

# SAFRAN TUTORIALS

Dmitry Hofman, Facilia AB, Sweden. Revision 2015-11-29

# **Table of Contents**

Introduction Important notes:	
Tutorial 1. Installing SAFRAN. Creating of the SAFRAN tutorial project SAFRAN installation instructions	7
Start SAFRAN	7
Reset SAFRAN's options	7
Create the SAFRAN tutorial project	
Tutorial 2. Define facilities, processes and waste management activities Add processing facility	
Add storage facility	
Add process and waste management activities	
Tutorial 3. Numerical properties of facilities, rooms and waste management a List of radionuclides	
Properties of the processing facility	
Properties of the sorting room	
Properties of the compaction and packaging room	
Properties of the storage facility	
Tutorial 4. Incoming waste component Add waste producer	
Add incoming waste component	
Properties of the waste component	
Tutorial 5. Waste stream Define type of container used for this project	
Create the waste stream	
Numerical properties of the waste components	
Tutorial 6. Regulatory Framework The regulatory framework	
Annual dose limits for normal operation	
Dose limits for accidental situation	
Tutorial 7. Safety Assessment Purposes and scope of the safety assessment	
Link to the regulatory framework	
Assessment for normal operations	
Assessment of dose to worker from inhalation and external exposure	
SAFRAN 2 Tutorials	Rev. 2015-11-29



Assessment of dose from external irradiation and inhalation due to participation in oth waste management activities	
Analysis	61
Assessing dose to public due to the normal release from processing facility	64
Assessment for accidental situation	68
PIE types. Excluding not relevant PIE types	68
Scenario "Fire in the storage facility"	72
Scenario "Drop of the drum in the Drum storage room"	75
Dose assessment for accidental increase of the external exposure due to drop of the dr	
Advanced exercise. Assessment of doses for workers and public due to the accidental release of radionuclides to the air	
Analysis	96
Tutorial 8. Database Overview of the database	
Tutorial 9. Sealed sources – system description Waste components	
Linking waste components to the waste management activities	115
<ul> <li>Tutorial 10. Sealed sources – assessment for normal operation</li> <li>Tutorial 11. Dose rate estimation for normal operation with SAFRAN exposure models</li> <li>Tutorial 12. Advanced analysis of safety assessment results. Discussion object. Modified/r safety elements.</li> <li>Tutorial 13. Database – advanced topics</li> <li>Advanced exercise. Adding user-defined values to database by copying of the rows</li> </ul>	130 new 137 146
Advanced exercise. Adding user-defined values to database by importing data from Excel	148
Tutorial 14. Reuse library objects Saving objects to the library	
Reusing of the library objects	154
Tutorial 15. Complex waste streams. Check for clearance Define several outputs for the same waste management activity	
Review the changes in the waste stream	162
Add "check for clearance" activity to the waste stream	166
Merge outputs of several activities in the waste stream	171
Perform check for clearance	174



# 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.



/	Тос	ols Window Help				
		Database				
ee		Library	•		<b>4</b> ×	<u>.</u>
-19		Advanced calculations				Properti
		Safety requirements				<b>2</b> ↓   □
		Document project with MS Word add-in	•			▲ Gen
		Import/Export	•			Des
		Options	•		Modify options	larr
	_				Reset options to default values	
				_		Path

## 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.

🖳 Create p	roject	
Properties		
Title	Tutorial	
Author		
Project s	started den 14 augusti 2013	
Descript	Exercise to learn more about SAFRAN	
	Create project Cancel	

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.



🖳 Projec	t propertie	s		Second Second	
Nuclides	Sources	Containers and packages Scales	Title, description, author, date		
Nucli	ides		Add/remove nuclide		

Here among other you are able to add nuclides and containers you will use to describe your waste components. This will be <u>done later</u> 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:

File Edit View Tools Window Help	
Object explorer (tree view) # ×	1
🔋 🎼 🐇 🏨 🔆 📄 👘 👔 🚰 🛐 🖡 Show description	Properties
Name	<ul> <li>General</li> </ul>
🕨 🖃 📜 Tutorial	Descriptio
🗄 😭 System description	Name
Site features	Short nar
Safety elements	Attachmen
- Carlities	Path
🖽 🖏 Waste management activities and processes	Project
🕀 🖏 Waste components	Author
Waste streams	Project sta
👔 Regulatory frameworks	A Review
Safety assessments	Review dat
	Reviewer
	Description
I	Description



## **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<sup>1</sup> is shown in the Fig. 1

<sup>&</sup>lt;sup>1</sup> 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" SAFRAN 2 Tutorials



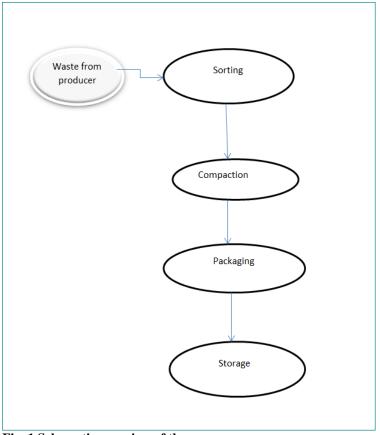


Fig. 1 Schematic overview of the process

## 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:<sup>2</sup>

<sup>&</sup>lt;sup>2</sup> Alternatively, you may click the right mouse button and select action from the context menu. SAFRAN 2 Tutorials Rev.



×	Actions 🛛 🕂 🗙
	Add
	🖑 Add Facility
	💐 Add User-defined folder
	Edit
	Reorder
	Document
	Print/Export/Insert as ta Word

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

ame		
遺 Tutorial		Descriptio
🖃 🕋 System description		Name
💐 Site features		Short nar
	- Address Factor	Attachment
💐 Facilities	- Add new Facility	Path
🖻 💐 Waste management a		
🖃 💐 Waste components		
🧃 Waste streams	Name	
📲 Regulatory frameworks		
🛄 Safety assessments		
	Processing facility	
	OK Cancel	
		description
		Description
		Edit -

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.



الله الله	Facility: Processing facility (System description/Facilities/Processing facility)			
Properties				
▲ General				
Description	Facility where processing operations take place			
Name	Processing facility			
Short name				
Attachments				
Path	System description/Facilities/			
Parmeters				
Filtration efficiency	0			
1				

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**".

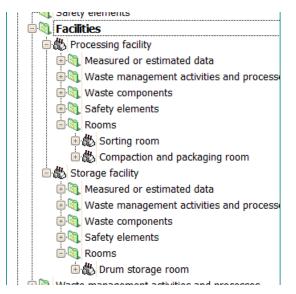
Add another room to the "*Processing facility*" with the name "*Compaction and packaging room*".

#### Add storage facility

Add new facility - "Storage facility".

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

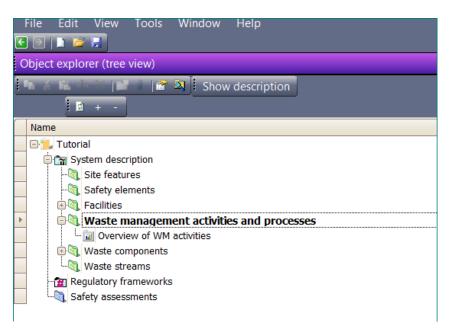
Finally you will see the following structure of facilities and rooms.





#### 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.

Tutorial				
System description				
Site features				
- 💐 Safety element				
🗄 💐 Facilities				
🖃 💐 Waste manage				
词 Overview of	Name			
🖃 💐 Waste compon	Name			
🛄 Waste streams				
🐮 Regulatory framev	Process 1			
🐧 Safety assessmen				
	OK Cancel			
		the second se		
		D		
1				

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

#### SAFRAN 2 Tutorials

Rev. 2015-11-29

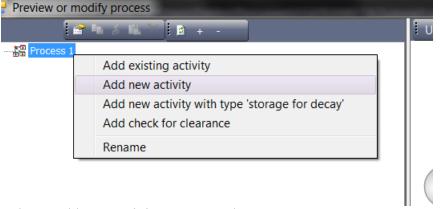


The "Preview or modify process" window will appear.

Preview or modify process	and who
	Update Print Zoom mode
読録 Process 1	Recent
Properties Links	

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.



Preview or modify process	
	Update Print Zoom mode
	Contraction of the second seco

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

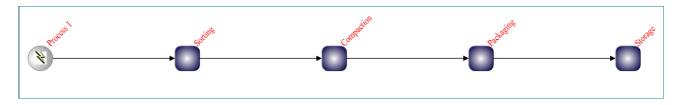
Update Print Zoom mode	
Broces 1     Gording     Gording     Gording     Gording     Gording	annin

Add new activity "Packaging" to "Compaction".

Preview or modify process	a frances of the		
2 % 3 能 2 + -	Update Print Zoom mode		
Sorting     Compaction     Compaction     Compaction     Compaction     Compaction     Compaction	Protoni	 	

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".

SAFRAN 2 Tutorials

Rev. 2015-11-29





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.

•	- Overview of waste management activities							
Dr	Drag a column header here to group by that column							
Π	Activity	Facility	Room	Area	Waste stream(s)	Process(es)		
•	Sorting					Process 1		
	Compaction					Process 1		
	Packaging					Process 1		
	Storage					Process 1		

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

•	Overview of waste management activities							
Di	Drag a column header here to group by that column							
	Activity Facility							
2. Sorting Processing facility								
Compaction Processing facility								
	Packaging	Storage facility						
Storage								

	Overview of waste management activities						
D	Drag a column header here to group by that column						
	Activity Facility						
	Sorting Processing facility						
	Compaction Processing facility						
	Packaging Processing facility						
	Storage	Storage facility					

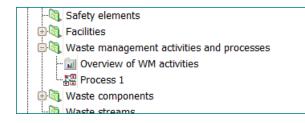


	Similarly, select	the room where	e each activity take place <sup>3</sup> :
--	-------------------	----------------	---

Drag a column header here to group by that column						
Activity	Facility	Room		Area		
Sorting	Processing facility	Sorting room				
Compaction	Processing facility	Compaction and packaging room				
Packaging	Processing facility	Compaction and packaging room	$\checkmark$			
Storage	Storage facility	Drum storage room				

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:

- Safety elements							
Recilities							
Processing facility							
🗉 💐 Measured or estimated data							
🖽 🐧 Waste management activities and processes							
🖽 💐 Waste components							
🖃 💐 Safety elements							
E Rooms							
🗐 🆏 Sorting room							
😥 💐 Measured or estimated data							
🖃 🖏 Waste management activities and processes							
🖬 Overview of WM activities							
Sorting							
😥 🖏 Waste components							

SAVING THE FILE:

Select File / Save project from the main menu.

<sup>&</sup>lt;sup>3</sup> If list of rooms is not appear in the cell, click outside the cell and then inside the cell SAFRAN 2 Tutorials



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

### List of radionuclides

Select View/Project properties in the main menu.



File	Edit	View	Tools	Window	Help			
$\mathbf{E} \mathbf{i}$	1 📁	0	bject exp	lorer (tree v	iew)	Ctrl+B		
Object	Object explorer (folders or types view)							
<b>1 1 1 1</b>	ja aļ€		operties	and links				
			ctions				- 1	
Name		Er	rors, task	s and comm	nents			
	Tutoria	Pr	oject pro	perties				
		W	aste strea	ams				
		0	verview o	of comments	s			
		0	verview o	of attachme	nts			

The Project properties window will appear.

Project	Project properties								
Nuclides	Sources	Containers and packages	Scales	Title, description, author, date					
Nuclio	Nuclides								
				Add/remove nuclide					
Ac	Add nuclides above to new waste components and measurement tables								

Click the "Add/remove nuclide" button.



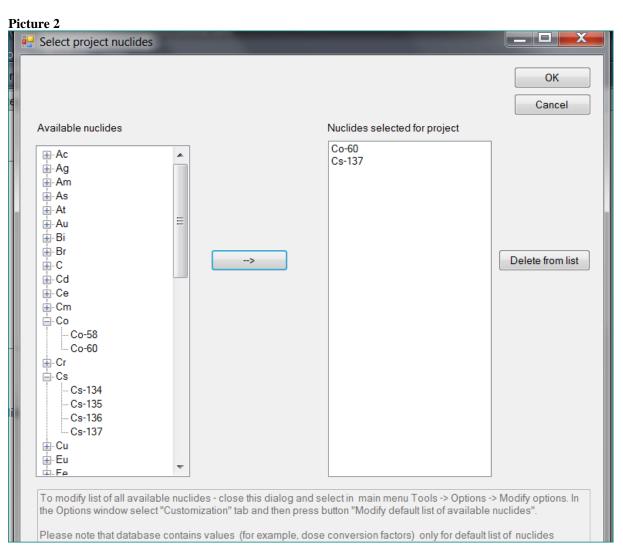
The following window will appear:

#### Picture 1

Select project nuclides	
Available nuclides selected for proje	OK Cancel
Ac Ag Ag Am As As At Au Bi Br C C C C C C C C C C C C C	Delete from list
To modify list of all available publices, place this dialog and select in main many Teals	Options > Madify aptions In
To modify list of all available nuclides - close this dialog and select in main menu Tools -> the Options window select "Customization" tab and then press button "Modify default list of a Please note that database contains values (for example, dose conversion factors) only fo provided with SAFRAN. When performing safety assessments you will need to extend dat specify necessary values directly in the safety assessment tables.	available nuclides". Ir default list of nuclides

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





#### Click "OK".

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

Project	propertie	25			1000
Nuclides	Sources	Containers and packages	Scales	Title, description, author, date	
Nuclio Co-6 Cs-13	des D			Add/remove nuclide	
<b>√</b> Ac	ld nuclide	s above to new waste com	ponents	and measurement tables	

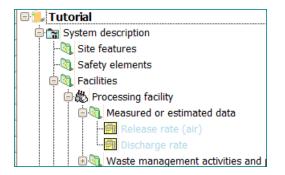
SAFRAN 2 Tutorials



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:

👋 Re	lease rate (air)				_	
	elease rate (air) d/remove nuclide	Export to Ex	cel Impo	ort from l	Excel View	Print/E:
	parameter	nuclide	value	unit	comment	
	Release rate (air)	maanaa		Bq/y		
	Release rate (air)	Cs-137		Bq/y		

Enter data<sup>4</sup> about release rate according to Table 2.

👹 Rel	ease rate (air)		_			
運 Re	elease rate (air)					
Ado	d/remove nuclide	Export to Ex	kcel Import	t from Ex	cel View	Print/Export/Ins
	parameter	nuclide	value	unit	comment	
	Release rate (air)	Co-60	4.41E+006	Bq/y		
•	Release rate (air)	Cs-137	2.27E+006	Bq/y		

Close the table.

<sup>&</sup>lt;sup>4</sup> Press Tab button after entering each value or click outside the cell. SAFRAN 2 Tutorials



Select "Processing facility".

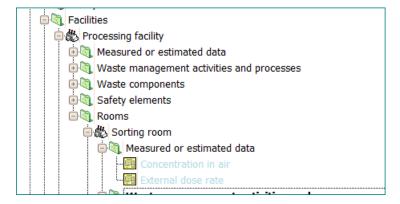
	Name
	🖃 📁 Tutorial
	🖹 🔚 System description
	-💐 Site features
	-💐 Safety elements
	🗐 🔍 Facilities
►	🖹 🖏 Processing facility
	🗐 🔍 Measured or estimated data
	Discharge rate
	Release rate (air)
	🖃 🔍 Waste management activities and processes
	🖃 🔍 Waste components

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

Ψ×	<b>8</b>	Facility: Processing facility (Syste	em description/Facilities/Processing facility)
	Properties		
	<b>₽</b> ↓ ■		
	<ul> <li>General</li> </ul>		
	Description		Facility where processing operations take p
	Name		Processing facility
	Short name		
	Attachments		
	Path		System description/Facilities/
	Parmeters		
	Filtration efficiency		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".

SAFRAN 2 Tutorials



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

#### Picture 3

	ADDRESS OF TAXABLE PARTY.	F	D	and the second	1 martine and				
	e nuclide	Export to Excel View	Print/Exp	oort/Insert	in Word	1			_
param (short		description	nuclide	unit	value	date of measur.	comment	reference	
C_AIF	ι	Concentration in air	Co-60	Bq/m3	2.80E-002				
C_AIR	Ł	Concentration in air	Cs-137	Bq/m3	1.70E-002				

Close the table.

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

+	Rooms
	- 🛃 Sorting room
	👻 🔯 Measured or estimated data
	Concentration in air
	External dose rate
	<ul> <li>Waste management activities and processes</li> </ul>
	Overview of WM activities and processes
	👩 Sorting

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

1	WM activity: Sorting	(System description,	/Facilities/Processing facility/Rooms/Sorting
Pro	operties Links		
•	2↓		
~	General		
	Name		Sorting
	Description		
	Short name		
	Attachments		
	Path		System description/Facilities/Processin
× ا	Capacity		
	Capacity (m3)		0.5
× ا	Decay		
	Account decay		No
	Activity duration (y	vears)	
× ا	Graphical preser	ntation	
	Color		blue 2
	Channel		

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



• Sortin	Add output with type inquid waste
⊕ 🐧 Waste con 划	Link safety element
🂐 Safety eler 🛐	Add Measured or estimated data
Sul Aroac	

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

👻 🖏 Waste management activities and processes
Overview of WM activities and processes
👻 🥳 Sorting
Measured or estimated data
Waste components

Expand this folder and double-click on the "External dose rate".

Ŧ	Waste management activities and processes
	Overview of WM activities and processes
	👻 🧭 Sorting
	👻 🐧 Measured or estimated data
	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:

Pi	icture 4		
ıd a	🛃 External dose rate (Sv/h)	-	
des fea sica	External dose rate (Sv/h) 6E-007	ОК	
sica ety	Comments	Cancel	
itie Proc	I		
10			

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.



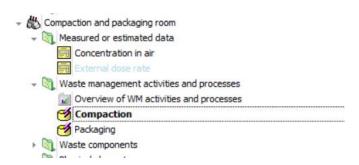
Facilities	
🖃 🎒 Processing facility	
👜 🖏 Measured or estimated data	
Waste management activities and processes	
🖲 💐 Waste components	
🖲 💐 Safety elements	
😑 💐 Rooms	
🕀 🏙 Sorting room	
🗄 🖑 Compaction and packaging room	
🗐 🔍 Measured or estimated data	
- Concentration in air	
External dose rate	
🖃 🔍 Waste management activities and processes	
🖶 🕅 Waste components	

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

V Concentration in air									
7 Concentration in air									
A	dd/remove nuclide Ex	port to Exce	I Import fr	om Excel	View	Prir	nt/Export/Insert in Word	S	
	parameter	nuclide	value	unit	comment				
	Concentration in air	Co-60	6.20E+001	Bq/m3					
•	Concentration in air	Cs-137	1.75E+001	Bq/m3					

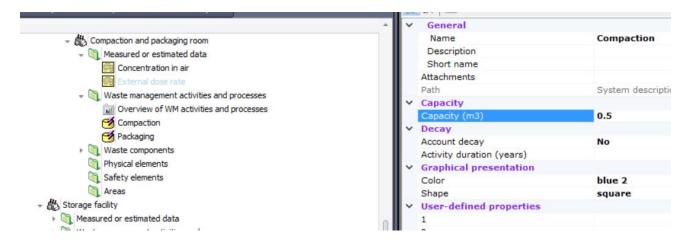
Close the table.

Select waste management activity Compaction.



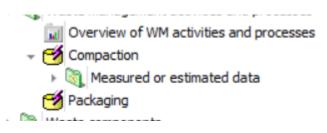


Provide data about its capacity according to Table 2.



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".



🛃 External dose rate (Sv/h)	_	
External dose rate (Sv/h) 3.2E-06	ОК	
Comments	Cancel	

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 <sup>3</sup> / y
Annual mass	11000 kg/y
Volumetric concentration of Co-60 <sup>5</sup>	$1.26E+12 Bq/m^3$
Volumetric concentration of Cs-137	$3.5E+10 \text{ Bq/m}^3$

#### Add waste producer

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

File	Edit	View	Tools	Window	Help						
€ 🖻	1 🞽	H									
Object	Object explorer (tree view)										
1 階 🐰	📭 🔏 🛍 🕖 📉 📄 🗉 🛯 🖀 🔕 🖡 Show description										
	Ø	+ -									
Name	e										
_ <b>⊡</b> °],	Tutoria	al									
ė.	😭 Sys	tem descr	ription								
	- 💐 :	Site featu	res								
	- 🐧	Safety ele	ments								
	ا 🔊 🕣	Facilities									
	🕀 💐 I	Waste ma	nagement	t activities and	d processes						
	<u>ا</u>	Waste cor	mponents								
	-	J Overvie	ew of was	te component	ts						
	-	Invento	ory of sour	rces							
	-	List of	containers	5							
Þ	[	Incon	ning was	ste							

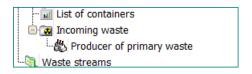
Select command "Add waste producer" from the context menu or in the "Actions" window.

