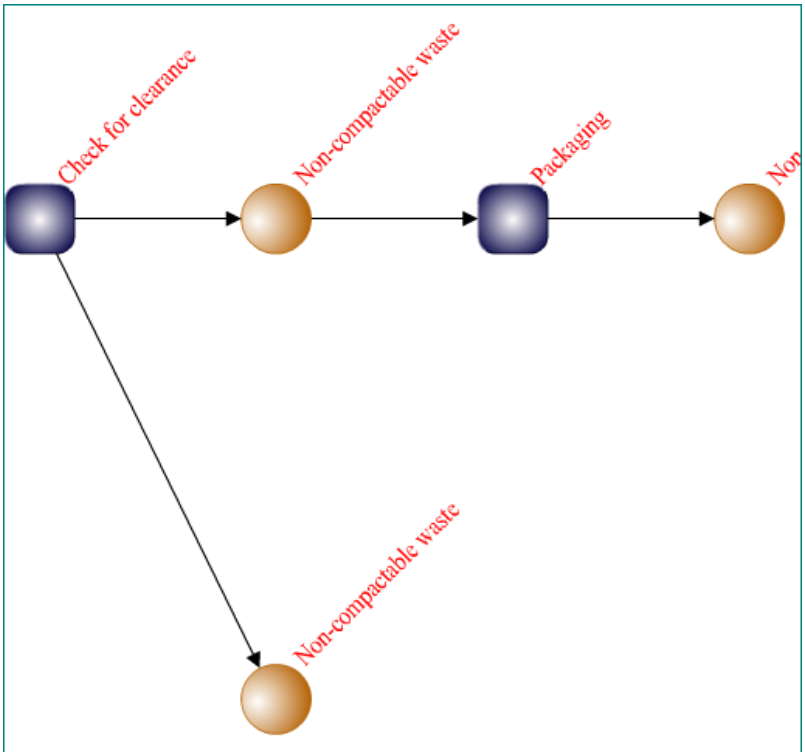


The list of activities will appear.



Select “Packaging” and click OK.

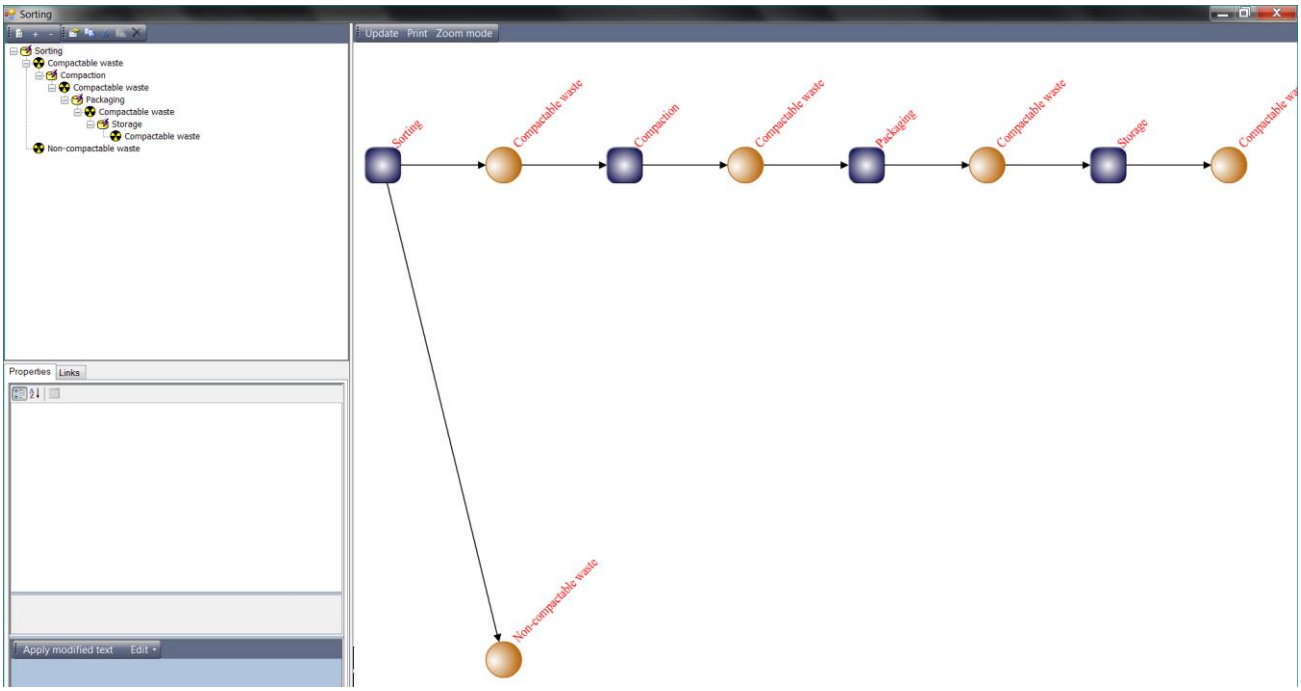
Note the changes in waste stream diagram.



