

SAFRAN TUTORIALS

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Introduction

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

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

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

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

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

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

It is then necessary to specify the properties of each room, area and waste management activity. These parameters include external dose rate, activity concentration in air, nuclides, etc. Specification of these properties is illustrated in Tutorial 3. SAFRAN 2 Tutorials Rev. 2020-12-29



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

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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 and learning recommendations

It is highly recommended to perform tutorials step-by-step following detailed instructions included in this document. To simplify this process the first tutorials include very detailed explanations and screen dumps for step.

The more complex tutorials contains the part marked as the advanced exercises. These parts can be skipped when tutorials are performed first time.

The series of tutorials from the Tutorial 9 to 12 are devoted to sealed sources. They assume that user is already a bit familiar with SAFRAN user interface (for example by preforming Tutorials 1 - 8). The same time they demonstrate simplified methods of making links between waste components and rooms/activities.

Finally, specific features of SAFRAN such as extending of database with own values and using libraries are separated to devoted tutorials (also marked as "advanced exercise") so they can be skipped for novice learners or those who are not intersected in these particular topics or opposite, those users who are going to use these features can study them with high level of details .

Ready-to-use tutorial files

While recommended way to perform tutorials is step-by-step using instructions included in this document, taking into account that learning situations and time available can be very different, all the results of tutorial exercises are also made available as files ready to be open in SAFRAN.

These files are available via the SAFRAN web site via menu item Resources->Shared projects. You need to register first at the SAFRAN site (see Tutorial 1) to reach this menu item.



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The web page which will appear contains SAFRAN files which developers or users decided to share. The files relevant to tutorials are located in section "SAFRAN Tutorial – already made .safx files". To get files it is necessary to click on the hyperlink selected by yellow in the picture below.

HOME RESOURCES SUPPORT MY PAGES ADMIN PAGES					
Projects					
Test Case: Use and Application of the SADRWMS Methodology and SAFRAN Tool on the Thailand Institute of Nuclear Technology (TINT) Radioactive Waste Management Facility <u>Test Case Results</u> Author RA, WG, DH Description Raport: Use and Application of the SADRWMS Methodology and SAFRAN Tool on the Thailand Institute ci Purpose Scope: Use and Application of the SADRWMS Methodology and SAFRAN Tool on the Thailand Institute of Nucleas Edit Delete	SAFRAN Tutorial already Made -safx files Muthor DH Description: SAFRAN Tutorial - already made -safx files Purpose: Scope: Edit Delete				
Central Nuclear Embalse Author: Ariel Gonzalez Description: Purpose: Scope:					



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.

- To be able to download SAFRAN software first time you will need to receive IAEA approval (this procedure is required only once and will not be required for the next downloads). To do this:

Send the e-mail to address **safran.facilia@afconsult.com**. Please specify in this e-mail the user name (login) you have selected for the SAFRAN site.

If not specified in your profile during the registration, please provide also the information about:

- your name and surname
- your organisation
- purposes of SAFRAN usage

When your request will be approved you will be able to download SAFRAN with the button which will appear in the page as shown below:



HOME RESOURCES SUPPORT MY PAGES ADMIN PAGES	Edit Profile Logout(Dmitry)
Downloads SAFRAN 2 Prerequisites SAFRAN is working on .NET 4 or higher under Windows 10/8/7/XP operating systems. SAFRAN installation program checks the presence of .NET and helps you to install it if necessary. You can optionally use Microsoft Word and Microsoft Excel together with SAFRAN.	
Download SAFRAN installation To download SAFRAN software first time please send request to safran.facilia@afconsult.com. Please specify in • the login you are using for SAFRAN site If not specified in your profile during the registration, please provide also the information about: • your name and surname • your organisation • purposes of SAFRAN usage When your request will be approved you will be able to downaload SAFRAN with the button which will be shown be SAFRAN 2.5.0.0 (issued 29 December 2020) Download Previos versions of software	

- Download and run the latest release of SAFRAN installation. This review of tutorials corresponds to the SAFRAN **2.5.0.0**

Start SAFRAN

SAFRAN starts after installation. Next time you can start it using desktop shortcut created by installation program.

Reset SAFRAN's options

If you already use SAFRAN then 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.

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1	Tools Window Help				
	Database				
e	Library	•		4 х 🛉	
	Advanced calculations				Properti
	Safety requirements Document project with MS Word add-in	•			₩ 2 ↓ C
	Import/Export	,			▲ Gen
					Des
	Options	•	M	odify options	lam
			Re	eset options to default values	sho
					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 project	
Properties	
Title Tutorial	
Author	
Project started	den 14 augusti 2013
Description	Exercise to learn more about SAFRAN
Create p	roject 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.



Project propert	es		
Nuclides Sources	Containers and packages Scal	s Title, description, author, date	
Nuclides		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 done later in the Tutorial 3. Close the dialog box without



entering information by clicking

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

5 🖻 🗋 🎽 🖬		
Object explorer (tree view) 🛛 👎	× 💁	Project: Tutorial
ங X LL 4€ X ■	Properties Links Errors!!! Comments Tasks	
🗯 Refresh Expand all		
Name	✓ General	
👻 📜 Tutorial	Name	Tutorial
 System description 	Description	Exercise to learn more about SAFRAN
Site features	Short name	
Physical elements	Attachments	
Safety elements	Path	
Facilities	✓ Project	
Waste managemen	Author	Dmitry
Image: Second Activities and Image: Second Activities Activities and Image: Second Activities Activit	Project started	2015-11-16
processes	✓ Review	
Waste component		
💐 Waste streams	Reviewer	
👔 Regulatory framework	s Vser-defined properties	
Safety assessments		
	2	
	3	
	4	
	5	



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 is shown in the Fig. 1





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:¹

¹ Alternatively, you may click the right mouse button and select action from the context menu. SAFRAN 2 Tutorials Rev. 2020-12-29



×	Actions	Ψ×
	Add	
	Add Facility	
	Add User-define	ed folder
	Edit	_
	Reorder	
	Document	
	Print/Export/Ins Word	sert as ta

In the window that appears, change default name of new facility ("*Facility*") to the "*Processing facility*", enter the description of facility "Facility where processing operations take place" and press "**OK**".

도 🔁 🗋 🎽 🚰 🚽		
Object explorer (tree view) 🛛 🕈 🗙	X	
唯 X 雌 小 X 📑 💡	Properties Links Errors!!! Comments Tasks	
Refresh Expand all		
Name	✓ General	
🚽 📜 Tutorial	Name Description	Facilities
✓ m System description N Site features	Short name	
Refeatures	Attachments	
Safety elements	Path	System de:
Facilities		_
Waste ma 🛃 Add r	new Facility — 🗆	×
processes		
→ 🔍 Waste cor Name		
Waste str Proce	ssing facility	
► Safety assess Descr	intion	
Facilit	ty where processing operations take place	- I
	,	
	OK	



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.



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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.



(🛍 de	🔜 Add new Process			×	.inł
fresh Exp	Name				
, Tutorial	Process 1				
· 😭 Syste	Description				
₩ Pł ₩ Sa + ₩ Fa + ₩					
- <u>e</u>					
Þ					
Þ					
- 🐧 w					
⊨ → (3), W (3), W	ОК	Ca	incel	.:	
	tory frameworks				
Coffee	seconomia				

Node "Process 1" will appear in the tree.

	Kooms
Ŧ	Waste management activities and processes
	Overview of WM activities and processes
	Process 1
⊧	🕅 Waste components

If it will not appear immediately – press button "Refresh" located in the toolbar:



Double-click on the "Process 1" in the browser. The "Preview or modify process" window will appear.





Observe the structure of this window. The object browser panel is located in the upper-left part of the window. This object browser is similar by functionality to the object browser you already used in main SAFRAN window. A panel with two tabs "Properties" and "Links" is located in the left-down part of the window. Diagram panel is 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 in the object browser.





Note the change in diagram window.