<sup>&</sup>lt;sup>5</sup> Values for concentration are not realistic. These are given for illustration. SAFRAN 2 Tutorials



- Inventory of so	ource ers	s	
Waste streams	acto	Add waste component with type 'solid waste' Add waste component with type 'liquid waste'	
- 💐 Safety assessments		Add waste component with type 'sealed sources' Assign sources to relevant waste components	
		Add Waste producer	
		Reorder	

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".

Incoming wast	e of primary waste
Waste streams	Add waste component with type 'solid waste'
Regulatory framewor Safety assessments	Add waste component with type 'liquid 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*".

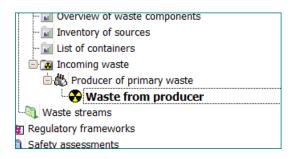
Object explorer (tree view)	🕀 🗙 😵 Waste component: Waste from producer (Syst	tem description/Waste components/Incoming waste/Producer of primary w				
📭 💰 😤 🌵 🗙 📄 🕴 🕍 🔊 E Show description	Properties	Properties				
<u>a</u> + -	24					
Name	General					
🖃 📜 Tutorial	Description	Waste received from the producer facility				
System description	Name	Waste from producer				
Site features	Short name					
Safety elements	Attachments					
E S Facilities	Path	System description/Waste components/Incoming was				
Waste management activities and processes	🔺 Data					
Waste components	Type of waste component	Solid waste				
Overview of waste components	Properties	Co-60Cs-137				
Inventory of sources	<ul> <li>Other</li> </ul>					
List of containers	Check for clearance info					
🗐 👿 Incoming waste						
💼 🆏 Producer of primary waste						
Waste from producer						
Waste streams						

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:

aste from producer I/remove nuclde Export to Excel Import fror	n Excel Hi	de/show groups View Pr	int/Export Show al	l columns Rese	et sorting Copy
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	9			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	



💥 Show properties of waste component J Waste from producer Add/remove nuclde Export to Excel Import from Excel Hide/show groups View Print/Export Show all columns Reset sorting Copy user-defined value SAFRAN parameter nuclide unit comment (prioritized) suggests 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 Cs-137 3.50E+010 volumetric concentration Bq/m3 Co-60 3.09E+009 mass concentration Bq/kg 8.59E+007 mass concentration Cs-137 Bq/kg activity in one container or package Co-60 Bq activity in one container or package Cs-137 Bq 1.02E+014 total activity Co-60 Ba 2.84E+012 total activity Cs-137 Bq 3.40E+013 annual activity Co-60 Bq/y 9.45E+011 annual activity Cs-137 Bq/y

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

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 5001 drums.

SAFRAN 2 Tutorials

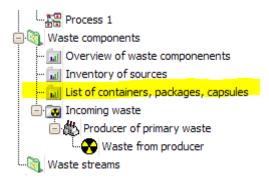
Rev. 2015-11-29



#### 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.

🚽 Projec	t propertie	S					• e	100.01-0-	Carrier, parket	PA AND ADDRESS OF TAXABLE
Nuclides	Sources	Containers ar	nd packages	Scales	Title, descripti	on, author, date				
	Add row	1	Delet	e row						
Na	me					Description				Internal volume

Click "Add row" button.

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

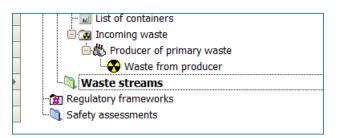
-	Project properties	New York		X
N	Iuclides Sources Containers and packages Scales Title, description, aut	hor, date		
	Add row Delete row			
	Name C	Description	Internal volume (m3)	
i -	> 500 l drum			

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.

WS1		ζ
Recalculate waste componnets data		
WS1 Recalculate waste componnets data	Update Print Zoom mode	
	2 opdate Print Zooin mode	
- 🛣 WS1		
	and a second sec	
	and the second s	
Properties Links		
21		
		_

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". SAFRAN 2 Tutorials Rev. 2015-11-29



Recalcul	ate waste componnets data	
<b>2</b> ) +	- <b>2 4 6 1</b>	
- <b>3</b>	Select the starting waste component of the	e stream
	Rename or change description	

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

Link			
Type			
туре		Name	Path
2			
🕨 😽 Waste	component	Waste from producer	System description/Waste components/Incoming waste/Producer of primary waste
		ОК	Cancel

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

WS1		_
Recalculate waste componnets data		
1 1 🕶 - 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Update Print Zoom mode	
E ∰ We1 L - O Wanta from profileers		3606

#### SAFRAN 2 Tutorials

Rev. 2015-11-29



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.

Waste from producer Waste received from the producer facility 5

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

laste from producer					
d/remove nuclde View Copy to clipb	oard WYSIV	WYG export to Excel	Data 👻 Insert in W	ord document	
parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	commen
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 component	s			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	Ba	

Close the table.

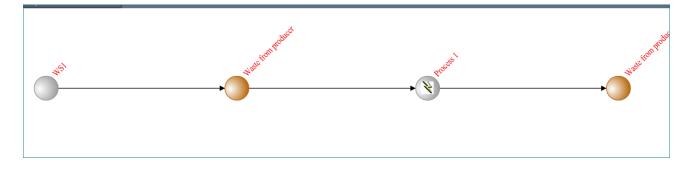
Expand "WS1" in the browser window, right-click on "Waste from producer" and select "Add process".



- WAT	Committee Concerns of the Concerns	and the same
Recalculate waste com	ponnets data	
🖻 + - 📑 👪 👗		Upda
🖃 🌺 WS1		1
Waste from production	Properties	
	Add process	
	Add existing activity	
	Add new activity	
	Add new activity with type 'storage for decay'	
	Add check for clearance	
	Сору	
-		$\top$

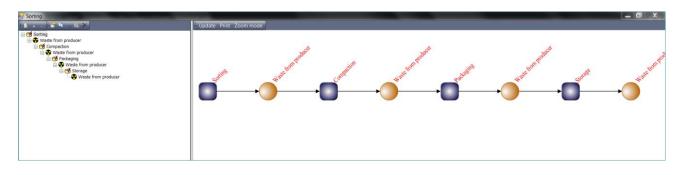
The window which will appear contains only one process – Process 1. Select OK.

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.



## SAFRAN 2 Tutorials



# 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.

🚽 Sorting				-
🗐 + -	8			Upr
⊖ 🧭 Sorting		Edit reduction factors		
	+	Add Waste component to merge		
	₽à ×	Copy Cut Delete		
	_	Print/Export		
				<b>_</b>

The following table will appear:

Compacti	producer ion			<u>رئ</u>	
😑 🧭 📍	Changing factors				
	Recalculate factors				Compaction
	Waste component	Volume	Mass	Activity	COLLIN
	Waste from producer	100	100	100	
Links					
cription					

Place in the table "80" instead of "100" according to the Table  $4^6$ .

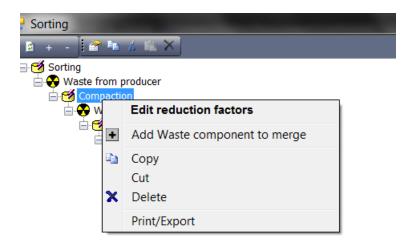
<sup>&</sup>lt;sup>6</sup> After entering value in each cell click Tab button or click mouse outside the cell SAFRAN 2 Tutorials



			Update Print Zoom mo	ode	
Sortin	Changing factors		1.75		, ,
	Waste component	Volume 80	Mass 80	Activity 80	+OCOMPACIAN

Close the table.

Right-click "Compaction" and select "Edit reduction factors".



According to Table 4, specify the following factors:

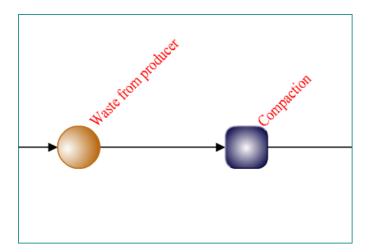
Generating Generation Gener	rom producer paction /aste from producer Packaging Changing factors Recalculate factors			
	Waste component	Volume	Mass	Activity
	Waste from producer	35	100	100

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<sup>7</sup>:

Waste properties after Sorting, before Compaction

<sup>&</sup>lt;sup>7</sup> 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.



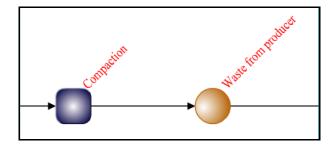


	1 1 1 1 1	( 1 ) ve	D: 1/5	ci ii i	D 1 1	<b>C</b> 1
/remove nuclde Export to Excel Import from Ex		user-defined	SAFRAN	Show all columns	Reset sorting	Copy to
parameter	nuclide	value (prioritized)	suggests	unit	comment	
duration		3.00E+000		year		
annual volume of waste			2.16E+001	m3/y		
total volume 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

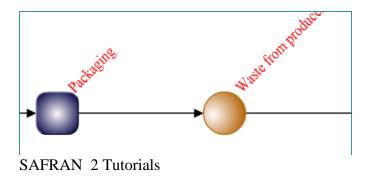
aste from producer /remove nuclde Export to Excel Import from Ex	cel Hide/s	show groups View	Print/Export S	how all columns	Reset sorting
parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration		3.00E+000		year	
annual volume of waste			7.56E+000	m3/y	
total volume of 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	

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:

/remove nuclde Export to Excel Import from E	xcel Hide/	show groups View	Print/Export Sho	w all columns	s Reset sorting	Copy to clip
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:



dd,	/remove nuclde	Export to Excel	Import from E	cel Hide/s	show groups View	Print/Export	Show a	all columns	Reset sorting	Сору
	parameter			nuclide	user-defined value (prioritized)	SAFRAN		unit	comment	
	duration	Select container	or package						• ×	
	annual vol									
	total volur	500 l drum					_	ОК		
	annual ma	o con circuit								
	total mass							Cance	el de la companya de	
	type of co									
	internal vo							Add ne	ew	
	mass of w									
	annual nu									
	total numb									
	volumetric									
	volumetric									
	mass conc									
	mass conc									
	activity in									
	activity in									
	total activi									
	total activi									
	annual act									
	annual act									

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<sup>8</sup>.

<sup>&</sup>lt;sup>8</sup> 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.





👏 Show properties of waste component

/remove nuclde Export to Excel Import from Ex	cel Hide/	show groups View	Print/Export S	how all columns	Reset sortin
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	Ba/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.

<u> </u>	
	<b>2</b> + -
	Name
	🖃 📜 Tutorial
	🖹 🕋 System description
	-💐 Site features
	🖃 🔍 Facilities
	🖃 🔍 Waste management activities and processes
	🖃 🔍 Waste components
	🖮 🔍 Waste streams
	WS1
•	👔 Regulatory frameworks
	🛄 Safety assessments

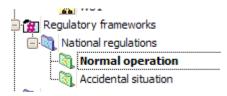
Click on the "Add regulatory framework" in the "Actions" window (or right-click on the "*Regulatory frameworks*" node and select corresponding command from the context menu).

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.

SAFRAN BETA 2.0.0.6 - C:\Users\Dmitry\Documents\SAFRANBETA\Tutorial1.safx		
File Edit View Tools Window Help		
Object explorer (tree view) # ×	🔶 Criterion: Dose limit to worker Worker,1	Normal operation,Dose,Sv/y (Regulatory frameworks/National regulations/Normal
🗄 🐜 🐇 🕮 🐳 📔 🕼 🚰 🔍 📔 Show description	Properties	
Name	<ul> <li>General</li> </ul>	
E Jutorial	Description	
🖹 😭 System description	Name	Dose limit to worker
- Site features	Short name	
- 🐧 Safety elements	Attachments	
🖲 🕅 Facilities	Path	Regulatory frameworks/National regulations/Normal or
Waste management activities and processes	Situation	Normal operation
waste components	Criterion	
👜 🖏 Waste streams	Application	Worker
	Limit	0.02
🖶 🍘 Regulatory frameworks	Туре	Dose
🖮 🕼 National regulations	Unit	Sv/y
🗼 🖄 Normal operation		
Dose limit to worker	4	
Accidental situation	4	
Safety assessments	4	

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.

roperties		
121 m		
General		
Description		
Name	Dose limit to public	
Short name		
Attachments		
Path	Regulatory frameworks/National regulations/Normal operation/	
Situation	Normal operation	
Criterion		
Application	Worker	~
Limit	Worker	
Туре	Public	
Unit	-SV/ 9	_
	21     Ceneral     Description     Name     Short name     Attachments     Path     Criterion     Application     Limit     Type	Alimit     General       Description     Dose limit to public       Short name     Attachments       Attachments     Regulatory frameworks/National regulations/Normal operation/       Struction     Normal operation       Criterion     Worker       Limit     Worker       Limit     Worker

## 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.

SAFRAN 2 Tutorials



# **Tutorial 7. Safety Assessment.**

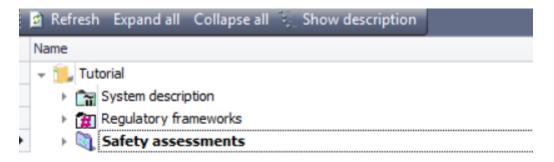
In this tutorial, you will perform the safety assessment.

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

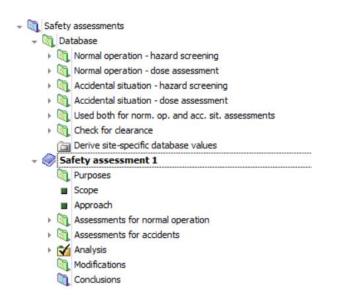
Collapse all branches in the "Object explorer (tree view)" window and select the "Safety assessments" node.



Add the safety assessment "Safety assessment 1".

Expand the "Safety assessment 1" node.

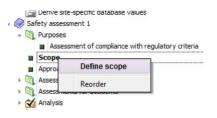




Right-click on the "Purposes" node. Select "*Import standard purposes*". In the window that appears, select "*Assessment of compliance with regulatory criteria*" and confirm by clicking on "OK" button.

🖳 Standard purposes of safety assesment 📃 🗖	X
<ul> <li>Assessment of compliance with regulatory criteria</li> <li>Assessment of design</li> <li>Site selection</li> <li>Identification of safety functions</li> <li>Establish limits and conditions</li> <li>Identify maintenance requirements</li> <li>Identify monitoring requirements</li> <li>Prepare operational procedures</li> <li>Prepare emergency procedures</li> <li>Identify requirements for personnel qualification</li> <li>Identify requirements for record keeping</li> <li>Identify requirements for physical protection</li> </ul>	
OK Cancel	

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:

SAFRAN 2 Tutorials



Ficilities/rooms/ares	WM Activities
Processing fac	m
Sorting roo	n and packaging room
Compactio	/

Ficilities/rooms/ares	WM Activities				
WM Activity	Facility	Room	Area	Waste stream	Process
<ul> <li>✓ Sorting</li> <li>✓ Compaction</li> <li>✓ Packaging</li> <li>✓ Storage</li> </ul>	Processing facil Processing facil Processing facil Storage facility	Sortin Comp Drum	Alea	Waste stream	Tibless

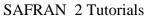
Click "OK".

# 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.

•			
view			
List	Туре	Name	Path
vi	٣		
w ob	Regulatory framework	National regulations	Regulatory frameworks
Tree view (to add new objs.  List view			
ree viev			
-			
	Link	Cancel	





# 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

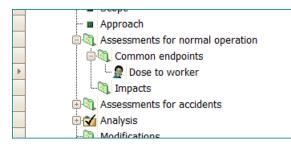
Tuble 0	
Activity	Working time (hours/year)
Sorting	300
Compaction	200
Packaging	300
Storage	50

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

	Situation	Normal operation
4	Endpoint	
	Туре	Dose
	Inside/Outside	Inside
	Unit	Sv/y

Select the "*Dose to worker*" node and click "**Link criterion**" in the "**Actions**" window. SAFRAN 2 Tutorials Rev. 2015-11-29



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".

- 🐧 Assessments for n	ormal operation	
🚽 💐 Common endp	pints	
Dose to wo	rker	
💐 Impacts —		_
Assessments 1	Wizard - Add/modify impacts for WM activities	
Analysis	Identify relevance for all included impacts	
Modifications	Wizard - specify/modify exposure time and dose rate for impacts	ne
	Add Norm. op. impact	

The wizard will be started.

Table_Overview_DoseEx	ternalExposure_XtraWizard
	Welcome to the wizard
	This wizard simplifies the adding and data setup for normal operation assessments connected to exposure via inhabition and external exposure.
	To continue, click Next
	< Box Next> Canal

Click "Next"



🖳 Add normal operation impacs

#### Select WM activities

Select WM activities for which you like to add/modify impacts.

-		Room	Area	Impact already exists
Sorting	Processing facility	Sorting r		no
Compaction	Processing facility	Compac		no
Packaging	Processing facility	Compac		no
Storage	Storage facility	Drum st		no

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."

2	Add	normal	operation	impacs
---	-----	--------	-----------	--------

Impacts

Specify endpoint and other properties of impacts.

Endpoint     Direct external exposure and exposure v     Radiol. conseq.       Affecting     Dose rate option	Assign the same for all rows			
✓ Affecting ✓ Dose rate option	~	Endpoint	Direct external exposure and exposure v $ \smallsetminus $	Radiol. conseq.
, noting	~	Affecting	~	Dose rate option

Click on the button "Radiol. conseq". SAFRAN 2 Tutorials



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

acts						
Specify endpoint and other properti	ties of impacts.					
ign the same for all rows						
~	Endpoint	Direct external expos	sure and exposure v V Radiol.	onseq.		
~	Affection		<ul> <li>Dose rat</li> </ul>	e option		
~ [	Affecting		✓ Dose rat	e option		
~	Affecting		✓ Dose rat	e option		
	Affecting				Radiol concert	Dose rate option
/M activity	Affecting		Endpoint	Affecting	Radiol. conseq.	Dose rate option
/M activity orting	Affecting		Endpoint Dose to worker	Affecting Inside	Direct external exposure and	Dose rate is known
VM activity iorting	Affecting		Endpoint Dose to worker Dose to worker	Affecting Inside Inside	Direct external exposure and Direct external exposure and	Dose rate is known Dose rate is known
VM activity orting compaction ackaging torage	Affecting		Endpoint Dose to worker	Affecting Inside	Direct external exposure and	Dose rate is known Dose rate is known Dose rate is known

Click Next.

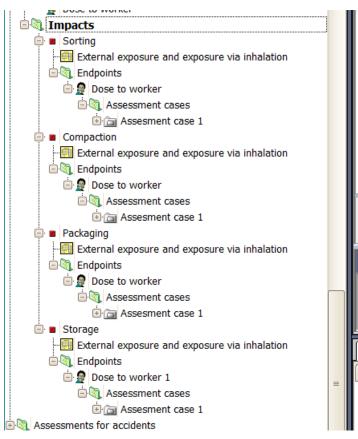
The last page of wizard will appear.

🖷 Add normal operation impacs		-	٥	×
	Completing the wizard			
	You have successfully completed the wizard. Please note that it will take some time (up to few minutes) for SAFRAN to create impacts			
	To dose this wizard, dick Finish			
	< Back	inish	Canc	el

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".

👷 🖉 Dose to worker
🖻 🔍 Impacts
🖃 🔳 Sorting
External exposure an
- 0m

Observe the properties of this impact.

	Quantitative/qualitative assessment Category of impact (for gualitative asses	Quantitative
~	Impact - quantitative or qualitative	
	Dose rate options	Dose rate is known
	Radiological consequences	Direct external exposure and exposure v
	Affecting	Inside
~	Impact	
	Situation	Normal operation

and link established between impact and waste management activity "Sorting".