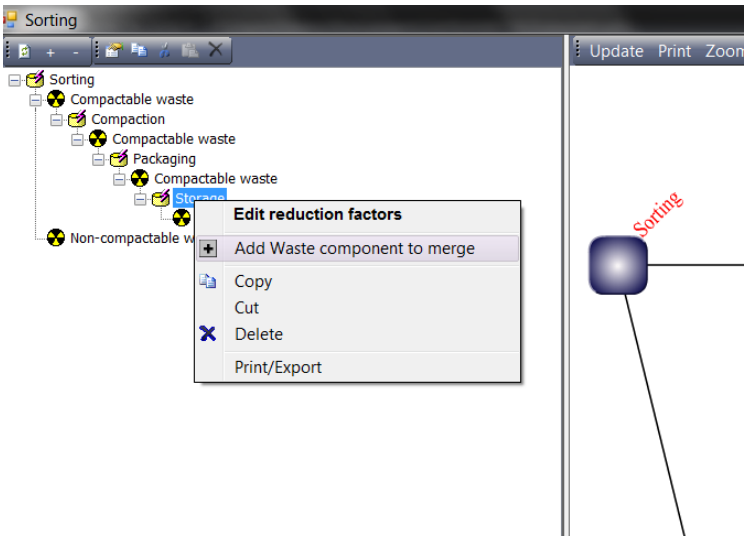
Merge outputs of several activities in the waste stream

To finalize modifications in the waste stream, it is necessary to indicate that the waste produced by Packaging are sent to the same Drum storage room as already used in stream (using activity Storage already existing in stream).

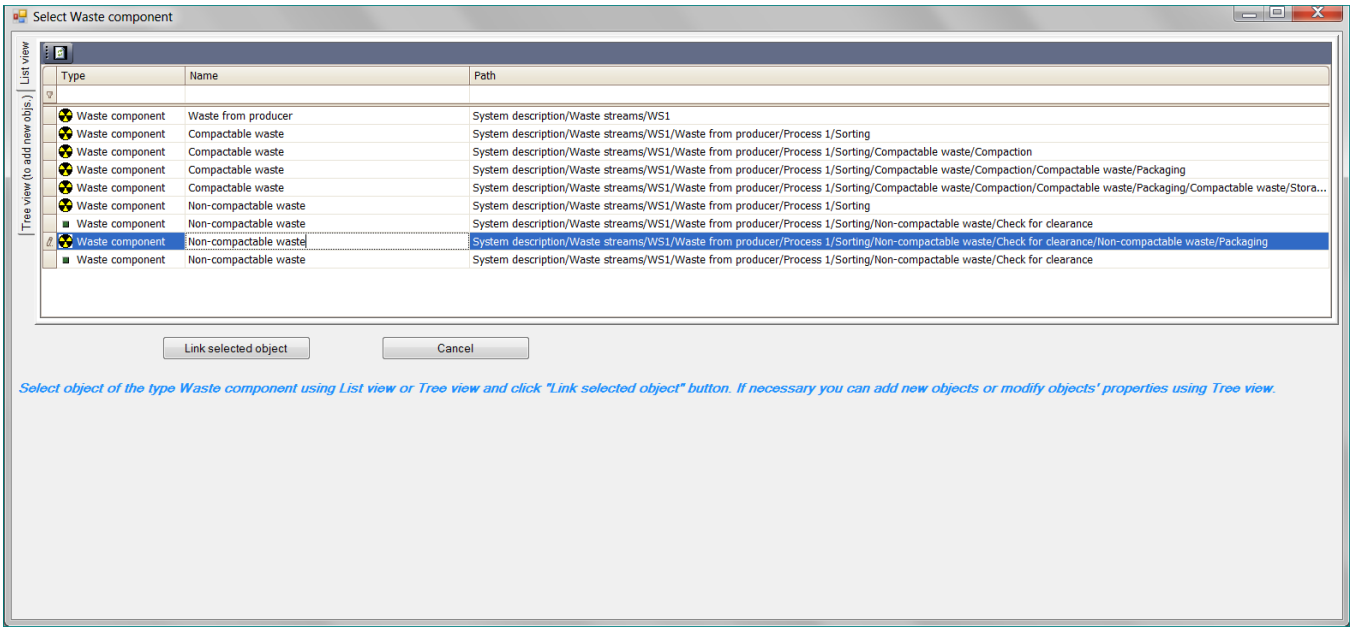
Click on the Process 1 circle. The window for Process 1 application in stream will appear again.