💀 Preview or modify process	
🚰 階 X 🛍 X 🔯 + 💡	Zoom + Zoom - Zoom to view
⊡-∰ Process 1 ∟ ⊘ Sorting	Process 1

Click right mouse button on the "Sorting" node in the object browser similarly as you just did or click right mouse button on the "Sorting" node of diagram as shown below



Add new activity "Compaction". After adding this activity diagram will looks like: SAFRAN 2 Tutorials Rev. 2020-12-29





Repeating steps shown above - add new activity "Packaging" to "Compaction" and new activity "Storage" to "Packaging"

Finally you will obtain the following process objects tree:



and diagram:





Compare this diagram with the diagram shown in Fig.1 at the beginning of this tutorial.

Close the "Preview or modify process" window.

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

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Safety elements
🖃 🔍 Waste management activities and processes
- 词 Overview of WM activities
Process 1
🛛 🕀 🧭 Sorting
Compaction
🛛 🗷 🥶 Packaging
🛛 🖃 🧭 Storage
Waste components

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 ma	anagement activities	<u> </u>	at Owners of the actual	in Owners of the activities. Spinor it				
Drag a column header here	Drag a column header here to group by that column							
Activity	Facility	Room	Area	Waste stream(s)	Process(es)			
 Sorting 					Process 1			
Compaction					Process 1			
Packaging					Process 1			
Storage					Process 1			
4								

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

•	Overview of waste management activities							
Dr	Drag a column header here to group by that column							
	Activity	Facility						
<i>0</i> .	Sorting	Processing facility						
	Compaction	Processing facility						
	Packaging	Storage facility						
	Storage							

j facility
) facility
) facility
cility

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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 🛛 🖂						
Storage	Storage facility	Drum storage room						

Similarly, select the room where each activity take place²:

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:

🖃 🐧 Facilities						
Processing facility						
🗉 💐 Measured or estimated data						
Waste management activities and processes						
🖶 💐 Waste components						
Đ 🖏 Safety elements						
🗄 💐 Rooms						
🗐 🆓 Sorting room						
😟 🔍 Measured or estimated data						
🗐 🖏 Waste management activities and processes						
🖬 Overview of WM activities						
E 🗹 Sorting						
🖻 💐 Waste components						
- 🖏 Safety elements						

SAVING THE FILE:

Select File / Save project from the main menu.

 $^{^2}$ 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 ³	
	Co-60	_	
	Concentration in air	$1.7E-02 \text{ Bq/m}^3$	
	Cs-137	_	
Sorting	Capacity of sorting equipment	0.5 m^3	
	External dose rate	6E-07 Sv/h	
Compaction and packaging	Concentration in air of Co-60	$6.2E+01 \text{ Bq/m}^3$	
room.	Concentration in air of Cs-137	1.75E+01 Bq/m ³	
	Capacity of compactor	0.5 m ³	
Compaction	External dose rate	3.2E-06 Sv/h	
I			
	Capacity of packaging	0.5 m ³	
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 ³	
Drum storage room		-	
	Concentration in air of Cs-137	2.7E-03 Bq/m ³	
	External dose rate	2.67E-06 Sv/h	

List of radionuclides

Select View/Project properties in the main menu.

File	Edit	View	Tools	Window	Help			
$\in \rightarrow$	🗋 🞽	0	bject exp	lorer (tree v	view)	Ctrl+B		
Object	t exploi	0	bject exp	lorer (folde	rs or type	es view)		I
E X	i i aje		roperties	and links			·	
	2		ctions					
Nam	e	Er	rrors, task	s and comm	nents			
▶ ⊡ .	Tutoria	Pr	roject pro	perties				
		W	aste stre	ams				
		0	verview o	of comment	s			
		0	verview o	of attachme	nts			

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The Project properties window will appear.

Project properties										
Nuclides	Sources	Containers and packages	Scales	Title, description, author, date						
Nuclio	des									
				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	Nuclides selected for project	OK Cancel
	Nuclides selected for project	
 Ac Ag Am As At Au Bi Br C Cd Cd Ce Cm Co Cr Co Cr Cs Cu Eu Fe Ga H Hg I In Mn 		Delete from list
	T	
To modify list of all available nuclides - close this dialog and see the Options window select "Customization" tab and then press b Please note that database contains values (for example, dose provided with SAFRAN. When performing safety assessments specify necessary values directly in the safety assessment tab	outton "Modify default list of available conversion factors) only for default li you will need to extend database for	nuclides". st 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	S		_	100
Nuclides	Sources	Containers and packages	Scales	Title, description, author, date	
Nuclic	les				
Co-60 Cs-13				Add/remove nuclide	
🔽 Ad	ld nuclide	s above to new waste com	ponents	and measurement tables	

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:

👹 Rel	ease rate (air)					
	elease rate (air)	Fundant das Fu	und Trans			Duringt /Ex
: Ad	d/remove nuclide	Export to Ex		ort from i	Excel view	Print/E:
	parameter	nuclide	value	unit	comment	
	Release rate (air)	Co-60		Bq/y		
	Release rate (air)	Cs-137		Bq/y		

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Enter data³ about release rate according to Table 2.

👹 Re	lease rate (air)	-	-	-	-	_
運 Re	elease rate (air)					
Ad	d/remove nuclide	Export to Export	cel 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) Release rate (air)		4.41E+006 2.27E+006			

Close the table.

Select and double-click on the "Processing facility".



Select tab "Properties" in the window which will appear:

³ Press Tab button after entering each value or click outside the cell. SAFRAN 2 Tutorials



Nam	ne and description Properties Links Attachments	
	2↓ □	
~	General	
	Name	Processing facility
	Description	Facility where processing operations take place
	Short name	
	Attachments	
	Path	System description/Facilities/
~	Parameters	
	Filtration efficiency	0
~	User-defined properties	
	1	
	2	
	3	
	4	
	5	
1	Name	

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



	Processing facili	ty			- 0	×
Nan	ne and description	Properties	Links	Attachments		
	2↓ 📼					
~	General					
	Name				Processing facility	
	Description				Facility where processing operations take place	
	Short name					
	Attachments					
	Path				System description/Facilities/	
~	Parameters					
	Filtration efficie	ency			0.9	
~	User-defined	l properti	es			
	1					
	2					
	3					
	4					
	5					
	Name					
	Name					

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*".

🖃 🐧 Facilities
🖹 🏙 Processing facility
🖲 💐 Measured or estimated data
👜 🖏 Waste management activities and processes
🖲 💐 Waste components
🖲 💐 Safety elements
😑 💐 Rooms
្នុំ🎳 Sorting room
🔲 🔍 Measured or estimated data
Concentration in air
External dose rate