SAFRAN 2.3.2.5 - C:\W_SAFRAN_TUTORIALS\Basic training Solid and liquid waste Advanc	ed topics\	Tutorial.safx			
File Edit View Tools Window Help					
Object explorer (tree view)	Ψ×	<ul> <li>Norm. op. impact: Sorting</li> </ul>	(Safe	ty assessments/Safet	y assessment
🖷 🔏 🛍 🌸 🗙 (🚅 🗉 ) 🚰 🔍		Properties Links			
🖪 Refresh Expand all Collapse all 🌾 Show description		Туре	Sho	Name	Path
Name	4	WM activity		Sorting	System desc
Approach  Assessments for normal operation  Assessments for normal operation  Common endpoints  Dose to worker  Compaction  Compaction  Compaction  Assessment cases  Compaction  External exposure and exposure via inhalation  External exposure and exposure via inhalation					

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

Dose to worker
🖃 🔍 Impacts
📮 🔳 Sorting
- External exposure and exposure via inhalation
Endpoints

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
	Co-60 Cs-137	Co-60         2.80E-002           Cs-137         1.70E-002	Co-60         2.80E-002         4.54E-010           Cs-137         1.70E-002         1.92E-010	Co-60         2.80E-002         4.54E-010           Cs-137         1.70E-002         1.92E-010           6.00E-007	Co-60         2.80E-002         4.54E-010           Cs-137         1.70E-002         1.92E-010           6.00E-007         6.00E-007	Co-60         2.80E-002         4.54E-010            Cs-137         1.70E-002         1.92E-010         6.00E-007

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.



🖃 🖏 Impacts
😑 🔳 Sorting
- 🔠 External exposure and exposure via inhalation
Endpoints
🖻 🧝 Dose to worker
🖃 🐧 Assessment cases
😑 🛅 Assesment case 1
Dose from external irradiation and inhalation inside the facility

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

The table for dose assessment will appear:

Dose from external irradiation and Referesh table • Reset table			
Impact	Exposure time (h/year)	Dose rate (Sv/h)	Annual dose (Sv/year)
▶ Sorting		6.01E-007	

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

The annual dose will be calculated:

🗜 Dose from external irradiation and inhalation inside the facility Safety assessments/Safety assessment 1/Assessments for n 💻 💷 🗮 🗡						
🔋 Referesh table 🔹 Reset table 🔒 Lock table   Row merging 🛛 Auto-filter row 🛛 Clear filter   🚽 Print 🖎 Print preview/export 💡						
Impact	Exposure time (h/year)	Dose rate (Sv/h)	Annual dose (Sv/year)			
I Sorting	300	6.01E-007	1.80E-004			

# 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"



👹 SAFRAN 2.3.2.5 - C:\W_SAFRAN_TUTORIALS\Basic training Solid and liquid waste Advanced top	pics\Tutorial.safx
File Edit View Tools Window Help	
Object explorer (tree view)	🗙 🧮 Table: D
1 1 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Properties
Refresh Expand all Collapse all Show description	Туре
Name	<b>^</b>
Approach	
Common endpoints     Pose to worker	
- M Impacts	
Wizard - Add/modify impacts for WM activities	
Identify relevance for all included impacts	
Wizard - specify/modify exposure time and dose rate for impacts	5
Add Norm. op. impact	
Add User-defined folder	
) Durada	
Reorder	
Overview/print/export as table	
Add from library	
🚽 🥘 Assessment cases	
Assesment case 1	

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	t	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	g	Inside Direct external exp	Sorting	Dose to worker	Assesment case 1		6.01E-007	300	1.80E-004
Compa	action	Inside Direct external exp	Compaction	Dose to worker	Assesment case 1		4.40E-006		
Packag	ging	Inside Direct external exp	Packaging	Dose to worker	Assesment case 1		3.20E-006		
Storage	ne .	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 " $\dots$ "

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

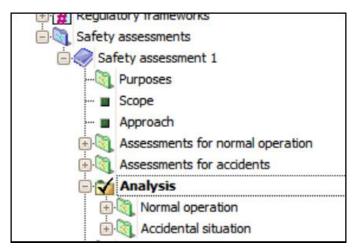
🛃 Norm. op. impact:Base configuration\Compaction	_	×
🌇 🦽 🏨 🗙 📑 🕘 🚰 🔍		
B Refresh Expand all Collapse all Show description		
Name		
<ul> <li>Compaction         External exposure and exposure via inhalation         Endpoints         ✓ Dose to worker         ✓ Assessment cases         ✓ Assessment cases         ✓ Assessment case 1         ✓ Dose from external irradiation or/and inhalation     </li> </ul>		
Jouble-click on tree node for default action; right-click for menu		.::

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).

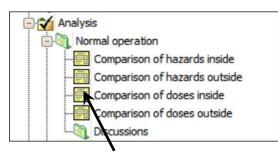


# Analysis

Expand the "Safety assessment 1/Analysis" node:



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



The following table will appear:

	Comparison of doses inside Safety assessments/Safety assessment 1/Analysis/Normal operation						
:	🖻 Referesh table 🏓 Rese	et table 🔒 Lock table	Row merging Auto-	filter row Clear filter	🖶 Print 🙇 Print previ	ew/export Insert in W	/ord
1	Show as chart						
$\left[ \right]$	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	
	<u>Storage</u>	Dose to worker	Assesment case 1	1.34E-004	Dose limit to worker	2.00E-002	
	<u>Total</u>	Dose to worker		2.16E-003	Dose limit to worker	2.00E-002	

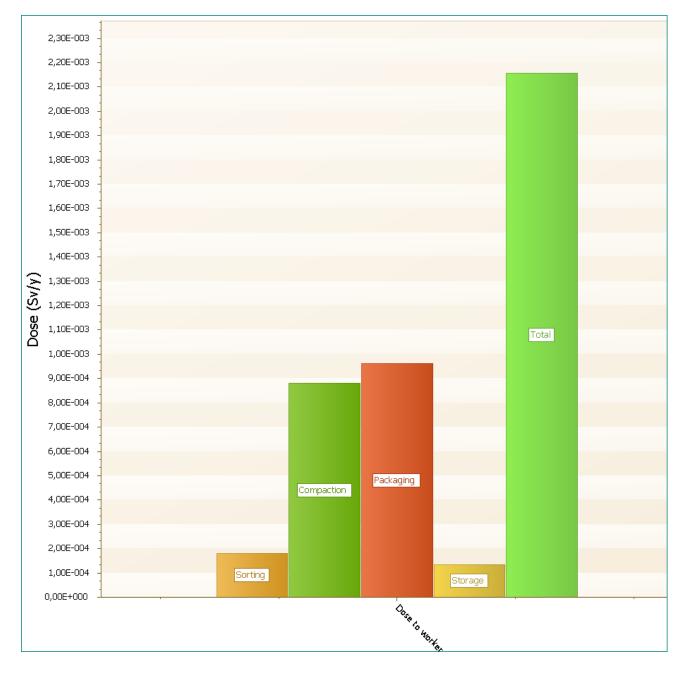
Click the "Show as chart" button located on the toolbar.



I

The window will appear showing the same data as chart:







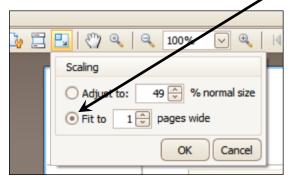
Double-click on the small rectangles shown in the legend to include/exclude a particular result from the chart:



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

The "Preview" window will appear.

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



SAFRAN 2 Tutorials

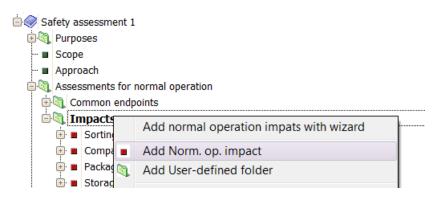


Click Ok. Click the "**Export document**" button and export the chart as PDF file.

# 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.

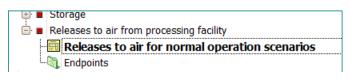
9	Type	Name	Path
,	acility	Processing facility	System description/Facilities
	🖏 Room	Sorting room	System description/Facilities/Processing facility/Rooms
	🥳 WM activity	Sorting	System description/Facilities/Processing facility/Rooms/Sorting room/Waste ma
	🖶 Room	Compaction and packaging room	System description/Facilities/Processing facility/Rooms
	🥳 WM activity	Compaction	System description/Facilities/Processing facility/Rooms/Compaction and packa
	🥳 WM activity	Packaging	System description/Facilities/Processing facility/Rooms/Compaction and packa
	🖏 Facility	Storage facility	System description/Facilities
	🖏 Room	Drum storage room	System description/Facilities/Storage facility/Rooms
	🥳 WM activity	Storage	System description/Facilities/Storage facility/Rooms/Drum storage room/Wast

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



General	
Description	
Name	Releases to air from processing facility
Short name	
Attachments	
Path	Safety assessments/Safety assessment 1/Assessments for normal ope
Situation	Normal operation
<ul> <li>Impact</li> </ul>	
Affecting	Outside
Radiological consequences	Release 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)	
A Bounded by another impact	

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

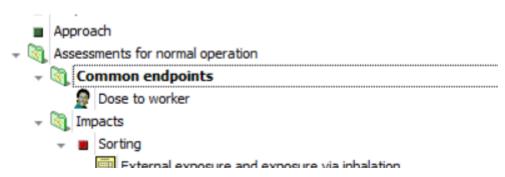


The following table will be shown:

Releases to air for normal operation scenarios Safe	ty assessments/Safety assessment 1/Assessme	ents for normal operation/Impacts/Releases	to air from pro
🖻 Referesh table 🔸 Reset table 🔒 Lock table   R	ow merging Auto-filter row Clear filter 📔	🕈 Print 🙇 Print preview/export 🛛 Insert in W	ord Copy to c
View inventory			
Nuclide	Release rate (Bq/year)	Screening release rate (Bq/year)	HQ
Co-60	4.41E+06	770000	5.73E+000
Cs-137	2.27E+06	1.97E+06	1.15E+000
Total			6.88E+000
	Referesh table Reset table Lock table R View inventory Nuclide Co-60 Cs-137	Referesh table       Reset table       Row merging       Auto-filter row       Clear filter       View inventory         Nuclide       Release rate (Bq/year)         Co-60       4.41E+06         Cs-137       2.27E+06	Nuclide         Release rate (Bq/year)         Screening release rate (Bq/year)           Co-60         4.41E+06         770000           Cs-137         2.27E+06         1.97E+06

Close the table.

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



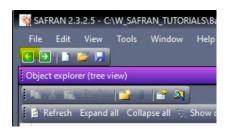
Add new endpoint "Dose to public" with property "Outside".



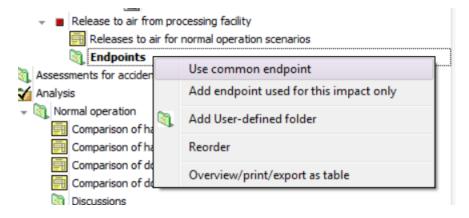
Safety assessments/Sa
Normal operation
Dose
Outside
Sv/y

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".

😑 🔳 Releases to air from processing facility
- 🚟 Releases to air for normal operation scenarios
🖃 🖏 Endpoints
🖃 🧟 Dose to public
🖃 🖏 Assessment cases
🖃 🛅 Assesment case 1
Dose outside the facility from releases to air outside the facility

The following table will be shown:



Referesh table 👂 Reset table 🔒 Loc	table Row merging Auto-filter row C	lear filter 🛛 🖶 Print 🔉 Print preview,	/export Insert in Word Copy to clipboard	
Scenario	Nuclide	Release rate (Bq/year)	DCFair,no (Sv/Bq)	Dose (Sv/year)
Releases to air from processing facility	Co-60	4.41E+06	1.30E-011	5.73E-005
Releases to air from processing facility	Cs-137	2.27E+06	5.07E-012	1.15E-005
Releases to air from processing facility	Total			6.88E-005

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):

💀 Comparison of hazards outside Safety assessments/Safety assessment 1/Analysis/Normal operation				
🖻 Referesh table ᠂ Reset table 🔒	Lock table   Row merging Au	to-filter row 🛛 Clear filter 🛛 🖶 Prin	nt I	
Show as chart				
Impact	Impact - quantitative	Impact - qualitative	Di	
Releases to air from processing facility	6.88E+000	Medium		

🚰 Comparison of doses outside Safety assessments/Safety assessment 1/Analysis/Normal operation					
🔋 🖻 Referesh table 🔹 Reset table 🔒 Lock table 🛛 Row merging 🛛 Auto-filter row 🛛 Clear filter 🛛 🖶 Print 🐚 Print preview/export					
Show as chart	Show as chart				
Impact	Endpoint	Assessment case	Dose (Sv/year)	Criterion	Limit (Sv/y)
Releases to air from processing f	Dose to public	Assesment case 1	6.88E-005	Dose limit to public	3.00E-004

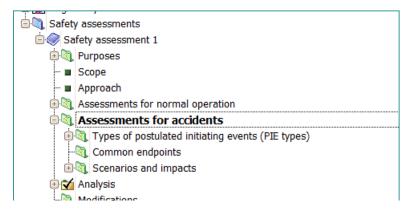
## End of advanced exercise



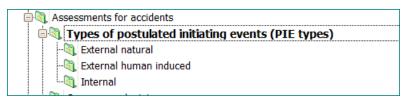
# Assessment for accidental situation

# PIE types. Excluding not relevant PIE types.

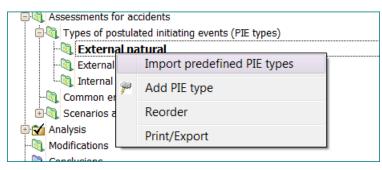
Expand folder "Assessment for accidents" located in Safety assessment 1.



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.



🖳 Ir	mport PIE types - External natural
	Select all Unselect all
	✓ Lightning (effect on power supply)
	Lightning (effect on surroundings of facility)
	<ul> <li>✓ Lightning (effect on facility)</li> <li>✓ Extreme snowing</li> </ul>
	Extreme showing     Extreme rain
	Extreme drought
	Strong wind
	Extreme temperatures
	V Hydrology and hydrogeology
	Geology of site and region
	Seismic events
	V Other effects of ground stability
	Geomorphology and topography of site
	V Terrestrial and aquatic flora and fauna
	Potential for natural fires, storms etc.
	V Flooding
	Ok

# Click OK.

PIE types will be included in project.

Ē	💐 Type	s of postulated initiating events (PIE types)
	🗏 🔍 🗉	xternal natural
	🜮	Lightning (effect on power supply)
		Lightning (effect on surroundings of facility)
	🜮	Lightning (effect on facility)
	🜮	Extreme snowing
	🜮	Extreme rain
	🜮	Extreme drought
	🌮	Strong wind
	🌮	Extreme temperatures
	🌮	Hydrology and hydrogeology
		Geology of site and region
		Seismic events
		Other effects of ground stability
	🌮	Geomorphology and topography of site
	🌮	Terrestrial and aquatic flora and fauna
		Potential for natural fires, storms etc.
	L., 🖗	Flooding
	🔍 Ex	ternal human induced
	60	

SAFRAN 2 Tutorials



Т

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

Assessments for normal operation     Assessments for accidents						
👻 🐧 Types of postulated in	<ul> <li>Types of postulated initiating events (PIE types)</li> </ul>					
- 🐧 External na	Import predefined PIE types					
Lightning	Identify relevance for all included PIE types					
🎾 Lightning 💯	Add PIE type					
Extreme	Reorder					
Extreme	Overview/print/export as table					
Strong wind						
🏸 Extreme tempe	Extreme temperatures					
P Hydrology and	hydrogeology					

The table with all just included PIE types will appear.

Print/Export Insert in Word document				
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".



#### 🖶 Set relevance

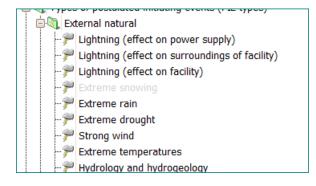
Serverence			
Print/Export Insert in Word document			
Name	Relevance	Justification	
Lightning (effect on power supply)	Relevant		
Lightning (effect on surroundings of facility)	Relevant		
Lightning (effect on facility)	Relevant		
Extreme snowing	Relevant 🔻		
Extreme rain	Relevant		
Extreme drought	Not 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		

#### Provide the justification - "Not relevant due to the climate":

1		Light may (effect of suffoundings of facility)	Relevant		
		Lightning (effect on facility)	Relevant		
	Ø.	Extreme snowing	Notrelevant	Not relevant due to climate	
		Extreme rain	Relevant		

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)".



4	General	
	Description	
	Name	Extreme snowing
	Short name	
	Attachments	
	Path	Safety assessments/Safety assessment 1/Assessments for accide
4	РІЕ Туре	
	Relevance	Not relevant
	Relevance - justification (if not relevant)	Not relevant due to climate
	Category	External natural

# Scenario "Fire in the storage facility"

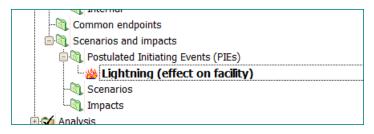
Select PIE type "Lightning (effect on facility)".

Assessments for accidents					
Types of postulated initiating events (PIE types)					
🖃 🔍 External natural					
- Jughtning (effect on power supply)					
- PLightning (effect on surroundings of facility)					
Lightning (effect on facility)					
- J Extreme snowing					
Extreme rain					

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

Types of postulated initiatir	■ power supply)
- Cline's	surroundings of facility)  Relevance - justification
Lightning (	Create PIE and link with this PIE type
	Create scenario and link with this PIE type
🎾 Extreme drou	Wizard - Create PIE and link with this PIE type, cont. to Scenario and Impact Wizards
デ Strong wind	Wizard - Create scenario and link it with this PIE type, cont. to Impact Wizard
	Сору

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



SAFRAN 2 Tutorials



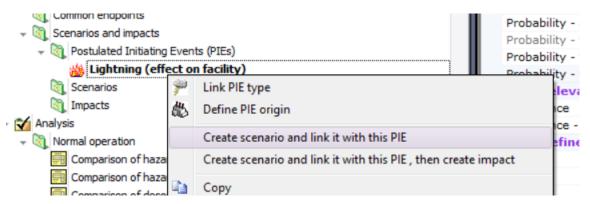
Note that PIE is already linked to the PIE type "Lightning (effect on facility)".

Li	inks			
	Туре	Short	Name	Path
×.	🎾 PIE type		Lightning (effect o	Safety assessn

Specify (qualitatively) probability for this PIE as "Low".

Properties	
4 General	
Description	
Name	Lightning (effect on facility)
Short name	
Attachments	
Path	Safety assessments/Safety assessment 1/Assessments for
Situation	Accidental
• PIE	
Probability - given as numerical/qualitative	Qualitative
Probability - time frames	% during the life time of facility
Probability - value (numerical)	
Probability - value (qualitative)	
PIE - relevance	Very High
Relevance	High
Relevance - justification (if not relevant)	Medium
	Low
	Very Low
Probability - value (qualitative)	

Select for this PIE "Create scenario and link it with this PIE".



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



Scenario			x	(qualit
Do you want to	define origir	n of scenari	o?	IE prob
	Yes	N	•	
		-		

Answer "Yes" and select Drum storage room:

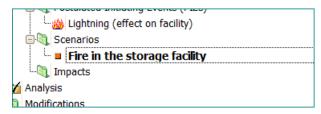
Image: Second processing facility       System description/Facilities         Image: Second processing facility       System description/Facilities/Processing facility/Rooms         Image: Second processing facility       System description/Facilities/Processing facility/Rooms/Sorting room/Waster         Image: Second processing facility       System description/Facilities/Processing facility/Rooms/Compaction and pack         Image: Second processing facility/Rooms/Compaction and pack       System description/Facilities/Processing facility/Rooms/Compaction and pack	List view	ſ	Туре	Name	Path				
WM acti Packaging System description/Facilities/Processing facility/Rooms/Compaction and pack	- 1	Q							
WM acti Packaging System description/Facilities/Processing facility/Rooms/Compaction and pack	ido y		🐇 Facility	Processing facility	System description/Facilities				
WM acti Packaging System description/Facilities/Processing facility/Rooms/Compaction and pack	drew		Room	Sorting room	System description/Facilities/Processing facility/Rooms				
WM acti Packaging System description/Facilities/Processing facility/Rooms/Compaction and pack	o ad		Room	Compaction and packaging r	System description/Facilities/Processing facility/Rooms				
WM acti Packaging System description/Facilities/Processing facility/Rooms/Compaction and pack	a) M	₽	戱 Room	Drum storage room	System description/Facilities/Storage facility/Rooms				
WM acti Packaging System description/Facilities/Processing facility/Rooms/Compaction and pack	ŝ		🧭 WM acti	Sorting	System description/Facilities/Processing facility/Rooms/Sorting room/Waste manage				
	<u>ا</u> ۲		🧭 WM acti	Compaction	System description/Facilities/Processing facility/Rooms/Compaction and packaging re				
WM acti Storage System description /Eacilities/Storage facility/Pooms/Drum storage room/Wa			🧭 WM acti	Packaging	System description/Facilities/Processing facility/Rooms/Compaction and packaging re				
Windeam Storage			🧭 WM acti	Storage	System description/Facilities/Storage facility/Rooms/Drum storage room/Waste man				
	Ľ								

can add new objects or modify objects' properties using Tree view.