Right-click in the browser on the Storage and select from menu “Add waste component to merge”.



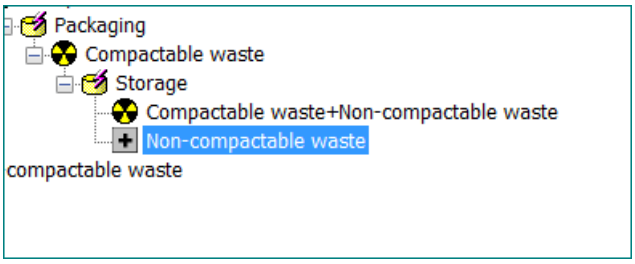
The list of waste component which can be “sent” to Storage and “merged” with already existing input to this activity will be shown:



Select the row with path *System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Non-compactable waste/Check for clearance/Non-compactable waste/Packaging* as shown in the picture above.

Click “Link selected object”.

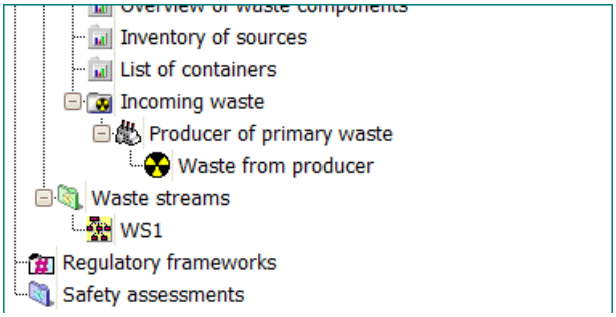
Note the change in the browser window.



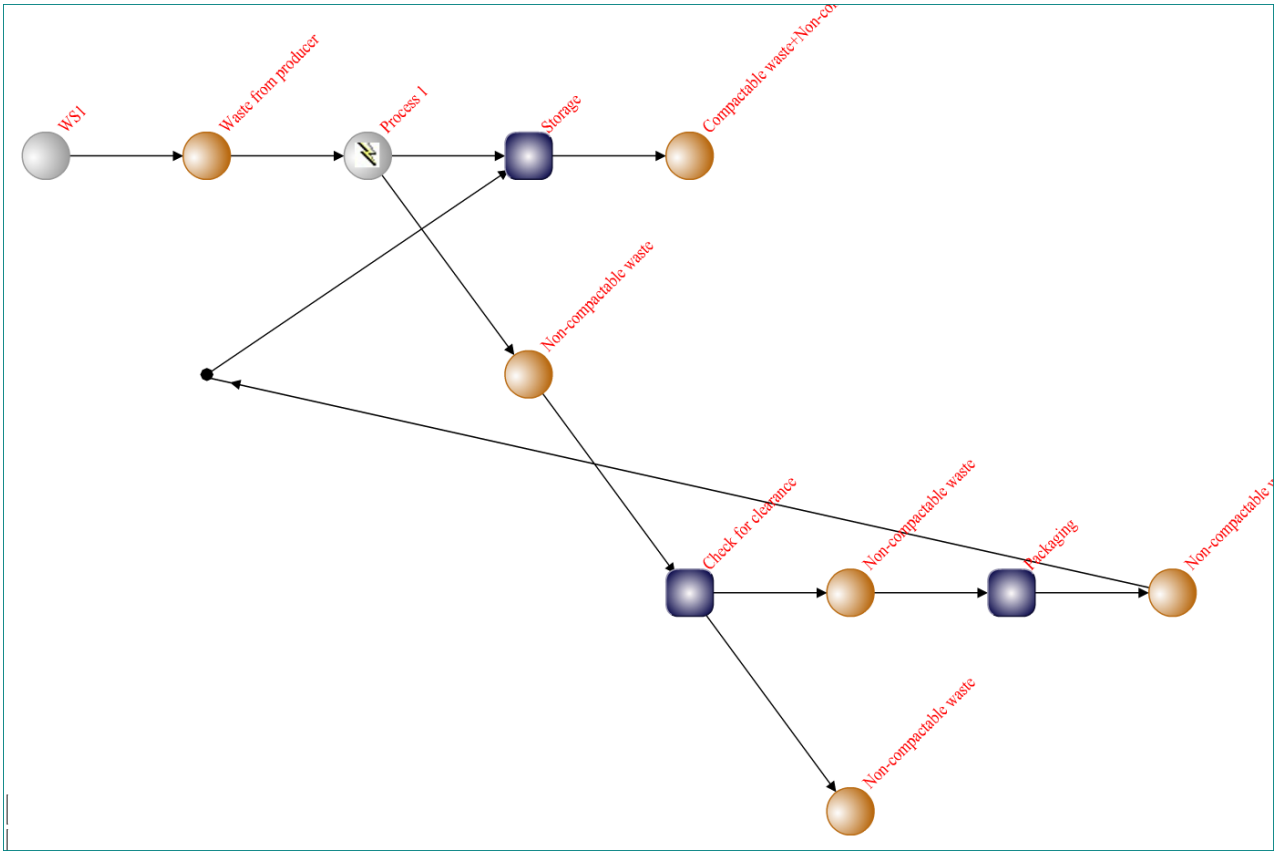
Close the window for Process 1.