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

~~~~~~	entration in air								
.dd/r	remove nuclide	Export to Excel View	Print/Exp	port/Insert	in Word				
	parameter (short name)	description	nuclide	unit	value	date of measur.	comment	reference	
0	C_AIR	Concentration in air	Co-60	Bq/m3	2.80E-002				
(	C_AIR	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
	🚽 🖏 Waste management activities and processes
	Overview of WM activities and processes
	🧭 Sorting
	Construction of the second sec

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			
P	roperties Links					
	2↓ 🖻					
~	General					
	Name		Sorting			
	Description					
	Short name					
	Attachments					
ι.	Path		System description/Facilities/Processin			
× ا	Capacity					
	Capacity (m3)		0.5			
۲×	Decay					
	Account decay		No			
	Activity duration (y	vears)				
۲×	Graphical preser	ntation				
	Color		blue 2			
	Change					

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

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Contin	Ана онграт или туре пария мазсе
🗄 🎽 Sortin	Link safety element
	Add Measured or estimated data

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

Ŧ	Waste management activities and processes
	Overview of WM activities and processes
	👻 🥳 Sorting
	Measured or estimated data
b	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		
id a	🙀 External dose rate (Sv/h)	-	
des fea	External dose rate (Sv/h) 6E-007	OK	
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	
H 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.

🥥 Co	oncentration in air			-			_	
뤧 C	oncentration in air							
Ad	ld/remove nuclide Ex	port to Exce	I Import fr	om Excel	View	Prir	nt/Export/Insert in Word	SI
	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 and double-click on the waste management activity Compaction and select "Properties".





Provide data about its capacity according to Table 2.

~	General	
	Name	Compaction
	Description	
	Short name	
	Attachments	
	Path	System descripti
~	Capacity	
	Capacity (m3)	0.5
~	Decay	
	Assessment deserve	No

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

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



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

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

🖳 External dose rate (Sv/h)			_	
External dose rate (Sv/h)	3.2E-06	]	ОК	
Comments		,	Cancel	
I				

Press OK.

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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	$27 \text{ m}^3/\text{ y}$
Annual mass	11000 kg/y
Volumetric concentration of Co-60 ⁴	$1.26E+12 Bq/m^3$
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					
Object explorer (tree view)					
🛿 🌬 🐇 🏨 🖉 🔛 🗊 🗊 🚰 🔍 🗄 Show description					
2 + -					
Name					
🖃 🗐 Tutorial					
System description					
- 🔍 Site features					
Safety elements					
🖃 💐 Facilities					
🖃 🔍 Waste management activities and processes					
🖃 🔍 Waste components					
- 🗑 Overview of waste components					
- inventory of sources					
- iii List of containers					
Incoming waste					

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

⁴ Values for concentration are not realistic. These are given for illustration. SAFRAN 2 Tutorials


	ource ers	s	
Waste streams	1	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	
	懲	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 waste	of primary waste
- 🐧 Waste streams	Add waste component with type 'solid waste'
<b>fm</b> Regulatory framewor 	Add waste component with type 'liquid waste'

Give a name for waste component – "Waste from producer" and add description - "Waste received from the producer facility".



<ul> <li>W Processing facility</li> <li>Waste management activities and p</li> <li>Overview of WM activities and p</li> <li>Process 1</li> <li>Compaction</li> <li>Packaging</li> <li>Storage</li> <li>Waste components</li> <li>Overview of waste componenen</li> <li>List of sources</li> <li>List of containers, packages, cap</li> <li>M Incoming waste</li> </ul>	ts	
Producer of primary waste	🔜 Add new Waste component — 🛛 🗌	x c
<ul> <li>Waste streams</li> <li>Regulatory frameworks</li> <li>Safety assessments</li> </ul>	Name Waste from producer Description Waste received from the producer facility	
	OK Cano	el

## Properties of the waste component

Double-click on the "Waste from producer".



The following table will appear:



aste from producer					
d/remove nuclde Export to Excel Import from	Excel Hid	de/show groups View P	Print/Export Show all	columns Res	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				m3	
mass of waste in one container or package				kg	
annual number of containers or packages				per year	
total number of containers or packages					
volumetric concentration	Co-60			Bq/m3	
volumetric concentration	Cs-137			Bq/m3	
mass concentration	Co-60			Bq/kg	
mass concentration	Cs-137			Bq/kg	
activity in one container or package	Co-60			Bq	
activity in one container or package	Cs-137			Bq	
total activity	Co-60			Bq	
total activity	Cs-137			Bq	
annual activity	Co-60			Bq/y	
annual activity	Cs-137			Bq/y	

Note that SAFRAN assumes that this waste component contains radionuclides specified via "Project properties" window during Tutorial 2.



• •	Naste from producer					
A	dd/remove nuclde Export to Excel Import from	Excel H	ide/show groups View Pri	nt/Export Show all o	columns Res	et sorting (
	parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
•	duration		3.00E+000		year	
	annual volume of waste		2.70E+001		m3/y	
	total volume of waste			8.10E+001	m3	
	annual mass of waste		1.10E+004		kg/y	
	total mass of waste			3.30E+004	kg	
	type of container or package					
	internal volume of one container or package				m3	
	mass of waste in one container or package				kg	
	annual number of containers or packages				per year	
	total number of containers or packages					
	volumetric concentration	Co-60	1.26E+012		Bq/m3	
	volumetric concentration	Cs-137	3.50E+010		Bq/m3	
	mass concentration	Co-60		3.09E+009	Bq/kg	
	mass concentration	Cs-137		8.59E+007	Bq/kg	
	activity in one container or package	Co-60			Bq	
	activity in one container or package	Cs-137			Bq	
	total activity	Co-60		1.02E+014	Bq	
	total activity	Cs-137		2.84E+012	Bq	
	annual activity	Co-60		3.40E+013	Bq/y	
	annual activity	Cs-137		9.45E+011	Bq/y	

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.

## 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.



i <del>e</del> P	roject	propertie	S			_		* a	100.01-0	righter, parkage	Capital State of
Nuc	lides	Sources	Containers a	nd packages	Scales	Title, descriptio	on, author, date				
		Add rov	/	Delet	e row						
	Nam	те					Description				Internal volume

Click "Add row" button.

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

Project properties uclides Sources Containers and packages Scales Title, description, a	uthor, date	cat of california and and		
Add row Delete row				
Name	Description	Internal volume (m3)		
▶ 500 l drum		5.00E-001		

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. If the WS1 node under "Waste streams" will not appear immediately after that - click on the "Refresh" button located in the toolbar



1		睢	aĵe	2
Ø	Refr	esh	Ехра	an
Na	ame			

Bigs Froducer of printary waste
🖃 🖏 Waste streams
- 🔐 WS1
- 🔐 Regulatory frameworks
🔊 Cofety accocomente

Double-click on the "WS1". The window allowing previewing and constructing waste stream will appear. Note that layout and sub-windows of this window are similar to the ones in the window "Create/modify process" you used during the performing of Tutorial 1.



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

📙 WS1		
Recalculate	e waste componnets data	
<b>g</b> + -	- <mark>. 29 m % m × .</mark>	
WS1	Select the starting waste component of the stream	
	Rename or change description	

#### SAFRAN 2 Tutorials



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

ſ	•🖁 Li	ink							
	List view								
	List	Туре	Name	Path					
		<b>v</b>							
		🕨 😴 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.



Right-click on "Waste from producer" and select "Add process".



<ul> <li>WS1</li> <li>Refresh diagram Recalculate waste componnets data</li> <li>WS1</li> <li>WS1</li> <li>Waste from producer</li> <li>Add process</li> <li>Add existing activity</li> <li>Add new activity</li> <li>Add new activity</li> <li>Add check for clearance</li> </ul>
WS1 Waste from producer Data Rename Add process Add existing activity Add new activity Add check for clearance
WS1 Waste from producer Data Rename Add process Add existing activity Add new activity Add check for clearance
Waste from producer Data Rename Add process Add existing activity Add new activity Add check for clearance
Data         Rename         Add process         Add existing activity         Add new activity         Add check for clearance
Rename         Add process         Add existing activity         Add new activity         Add check for clearance
Add process         Add existing activity         Add new activity         Add check for clearance
Add existing activity Add new activity Add check for clearance
Add new activity Add check for clearance
Add check for clearance
Communication of the second seco
Сору
Properties