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

i Notulated Initiating Events (PIEs)
Lightning (effect on facility)
🗐 🔍 Scenarios
Lightning (effect on facility)
Analysis

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



SAFRAN 2 Tutorials

Rev. 2015-11-29



Observe properties of the scenario.

4	General				
	Description				
	Name	Fire in the storage facility			
	Short name				
	Attachments				
	Path	Safety assessments/Safety assessment 1/Assessme			
	Situation	Accidental			
4	Scenario - probability				
	Is same as in linked PIE	True			
	Given as numerical/qualitative	Qualitative			
	Probability - time frames	% during the life time of facility			
	Value (numerical)				
	Value (qualitative)	Low			
4	Scenario - relevance				
	Relevant	Relevant			
	Justification if not relevant				

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).

Name	Fire in the storage facity
Short name	Fire
Attachments	

# Scenario "Drop of the drum in the Drum storage room"

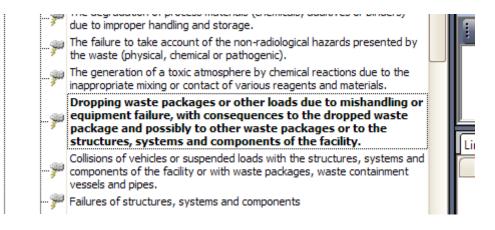
Right-click to the folder "Internal" for the types of postulated initiating events and select "Import predefined PIE types".

Import the PIE types proposed by the SAFRAN.



💐 Internal			
<i>9</i> 9	The acceptance (inadvertent or otherwise) of incoming waste, waste containers, process chemicals, conditioning agents, etc., that do not meet the specifications (acceptance criteria) included in the design basis.		
<i>9</i> 9	The processing of waste that meets acceptance criteria but that is subsequently processed in an inappropriate way for the particular type of waste (either inadvertently or otherwise).		
🌮	A criticality event due to the inappropriate accumulation of fissile material, change of geometrical configuration, introduction of moderating material, removal of neutron absorbing material or various combinations of these.		
	Explosion due to the evolution of explosive gas mixtures		
	Spontaneous combustion		
	Local hot spots generated by malfunctions of structures, systems or components		
<i>ş</i> ə	Sparks from machinery, equipment or electrical circuits		
	Sparks from human activities such as welding or smoking		
<i>9</i> 9	Explosions		
<i>ş</i> e	Gross incompatibilities between the components of a process system and the materials introduced into the system.		
<i>9</i> 9	The degradation of process materials (chemicals, additives or binders) due to improper handling and storage.		
<i>?</i> ?	The failure to take account of the non-radiological hazards presented by the waste (physical, chemical or pathogenic).		
<i>ş</i> ə	The generation of a toxic atmosphere by chemical reactions due to the inappropriate mixing or contact of various reagents and materials.		
🌮	Dropping waste packages or other loads due to mishandling or equipment failure, with consequences to the dropped waste package and possibly to other waste packages or to the structures, systems and components of the facility.		

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".

Ψ× Scenario: Drop of the drum in the Drum storage room (Safety assessments/Safety assessment 1/Assessments for accidents/Scenarios and impacts/Scenarios Properties 🔡 **2** | 🖻 General Description Drop of the drum in the Drum storage room Name Drop tended Attachments Path Safety assessments/Safety assessment 1/Assessm ons in Situation Accidental Scenario - probability se Is same as in linked PIE True Given as numerical/qualitative Qualitative arms Probability - time frames % during the life time of facility Value (numerical) uch as Value (qualitative) Medium Scenario - relevance Relevant Relevant ansfer Justification if not relevant ntrol ns and on. Short name

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").

Common endpoint Common endpoint Scenarios and imp Postulated Ini Scenarios	ts bacts tiating		Dr	op of the dru	m in th	e Drum storage ro
	_	Link PIE type	ſ	nks Type		Name
Modifications Conclusions		Create impact and link it with this scenario Copy Cut	•	🖑 Roo 🏄 PIE		Drum storage roo Dropping waste g
	X	Delete				

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):



## A Bounded by another impact

1	Impact 📉	
Na	Do you like to specify that impact will be linked to the Drum storage room (origen of relevant scenario)?	
Ed	Yes No	

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

1	<u>ounded by another impact</u>
E	
а	Impact 'Impact for scenario Drop' had been created. After finishing of wizard you will need to specify properties 'Affecting' (inside/outside) and 'Radiological consequences' for this impact
id aq	ОК

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

Name	Increased external exposure
Short name	EXP INS
Attachments	
Path	Safety assessments/Safety assessment 1/Assessments for acc
Situation	Accidental
<ul> <li>Impact</li> </ul>	
Affecting	Inside
Radiological consequences	Increased direct external exposure
Impact - quantitative or qualitative assessment	

Open the screening table.

😑 💽 Increased external exposure
- Direct external exposure
📖 🕅 Endpoints
Analysis



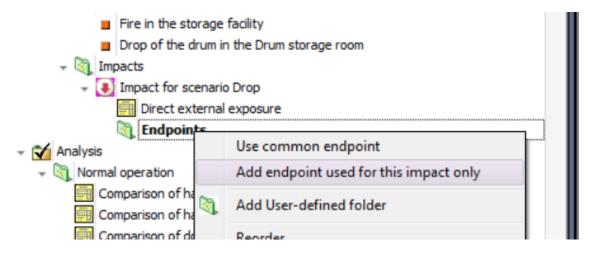
-	Selected	Waste component	Nuclide	Inventory of one (Bq)	N	Invento	SGRDC	Max. do	Screeni	Hazard Quotie
Γ		[Packaging] - Waste from producer - [Storage]	Co-60	1.8E+12	45	8.1E+13	3.70E-013	3.00E+001	1.00E-004	299700
	$\checkmark$	[Packaging] - Waste from producer - [Storage]	Cs-137	5E+10	45	2.25E+12	1.02E-013	2.30E-001	1.00E-004	2295
Γ	$\checkmark$	[Packaging] - Waste from producer - [Storage]	Total							301995

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).

•	Direct external exp	osure Safety assessments/Safety assessment 1/Ass	essments for accid	dents/Scenarios and impacts/I	mpacts/Increa	sed external	exposure			
1	🙎 Referesh table 🚽	🕽 Reset table 🔒 Lock table   Row merging 🛛 Aut	o-filter row Clea	r filter 🛛 🚔 Print 🛛 🐧 Print pre	view/export	Export to Wo	rd Copy to c	lipboard		
:	Select/unselect was	te components								
	Selected	Waste component	Nuclide	Inventory of one (Bq)	N	Invento	SGRDC	Max. do	Screeni	Hazard Qu
		[Packaging] - Waste from producer - [Storage]	Co-60	1.8E+12	1	1.8E+12	3.70E-013	6.66E-001	1.00E-004	6660
I		[Packaging] - Waste from producer - [Storage]	Cs-137	5E+10	1	5E+10	1.02E-013	5.10E-003	1.00E-004	51
		[Packaging] - Waste from producer - [Storage]	Total						1.00E-004	6711

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.



Description	l		
Name			Dose to worker, acc. – increased exposure
Short name	е		DW EXP INS
Attachments	;		
Path			Safety assessments/Safety assessment 1/Assessm
Situation			Accidental
Endpoint			
Туре			Dose
Inside/Outsid	de		Inside
Unit			Sv
Short name			
Short name of	the object.		
Edit 🝷			
DW EXP INS			
Links			
Туре	Short name	Name	Path
Criterion		<u>Dose limit to worker</u>	Regulatory frameworks/National regulations/Accidental situation
-			

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

🖹 💽 Increased external exposure
Direct external exposure
🗐 🔍 Endpoints
😑 🧟 Dose to worker, acc. – increased exposure
🖃 🔍 Assessment cases
😑 🛅 Assesment case 1
Dose (direct extenal exposure inside the facility)
alysis



		Dose (direct extenal exposure in	nside the facility) Safety assessm	nents/Safety assessment 1/A	ssessments
1		🖇 Referesh table 🌘 Reset tabl	e 🔒 Lock table   Row merging	g Auto-filter row Clear filt	er 🛛 📄 Prin
		Run exposure models			
ſ		Waste component	Nuclide	Inventory (Bq)	Distance (cr
	Þ	[Packaging] - Waste from prod	Co-60	1.8E+12	
		[Packaging] - Waste from prod	Cs-137	5E+10	
		[Packaging] - Waste from prod	Total		

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.

•	Dose (direct extenal exposure i	nside the facility) Safety assessn	nents/Safety assessment 1/A	ssessments for accidents/So	enarios and impacts/Impact	s/Increased external exposu	re/Endp
1	💈 Referesh table 🏼 🧕 Reset tabl	e 🔒 Lock table   Row mergin	g Auto-filter row Clear filt	er 🛛 📄 Print 🛛 🐧 Print previ	ew/export Export to Word	Copy to clipboard	
1	Run exposure models						
	Waste component	Nuclide	Inventory (Bq)	Distance (cm)	Dose rate (Sv/h)	Exposure time (h)	Dose (Sv)
	[Packaging] - Waste from prod	Co-60	1.8E+12	50		2.50E-001	
I	[Packaging] - Waste from prod	Cs-137	5E+10	50		2.50E-001	
	[Packaging] - Waste from prod	Total					

Click on the first row cell in the column "Dose rate" and double-click on the "…" button<sup>9</sup> to select and run one of the available models calculating dose rate for simple geometries.

Inventory (Bq)	Distance (cm)	Dose rate (Sv/h)
1.8E+12	50	
5E+10	50	

<sup>&</sup>lt;sup>9</sup> Alternatively you can select the row and press button "Run exposure models" located on toolbar SAFRAN 2 Tutorials Rev. 2015-11-29



The model selection dialog box will appear:

🖳 Select models		_	×
OK       Available models         Cancel       Point source, concrete shield         Point source, lead shield       Point source, water shield         Point source, without shielding       Cube, concrete shield         Cube, lead shield       Cube, water shield         Cube, water shield       Cube, water shield         Disc, concrete shield       Disc, concrete shield         Disc, concrete shield       Disc, water shield         Disc, water shield       Disc, water shield         Disc, water shield       Disc, water shield         Drum axial, concrete shield       Drum axial, water shield         Drum axial, water shield       Drum axial, water shield	<ul> <li>Drum radial,concrete shield</li> <li>Drum radial,lead shield</li> <li>Drum radial,water shield</li> <li>Drum radial,without shielding</li> </ul>		

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

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

	_		×
			_
Dose rate calculation for Waste from producer			
Description			
			_
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			]
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			]
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer			
DrumAxial_WithoutShileId waste component: Waste from producer		Cancel	
		Cancel	

Click OK

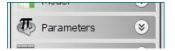
The SAFCALC tool will start. You might need to wait a bit until it will be loaded.



er (tree	view)	Waste component	Nuclide	Inver
aje 🗡		// [Packaging] - Waste from prod	Co-60	1.8E+
Expan	🖳 Extracting calculation module files: 8% ready			E+1
rial	Calculation module files are extracted before the first usage.			
ystem (				
🐧 Site				
🐧 Safe	Carting			
] Facil ∃∰ F	Continue			
Ð 🖑 🖡			.11	
🗏 🖑 S	torage facility			
<u>ب</u>	Measured or estimated data			
<u>ج</u> (	Waste management activities and processes			
<u>ب</u>	Waste components			

Context   Model   Model   Start time   0.0   Years   End time   100.0   Years   Type of simulation   Best estimate   Probabilistic   Probabilistic   Probabilistic   Simulation table   Number of simulations   1000
Errors
Source Object Description
SAFCALC SVERA STRUTTURE (S) ESTRUCTURE (S) ESTRUCTU

Click on the "Parameters" in the left part of the SAFCALC window.



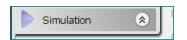
The window will show the list of parameters used by model and their values:



SafCalc2 - DrumAxial*	the second se	_	_			-		_ 0	x
SalCalC2 - DIUMAXIA     Context     Context     Model     Simulation     Simulation     Simulation	bulkuphSource distance exposureTime IZA MatNo slabThicknes sourceHeight sourceRadius	Information			Syml Unit Bq		Full na	Brief	Full
Report S		Data Radionuclides Default	Value	Min	Max	PDF	Unit	Comment	E
Web	/ Name	Co-60 Cs-137	1.8E12 5.0E10				Bq Bq		

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.

۲	Basic settings	Simulation
	0.0 Years	Information
8	End time 100.0 Years	
8	Type of simulation ——	
8	<ul> <li>Best estimate</li> </ul>	
ings	Probabilistic	
ttings	Simulation table	
AN	Number of simulations	

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



i.

nformation	
19:27:11	Simulation started
19:27:11	Generating parameter values
19:27:11	Done. [20 ms]
19:27:11	Pre-processing
19:27:16	Done. [5,4s]
19:27:16	Simulation finished. Total time 5,9s

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.

🐐 SafCalc2 - DrumAxial_W	/ithoutShield*			- 🗆	×
Context 🛛 😸	Results	Table	k View Dose rate (Sv/h)		
💽 Model 💽		Nucli		✓ doseRate	Ę
Parameters 😵	• slabMaterial • sourceMaterial	Co-6	0	1.26E-1	~
Result tables		Cs-1	37	6.33E-4	
Time Table					
5 Statistics Table					
View in Excel     Clone					
Provide the second seco					
Simulation 🛛 😸					
Report 🛛 😒					
	Search				
NHK A	Name				
CAECAL	Search	9			
	Index				~
Hara , IRSH NDA IAEA 600 Facilia	- All indices -	Forr	nat		
ESECTION INCOMING A GRANTING	Туре	Scie	entific V Digits 2		
P	- All Types -		origina z		

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<sup>10</sup>.

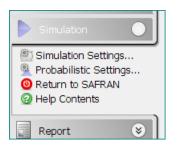
 $<sup>^{10}</sup>$  You may create also other tables to observe values of different results.



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.

lun exposure model							
Waste component	Nuclide	Activity (Bq)	Distance (cm)	Dose rate (Sv/h)	Calculation	Exposure time (h)	Dose (Sv)
Packaging] - Waste from produc	Co-60	1.8E+12	50	1.26E-001	DrumAxial_WithoutShileId wa	2.50E-001	3.14E-002
Packaging] - Waste from produc	Cs-137	5E+10	50	6.33E-004	DrumAxial_WithoutShileId wa	2.50E-001	1.58E-004
Packaging] - Waste from produc	Total			1.26E-001			3.16E-002

Close the table.

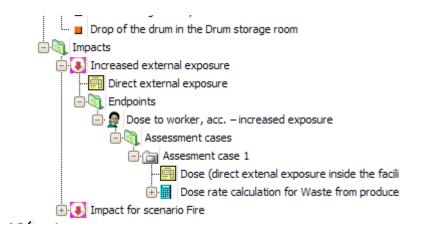
# Advanced exercise. Assessment of doses for workers and public due to the accidental release of radionuclides to the air

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

			1	
<ul> <li>Fire in the storage facility</li> <li>Drop of the drum in the Drum</li> </ul>	P	Link PIE type	2	
↓ Impacts ↓ Impact for scenario Drop		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:

	Accounteries	
	Path	Safety assessments/Safety ass
	Situation	Accidental
$\sim$	Impact	
	Affecting	Inside
	Radiological consequences	Release to air
$\sim$	Impact - quantitative or qualitative as	ssessment
	Quantitative/qualitative assessment	Quantitative

Set the short name for impact as "REL INS".

Name	Release to air (inside) in the Drum storage room
Short name	REL INS
Attachments	

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

🗐 💽 Release to air (inside) in the Drum storage room					
Release to air, inside					
Endpoints					
Analysis					

The following table will appear:

Select/unselect waste components									
	Selected	Waste component	Nuclide	Inventory of o	N	Inventory (Bq)	Max. release inside (	Screening release inside (Bq)	Hazard Quotient (
Þ		[Packaging] - Waste f	Co-60	1.8E+12	45	8.1E+13	8.1E+13	164000	4.94E+008
		[Packaging] - Waste f	Cs-137	5E+10	45	2.25E+12	2.25E+12	238000	9.45E+006
	~	[Packaging] - Waste f	Total						5.03E+008



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

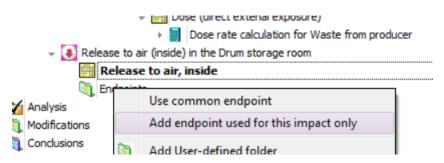
Inventory of one (Bq)	Ν	Inventory (Bq)	Max. release
1 0E+17	AS		8.1E+13
5	package. Used only for impacts co	Shnected with area/room/racility	2.25E+12

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:



Properties							
2↓ □							
<ul> <li>General</li> </ul>							
Descriptio	'n						
Name			Dose to worker, release inside				
Short nar	ne		DW REL INS				
Attachment	ts						
Path			Safety assessments/Safety assessment 1/Assess				
Situation			Accidental				
Endpoint	A Endpoint						
Туре			Dose				
Inside/Outside			Inside				
Unit			Sv				
Short name Short name o	Short name						
Edit -							
DW REL INS							
Links							
Туре	Short name	Name	Path				
🕨 🧶 Criterion		Dose limit to worker	Regulatory frameworks/National regulations/Accidental situation				

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

🖃 💽 Release to air (inside) in the Drum storage room	
Release to air, inside	
🖃 💐 Endpoints	
🖃 🧝 Dose to worker, release inside	
🖃 🔍 Assessment cases	
🖃 🛅 Assesment case 1	
Dose (release to air, inside)	

The following table will appear:

-	🖁 Dose (release to air, inside) Safety assessments/Safety assessment 1/Assessments for accidents/Scenarios and impacts/Impacts/REL INS/Endpoints/ 🗀 😐 🖄										
1	Identify ARF										
_	Waste com	Nuclide	Inventory (	ARF	Release ins	Room volu	Distance (m)	Exposure ti	Dispersion f	Protection f	Dose
Þ	Packaging	Co-60	8.1E+13								
	Packaging	Cs-137	2.25E+12								

Note that table contains inventory calculated during the screening step.

Now you need to identify the  $\mbox{ARFs}$  – airborne release fractions for nuclides of waste component.

Click on the first row cell in the column ARF and double click on the "..." button<sup>11</sup>.

<sup>&</sup>lt;sup>11</sup> Alternatively you can select the row and press the button "Identify ARF" located on the toolbar SAFRAN 2 Tutorials Rev. 2015-11-29



	Deleges inside (De)
ARF	 Release inside (Bq)

The first page of Wizard will appear:

Airborne Release Fraction	on (ARF)			
	Welcome to the wizard			
	This wizard simplifies the selection of airborne release fraction by guiding the user through a series of simple steps			
	To continue, click Next			
		< Back	Next >	Cancel

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).

Type of the waste Identify type of the waste (solid, liquid, gaseous)	Ту				
Solids					
© Liquids					
© Surface contamination					
C Gaseous					

Click Next. SAFRAN 2 Tutorials

Rev. 2015-11-29



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

	w	aste form type
L.		Select row with the relevant waste form type. Use first row as filer, if necessary. If table does not contain correct wast
U.		
U.		Waste type
U.	8	
II.		Not defined
Ь.		Solids. Non metallic or composite solids. Aggregate (e.g., concrete, cement), suspendible powder
		Solids. Powders
		Solids. Powders. Cohesionless powders
		Solids. Homogeneous immobilized liquids / sludges within 500 litre drum (0.8 m diam., 1.2 m high)
		Solids. Heterogeneous wastes immobilized (e.g. grouted) within 500 litre drum (0.8 m diam., 1.2 m high)
	•	Solids. Compacted wastes within 500 litre annular grouted drum (0.8 m diam., 1.2 m high)
		Solids. Heterogeneous wastes immobilized (e.g. grouted) within 3 m3 box (1.7*1.7 m plan, 1.2 m high)
		Solids. Homogeneous immobilized sludges / resins within 3 m3 drum (1.7 m diam., 1.2 m high)
		Solids. Heterogeneous wastes within 4 m box (4.0*2.4 m plan, 2.2 m high)

Click Next.