Close the window for stream and return to the main window.

Double-click again on the WS1 node to re-open stream window.



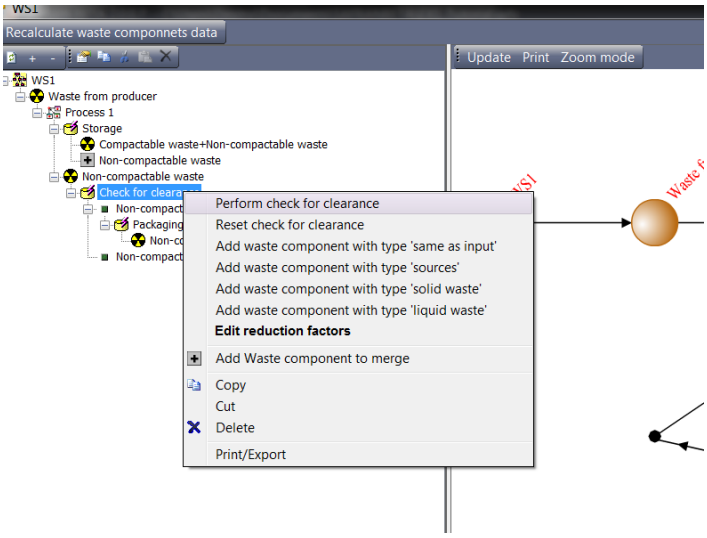
Note the changes in the waste stream diagram.



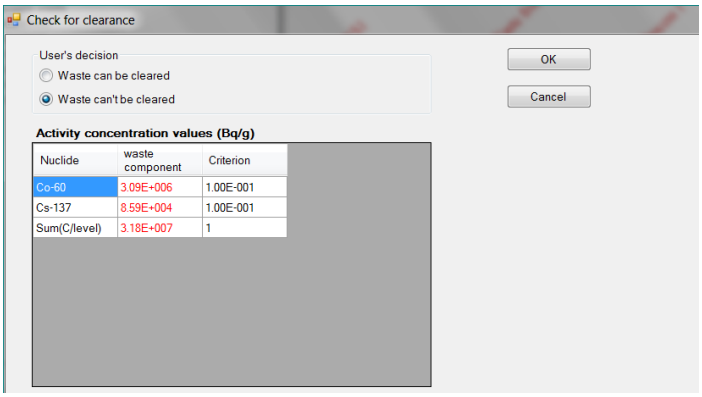
Now check for clearance for non-compactable waste will be implemented.

Perform check for clearance

Right-click on the “Check for clearnce” in the browser window and select “Perform check for clearance”.