Overview/print/export as table

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

Note the changes in the browser and diagram.

🛃 WS1		
Refresh diagram Recalculate waste componnets data		
🖻 + - 🔮 🎭 🕉 🛍 📉	Zoom + Zoom to view	
Herich diagram Recolculate weste components data     Herich free producer     Weste free producer     Waste free producer	WS1 Wata form Vandacer	
Propeties Links	Sorting	
Verral     WS1     Description     Short name     Attachments     Path     Vuser-delined properties	Wark from	
1		
2 3 4 5	Compation	
Name	Wasefrom	

If diagram is larger than the window you can use scrollers or button "Zoom to view" shown with yellow colour in the picture above. If after "Zoom to view" diagram nodes will be too small – hove mouse over node and it's name will be shown as tool-tip:

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## Numerical properties of the waste components

The waste stream has been constructed. Now we are able to specify the properties of the waste after the different waste management activities as specified in the Table 4.

Increase diagram's nodes size if they are small after the previous steps using the Zoom+ button:



Double-click on the "Waste from producer" (located after WS1) in the diagram. The same table of properties as you already observed working with Tutorial 4 will appear:

Waste from producer					
dd/remove nuclde View Copy to clipbe	oard WYSIV	VVG export to Excel	Data 👻 Insert in W	ord document	
parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
duration		3.00E+000		year	
annual volume of waste		2.70E+001		m3/y	
total volume of waste			8.10E+001	m3	
annual mass of waste		1.10E+004		kg/y	
total mass of waste			3.30E+004	kg	
type of container					
internal volume of container				m3	
mass of waste in one container				kg	
annual number of waste 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	Bg	

Close the table.

To calculate properties for other waste components in the stream we will specify the reduction factors for waste management activities.

#### SAFRAN 2 Tutorials



Right-click on the "Sorting" in the browser's tree and select command "Edit reduction factors" from the menu.

📙 WS1	
Refresh diagram Recalcu	ulate waste componnets data
🖻 + - 📑 🎦 i	( n ×
WS1	icer
⊡ <mark>≪ Sorting</mark> ⊡ ∰ Was	Rename
- <b>6</b>	Edit reduction factors
•••	Add Waste component to merge
E	Сору
	Cut
×	Delete
<b>*</b>	Properties
	Overview/print/export as table

The following table will appear:

🚽 WS1				
Refresh diagr	am Recalculate waste compon	nets data		
<b>2</b> + -	🚰 🖷 🥻 🏥 🗙	1	Zoom + Zoom - Zoom to	view
	🔜 Changing factors			– 🗆 X
	Recalculate factors			
	Waste component	Volume	Mass	Activity
	[Sorting] - Waste from prod	100	100	100
			<b></b>	



Place in the table "80" instead of "100" according to the Table 4⁵. Click somewhere outside table cell you have edited to save the latest value.

WS1					
fresh diagr	ram Recalculate waste compor	nnets data			
	🚰 🛍 🤞 🛍 🗙		Zoom + Zoom - Zoo	m to view	
💀 WS1 🖃 💎 Was	🔜 Changing factors			- 0	×
Was 🛟	Recalculate factors				
	Waste component	Volume	Mass	Activity	
	<u>A</u> [Sorting] - Waste from prod	80	80	80	
			Sorting		
perties Link	(S				

Close the table.

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



According to Table 4, specify the following factors:

 5  After entering value in each cell click Tab button or click mouse outside the cell SAFRAN 2 Tutorials



🛃 Preview or modify process				
i 🖀 ங 🔏 🛍 🗙 i 🙍	+ -			Zoom + Zoom - Zoom to view
□···\$\$ Process 1 □··· Sorting □··· Waste from prod □··· Compaction □··· Waste fr □··· Pack	om producer			Process 1
🗎 💮 🖓 \	Nanto from producor			– 🗆 X
Ē- <b>(</b>				- U ×
	Recalculate factors			
	Waste component	Volume	Mass	Activity
	[Compaction] - Waste from	35	100	100

Click somewhere outside table cell you have edited to save the latest value.

Close the table.

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

Double-click on the diagram's node "Waste from producer" located **before** Compaction. The following table will appear⁶:

Waste properties after Sorting, before Compaction

⁶ 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.





View and the Function Function Frank	aal Ilida/	-h	Deinet/Franzert	Channell and unan	Dententing	Comuto
l/remove nuclde Export to Excel Import from Ex	cel Hide/	show groups View	SAFRAN	Show all columns	Keset 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

/remove nuclde Export to Excel Import from Ex	cel Hide/s	how groups View	Print/Export Sl	now 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 container for ouput of Packaging activity can be specified.

Double-click on the node "Waste from producer" located after Packaging activity.



## The following table will appear:

#### Waste propeties after Packaging

Wa	aste from producer						
١dd	/remove nuclde Export to Excel Import from Ex	cel Hide/s	how groups View	Print/Export Show	all columns	Reset sorting	Copy to clipb
	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 below⁷.

⁷ 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/s	how groups View	Print/Export Sł	now 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		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	Bg/y	

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

#### Alternative ways to preview waste streams

When stream is created, SAFRAN includes several possibilities to quickly preview waste stream structure and properties of the waste components in the stream (in addition to the window "Edit waste stream diagram" which you have just used).

In the main window of SAFRAN, select "View->Waste streams"



File Edit	View	Tools	Window	Help		
	Pro	ject pro	perties			
Object explor	Ov	erview o	of activities	and process	es	
	Ov	erview o	of waste co	mponents		s Comments :
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Window showing all streams defined in your project will appear. In the case of multiple streams it will contain all the streams (with the possibility to unselect some of them) and even eventual links between them; this situation is illustrated in Tutorial 15. In current case the window will contain one stream. Click on any of the waste component nodes to get table with waste component data.

eam i1	Path	Zoom + Zoom - Zoom to view						
	System description./Waste streams	ws1						
			Show data for waste component	_	_	_	_	_
			Waste from producer Add/remove nuclde View Copy to clipbo	and MOVER	ING expect to Excel	Data - Jacost in W	ard decoment	
		Waste from producer	parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
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			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	
		Sorting	type of container					
			internal volume of container				m3	
			mass of waste in one container				kg	
			annual number of waste components				per year	
			total number of waste components					
		Waste from	volumetric concentration	Co-60	1.26E+012		Bq/m3	
		producer	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	
		Compaction	total activity	Cs-137		2.84E+012	Bq	
			annual activity	Co-60		3.40E+013	Bq/y	

Close the waste component data table and "Waste streams" window.

Another way to preview individual stream and properties of it's components is just to select it in "Object explorer". Diagram of the stream will appear in the right part of the SAFRAN window. All objects in this diagram are also clickable.

SAFRAN 2 Tutorials



File Edit View Tools Window Hel	lp			
Object explorer (tree view) # ×	*	Waste stream: WS1 (System description/Waste streams/WS1)	) ×	Actions 4 ×
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sameter         rude         r	der     ndde     uwderborded wate porteriols     SRPN1 upgets     ut     comment       in     306:000     in     ref     in       volume of waste     2,76:011     n3/v     in       inmas of waste     1,106:004     in     in/v     in       inmas of waste     1,106:004     kg/v     in     in       inmas of waste     2,308+004     kg     in     in       inmas of waste     2,08+004     kg     in     in       in umber of waste components     in     in     in       in umber of waste components     in     in     in       in or of in waste components     in     in     in       in or of in waste components     in     in     in       in or of in waste component     in     in     in       in or of in waste component     in     in     in       in or of in waste component     in     in     in       in or of waste component     in     in     in       in or of waste component     in	<del>fom producer</del> nove nuclde View Copy to clipbe	oard WYSIV	VVG export to Excel	Data 👻 Insert in V	ord document	eams/WS1) Context-dependent diagram Links diagram	× Actions