On the page "Type of effect", select "Thermal stress. 1000 °C fire 1 h duration".

Т	vpe of effect
.,	Select row with the type of effect. Use first row as filer, if necessary. If table does not
	Type of effect
Q	
	Not defined
	Free fall spill / impaction stress. Drop height 25 m, aggressive target
	Thermal stress. 1000 °C fire of 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)



This page shows database (based on the waste form This page shows database values for ARF for waste form user-defined value. Browsing of entire ARF database tabl							
		ARF	ARF - user	-			
	Nuclide	database value	defined value				
•	Nuclide	database	defined				

## Click Next.

The final page of wizard summarizes the wizard results:

🖳 Airborne Release Fraction	(ARF)				
	Con	npleting th	e wiz	ard	
		ve successfully complete			table
		Waste component	Nuclide	ARF	
	•	Waste from producer	Co-60	1.90E-005	
		Waste from producer	Cs-137	3.00E-004	

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.  $^{12}$ 

<sup>&</sup>lt;sup>12</sup> 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).

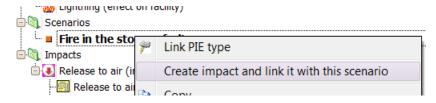
Note that values in the Dose column were calculated.

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:

	i wui	ourcey assessmental ourcey assessment at reacesmenta for a
	Situation	Accidental
~	Impact	
	Affecting	Outside
	Radiological consequences	Release to air inside the build. and to atmosphere $\bigtriangledown$
~	Impact - quantitative or qualitative assessment	
	Ousetitative/auslitative assessment	Ousetitativa

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



🖃 💽 Release to air (outside) from storage facility
Release to air, inside
- 🕅 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:

Name			Dose to public, acc release outside
Short name	e		DW REL OUT
Attachments			
Path			Safety assessments/Safety assessment 1/A
Situation			Accidental
Endpoint			
Туре			Dose
Inside/Outsid	de		Outside
Unit			Sv
Short name hort name of t	the object.		
Edit -			
W REL OUT			
inks			
Туре	Short name	Name	Path
Criterion		Dose limit to public	Regulatory frameworks/National regulations/Accidental situation

Expand "Assessment case 1" created for this endpoint:

🗐 💽 Release to air (outside) from storage facility
Release to air, inside
- 📰 Release to air, outside
🖮 🖏 Endpoints
🖃 🧟 Dose to public, acc release outside
😑 💐 Assessment cases
🖻 🛅 Assesment case 1
Release to air (inside, accounting ARF)
Dose (release to air, outside)
Amelyete

# SAFRAN 2 Tutorials



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

🖃 🖏 Endpoints
🖻 🧝 Dose to public, acc release outside
🖃 🔍 Assessment cases
😑 🛅 Assesment case 1
Release to air (inside, accounting ARF)
Dose (release to air, outside)
ysis

#### The following table will be shown:

Identify ARF Import from similar table	J			
Waste component	Nuclide	Inventory (Bq)	ARF	Release ins
[Packaging] - Waste from producer - [St	Co-60	8.1E+13		
[Packaging] - Waste from producer - [St	Cs-137	2.25E+12		

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.

ARF Import from similar table

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

🖳 Import data from table Dose - releaase to air (inside)	
Select impact containing table Dose - release to air (inside)	ОК
Impact Release to air (inside) in the Drum storage room	Cancel

Click OK and observe the changes in the table.

🛱 Referesh table 🤹 Reset table 🔒 Lock table   Row merging Auto-filter row Clear filter   🚽 Print 📐 Print preview/export Export to Word Copy to clipboard							
	Waste component	Nuclide	Inventory (Bq)	ARF	Release inside (Bq)		
•	[Packaging] - Waste from producer - [St	Co-60	8.1E+13	1.90E-005	1.539E+09		
	[Packaging] - Waste from producer - [St	Cs-137	2.25E+12	3.00E-004	6.75E+008		

Close the table.

Open table "Dose (release to air, outside)".



🗉 💐 Ass	sessment cases
	Assesment case 1
	Release to air (inside, accounting ARF)
	🔜 Dose (release to air, outside)

:	🖻 Referesh table 🏼 单 Reset t	table 🔒 Lock table   Row r	merging Auto-filter row C	Clear filter 🛛 🖶 Print 🔼 Print	preview/export Insert in V	Vord Copy
	Nuclide	Release inside (Bq)	Filtration efficiency	Release outside (Bq)	DCFair,acc (Sv/Bq)	Dose (Sv)
Þ	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
	2					

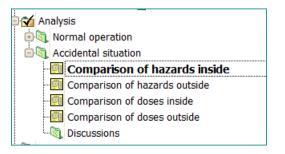
Note that this table use filtration efficiency to calculate dose obtained from System description (similarly to the screening table).

Close the table.

#### End of advanced exercise

# Analysis

Open table "Analysis/Accidental situation/Comparison of hazards inside".



l	Show as chart						
	Scenario In	mpact	Probability - quantitative	Probability - qualitat	Impact - quantitative	Impact - qualitative	
1	Fire Re	elease to air (inside) i		Low	5.03E+008	Very High	
	Drop In	ncreased external exp		Medium	6711	Very High	



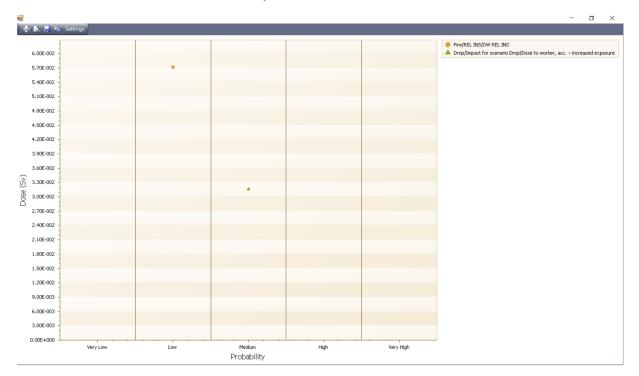
Click button "Show as chart". The Probability/Impact matrix will be shown.

Close chart and table.

Open table "Comparison of doses inside".

a.	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									
1	Show as chart									
	Scenario	Impact	Probability - quantitative	Probability - qualita	Endpoint	Case	Dose (Sv)	Criterion	Limit (Sv)	Discus
•	<u>Fire</u>	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.

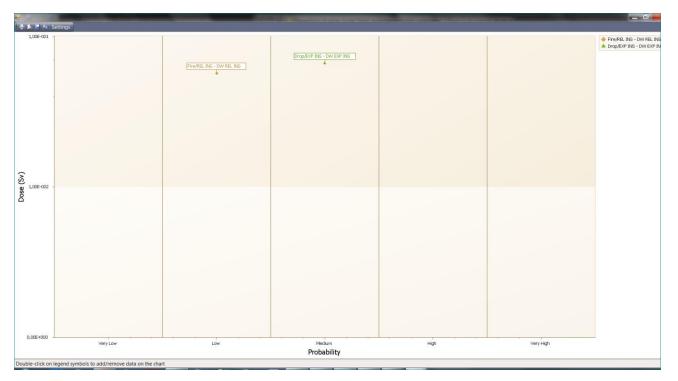
Click on the "Settings" button located in the chart's toolbar.

Select "Y logarithmic" option as shown in the picture.

General Chart settings	
Show/Hide Legend	
Show/Hide Legend         Zoom       To zoom the chart - close this window and press Shift key         X logarithmic       Image: Y logarithmic         User-defined scale         X       Min:         Max:       Y:         Max:       Max:         Apply       Reset	
X logarithmic V logarithmic AutoCorrectAxis	
User-defined scale	
X: Min: Y: Min: 0.00E+000 Max: Max: 7.33E-002	
Apply Reset	

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.

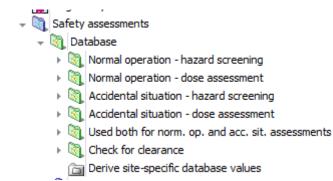
Database contains the values used during the safety assessment. The values are taken from the IAEA documents or pre-calculated (accounting conservative conditions) with the SAFRAN calculation (SAFCALC) models.

Expand node "Database" (located under "Safety assessments")



Safety assessment

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).

🚽 🥘 Databa	ase
- 🖏 No	rmal operation - hazard screening
	Momentary breathing rate (Normal operation) for adult male depending on level of physical activity
	Screening dose rate for normal operation
	Screening release rate (Bq/y) to the atmosphere for normal operation conditions
	Screening discharge rate (Bq/y) for normal operation conditions
🕨 🏹 No	rmal operation - dose assessment

Double-click on the icon for table "Screening release rate ..."



🖃 💐 Datab	base
📥 💐 No	ormal operation - hazard screening
ė- 💐	Momentary breathing rate (in m3/h) for adult male depending on level of physical activity (normal operation
	Momentary breathing rate (Normal operation) for adult male depending on level of physical activity
<u> </u>	Screening dose rate for normal operation
	Screening release rate to the atmosphere for normal operation conditions
	Screening release rate (Bq/y) to the atmosphere for normal operation conditions
	Screening discharge rate for normal operation conditions
	Screening discharge rate (Bq/y) for normal operation conditions
📥 💐 No	ormal operation - dose assessment
🗄 💐 Ac	ccidental situation - hazard screening
🗄 🕅 Ac	ccidental situation - dose assessment

## The table will appear:

w undefined 🛛 Make copy of selected rows 🛛 Export to Excel 🖉 Import from Excel 🖉 Update with new nuclides 🌵 Print 🔖 Print preview/export 🛤 Insert in Word						Insert in Word	
Parameter	nuclide	Value(Bq/y)	Data source	Default	Reference	Comment	
1							
ScreeningReleaseRate	Ac-228	6.71E+008	SAFRAN DB				
ScreeningReleaseRate	Ag-110m	5.01E+006	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Am-241	3.99E+005	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	As-76	4.57E+009	SAFRAN DB				
ScreeningReleaseRate	At-211	1.75E+008	SAFRAN DB				
ScreeningReleaseRate	Au-198	2.63E+009	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Bi-206	1.66E+008	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Bi-210	1.97E+008	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Bi-212	5.95E+008	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Br-82	8.53E+008	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	C-14	7.81E+009	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Cd-109	1.13E+008	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Ce-141	5.64E+008	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Ce-144	3.39E+007	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Cm-242	3.47E+006	SAFRAN DB				
ScreeningReleaseRate	Cm-244	6.44E+005	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Co-58	4.71E+007	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Co-60	7.70E+005	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Cr-51	3.39E+009	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Cs-134	3.22E+006	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Cs-135	3.85E+008	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Cs-136	1.13E+008	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Cs-137	1.97E+006	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Cu-64	2.63E+010	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Eu-154	9.86E+005	SAFRAN DB	$\checkmark$			
ScreeningReleaseRate	Eu-155	3.16E+007	SAFRAN DB				
ScreeningReleaseRate	Fe-55	1.09F+009	SAFRAN DB				

#### Observe the structure of each row of the table.

Parameter	nuclide	Value(Bq/y)	Data source	Default	Reference	Comment
creeningReleaseRate	Ac-228	6.71E+008	SAFRAN DB			
creeningReleaseRate	Ag-110m	5.01E+006	SAFRAN DB	$\checkmark$		
creeningReleaseRate	Am-241	3.99E+005	SAFRAN DB	$\checkmark$		
creeningReleaseRate	As-76	4.57E+009	SAFRAN DB	$\checkmark$		
creeningReleaseRate	At-211	1.75E+008	SAFRAN DB	$\checkmark$		
creeningReleaseRate	Au-198	2.63E+009	SAFRAN DB	$\checkmark$		
creeningReleaseRate	Bi-206	1.66E+008	SAFRAN DB	$\checkmark$		

Note that, in addition 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).

#### SAFRAN 2 Tutorials





# 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

Pro\_
Nuclides
Containers and packages
Scales
Title, description, author, date
Nuclides
Add/remove nuclide

☑ Add nuclides above to new waste components and measurement tables

In the "Nuclides" tab – click "Add/remove nuclide" and select Co-60 and Cs-137 Nuclides Sources Containers and packages Scale

Nuclides

Co-60 Cs-137

Select tab "Sources"	and (using the button "Ad	ld row") ei	nter the follo	wing information	on:
Source	Description	Nuclid	A1	Date	NT
		e			
Irradiator	In their working shield,	Cs-137	2.60E+1	Date of the	10
	Cat I		3	exercise	
Radiotherapy	In their working shield,	Co-60	7.40E+1	Date of the	10
sources	Cat I		3	exercise	

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



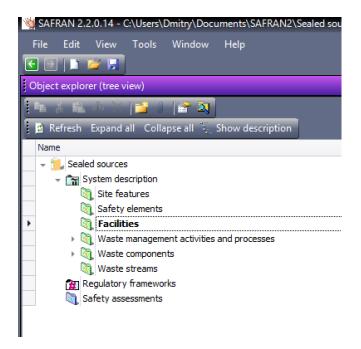
Capsule large	Stainless steel, typical dimensions 152mm long and inside diameter 48mm, thickness 4mm
Long term storage shield for high activity sources	It can contain several capsules

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"



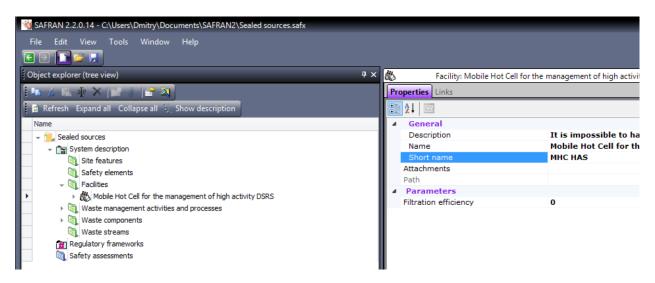
Righ-click on the node and select "Add Facility".

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.

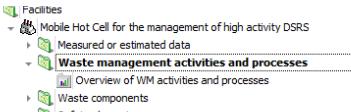


Description It is impossible to handle high activity DSRS outside their working shields in countries, which do not possess a hot cell and remote handling equipment. A mobile hot cell facility which can handle high activity DSRS and allow for the transfer of the source from its Original Source Shield to a storage shield was designed and constructed. The facility consists of a biological shield with a window for viewing work in progress inside the shield. It makes use of master-slave manipulators and an internal crane to handle and lift various objects within the hot cell. There is a crane outside the shield for use in lifting heavy objects in and out of the biological shield. An extract ventilation system maintains a negative pressure within the hot cell to contain and prevent the possible spread of contamination. The long term storage container for the encapsulated high activity DSRS will be coupled to the side of the biological shield for easy and safe transfer of the sources from the hot cell.]	Mobile Hot Cell for the ma	anagement of high activity DSRS	
possess a hot cell and remote handling equipment. A mobile hot cell facility which can handle high activity DSRS and allow for the transfer of the source from its Original Source Shield to a storage shield was designed and constructed. The facility consists of a biological shield with a window for viewing work in progress inside the shield. It makes use of master-slave manipulators and an internal crane to handle and lift various objects within the hot cell. There is a crane outside the shield for use in lifting heavy objects in and out of the biological shield. An extract ventilation system maintains a negative pressure within the hot cell to contain and prevent the possible spread of contamination. The long-term storage container for the encapsulated high activity DSRS will be coupled to the	Description		
	possess a hot cell and re	emote handling equipment. A mobile hot cell facility wh	
	shield was designed and viewing work in progress crane to handle and lift use in lifting heavy objec a negative pressure with The long-term storage co	d constructed. The facility consists of a biological shie s inside the shield. It makes use of master-slave manip various objects within the hot cell. There is a crane or cts in and out of the biological shield. An extract ventil in the hot cell to contain and prevent the possible spr ontainer for the encapsulated high activity DSRS wi	Shield to a storage Id with a window for julators and an internal utside the shield for lation system maintains read of contamination. ill be coupled to the

Place "MHC HAS" as a short name for this facility



Expand node "Waste management activities and processes"



🕨 🔝 Safety elements

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



Add new Process	-		
Name			
Management of the High Activity Sources in the Mobile Hotcell			
Description			
ок	Cano	cel	]

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

<del>2</del>	Preview or modify process
	Update Print Zoom mode
The fight fight Activity Sources in the Holde Notes	
Properties Links	

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

🚰 階 X 🛍 X 📴 + -	I
select "Add new activity" and give it name "Preparation for introduction into cell"	1



<b></b>	Add new WM activity – 🗖 💌	
	Name	
	Preparation for introduction into cell	
	Description	
	OK	

The process diagram will change:

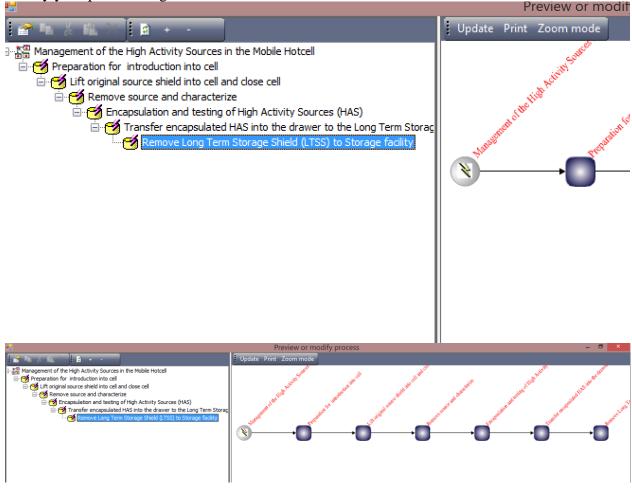
ee	Preview or modify process	- 8	×
] 🖀 Ma & Ma Y   B + -	Update Print Zoom mode		
Hanagement of the High Activity Sources in the Mobile Hotcell	Burney and and a start of the s	→0	and a start of the

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

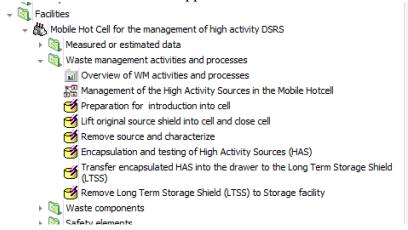


Finally your process diagram should looks like:



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):

SAFRAN 2 Tutorials



Activity	External exposure dose rate Sy/h
Activity Preparation for introduction into cell	External exposure dose rate Sv/h
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

	Review/modify external dose rate data 🛛 🚽 🗖 💌
2 Ve	Welcome to the wizard
п + 4	This wizard simplifies the verification and modifiaction of the external dose rate data for the system description objects.
٤	To continue, click Next
fe o n ev or www.armunes.ang.processes	< Back Next > Cancel

Click "Next"

Enter data according to the table above



Orag a colu					
Facility		Room	Area	WMActivity	External dose rate (
MHC HA	AS			Preparation for introduction into cell	
MHC HA	AS			Lift original source shield into cell and clos	
MHC HA	AS			Remove source and characterize	2.20E-005
MHC HA	AS			Encapsulation and testing of High Activity	. 4.10E-005
MHC HA	AS			Transfer encapsulated HAS into the draw	
MHC HA	AS			Remove Long Term Storage Shield (LTSS) .	

Click "Next" and then "Finish"

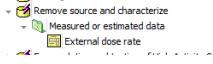
Click on the "Refresh" button located on the toolbar of the browser



Note that nodes for two of the activities are now "expandable"

- 🛃 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

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.