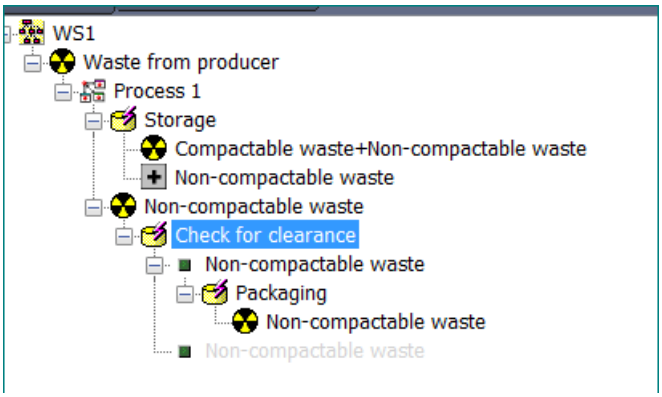
The following window will appear:



The data in this window are based on the mass concentration data calculated by SAFRAN which was previewed earlier in this tutorial.

SAFRAN suggested that waste can't be cleared. Click OK to confirm this decision.

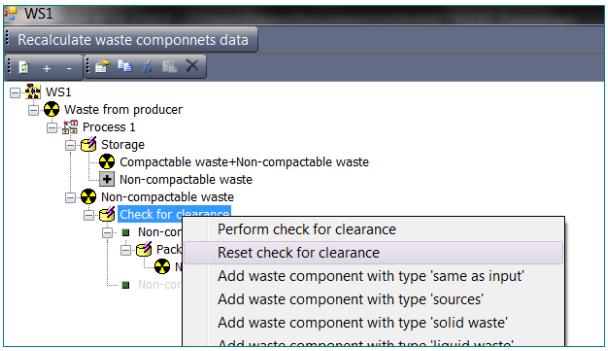
Note that branch corresponding to the waste which can be cleared was disabled in the browser.



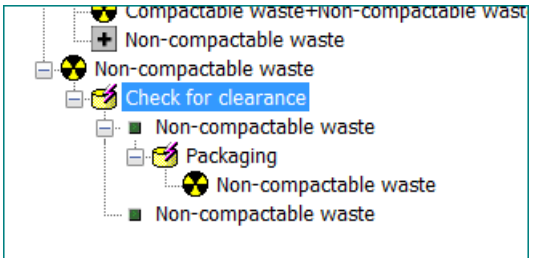
(You can check whether output starts the branch for waste which can be cleared by observing its properties as shown earler in this tutorial)

Disabling branch means that the corresponding waste components will not be taken into account during the safety assessment.

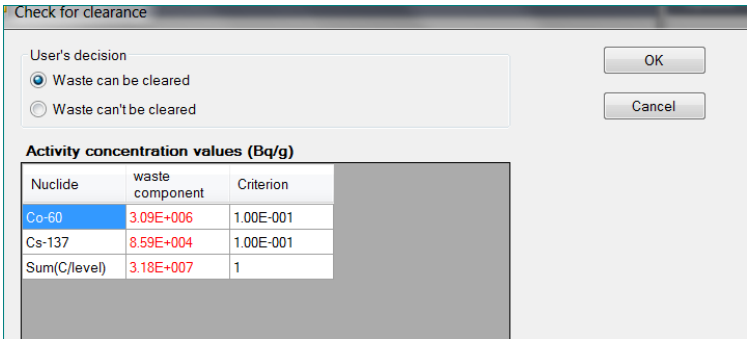
You may change the decision for check for clearance. Reset the results of the check for clearance by clicking right mouse button on "Check for clearance" and selecting "Reset check for clearance".



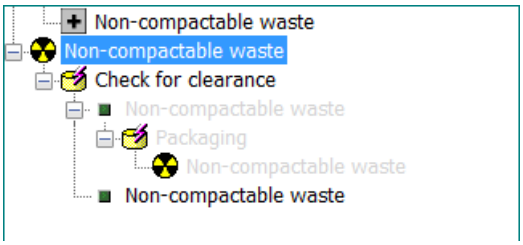
All waste components will be enabled again.



Perform again check for clearance, but this time select “Waste can be cleared”.



Note that another branch of waste stream (corresponding for waste which can’t be cleared) will be disabled.



Close the waste stream window.

SAVING THE FILE:

Save the project.

End of advanced exercise