Grandon         3.08E-000         year           minual volume of waste         2.70E-001         m3/y           ninual modu of waste         1.0E-001         m3/y           otal volume of vaste         1.0E-004         kg/y           statistic         1.0E-004         kg/y           statistic         1.0E-004         kg/y           statistic         1.0E-004         kg/y           statistic         1.0E-004         kg           statistic         1.0E-012         Bg/m3           statistic         3.0E-010         Bg/m3           statistic         3.0E-010         Bg/m3           statistic         1.0E-012         Bg/m3           statistic         1.0E+013         Bg/g           statistic         1.0E+014         Bg           statistic         1.0E+013         Bg/g           statistic <td< th=""><th>n     3.0E-000     var     var       ulume of waste     2.70E-001     m3/y     mass of waste     n.0E/y       ulume of waste     1.0E-004     kg/y     mass of waste     n.0E/y       of orstainer     1     1.0E-004     kg/y     mass of waste     n.0E/y       of orstainer     1     1.0E-004     kg/y     mass of waste     n.0E/y       of orstainer     1     1.0E-004     kg     mass of waste     n.0E/y       in umber of waste components     1     1.0E-004     kg     mass of waste       in concentration     Ca-60     1.0E-010     0.0E/y     0.0E/y       oprocentration     Ca-137     3.0E+010     0.0E/y     0.0E/y       oprocentration     Ca-137     0.0E+010     0.0E/y     0.0E/y       oprocentration     Ca-137     0.0E+012     0.0E/y     0.0E/y       oprocentration     Ca-137     0.0E+012     0.0E/y     0.0E/y       otivity     Ca-60     1.0E+014     0.0E/y     0.0E/y       otivity     Ca-60     1.0E+012     0.0E/y     0.0E/y       otivity     Ca-60     1.0E+014     0.0E/y     0.0E/y       otivity     Ca-60     0.0E/y     0.0E/y     0.0E/y       otitity     Ca-60</th><th></th><th></th><th>user-defined</th><th>SAFRAN</th><th></th><th></th><th></th></td<>	n     3.0E-000     var     var       ulume of waste     2.70E-001     m3/y     mass of waste     n.0E/y       ulume of waste     1.0E-004     kg/y     mass of waste     n.0E/y       of orstainer     1     1.0E-004     kg/y     mass of waste     n.0E/y       of orstainer     1     1.0E-004     kg/y     mass of waste     n.0E/y       of orstainer     1     1.0E-004     kg     mass of waste     n.0E/y       in umber of waste components     1     1.0E-004     kg     mass of waste       in concentration     Ca-60     1.0E-010     0.0E/y     0.0E/y       oprocentration     Ca-137     3.0E+010     0.0E/y     0.0E/y       oprocentration     Ca-137     0.0E+010     0.0E/y     0.0E/y       oprocentration     Ca-137     0.0E+012     0.0E/y     0.0E/y       oprocentration     Ca-137     0.0E+012     0.0E/y     0.0E/y       otivity     Ca-60     1.0E+014     0.0E/y     0.0E/y       otivity     Ca-60     1.0E+012     0.0E/y     0.0E/y       otivity     Ca-60     1.0E+014     0.0E/y     0.0E/y       otivity     Ca-60     0.0E/y     0.0E/y     0.0E/y       otitity     Ca-60			user-defined	SAFRAN			
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a volume of wate       0       0-0-01       in 3         al mass of wate       1.10E-004       kg/y       0         al mass of wate       0       3.30E+004       kg       0         se of container       0       0       0       0         se of container       0       0       0       0         se of container       0       0       0       0         al mass of wate components       0       0       0       0         al number of wate components       0       0       0       0         ses onewriteion       Ce-04       1.20E-012       0       0       0         ses concentration       Ce-03       1.20E-012       0       0       0         ses concentration       Ce-04       1.20E+034       0       0       0         ses concentration       Ce-03       1.20E+034       0       0       0       0       0         set/vity       Ce-06       1.20E+034       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       <	Name         Difference         Difference <td>nual volume of waste</td> <td></td> <td>2.70E+001</td> <td></td> <td>m3/y</td> <td></td> <td>Edit</td>	nual volume of waste		2.70E+001		m3/y		Edit
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e d'ordinaire       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       i       <	forstairer	al mass of waste			3.30E+004	kg		
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unretic concentration         Co-60         D.8E+012         Iso By/m3           unretic concentration         Co-137         350E+010         By/m3           as concentration         Co-60         3.09E+009         By/g           as concentration         Co-137         Co         80,9407         By/g           witry of on exasts component         Co-137         Co         Bq         Co           witry of on exasts component         Co-137         Co         Bq         Co           al activity         Co-60         Co         1.02E+014         Bq         Co           al activity         Co-60         Co         1.02E+012         Bq         Co           al activity         Co-60         3.40E+013         Bq/y         Co         Co           al activity         Co-60         3.40E+013         Bq/y         Co         Co         Co	chr     concentration     Ce-60     1.26E-102     Bg/m3       chr     concentration     Ce-107     3.09E-100     Bg/m3       concentration     Ce-107     3.09E-100     Bg/m3       concentration     Ce-60     3.09E-100     Bg/m3       concentration     Ce-60     0.09E+000     Bg/m3       concentration     Ce-60     0.09E+000     Bg/m3       chr     concentration     Ce-60     0.09E+010     Bg/m3       chr     concentration     Ce-60     0.02E+014     Bg       chr     concentration     Ce-60     1.02E+012     Bg       chr     concentration     Softenore     Ce-60       chr     concentration     Softenore	al number of waste components						
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wiky of one waste component         Co-60         Eq           wiky of one waste component         Co-50         Bq           al activity         Co-50         1.022+014         Bq           al activity         Co-50         3.402+012         Bq           uail activity         Co-60         3.402+013         Bo/y	y of one waste component       0x-60       0x-00       0	ss concentration	Co-60		3.09E+009	Bq/kg		
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viky of cen waste component         Cc-137         Bq           al activity         Cc-60         1.02E+14         Bq           al activity         Cc-137         2.48E+012         Bq           nual activity         Cc-60         3.40E+013         Bq/y	v of one wasta component       02-137       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0 <t< td=""><td>ivity of one waste component</td><td>Co-60</td><td></td><td></td><td>Bq</td><td></td><td></td></t<>	ivity of one waste component	Co-60			Bq		
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Fire -	1 East - Compaction	-					Wate toon producer	

#### SAVING THE FILE:

Save the project.

## SAFRAN 2 Tutorials



# **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.

•								
	<b>a</b> + -							
	Name							
	🖃 📜 Tutorial							
	🖹 🕋 System description							
	- 🖏 Site features							
	💐 Safety elements							
	🖻 💐 Facilities							
	🖃 💐 Waste management activities and processes							
	🖲 💐 Waste components							
	៉ 🐧 Waste streams							
×	👔 Regulatory frameworks							
	Safety assessments							
<u> </u>								

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".

🗸 🔯 Notaional regulations
👻 🔯 Normal operation
🔶 Dose limit to worker
Accidental situation
Safety assessments

Specify the dose limit for this criterion according to the first row of Table 5 shown at the beginning of this tutorial.

Double-click on the "Dose limit to worker" and in the "Properties" tab specify 0.02 as the **limit**. (see first row of the Table 5). Notice that unit is already set to Sv/y.

Nan	ne and description Properties Links	ttachments
•	2↓ 📼	
~	General	
	Name	Dose limit to worker
	Description	
	Short name	
	Attachments	
	Path	Regulatory frameworks/Notaional regulations/Normal oper-
	Situation	Normal operation
~	Criterion	
	Application	Worker
	Limit	0.02
	Туре	Dose
	Unit	Sv/y
¥	User-defined properties	
	1	
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#### SAFRAN 2 Tutorials



Note that you can also preview/edit properties if you select the tab page properties of the window located in the middle of SAFRAN interface:

ject explorer (tree view) 5 🦽 🏨 🛠 🔝 🗊 🖀 🏹	4 × 🧶 Criterion: Dose limit to worker W	
, /, i≅ ale × ( = 1   2 ₪		Vorker,Normal operation,Dose,Sv/y (Regulatory frameworks/Notaional regulations/Normal operation/Dose limit to
	Context-dependent diagram Properties Links diagram	Links   Errors   Comments   Tasks
Refresh Expand all Collapse all 📜 Show description		
lame	✓ General	
- Tutorial	Name	Dose limit to worker
System description	Description	
System description     Site features	Short name	
<ul> <li>Site reatures</li> <li>Physical elements</li> </ul>	Attachments	
	Path	Regulatory frameworks/Notaional regulations/Normal operation/
Safety elements	Situation	Normal operation
Fadities	✓ Criterion	
<ul> <li>Waste management activities and processes</li> </ul>	Application	Worker
<ul> <li>Waste components</li> </ul>	Limit	0.02
Waste streams	Туре	Dose
<ul> <li>Regulatory frameworks</li> </ul>	Unit	Sv/y
🗸 🕅 Notaional regulations	<ul> <li>User-defined properties</li> </ul>	
- 💐 Normal operation	1	
🔗 Dose limit to worker	2	
Accidental situation	3	
Safety assessments	4	
	5	