•		External dose rate (Sv/h)	
	External dose rate (Sv/h) Comments	<mark>2:20E-005</mark>	OK Cance

Click Ok or Cancel

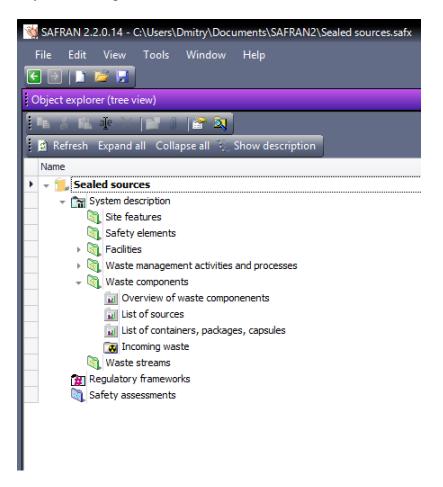
# SAFRAN 2 Tutorials



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



M Over view of wire dedivides and processes
👻 🐚 Waste components
Overview of waste componenents
🔟 List of sources
🔟 List of containers, packages, capsules
📷 Incoming waste
😽 Working shield for high activity sources-IRR-Cs
🖎

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"

-		Assign/unassign source	s to waste component	- 🗆 🗙
Viev	w/modify list of available sources			
Nam	me	Total number of sources	Present in waste component	Number of sources in waste compon
Irra	adiator	10		
I Rad	diotherapy sources	10		

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

		Assign/unassign source	s to waste component	
	View/modify list of available source			
	Name	Total number of sources	Present in waste component	Number of sources in waste compon
	Irradiator	10		
I	Radiotherapy sources	10		10

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

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



•		Assign/unassign source	s to waste component	_ 🗆 🗙
1	View/modify list of available source	5		
	Name	Total number of sources	Present in waste component	Number of sources in waste compon
Ø.	Irradiator	10		
	Radiotherapy sources	10		1

Close the sources selection dialog

Now the form for waste component will looks like:

Waste component							- 6	5 ×		
+- Source Type of conta	iner		- +	Number of waste componen	ts 1	Account decay to date	_ 31			
Name of source	Description of source	Category	Nuclide	Init. activity in one source (	Date for initial activity	Number of sources in waste	Leaking	Total activity (Bq)		
<ul> <li>Radiotherapy sources</li> </ul>	In their working shield, Cat I		Co-60	7.4E+13	2014-04-03	1		7.4E+13		
	5									

(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"

Type of contai	iner		
irce <sup>9</sup>	Description of source	Category	Nuclide

Select "Working shield for high activity sources"

Type of container		Working shield for high activity sources			Ŧ	ľ	+
ce 🖗		cription of source	Category	Nuclide			

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



Waste component							
+	+ Number of waste components 10 Acc						
	Init. activity in one source (	Date for initial activity	Nu				
	7.4E+13	2014-04-03	1				

### Finally the waste component description will looks like:

	a Waste component									
	+- Source   Type of contain	iner Working shield for high	activity source	es +	Number of waste componer	its 10	Account decay to date	_ 31		
	Name of source	Description of source	Category	Nuclide <sup>9</sup>	Init. activity in one source (	Date for initial activity	Number of sources in waste	Leaking	Total activity (Bq)	
,	Radiotherapy sources	In their working shield, Cat I		Co-60	7.4E+13	2014-04-03	1		7.4E+13	

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

+-Waste component		
e	Waste component	
+-Waste component   Type of container	<ul> <li>+ Number of waste components 1</li> </ul>	Account deca
Show total activity by nuclide   Show form for selected component		
Waste component		Number o

	Waste component	Present in this waste component	Number of waste components
	Working shield for high activity sources-IRR-Cs		
	Working shield for high activity sources-RT-Co		
	Bare source-IRR-Cs		
	Bare source-RT-Co		
Ø.	Capsule large with IRR-Cs		2
	Capsule large with RT-Co		

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.



Type Name			
🧭 WM activity Preparation for introduction into cell	MHC HAS		
MM activity Lift original source shield into cell and close cell	MHC HAS		
🧭 WM activity Remove source and characterize	MHC HAS		
WM activity Encapsulation and testing of High Activity Sources (HAS)	MHC HAS		
	MHC HAS		
🧭 WM activity Remove Long Term Storage Shield (LTSS) to Storage facility	MHC HAS		
WM activity Remove Long Term Storage Shield (LTSS) to Storage facility			

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"

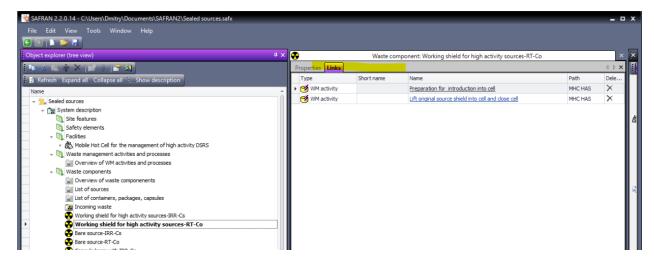
Link other waste components with the WM activities according to the table below.

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

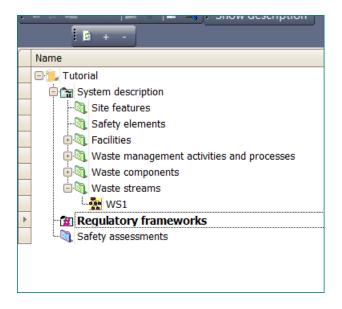
# **Regulatory framework**

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.

SAFRAN 2 Tutorials

Rev. 2015-11-29



👹 SAFRAN BETA 2.0.0.6 - C:\Users\Dmitry\Documents\SAFRANBETA\Tutorial1.s	afx	
File Edit View Tools Window Help		
Object explorer (tree view)	a 🗴 🧶 Criterion: Dose limit to worker Worker,N	lormal operation,Dose,Sv/y (Regulatory frameworks/National regulations/Normal
🛤 🤞 🛍 🛊 🗙 📰 🕕 🚰 🔍 🗄 Show description	Properties	
B + -	21 <u>2</u> 1	
Name	▲ General	
🖃 📜 Tutorial	Description	
E Cara System description	Name	Dose limit to worker
Site features	Short name	
- Safety elements	Attachments	
🔅 🔍 Facilities	Path	Regulatory frameworks/National regulations/Normal op
Waste management activities and processes	Situation	Normal operation
💩 🔍 Waste components	<ul> <li>Criterion</li> </ul>	
👜 🖏 Waste streams	Application	Worker
WS1	Limit	0.02
🗏 🗐 Regulatory frameworks	Туре	Dose
👜 🔍 National regulations	Unit	Sv/y
Normal operation		
Dose limit to worker		
Safety assessments		

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.

Pr	Properties					
Ξ	General					
	Description					
	Name	Dose limit to public				
	Short name					
	Attachments					
	Path	Regulatory frameworks/National regulations/Normal operation/				
	Situation	Normal operation				
	Criterion					
	Application	Worker 🛛				
	Limit	Worker				
	Туре	Public				
	Unit	SV/ J				

### 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.



🖳 Standard purposes of safety assesment 🛛 📃 🛽	
Assessment of compliance with regulatory criteria     Assessment of design     Site selection     Identification of safety functions     Establish limits and conditions     Identify maintenance requirements     Identify monitoring requirements     Prepare operational procedures     Prepare emergency procedures     Identify requirements for personnel qualification     Identify requirements for record keeping     Identify requirements for physical protection	
OK Cancel	

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.

	Select Regulatory framework		
view			
Tree view (to add new objs.)	Туре	Name	Pa
Gi i	2		
iĝ	Regulatory framework	National regulations	Re
New			
ppe			
(fe			
view			
ree			
느느			
			_
	Link selected object	Cancel	
		Cancer	
Se	lect object of the type Regulatory framework using List view	or Tree view and click "Link selected object"	' bi

SAFRAN 2 Tutorials

Rev. 2015-11-29



### 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<sup>13</sup>:

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

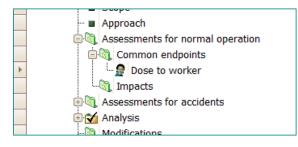
<sup>&</sup>lt;sup>13</sup> During the description of the system configuration we assumed that for the WM activities which take place inside the cell dose rate for external exposure is known from the measurements. For other WM activities we will estimate it based on the inventory and shield characteristics 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.



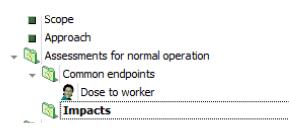
Set the properties of the endpoint:

- Type *Dose*
- Inside/Outside Inside

	Situation	Normal operation
4	Endpoint	
	Туре	Dose
	Inside/Outside	Inside
	Unit	Sv/y

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.

🛃 Add normal operation impacs		-	-	٥	×
	Welcome to the wizard				
	This wizard simplifies process of adding and update of the normal operation impacts connected to the waste management activities.				
	To continue, click Next				
	< Back	Next >		Cance	el

## Click "Next"

----

# The page of wizard showing all the activities will appear

Add normal operation impacs

#### Select WM activities

Select WM activities for which you like to assess annual doses from inhalation and external exposure under normal operation. After completion of w impacts of this type linked to this activity.

Facility	Room	Area	Impact(s) already exist
MHC HAS			no
	MHC HAS MHC HAS MHC HAS MHC HAS MHC HAS	MHC HAS MHC HAS MHC HAS MHC HAS MHC HAS	MHC HAS MHC HAS MHC HAS MHC HAS MHC HAS

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.



#### 🛃 Add normal operation impacs

Impacts Specify endpoint and other properties of impacts

✓ Endpoint	✓ Radiol. conseq.			
✓ Affecting	<ul> <li>Dose rate option</li> </ul>			
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.

🖷 Add normal operation impacs					
Impacts Specify endpoint and other properties of impacts.					
Assign the same for all rows	Endpoint	~	Radiol. conseq.		
· · · · · ·	Affecting	Calculate dose rate	Dose rate option		

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 Shi	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:



Affecting Calculate dose rate  Dose rate option						
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		

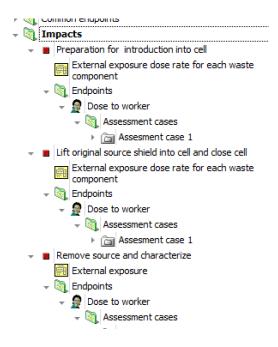
The values in the last column are:

	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.

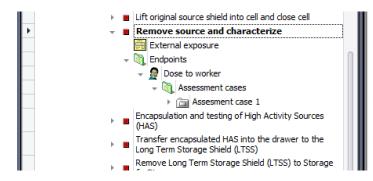




Collapse all impact objects except on the node "Remove source and characterize" – first of impacts where external dose rate associated with activity is known in advance.

	-			
-	3	In	ipacts	
	Þ		Preparation for introduction into cell	
	►		Lift original source shield into cell and close cell	
	-		Remove source and characterize	
			External exposure	
		Ŧ	💐 Endpoints	A
			🚽 🧟 Dose to worker	
			👻 🐧 Assessment cases	
			Assessment case 1	
	ŀ		Encapsulation and testing of High Activity Sources (HAS)	
	Þ		Transfer encapsulated HAS into the drawer to the Long Term Storage Shield (LTSS)	
	ŀ		Remove Long Term Storage Shield (LTSS) to Storage facility	
30				

Select "Remove source and characterize"



Observe the properties of this impact:

	1 GUT	ourcey assessmental ourcey assessment Assessmenta	
× ×	Situation	Normal operation	
	Impact		
	Affecting	Inside	
	Radiological consequences	Direct external exposure	
	Dose rate options	Dose rate is known	
$\sim$	Impact - quantitative or qualitative assessment		

Double-click on the table "External exposure".

星 External exposure Safety assessments/Safety assessment/Assessments for normal operation/Impacts/Remove source and characterize

ł	😰 Referesh 🛛 🛛 Reset 🔒 Lock table	Auto-filter row Clear filter Row r	merging 📋 Insert in Word document [ 📐 Print/export 睹 Cop
		Screening dose rate (Sv/h)	Hazard Quotient (HQ)
Þ	2.20E-005	5.00E-008	440

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"

SAFRAN 2 Tutorials

Rev. 2015-11-29



_	Remove source and characterize		Path
Ŧ	External exposure	$\sim$	User-d
			1
	- 💐 Endpoints		2
	👻 👰 Dose to worker		3
	🚽 💐 Assessment cases		4
	👻 🛅 Assesment case 1		5
	Dose from external irradiation or/and inhalation		5

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

Referesh       Reset       B Lock table       Auto-filter row       Clear filter       Row merging       Insert in Word document       Print/export       Exposure         Impact       Exposure time (h/year)       Dose rate (Sv/h)       Annual dose (Sv/year)         Remove source and characterize       2.20E-005	🖳 🖳 Dose from external irradiation or/	and inhalation Safety assessments/	'Safety assessment/Assessments for	normal 🗕 🗆 🗙
	🔋 🖻 Referesh 🛛 🛛 Reset 🔒 Lock tab	le   Auto-filter row Clear filter R	low merging   Insert in Word docur	ment 🛕 Print/export 📭 Copy
Remove source and characterize     2.20E-005	Impact	Exposure time (h/year)	Dose rate (Sv/h)	Annual dose (Sv/year)
	Remove source and characterize		2.20E-005	

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

η.	ASS	sess	ments for normal operation
Þ	<b>N</b>	Co	mmon endpoints
Ŧ	<b>R</b> .	In	ipacts
	$\overline{\mathbf{v}}$		Preparation for introduction into cell
			External exposure dose rate for each waste co

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:

	eview/modify dose rate an									
	ter exposure time or pres	ss button '' in dose ra	te cell to assign/modify o	lose rate						
	Impact	Impact's properties	Impact is linked to	Endpoint	Assessment case	Waste component (if rel	Dose rate (Sv/h)	Exposure time (h/y)	Dose (Sv/y)	
•	Preparation for introduc	Inside External dose rate	Preparation for introduc	Dose to worker	Assesment case 1	Working shield for high a				
	Preparation for introduc	Inside External dose rate	Preparation for introduc	Dose to worker	Assesment case 1	Working shield for high a				
	Lift original source shield	Inside External dose rate	Lift original source shield	Dose to worker	Assesment case 1	Working shield for high a				
	Lift original source shield	Inside External dose rate	Lift original source shield	Dose to worker	Assesment case 1	Working shield for high a				
	Remove source and cha	Inside External dose rate	Remove source and cha	Dose to worker	Assesment case 1		2.20E-005			
	Encapsulation and testin	Inside External dose rate	Encapsulation and testin	Dose to worker	Assesment case 1		4.10E-005			
	Transfer encapsulated H	Inside External dose rate	Transfer encapsulated H	Dose to worker	Assesment case 1	Capsule large with IRR-Cs				
	Transfer encapsulated H	Inside External dose rate	Transfer encapsulated H	Dose to worker	Assesment case 1	Capsule large with RT-Co				
	Remove Long Term Stor	Inside External dose rate	Remove Long Term Stor	Dose to worker	Assesment case 1	Long term storage shield				
	Remove Long Term Stor	Inside External dose rate	Remove Long Term Stor	Dose to worker	Assesment case 1	Long term storage shield				



Enter in the column "Exposure time (h/y)" the exposure time associated with each activity according to the Table  $10.1^{14}$ .

er exposure time or pres	s button '' in dose ra	te cell to assign/modify o	iose rate					
impact	Impact's properties	Impact is linked to	Endpoint	Assessment case	Waste component (if rel	Dose rate (Sv/h)	Exposure time (h/y)	Dose (Sv/y)
Preparation for introduc	Inside External dose rate	Preparation for introduc	Dose to worker	Assesment case 1	Working shield for high a		20	
Preparation for introduc	Inside External dose rate	Preparation for introduc	Dose to worker	Assesment case 1	Working shield for high a		20	
ift original source shield	Inside External dose rate	Lift original source shield	Dose to worker	Assesment case 1	Working shield for high a		10	
ift original source shield	Inside External dose rate	Lift original source shield	Dose to worker	Assesment case 1	Working shield for high a		10	
Remove source and cha	Inside External dose rate	Remove source and cha	Dose to worker	Assesment case 1		2.20E-005	25	5.50E-004
Encapsulation and testin	Inside External dose rate	Encapsulation and testin	Dose to worker	Assesment case 1		4.10E-005	30	1.23E-003
Fransfer encapsulated H	Inside External dose rate	Transfer encapsulated H	Dose to worker	Assesment case 1	Capsule large with IRR-Cs		5	
Fransfer encapsulated H	Inside External dose rate	Transfer encapsulated H	Dose to worker	Assesment case 1	Capsule large with RT-Co		5	
Remove Long Term Stor	Inside External dose rate	Remove Long Term Stor	Dose to worker	Assesment case 1	Long term storage shield		10	
Remove Long Term Stor	Inside External dose rate	Remove Long Term Stor	Dose to worker	Assesment case 1	Long term storage shield		10	

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".

	—	-
Ŧ		Remove source and characterize
		External exposure
	Ŧ	Contempoints
		🚽 🧝 Dose to worker
		🚽 💐 Assessment cases
		👻 🛅 Assesment case 1
		Dose from external irradiation or/and inhalation
ь		Encansulation and testing of High Activity Sources (HAS)

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

🛃 Dose from external irradiation or/and inhalat	ion Safety assessments/Safety assessment/Asse	essments for normal operation/Impacts/Remove	e source and charact —	×
😰 Referesh 🏮 Reset 🔒 Lock table   Auto-f	ilter row Clear filter Row merging   Insert in	Word document 🚺 Print/export 👫 Copy		
Impact	Exposure time (h/year)	Dose rate (Sv/h)	Annual dose (Sv/year)	
Remove source and characterize	25	2.20E-005	5.50E-004	

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.

<sup>&</sup>lt;sup>14</sup> 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.



	Preparation for introduction into cell
	External exposure dose rate for each waste component
÷ 🔍	Endpoints
-	🖉 Dose to worker
	🚽 💐 Assessment cases
	→  and Assessment case 1
	Dose - external exposure for each waste component and inh. exposure

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

Referesh	👂 Reset 🔒 Lock table   Auto-filter row 🛛 Clear f	ilter Row mer	rging   Insert in	Word d	ocument [ 👌 Prii	nt/export 👫	Сору				
elect/unselec	t waste components Run exposure model										
elected	Waste component	Nuclide	Activity (Bq)	N	Total acti	Distance (	Dose rate	Calculation	Screening	HQ	
$\checkmark$	Working shield for high activity sources-IRR-Cs	Cs-137	2.6E+13	10	2.6E+14				5.00E-008		
$\checkmark$	Working shield for high activity sources-RT-Co	Co-60	7.4E+13	10	7.4E+14				5.00E-008		
$\checkmark$	Total								5.00E-008		

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)

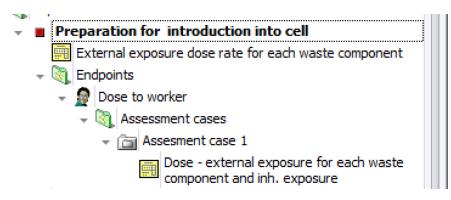
	Selected	Waste component	Nuclide	Activity (Bq)	N	Total activity (Bq)	Distance (cm)	Dose rate (Sv/h)	Calculation
•	$\checkmark$	Working shield for	Cs-137	2.6E+13	1	2.6E+13	200	•••	
	$\checkmark$	Working shield for	Co-60	7.4E+13	1	7.4E+13	200		
	$\checkmark$	Total							

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)

-	Selected	waste components	Nuclide	Activity (Bg)	N	Total activity (Bg)	Distance (cm)	Dose rate (Sv/h)	Calculation
-					IN			Dose rate (SV/II)	Calculation
1	$\checkmark$	Working shield for	Cs-137	2.6E+13	1	2.6E+13	200	•••	
	$\checkmark$	Working shield for	Co-60	7.4E+13	1	7.4E+13	200		
	$\checkmark$	Total							

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

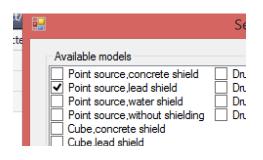
Available models Point source, concrete shield Point source, webra shield Point source, without shielding Cube, concrete shield Cube lead shield Cube, without shielding Disc, concrete shield Disc, water shield Disc, water shield Disc, water shield Disc, water shield Drum axial, concrete shield Drum axial, water shield Drum axial, without shielding Drum axial, without shielding	Drum radial,concrete shield Drum radial,lead shield Drum radial,water shield Drum radial,without shielding	OK Cancel
<	>	

SAFRAN 2 Tutorials

Rev. 2015-11-29



Select "Point source, lead shield"



# Click OK

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

		×
Dose rate calculation for Working shield for high activity sources-IRR-Cs 1		1
Description		1
Point_Lead waste component: Working shield for high activity sources-IRR-Cs		
ОК	Cancel	1
	Cancer	:

Click OK

The SafCalc2 window will appear



З.	SafCalc2 - Po	pint_Lead	*	-	×
<ul> <li>Context</li> <li>Model</li> <li>Model</li> <li>Parameters</li> <li>Result tables</li> <li>Simulation</li> <li>Simulation Settings</li> <li>Probabilistic Settings</li> <li>Return to SAFRAN</li> <li>Help Contents</li> <li>Report</li> </ul>	Basic settings Start time 0.0 Years End time 100.0 Years Type of simulation Best estimate Probabilistic Simulation table Number of simulations	Simulation			
SAFCALC SAFRAN calculation tool	1000	Errors S	Gource	Object	Description

Maximize it and select the "Parameters" tab

¥.			SafCa	llc2 - Point_Lead*						×
Parameters     Database     Export to Excel     Help Contents	i7A	Nome activity Sub-system Description		Symbol Unit Bq			full name Category		Brief	Full
	Name Search Q Category - All categories - V Sub-system	Data Radionuclides Default Cs-137	Value 0.0E0 2.6E13	Min	Max	PDF	Unit Bq Bq	Comment		Toggle
	All addrayaterina -									Alling

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

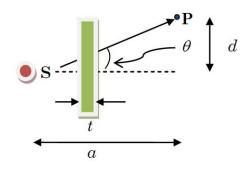
SAFRAN 2 Tutorials



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:

arameters	Information		
activity	Name		
distance	activity		
exposureTime neight	Sub-system		
ZA MatNo	Description		
atNo abThicknes			
	Data		
	Data Radionuclides	Value	Mir
		Value 0.0E0	Mir

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



eiga iZA Mati	Description Thicknes of shielding between a
	Data Value 5.0E0

Click on the "Simulation" tab:

rai ameters	F
Result tables	8 j
Simulation	
<ul> <li>Simulation Settings</li> <li>Probabilistic Settings.</li> <li>Return to SAFRAN</li> <li>Help Contents</li> </ul>	
Report	

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

Context	<b>%</b>	Basic settings		Simulation
Model	8	Start time		
Parameters		0.0	Years	Information
Result tables	8	End time		
		100.0	Years	
Simulation	۵	Type of simulation —		
Simulation Settings		Best estim	nate	

Wait until simulation will be finished

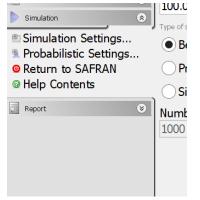


<i>a</i>			SafCalc2 - Point Lead*
Context C Model C Furding tables C	Start time 0.0 Years End time	Simulation Information 5:38:29 AM	Simulation started
Result later     Normation     Simulation Settings     Probabilistic Settings     Return to SAFRAN     Help Contents	100.0 Years Type of simulaton Best estimate Probabilistic	5:38:29 AM 5:38:29 AM 5:38:29 AM 5:38:30 AM 5:38:30 AM	Generating parameter values Done. [0 ms] Pre-processing Done. [1.8s] Simulation finished, Total time 2.1s
Report	Simulation table Number of simulations		

# Select "Result tables" tab - here you can see the result of the calculations

×.		SafCalc2	- Point_Lead*
Context S	Results • dose • doseRate • doseRate Total • slabWaternal	Tables Quick View Dose rate ✔	
Parameters S	slabMaterial	Nuclide	doseRate
Result tables		Cs-137	1.88E-3
<ul> <li>Time Table</li> <li>Index Table</li> <li>Statistics Table</li> <li>Raw Data Table</li> <li>Correlation Table</li> <li>View in Excel</li> <li>Clone</li> <li>Help Contents</li> </ul>			
Simulation Simulation			

# Click on the button "Return to SAFRAN" located on the "Simulation" tab



### Note that result was transferred into the assessment table:

introduction into ce		_ 0 ×
Distance (cm)	Dose rate (Sv/h)	Calculation
200	1.88E-003 ····	Point_Lead waste compo
200		

# SAFRAN 2 Tutorials



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

	SafCalc2	- Point_Lea	d_4_1_	_1*				×
© ©	Parameters activity distance exposureTime height iZA	Name slabThic Sub-syst	em			Symbol Unit cm	Brief Full name Category	Fu
; MatNc sabTi	MatNo	Descript				rce and t		
		Data —	Data					
		Value	Min	Max	PDF	Unit	Comment	
		1.0E1		ndx.		cm	comment	
	Name	9						

The final assessment table will looks like:

ē	External exposure dose rate for each waste component Safety assessment/Preparation for introduction into cell – 🗖 💌							_ = ×	
1	🖻 Referesh table 🤌 Reset table 🔒 Lock table   Row merging: Auto-filter row: Clear filter   📲 Print 📭 Print preview/export: Export to Word: Copy to clipboard								
1	Select/unselect waste components Run exposure model								
	Selected	Waste component	Nuclide	Activity (Bq)	N	Total activity (Bq)	Distance (cm)	Dose rate (Sv/h)	Calculation
		Working shield for high activ	Cs-137	2.6E+13	1	2.6E+13	200	1.88E-003	Point_Lead waste compo
	$\checkmark$	Working shield for high activ	Co-60	7.4E+13	1	7.4E+13	200	2.42E-002	Point_Lead waste compo
	$\checkmark$	Total						2.61E-002	



# 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

🛒 Common endpoints
Scenarios and impacts
🗕 🏹 Analysis
👻 💐 Normal operation
Comparison of hazards inside
Comparison of hazards outside
Comparison of doses inside
Comparison of doses outside
Contractions Contraction Contraction
Accidental situation
Modifications

💀 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 ங 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.



🖳 Discussions		_	×
Edit discussion			
Add new discussion	Add already existing discussion	Remove discussion from row	

Click "Add new discussion"

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

Edit discussion		-	×
Name	ose for Preparation for introduction into the cell	ОК	
Description	Dose for this activity is over the limit. It is not possible to increase the shield, so the working time have to be limited.	Cancel	
Show links of	Add new link		

Click Ok button.

Close the "Discussions" dialog.

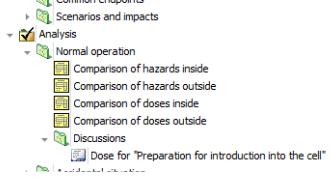
The discussion's name will appear in the analysis table:



👌 Print/export 📭 Copy			
Criterion	Limit (Sv/y)	Discussions	Modifications
Worker	2.00E-002	Dose for Preparation for	
Worker	2.00E-002		

### 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"

Preparation for introduction into cell
 External exposure dose rate for each waste component
 External exposure and exposure via inhalation
 Endpoints
 Endpoints
 Dose to worker
 Assessment cases
 Assessment case 1
 Dose - external exposure for each waste component and inh. exposure

Select "Add assessment" case



•	Add new Assessment case		×
Name			
Assessment case			
Description			
ОК		Cancel	
		Calicer	

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

 Add new Assessment case 🚽 🗖 🗖	×
Name	
Shorter time	
Description	
Shorter annual working time per worker for this operation	
0//	
OK	

Double-click on the table "Dose – external exposure ..." for this assessment case

$\overline{\mathbf{v}}$	🖉 Dose to t	юrкer				
	🚽 🧃 Asse	sment cases				
	- 🛅 A	ssesment case 1				
		Dose - external	exposure fo	r each waste o	component and inh	n. exposure
	👻 👻 S	norter time				
		Dose - extern	al exposu	re for each w	aste componer	nt and inh.
	A 4 4					

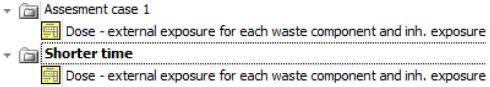


	🔛 Dose - external exposure for each waste component and inh. ex 💻 🗖 📉 🗙						
1	💈 🛱 Referesh table 🗕 Reset table 🔒 Lock table 🛛 Row merging 🛛 Auto-filter row 🛛 Clear filter 👘						
	Waste component	Inhalation dose r	External dose rat	Exposure time (h/	Dose (Sv/year)		
×.	Working shield for hi	0	1.88E-003	20	3.76E-002		
	Working shield for hi	0	2.42E-002	20	4.85E-001		
	<u>Total</u>				5.22E-001		

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

	💀 Dose - external exposure for each waste component and inh. ex – 🗖 🗙							
1	💈 🖻 Referesh table 🗕 Reset table 🔒 Lock table 🛛 Row merging 🛛 Auto-filter row Clear filter 📔 🥫							
	Waste component	Inhalation dose r	External dose rat	Exposure time (h/	Dose (Sv/year)			
	Working shield for hi	0	1.88E-003	4	7.52E-003			
•	Working shield for hi	0	2.42E-002	5.00E-001	1.21E-002			
	<u>Total</u>				1.96E-002			
	-				E			

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:

	Path	Safety assessme
	Situation	Normal operatio
⊿	Case	
	Show in analysis tables	Yes
	Use in cumulative results	Yes

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

SAFRAN 2 Tutorials

Rev. 2015-11-29



### Observe now the comparison table in the Analysis section:

Comparison of doses inside Safety assessment –								
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.

🔜 Dose - external exposure for each waste component and inh. ex 🗕 🗖 💌								
📓 Referesh table 🗕 Reset table 🔒 Lock table 🛛 Row merging 🛛 Auto-filter row Clear filter 📔								
	Waste component In	halation 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			
	<u>Total</u>				1.59E-002			

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

### Now the Analysis table looks like:

Comparison of doses inside Safety assessment								
🚊 Referesh table 🔸 Reset table 🔒 Lock table   Row merging 🛛 Auto-filter row: Clear filter   🚽 Print 🔥 Print preview/export 🛛 Export to Word 🖉 Copy to clipboard								
Show as chart								
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 a		
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 Discussion	-			
List view							
		Туре	Name	Path			
	٩						
do w	×	📃 Discussion	Dose for "Preparation for introduction into the cell"	Safety assessment			
Tree view (to add new objs.]							
		Link select t object of the type Discu dify objects' properties of	ussion using List view or Tree view and click "Link selected object" button. If new	cessary you can add ne			

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.

🖻 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)	Discussions	Modifications
Preparation for introduction into	. Dose to worker	Assesment case 1	5.22E-001	Worker	2.00E-002	Dose for Preparation for	
Preparation for introduction into	. Dose to worker	(+)Shorter time	1.59E-002	Worker	2.00E-002	Dose for Preparation for	
Lift original source shield into cell	. Dose to worker	(+)Assesment case 1		Worker	2.00E-002		

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

Ŧ	💐 N	aste management activities and processes
	6	Overview of WM activities and processes
	5	a Management of the High Activity Sources in the Mobile Hotcell
	6	Preparation for introduction into cell
	6	Lift original source shield into cell and close cell
	- E 🔂	Remove source and characterize
	+ 🖯	Encapsulation and testing of High Activity Sources (HAS)
	6	Transfer encapsulated HAS into the drawer to the Long Term Storage Shie
	6	Remove Long Term Storage Shield (LTSS) to Storage facility
	(Co. )	



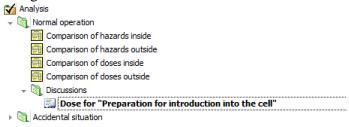
# Right-click on it and select "Add limit and condition"

🖳 Rename or change description 🦳 —		×
Name		
Limit and condition		]
Description		
The annual working time for preparation of Cs-137 sources for one worker can't be more t hours and for Co-60 sources more than 30 min.	han 2	
ОК	Cancel	

### 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.



•				
new objs.] List view	1			
List		Туре	Name	Path
s.	٩			
v obj	Þ	💱 Limit and condition	Limit and condition	System description/Fa
l nev		🖶 Safety function	Filtration	System description/Fa
o ado				
iew (to add				
<u>e</u> .				

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.

			port from Excel Update w	_				
Parameter	nuclide	Value(Bq/y)	Data source	Default	Reference	Comment		
creeningReleaseRate	Ac-228	6.71E+	SAFRAN DB					
creeningReleaseRate	Ag-110m	5.01E+006	SAFRAN DB	$\checkmark$				
creeningReleaseRate	Am-241	3.99E+005	SAFRAN DB					
creeningReleaseRate	As-76	4.57E+009	SAFRAN DB					
creeningReleaseRate	At-211	1.75E+008	SAFRAN DB	$\checkmark$				
creeningReleaseRate	Au-198	2.63E+009	SAFRAN DB	$\checkmark$				
creeningReleaseRate	Bi-206	1.66E+008	SAFRAN DB	~				
creeningReleaseRate	Bi-210	1.97E+008	SAFRAN DB	$\checkmark$				
creeningReleaseRate	Bi-212	5.95E+008	5			X		
creeningReleaseRate	Br-82	8.53E+008	S			25		
creeningReleaseRate	C-14	7.81E+009	\$					
creeningReleaseRate	Cd-109	1.13E+008	\$					
creeningReleaseRate	Ce-141	5.64E+008	3	You can't change values provided with SAFRAN. Make a copy of the row and mark it as default				
creeningReleaseRate	Ce-144	3.39E+007	and mark it as					
creeningReleaseRate	Cm-242	3.47E+006	3					
creeningReleaseRate creeningReleaseRate	Cm-242 Cm-244	3.47E+006 6.44E+005	3					
-						ОК		
creeningReleaseRate	Cm-244	6.44E+005				ОК		
creeningReleaseRate	Cm-244 Co-58	6.44E+005 4.71E+007	5			ОК		
creeningReleaseRate creeningReleaseRate creeningReleaseRate	Cm-244 Co-58 Co-60	6.44E+005 4.71E+007 7.70E+005	SAFRAN DB			ОК		
creeningReleaseRate creeningReleaseRate creeningReleaseRate creeningReleaseRate	Cm-244 Co-58 Co-60 Cr-51	6.44E+005 4.71E+007 7.70E+005 3.39E+009	SAFRAN DB	y y		ОК		
creeningReleaseRate creeningReleaseRate creeningReleaseRate creeningReleaseRate creeningReleaseRate	Cm-244 Co-58 Co-60 Cr-51 Cs-134	6.44E+005 4.71E+007 7.70E+005 3.39E+009 3.22E+006				ОК		
creeningReleaseRate creeningReleaseRate creeningReleaseRate creeningReleaseRate creeningReleaseRate creeningReleaseRate creeningReleaseRate	Cm-244 Co-58 Co-60 Cr-51 Cs-134 Cs-135	6.44E+005 4.71E+007 7.70E+005 3.39E+009 3.22E+006 3.85E+008	SAFRAN DB	$\checkmark$		ОК		
ccreeningReleaseRate ccreeningReleaseRate ccreeningReleaseRate ccreeningReleaseRate ccreeningReleaseRate ccreeningReleaseRate ccreeningReleaseRate	Cm-244 Co-58 Co-60 Cr-51 Cs-134 Cs-135 Cs-135 Cs-136	6.44E+005 4.71E+007 7.70E+005 3.39E+009 3.22E+006 3.85E+008 1.13E+008	SAFRAN DB SAFRAN DB			ОК		

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.

•								
:[	Show undefined Make	e copy of selected rows	Export to Excel	Import from Ex	cel Update with new n	uclides 凄 Print 🛕 Print p		
	Parameter	nuclide	<sup>▽</sup> Value(Bq/y)	Di	ata source	Default		
4		Cs-137						
	ScreeningReleaseRate	Cs-137	1.97E+006	SA	AFRAN DB			
	_							

Click somewhere in the row to select it.

Parameter	nuclide	. 2					
			Value(Bq/y)	Data source	Default	Reference	Comment
2	Cs-137						
2 ScreeningF	ReleaseRate Cs-137	1	1.97E+006	SAFRAN DB			

SAFRAN 2 Tutorials

Rev. 2015-11-29



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

d Make	copy of selected rows	Ex
	nuclide	7

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.

	Screening release rate (Bq/y) to the atmosphere for normal operation conditions						
	Show undefined Make	copy of selected rows	Export to Excel	Import from Excel	Update with new n	uclides  🚽 Print	这 Print previe
$\left[ \right]$	Parameter	nuclide	<sup>▽</sup> Value(Bq/y)	Data s	ource	Default	Ref
4		Cs-137					
Ø.	ScreeningReleaseRate	Cs-137	1.97E+006	SAFRA	N DB		1
	ScreeningReleaseRate	Cs-137	1.97E+006	user			

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

	03 137		
ScreeningReleaseRate	Cs-137	1.97E+006	SAFRAN DB
ScreeningReleaseRate	Cs-137	1.50E+006	user

Finally, mark this row as "Default".

Value(Bq/y)	Data source	Default	Re
1.97E+006	SAFRAN DB		
1.50E+006	user		

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.

atmosphere for normal operation condit					
ected rows Export to Excel Import fror					
	Value(Bq/y)				
	9.86E+007				

The dialog box "Export to Excel" will appear:

Export to MS Excel			
Export to New file  Existing file		Browse	OK Cancel
Create worksheet with name	ScreeningReleaseRate		

#### Click OK.

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



X	<mark>8</mark> ນ - ທ		_	_
Fi	ile Horr	ie Insert	Page Layo	out Formulas
Pas	Clipboard	•		• 11 • A <sup>*</sup> 
	A1	• (	<u></u>	🛣 nuclide
	А	В	С	D
1	nuclide	Screening	F Reference	e Comment
2	Ac-228	6,71E+08	3	
3	Ag-110m	5010000	)	
4	Am-241	399000	)	
5	As-76	4,57E+09	)	
6	At-211	1,75E+08	3	
7	Au-198	2,63E+09	)	
8	Bi-206	1,66E+08	3	
9	Bi-210	1,97E+08	3	
10	Bi-212	5,95E+08	3	
11	Br-82	8,53E+08	3	
12	C-14	7,81E+09	)	
13	Cd-109	1,13E+08	3	
14	Ce-141	5,64E+08	3	
15	Ce-144	33900000	)	
16	Cm-242	3470000	)	
17	Cm-244	644000	)	
18	Co-58	47100000	)	

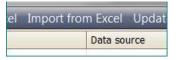
Change the values for first 3 nuclides.

1	nuclide	ScreeningRe Reference	:е
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.



SAFRAN 2 Tutorials

Rev. 2015-11-29



The "Import from MS Excel" dialog box will appear.

🖳 Import from M	S Excel	-		
File Worksheet			Browse	OK
	Baramatar	pudida	Value/Bels)	Data cource

Select the Excel file and worksheet "ScreeningReleaseRate".

🖳 Import from I	MS Excel		
File			
C:\Users\D	mitry\Desktop\Test.xlsx	Browse	ОК
Worksheet	ScreeningReleaseRate	•	Cancel
			.4

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.



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

Close the database table and database window.

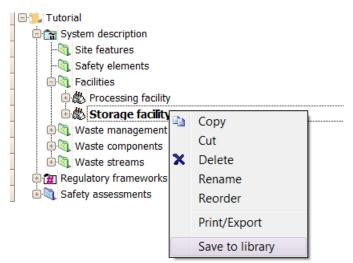


# **Tutorial 14. Reuse library objects**

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<sup>15</sup>

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".

<sup>15</sup> 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. SAFRAN 2 Tutorials



🖃 💐 Safety assessments			
🖃 🧼 Safety assessment 1			
🖃 💐 Purposes			
- Scope			
- Approach			
Assessments for normal operation			
Assessments for accidents			
■ Types of postulated initiating events	(PIE	types)	
Common endpoints			
Scenarios and impacts			
🖃 🔍 Postulated Initiating Events (PIEs)			
Fire in the storage facity	P	Link PIE type	·····
Drop of the drum in the Drum			
Impacts		Create impact and link it with this scenario	
	100	Сору	
	1	Cut	
Analysis	×	Delete	
- Modifications		Rename	
		Reorder	
		Print/Export	
ouble-click on tree node for default action: right-	GIG	Save to library	

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

👹 SAFRAN BETA 2.0.0.9 🛛 -	C:\Users\Dmitry\Documents\SAFRANBETA	\\Tuto	orial6.safx	
File Edit View To	ols Window Help			
🗲 🕞   🗋 🎽 🔛	Database			
Object explorer (tree	Library	•	Preview library	₽ × 🔳
🏗 🤞 🛍 🕸 🗙 📄	Advanced calculations		Manage library	PI
B + -	Safety requirements			· · · · · · · · · · · · · · · · · · ·
	Document project with MS Word add-in			
Name	Import/Export	•		
🔄 🖄 Storag	Options	•		
🖽 💐 Waste n	nanagement activities and processes			
🗄 🔍 Waste o	•			
	lements			
E S Rooms	1 10 10 11 I			

The "Library" window will appear<sup>16</sup>.