Click again on the "Normal operation" node and select again "Add criterion" command. According to the second row of the Table 5, specify the name "Dose limit to public" and value for dose limit (either by double-clicking on the node "Dose limit to public" and selecting "Properties" tab or by specifying value in the "Properties" tab of the window located in the central part of the SAFRAN user interface). Notice that a "Application" property should be changed from "Worker" to "Public" as shown in the picture.

Properties	
🗄 General	
Description	
Name	Dose limit to public
Short name	
Attachments	
Path	Regulatory frameworks/National regulations/Normal operation/
Situation	Normal operation
E Criterion	
Application	Worker
Limit	Worker
Туре	Public
Unit	37/7

## Dose limits for accidental situation

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

SAVING THE FILE:

Save the project.



# Tutorial 7. Safety Assessment.

In this tutorial, you will perform the safety assessment.

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

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

## Purposes and scope of the safety assessment

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



Add the safety assessment "Safety assessment 1".

Expand the "Safety assessment 1" node.





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

🖳 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:

Ficilities/rooms/ares	WM Activities					
Processing fa      Sorting roo      Compactio      Storage facilit      V Drum stora	om on and packagin y	g room				
Ficilities/rooms/ares	WM Activities					
WM Activity	Facility		Room	Area	Was	te stream

Ficilities/rooms/ares	WM Activities				
WM Activity	Facility	Room	Area	Waste stream	Process
Sorting	Processing facil	Sortin			
Compaction	Processing facil	Comp			
🔽 Packaging	Processing facil	Comp			
Storage	Storage facility	Drum			

Click "OK".

## Link to the regulatory framework. Study diagram window

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
<u>s</u>	•		
w ob	Regulatory framework	National regulations	Regulatory frameworks
Tree view (to add new objs.] List view			

Note that diagram appeared in the tab "Context-dependent diagram" shows the link which you have just established:

/ assessment 1)	
Context-dependent	diagram Links diagram
Zoom + Zoom -	Zoom to view
Safety assess	nent 1

Sometimes entire diagram is not shown in the window "Context-dependent diagram" as in the pucture below



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In this case make window wider by pulling its left frame

>	Safety assessment: Safety asses	sment 1 (Safety assessments/Safety assessment 1)	
Properties Links   Errors   Comments   Ta	asks	Context-dependent diagram Links diagram	
21 21 🖾		Zoom + Zoom - Zoom to view	
✓ General			
Name	Safety assessment 1		
Description		Safety assessment 1> National regulations	
Short name			
Attachments			
Path	Safety assessments/		
<ul> <li>Safety assessment</li> </ul>			
Title			
Abstract			
Author			
Data origin			
Nature of assumption			
Reviewer			
<ul> <li>User-defined properties</li> </ul>			
1			
2			
3			
4			
5			

Diagram provide an alternative (to object browser) way to navigate between objects and to get objects' properties – click on the node "Regulatory framework: National regulations" located in the diagram:

Note that you have navigated to the corresponding object in the object browser



and that diagram have been modified (it shows the same link between safety assessment and regulatory framework, but from "point of view" of regulatory framework):



Context-dependent diagram	Links diagram
Zoom + Zoom - Zoom to v	riew
National regulations	Safety assessment 1

Click again the diagram node "Safety assessment: Safety assessment1" to novigate back to the safety assessment object. Note that diagram is changed again.

Right-click on the one of the diagram nodes and the window describing object (similar to one appearing on the double-click in the objects' tree) will appear. For example, afer the right-click on the "Safety assement 1" you will see the following window:

Tasks	Context-dependent diagram Links diagram
	Zoom + Zoom - Zoom to view
Safety assessment 1	<u>ه</u>
😸 Safety assessment 1	- 🗆 🗙 vent 1 - National regulations
Iame and description Properties Links Attachments Specific properties           Name         Safety assessment 1           Description	
Apply	



## Assessment for normal operations

## Assessment of dose to worker from inhalation and external exposure.

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

#### Table 6

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

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

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

Add the "Dose to worker" endpoint.

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



Set the properties of the endpoint:

- Type *Dose*
- Inside/Outside Inside

There are 4 alternative ways to get "Properties" window and some of them was already shown in these tutorials:

- right-click on the object's node in the object's browser and select "Properties" menu item and then tab "Properties" in the dialog window which will appear (works for all objects)

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- double-click on the object's node in object browser (works for most objects, but for some, for example waste components, will call another action which is considered more important for this type of object and therefore set as default)
- or select the tab "Properties" in the window located in central part of the user interface (works for all objects, do not require further actions once selected)
- or right-click on the diagram node corresponding to the object (works for all objects)

In the tutorials below we will use the tab "Properties" located in the central part of the user interface while you can select any other method you will find convenient.

Situation	Normal operation
<ul> <li>Endpoint</li> </ul>	
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.

Table_Overview_DoseExt	ternalExposure_XtraWizard
	Welcome to the wizard
	This witzerd simplifies the adding and data setup for normal operation assessments connected to exposure via inhalation and external exposure.
	To continue, click Next
	To continue, citck next
	< Back Next > Cancel

#### Click "Next"

Hand Add normal operation impacs

#### Select WM activities

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

WM Activity	Facility	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
	otorago raomy	Dian at	

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.

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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."

Add normal operation impacs				
Impacts Specify endpoint and other proper	ties of impacts.			
Assign the same for all rows	Endpoint Affecting	Direct external exposure and exposure v v	Radiol. conseq. Dose rate option	

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

nu	ld normal operation impacs				
P	acts Specify endpoint and other properties of impacts.				
5	sign the same for all rows           Image: sign the same for all rows         Image: sign the same for all rows           Image: sign the same for all rows         Image: sign the same for all rows           Image: sign the same for all rows         Image: sign the same for all rows           Image: sign the same for all rows         Image: sign the same for all rows           Image: sign the same for all rows         Image: sign the same for all rows           Image: sign the same for all rows         Image: sign the same for all rows           Image: sign the same for all rows         Image: sign the same for all rows	and exposure v v Radiol. conseq.			
	WM activity	Endpoint	Affecting	Radiol. conseq.	Dose rate option
	WM activity Sorting	Endpoint Dose to worker	Affecting	Radiol. conseq. Direct external exposure and	
			-		Dose rate is known
	Sorting	Dose to worker	Inside	Direct external exposure and	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			
	< Badk Finite	sh	Cance	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.

🖻 🔍 Impacts	
😑 🔳 Sorting	
- 📰 External exposure and exposure via inhalation	
🖃 🔍 Endpoints	
😑 🧟 Dose to worker	
🖃 🐧 Assessment cases	
🗄 🛅 Assesment case 1	
E Compaction	
External exposure and exposure via inhalation	
🖃 🔍 Endpoints	
🖃 🧟 Dose to worker	
🖃 💐 Assessment cases	
速 🛅 Assesment case 1	
📄 🔳 Packaging	
External exposure and exposure via inhalation	
Endpoints	
🖃 🧝 Dose to worker	
🖃 💐 Assessment cases	
🖶 🛅 Assesment case 1	
🖃 🔳 Storage	
External exposure and exposure via inhalation	
Endpoints	
🖃 🧟 Dose to worker 1	
🖃 💐 Assessment cases	
🖶 🛅 Assesment case 1	
Assessments for accidents	

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#### Select impact "Sorting".



Observe the properties of this impact.

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

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



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

<b>@</b>	Dose to worker				
🖃 💐 In	npacts				
📄 🔳	Sorting				
External exposure and exposure via inhalation					
Ė	California				

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

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

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

Close the table.

Expand node "Assessment case 1" of "Sorting" impact.



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

The table for dose assessment will appear:

🖶 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)			
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)			
1	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_SAFRA	AN_TUTORIALS\Basic training Solid and liquid waste Advanced topics\	Tutorial.safx			
File Edit View Tools	Window Help				
🗲 🖻   🗋 🎽 🛃					
Object explorer (tree view)	<del>4</del> ×	📑 Table: D			
📭 X 🛍 40 X 📑 0	1 A	Properties			
😰 Refresh Expand all Colla	pse all 🗽 Show description	Туре			
Name	A				
Approach	for normal operation				
- Common e					
Common endpoints     Dose to worker					
+ 🐧 Impacts					
- <b>- -</b>	Wizard - Add/modify impacts for WM activities				
	Identify relevance for all included impacts				
- · · ·	Wizard - specify/modify exposure time and dose rate for impacts				
•	Add Norm. op. impact				
Q	Add User-defined folder				
	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	Impact's properties	Impact is linked to	Endpoint	Assessment case	Waste component (if rele	Dose rate (Sv/h)	Exposure time (h/y)	Dose (Sv/y)
Sorting	Inside Direct external exp	Sorting	Dose to worker	Assesment case 1		6.01E-007	300	1.80E-004
Compaction	Inside Direct external exp	Compaction	Dose to worker	Assesment case 1		4.40E-006		
Packaging	Inside Direct external exp	Packaging	Dose to worker	Assesment case 1		3.20E-006		
Storage	Inside Direct external exp	Storage	Dose to worker	Assesment case 1		2.67E-006		

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

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



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

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

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



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



# Observe exposure pathways with diagram of endpoints

Select in the browser the endpoint "Dose to worker" located in the "Common endpoints" folder:



Observe the diagram appeared in the "Context-dependent diagram" window (make window wider if necessary by pulling it's left frame):



You can increase the size of diagram nodes with the toolbar







# Analysis

Expand the "Safety assessment 1/Analysis" node:



tegua	tory maneworks
🖃 🏹 Safety	assessments
🖃 🥏 Sa	fety assessment 1
	Purposes
🔳	Scope
🔳	Approach
🔁 🕅	Assessments for normal operation
🗩 💐	Assessments for accidents
	Analysis
÷	Normal operation
( )	Accidental situation

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



The following table will appear:

	🖻 Referesh table 🔎 R	eset table 🔒 Lock tab	le Row merging Aut	o-filter row Clear filte	er 🛛 🖶 Print 🖾 Print pre	eview/export Insert	in Word
	Show as chart						
	Scenario	Endpoint	Assessment case	Dose (Sv/year)	Criterion	Limit (Sv/y)	Di
Þ	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	
	Total	Dose to worker		2.16E-003	Dose limit to worker	2.00E-002	

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



The window will appear showing the same data as chart:

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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**".



<b>V</b>	🔁 🖑 🔍 🍳 100° 🗸 🕅
ſ	Scaling
	Adjuet to: 49 😓 % normal size
	● Fit to 1 → pages wide
	OK Cancel

Click Ok.

Click the "**Export document**" Lie 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.



Г	Туре	Name	Path
٩	,		
,	Bacility	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
	👸 Room	Compaction and packaging room	System description/Facilities/Processing facility/Rooms
	🥳 WM activity	Compaction	System description/Facilities/Processing facility/Rooms/Compaction and pack
	🥳 WM activity	Packaging	System description/Facilities/Processing facility/Rooms/Compaction and pack
	🖏 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/Wa

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

Properties	
▲ General	A
Description	
Name	Releases to air from processing facility
Short name	
Attachments	
Path	Safety assessments/Safety assessment 1/Assessments for normal oper
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)	
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	o air from proc
	🕯 Referesh table 🔎 Reset table 🔒 Lock table   R	ow merging Auto-filter row Clear filter 🖡	🕈 Print 这 Print preview/export 🛛 Insert in Wo	ord Copy to c
1	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

Close the table.

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



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

<u> </u>	
	Safety assessments/Sa
	Normal operation
	Dose
;	Outside
	Sv/v
	•

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".



	👻 📕 Release to air fro	om pro	cessing facility			
	Com.	Releases to air for normal operation scenarios				
1	Assessments for accider		Use common endpoint	]l		
1	Analysis		Add endpoint used for this impact only			
*	Normal operation	1	Add User-defined folder			
	Comparison of h	~				
	Comparison of h		Reorder			
	Comparison of de		Overview/print/export as table			
	Comparison of d		overview, print, export as table			
	Discussions					

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 🔒 Lock	table   Row merging Auto-filter row Cle	ar filter 🛛 🖶 Print 🛝 Print preview/e	xport 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

Click on the common endpoint "Dose to public" and observe the diagram:





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 🛛 Auto-filter row 🛛 Clear filter   🖶 Print 🕨				
Show as chart				
Impact	Impact - quantitative	Impact - qualitative	Di	
Releases to air from processing facility	6.88E+000	Medium		

E Comparison of doses outside Safety assessments/Safety assessment 1/Analysis/Normal operation

🔋 🖻 Referesh table 🔎 Reset table	e 🔒 Lock table   R	low merging Auto	-filter row Clear fil	ter 🛛 🖶 Print 🔼 Pri	int preview/export
Show as chart					
Impact	Endpoint	Assessment case	Dose (Sv/year)	Criterion	Limit (Sv/y)
Releases to air from processing f	<u>Dose to public</u>	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.



Import PIE types - External natural	100 B
Select all Unselect all	
Lightning (effect on power supply)	
Lightning (effect on surroundings of facility)	
Lightning (effect on facility)	
Extreme snowing	
Extreme drought	
Strong wind	
<ul> <li>Extreme temperatures</li> <li>Hydrology and hydrogeology</li> </ul>	
Geology of site and region	
Seismic events	
✓ Other effects of ground stability	
Geomorphology and topography of site	
<ul> <li>Terrestrial and aquatic flora and fauna</li> </ul>	
Potential for natural fires, storms etc.	
✓ Flooding	
	Ok

Click OK.



PIE types will be included in project.



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



The table with all just included PIE types will appear.



Print/Export Insert in Word document				
Name Ÿ	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	Not relevant	Not relevant due to climate
		Extreme rain	Relevant	
- 62				

#### 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				
Lightning (effect on surroundings of facility)				
- P Lightning (effect on facility)				
- Jack Extreme snowing				
Extreme rain				

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

-Genia	
Lightning (	Create PIE and link with this PIE type
	Create scenario and link with this PIE type
	Wizard - Create PIE and link with this PIE type, cont. to Scenario and Impact Wizards
💬 Strong wind	Wizard - Create scenario and link it with this PIE type, cont. to Impact Wizard
>>>> Extreme tem	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"):

The meridi
- 💐 Common endpoints
🖃 🖏 Scenarios and impacts
🗐 🔍 Postulated Initiating Events (PIEs)
Lightning (effect on facility)
- 🔍 Scenarios
Ling Impacts
Analysis

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

inks			
Туре	Short	Name	Path
🏸 PIE type		Lightning (effect o	Safety assessn
	Туре	Type Short	Type Short Name

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 a
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)	

Oualitative value for PIE probability

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

Common enapoints			Probabilit	y -
<ul> <li>Scenarios and impa</li> </ul>			Probabilit	y -
👻 💐 Postulated Initia			Probabilit	y -
👑 Lightning	(effect or	ı facility)	Brobabilit	y -
💐 Scenarios	<b>9</b>	Link PIE type		leva
💐 Impacts	畿	Define PIE origin		ce
Analysis				ce -
🚽 💐 Normal operation		Create scenario and link it with this PIE		fine
Comparison of t	naza	Create scenario and link it with this PIE , then create in	mpact	
Comparison of t	naza	Copy		
Comparison of		cop)		

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



Scenario	(qualit
Do you want to define origin of scenario?	IE prob
	not a tex
Yes No	

Answer "Yes" and select Drum storage room:

List view	I			
Tree view (to add new objs.)	Type Name Pa			Path
	8	2		
do 🕺		🖏 Facility	Processing facility	System description/Facilities
dne		🖏 Room	Sorting room	System description/Facilities/Processing facility/Rooms
o ad		🖏 Room	Compaction and packaging r	System description/Facilities/Processing facility/Rooms