<sup>&</sup>lt;sup>16</sup> In this tutorial the library distributed with SAFRAN was initially empty. If library already contains some objects they will be shown. SAFRAN 2 Tutorials



lame	Type Description
Scenario	-
Fire in storage facility	Scenario
Facility	
Storage facility	Facility

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".

Object explorer (tree view)						
📑 🖌 🛍 🗄 🗙 🔂 🚺	🖀 획 🗄 Show description					
<b>a</b> + -						
Name						
🖃 🖃 📜 TestL						
System description						
Site features	- 🖏 Site features					
Safety elements						
Facilities	Add Facility					
🗄 🔍 Waste man	Add User-defined folder					
Waste com	Add oser defined folder					
	Reorder					
Regulatory fra	Print/Export					
	Add from library					

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

Name	Туре	Description	Select Cancel
Scenario			Cancer
Fire in storage facility	Scenario		
Facility			
Storage facility	Facility		

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



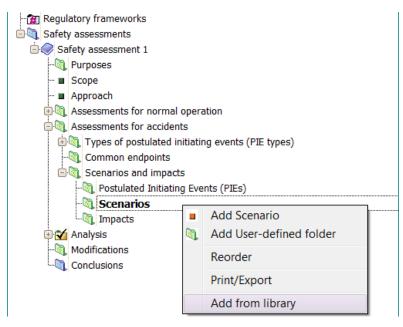
Expand node "Storage facility".

🖻 🖏 Storage facility
🖲 🔍 Measured or estimated data
🖽 🔍 Waste management activities and processes
🖽 🔍 Waste components
🖲 🔍 Safety elements
🗐 🔍 Rooms
🖃 🆏 Drum storage room
🖽 🔍 Measured or estimated data
🗐 🖏 Waste management activities and processes
- 🖬 Overview of WM activities
🗄 🧭 Storage
😥 🖏 Waste components
🔍 Safety elements
- 🕅 Areas

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.

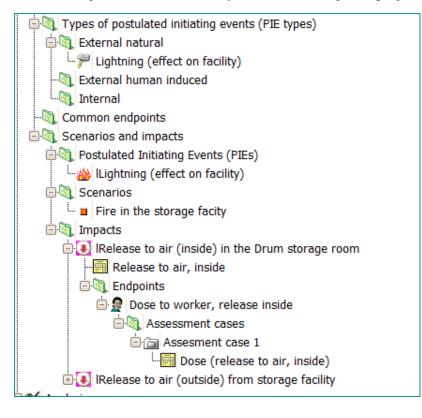


In the window "Library" which will appear, select scenario "Fire in storage facility".



<b>!!</b>	ibrary			
	Name	Туре	Description	Select
	Scenario Fire in storage facility Facility	Scenario		Carca
	dis Storage facility	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.



≝) Ž↓   🖾	
• General	
Description	
Name	IRelease 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
<ul> <li>Impact - quantitative or qualitative assessment</li> </ul>	
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	Lightning (effect on facility)
Short name	
Attachments	
Path	Safety assessments/Safety assessment 1/Assessment
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

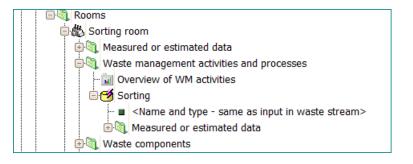
The window for management of the outputs of waste management activcity will appear

		11	VI.
🐖 Sorting	- 6	3 ×	
	Update Print Zoom mode		
Sorting         Image: Sorti			
	<b>6</b>		4157
Properties Links			
24 📼			

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"



Properties	
General	
Description	Made fr. process diagr. as input to Compaction.
Name	<name -="" and="" as="" in="" input="" same="" stream="" type="" waste=""></name>
Short name	
Attachments	
Path	System description/Facilities/Processing facility/Rooms/Sorting room/
A Data	
Type of waste component	Not defined - same as input
▲ Other	
Check for clearance info	
Name same as input	True
	True
	False

Properties	
▲ General	
Description	Made fr. process diagr. as input to Compaction.
Name	Waste - output from Sorting
Short name	
Attachments	
Path	System description/Facilities/Processing facility/Rooms/Son
▲ Data	
Type of waste component	Not defined - same as input
▲ Other	
Check for clearance info	
Name same as input	False

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

Change the property "Name" to "Compactable waste".

۱ 🗉	Waste component:	<name -="" and="" as="" in="" input="" same="" stream="" type="" waste=""> (System description/Facilities/Processing facility/Rooms/Sorti 🗙</name>
Pro	operties	
	<b>2</b> ↓ □	
4	General	
	Description	Made fr. process diagr. as input to Compaction.
	Name	Compactable waste
	Short name	
	Attachments	

Note that name was also changed in the browser window.

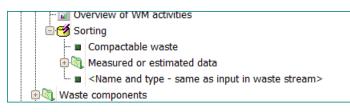
🗏 🖻 🧭 So	rting	
	Compactable waste	
	Measured or estimated data	
🖃 🕅 Waste components		

Right-click on Sorting and select from the menu "Add output with type 'same as input".

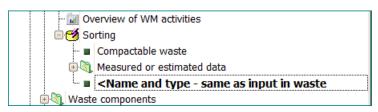


Surcy clement	nco -		
🖃 💐 Rooms			
🖃 🖏 Sorting room	m		
🗉 💐 Measure	ed o	r estimated data	
🖃 💐 Waste m	🖃 🖏 Waste management activities and processes		
- 词 Overview of WM activities			
🗉 🧭 Sort	tina		
		Add output with type 'same as input'	
🗷 💐 Waste		Add output with type 'sources'	
💐 Safety		Add output with type 'solid waste'	
💐 Areas		Add output with type 'liquid waste'	
🗄 🎒 Compactic		Add output with type liquid waste	
🗄 🎒 Stirage facility 🚦	5	Link safety element	
🕀 🕅 Measured or			

#### The new output will be added to Sorting:



#### Select this output.



#### Change the property "Name same as input" to False:

Properties	
▲ General	
Description	
Name	Waste - output from Sorting
Short name	
Attachments	
Path	System description/Facilities/Processing facili
▲ Data	
Type of waste component	Not defined - same as input
▲ Other	
Check for clearance info	
Name same as input	False



Change for the property Name to "Non-compactable waste".

4 General	
Description	
Name	Non-compactable waste
Short name	
Attachments	
Path	System description/Facilities/Process
4 Data	
Type of waste component	Not defined - same as input
4 Other	
Check for clearance info	
Name same as input	False

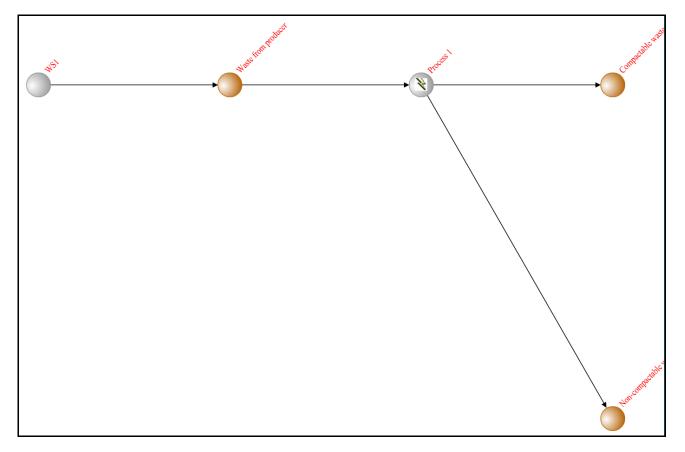
··· 🖬 Overview of WM activities		
🖃 🥶 Sorting		
	Compactable waste	
📃 😟 🕅	Measured or estimated data	
	Ion-compactable waste	
🗄 🕅 Waste components		

# Review the changes in the waste stream

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

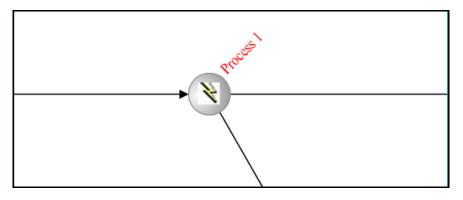




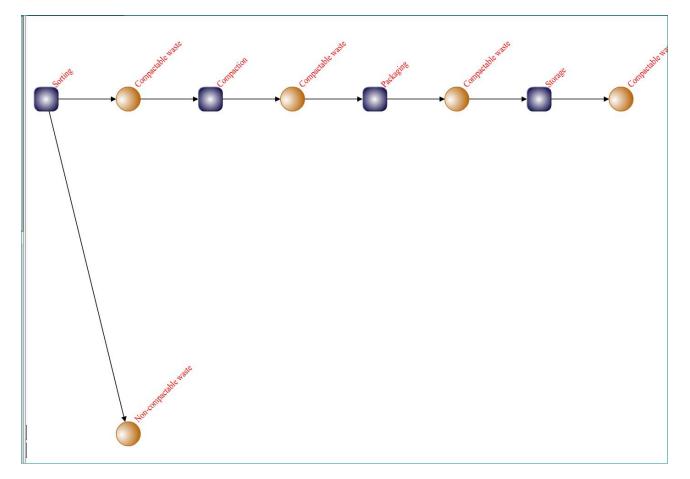


The stream was modified in comparison with Tutorial 4. Now it has two outputs from Process 1 – "Compactable waste" and "Non-compactable waste".

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

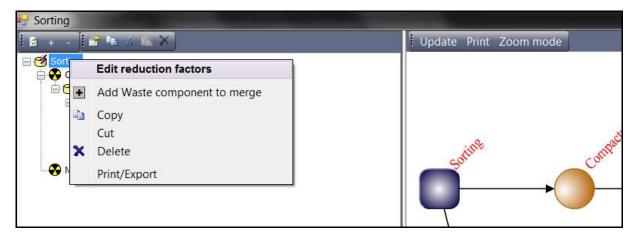






Because a second output was added to the sorting activity, it is necessary to verify that reduction factors for Sorting are correct (see Tutorial 4).

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



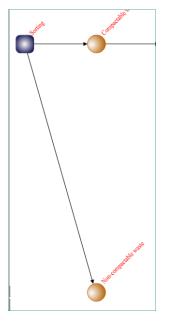


Changing factors			
Recalculate factors			
Waste component	Volume	Mass	Activity
[Sorting] - Compactable waste	80	80	80
[Sorting] - Non-compactable wa	20	20	20

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 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".

🚽 WS1	the second s	
Recalculate waste c	omponnets data	
🖻 + - 🚰 🛍		Update Print Zoom mode
🖃 🔐 WS1		
🖮 😯 Waste from pr	roducer	
😑 🚟 Process 1		
	table waste	
Non-co	Properties	
	Add process	WS1
	Add existing activity	A.
	Add new activity	
	Add new activity with type 'storage for decay'	
	Add check for clearance	
	🗈 Copy	

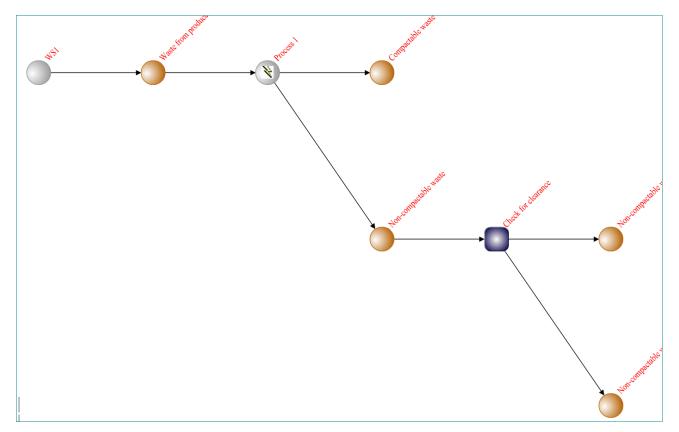
#### A dialog box will appear:

ncel
Ca

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.







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.

🖳 WS1	
Recalculate waste componnets data	
□-₩ WS1	
WS1 WS1 WS1 WS1 WS1	
📄 🚟 Process 1	
Compactable waste	
📥 😯 Non-compactable waste 🛓 🧭 Check for clearance	
Non-compactable waste	
Non-compactable waste	
Properties Links	
▲ General	
Description	
Name	Non-compactable waste
Short name	
Attachments	Custom description (Maste stronge (MC1/Maste fro
Path	System description/Waste streams/WS1/Waste fro
Type of waste component	Solid waste
Properties	Co-60 Cs-137
4 Other	
Check for clearance info	Starts branch for waste which can't be cleared,



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

🖳 WS1	
Recalculate waste componnets data	
🖃 🙀 WS1	
🖮 🚱 Waste from producer	
Process 1	
- 😽 Compactable waste - 😽 Non-compactable waste	
in the compactable waste	
Non-compactable waste	
Non-compactable waste	
Properties Links	
4 General	
Description	
Name	Non-compactable waste
Short name	
Attachments	
Path	System description/Waste streams/WS1/Waste fror
4 Data	
Type of waste component	Solid waste
Properties	Co-60 Cs-137
▲ Other	
Check for clearance info	Starts branch for waste which can be cleared.

Now the stream for "waste which can't be cleared" will be developed with Packaging.



🚽 WS1		and an an and a state of the local	and the second se	
Recalculate waste componnets data				
🖻 + - 📓 🖥 🔏 🏨 🗙			Update Print	Zoom mode
WS1				
<ul> <li>Non-compactable w</li> <li>Non-compactable w</li> </ul>		Properties		
		Add process		
		Add existing activity		
		Add new activity Add new activity with type 'storage Add check for clearance	e for decay'	
	6	Copy Cut		
	×	Delete		
		Reorder		

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

The list of activities will appear.

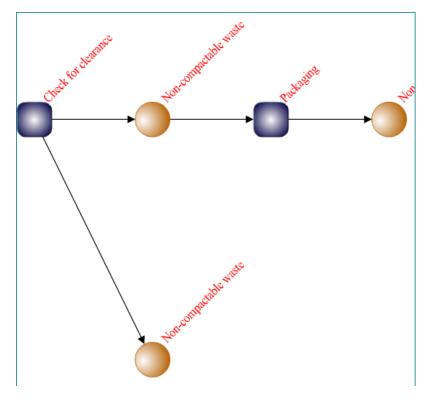
1 Was	•	Lir	nk			
	List view	1	: [	đ		
	List	(		Туре	Name	Path
1			8			
				🧭 WM acti	Sorting	System description/Facilities/Process
					act. for <name -="" and="" as="" in="" input="" same="" stre<="" th="" type="" waste=""><th>System description/Facilities/Process</th></name>	System description/Facilities/Process
				🧭 WM acti		System description/Facilities/Process
			_	🥳 WM acti		System description/Facilities/Proces
				🥳 WM acti	Storage	System description/Facilities/Stirage
		L				
		L				
		L				
		L				
		L				
		-	-			
					ОК	Cancel

Select "Packaging" and click OK. SAFRAN 2 Tutorials

Rev. 2015-11-29



Note the changes in waste stream diagram.

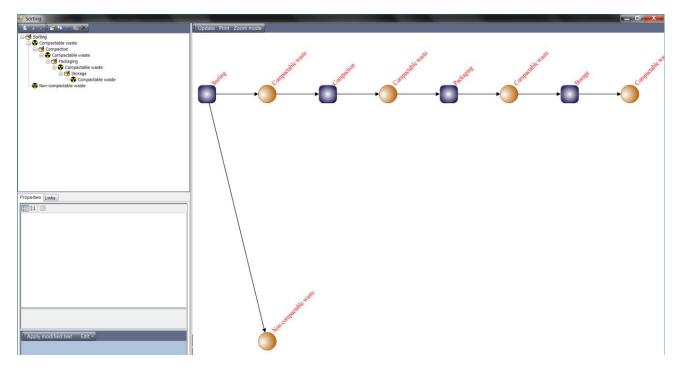


## Merge outputs of several activities in the waste stream

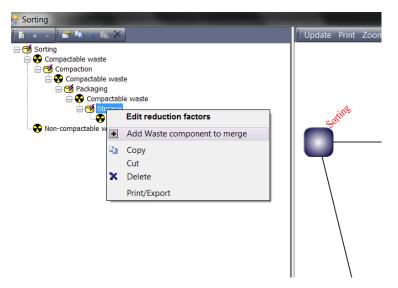
To finalize modifications in the waste stream, it is necessary to indicate that the waste produced by Packaging are sent to the same Drum storage room as already used in stream (using activity Storage already existing in stream).

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:

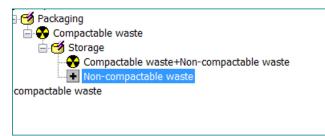


Туре	Name	Path
4		
😯 Waste component	Waste from producer	System description/Waste streams/WS1
😯 Waste component	Compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting
😯 Waste component	Compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Compactable waste/Compaction
🚱 Waste component	Compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Compactable waste/Compaction/Compactable waste/Packaging
🚱 Waste component	Compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Compactable waste/Compaction/Compactable waste/Process 1/Sorting/Compactable waste/Sto
🚱 Waste component	Non-compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting
<ul> <li>Waste component</li> </ul>	Non-compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Non-compactable waste/Check for clearance
🥂 🔂 Waste component	Non-compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Non-compactable waste/Check for clearance/Non-compactable waste/Packaging
<ul> <li>Waste component</li> </ul>	Non-compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Non-compactable waste/Check for clearance
	Link selected object Canc	el
		<b>9</b>
ant object of the type	Waste component using List view or Tree vi	ew and click "Link selected object" button. If necessary you can add new objects or modify objects' properties using Tree view.

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.

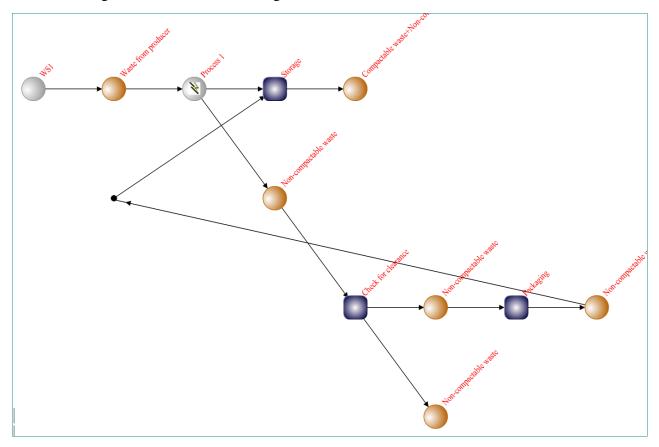
Double-click again on the WS1 node to re-open stream window.



## SAFRAN 2 Tutorials

Rev. 2015-11-29



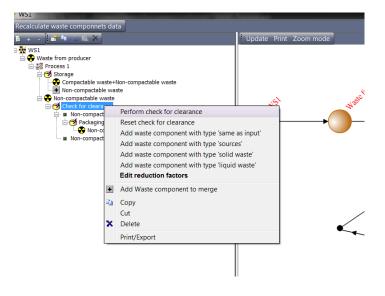


Note the changes in the waste stream diagram.

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".



SAFRAN 2 Tutorials

Rev. 2015-11-29



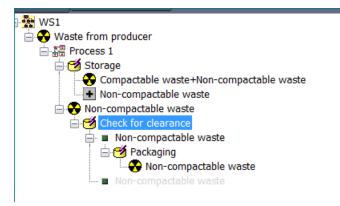
The following window will appear:

User's decisio Waste car Waste car	be cleared	OK		
Activity con	centration val	ues (Bq/g)		
Nuclide	waste component	Criterion		
	3.09E+006	1.00E-001		
Cs-137	8.59E+004	1.00E-001		
Sum(C/level)	3.18E+007	1		

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.

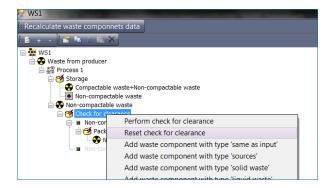


(You can check whether output starts the branch for waste which can be cleared by observing its properties as shown earler in this tutorial)

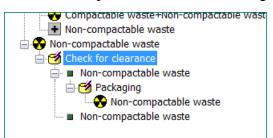
Disabling branch means that the corresponding waste components will not be taken into account during the safety assessment.

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".





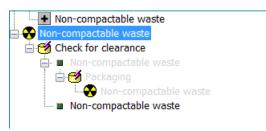
All waste components will be enabled again.



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

SAFRAN 2 Tutorials