Ew (I	•	🤹 Room	Drum storage room	System description/Facilities/Storage facility/Rooms
e vi		🥳 WM acti	Sorting	System description/Facilities/Processing facility/Rooms/Sorting room/Waste manager
Tre		🧭 WM acti	Compaction	System description/Facilities/Processing facility/Rooms/Compaction and packaging ro
		🧭 WM acti	Packaging	System description/Facilities/Processing facility/Rooms/Compaction and packaging ro
		🧭 WM acti	Storage	System description/Facilities/Storage facility/Rooms/Drum storage room/Waste mana
	L			
			Link selected object	Cancel

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

Postulated Initiating Events (PIEs)
Lightning (effect on facility)
🗐 🔍 Scenarios
Lightning (effect on facility)
📖 Impacts
Analysis

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



Lightning (effect on facility)
Fire in the storage facility
Impacts
🖌 Analysis
Modifications

Observe properties of the scenario.

▲ General			
Description			
Name	Fire in the storage facility		
Short name			
Attachments			
Path	Safety assessments/Safety assessment 1/Assessme		
Situation	Accidental		
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		
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.



💐 Int	ernal
<b>P</b>	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.
- <del>p</del>	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).
<i>9</i> 9	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
<i>P</i>	Local hot spots generated by malfunctions of structures, systems or components
	Sparks from machinery, equipment or electrical circuits
<i>ş</i> e	Sparks from human activities such as welding or smoking
	Explosions
<i>P</i>	Gross incompatibilities between the components of a process system and the materials introduced into the system.
÷	The degradation of process materials (chemicals, additives or binders) due to improper handling and storage.
<i>9</i> 9	The failure to take account of the non-radiological hazards presented by the waste (physical, chemical or pathogenic).
<i>?</i>	The generation of a toxic atmosphere by chemical reactions due to the inappropriate mixing or contact of various reagents and materials.
<i>P</i>	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";

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

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

		roperties	
^	⊿	General	
		Description	
		Name	Drop of the drum in the Drum storage room
ded		Short name	Drop
		Attachments	
		Path	Safety assessments/Safety assessment 1/Assessments for accidents/Scenarios
sin		Situation	Accidental
	⊿	Scenario - probability	
		Is same as in linked PIE	True
ns		Given as numerical/qualitative	Qualitative
		Probability - time frames	% during the life time of facility
n as		Value (numerical)	
		Value (qualitative)	Medium
	4	Scenario - relevance	
		Relevant	Relevant
sfer		Justification if not relevant	
ol			
and			

# 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 endpoints Scenarios and impacts Postulated Initiating Events (PIEs) Scenarios				Drop of the drum in the Drum storage ro				
Fire in sto		acility	_		Links			
	7	Link PIE type			Туре		Name	
Analysis		Create impact and link it with this scenario			▶ 🖏 Roo		Drum storage roo	
Conclusions		Сору			📸 PIE		Dropping waste (	
		Cut		I				
	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)?	
Ec Impac	Yes No	

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

	ounded by another impact	
E		×
a	Impact 'Impact for scenario Drop' had been created. After finishing of wizard will need to specify properties 'Affecting' (inside/outside) and 'Radiological consequences' for this impact	you
id ac		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 - guantitative or gualitative asses	ssment

Open the screening table.

🖃 💽 Increased external exposure				
Direct external exposure				
Analysis				



S	elect/unselect w	aste components								
	Selected	Waste component	Nuclide	Inventory of one (Bq)	N	Invento	SGRDC	Max. do	Screeni	Hazard Quotie
	~	[Packaging] - Waste from producer - [Storage]	Co-60	1.8E+12	45	8.1E+13	3.70E-013	3.00E+001	1.00E-004	299700
	<b>~</b>	[Packaging] - Waste from producer - [Storage]	Cs-137	5E+10	45	2.25E+12	1.02E-013	2.30E-001	1.00E-004	2295
1	~	[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 exposure Safety assessments/Safety assessment 1/Assessments for accidents/Scenarios and impacts/Impacts/Increased external exposure									
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									
	Selected	Waste component	Nuclide	Inventory of one (Bq)	N	Invento	SGRDC	Max. do	Screeni	Hazard Que
	Image: A start of the start	[Packaging] - Waste from producer - [Storage]	Co-60	1.8E+12	1	1.8E+12	3.70E-013	6.66E-001	1.00E-004	6660
1	Image: A start of the start	[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			
Name			Dose to worker, acc. – increased exposure
Short name	e		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 t	the object.		
Edit 🝷			
DW EXP INS			
Links			
Туре	Short name	Name	Path
Oriterion		<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 inside the facility) Safety assessments/Safety assessment 1/Assessments						
	👔 🖻 Referesh table 🛛 🗧 Reset table 🔒 Lock table   Row merging 🛛 Auto-filter row 🛛 Clear filter   🖶 Prin						
	Run exposure models						
	Waste component	Nuclide	Inventory (Bq)	Distance (cr			
•	[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 inside the facility) Safety assessments/Safety assessment 1/Assessments for accidents/Scenarios and impacts/Impacts/Increased external exposure/Endp						
1	😰 Referesh table 🧕 Reset table 🔒 Lock table 🛛 Row merging 🛛 Auto-filter row 🛛 Clear filter 🛛 🖶 Print Ď Print preview/export 🛛 Export to Word 🖉 Copy to clipboard						
I	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 "…" button⁸ 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	

⁸ Alternatively you can select the row and press button "Run exposure models" located on toolbar SAFRAN 2 Tutorials Rev. 2020-12-29



The model selection dialog box will appear:

🛃 Select models		_	$\times$
OK       Available models         Point source, concrete shield         Point source, lead shield         Point source, water shield         Point source, without shielding         Cube, concrete shield         Cube, lead shield         Cube, lead shield         Cube, water shield         Cube, water shield         Disc, concrete shield         Disc, concrete shield         Disc, without shielding         Disc, water shield         Disc, water shield         Disc, water shield         Drum axial, concrete shield         Drum axial, ead shield         Drum axial, water shield         Drum axial, without shielding	<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.

			~
	_		$\times$
			-
Dose rate calculation for Waste from producer			
			-
Designed			
Description			
DrumAxial_WithoutShileId waste component: Waste from producer			
L			_
OK			
UN		Cancel	

Click OK

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



er (tree	view)	Ψ×	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 fi	ìrst usage.			
ystem (					
🐧 Site					
🐧 Safe		0			
] Facil ∋∰s R		Continue			
9 🖏 K					
🗏 🖑 S	orage facility				
<u>با</u> ج	Measured or estimated data				
庄 🔇	Waste management activities and processes				
Ē.	Waste components				

SafCalc2 - DrumAxial*		_	_	Access of the		X
Context         Model         Parameters         Result tables         Simulation         Simulation Settings         Probabilistic Settings         Resurt to SAFRAN         Help Contents         Report	Basic settings Start time 0.0 Years End time 100.0 Years Type of simulation Best estimate Probabilistic Simulation table Number of simulations 1000	Simulation  Information				
		Errors				
			Source	Object	Description	R
SAFCALC SERIA catedration sect						4

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:

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😵 SafCalc2 - DrumAxial*		_	_	-		-		_	x
Context 😵	Parameters	Information			Symt	ol	Full na	ime	Full
Parameters	distance exposureTime JIZA MatNo	Sub-system Description			Unit Bq		Catego	bry	
Export to Excel     G Help Contents      Result tables	slabThicknes sourceHeight sourceRadius								
Simulation Simulation									
		Data				205		2	
		Radionuclides	Value	Min	Max	PDF	Unit	Comment	₽.
		Default	0.0E0				Bq		
		Co-60	1.8E12			_	Bq		_
		<u>Cs-137</u>	5.0E10				<u> </u> ₿q		

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.

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

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



19:27:11	Simulation started
1	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				- C	x I
Context 😵	Results	—— Tab	oles		
	o dose	0	uick View Dose rate (Sv/h)		
Model 📀			uclide	doseRate	Ę
🕭 Parameters 🛛 😣	• slabMaterial		-60	1.26E-1	
Result tables			-137	6.33E-4	
Time Table					
Correlation Table					
1 View in Excel					
Clone					
Theip contents					
Simulation 😵					
Report 📎					
	Search				
Star I	Name				
SAFCALC	Search	<u> </u>			
SAFRAM calculation scol	Index - All indices -	~			~
HAEA BFacilia			ormat		
	Type - All Types -	×	icientific $\checkmark$ Digits 2		

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 simulation⁹.

⁹ You may create also other tables to observe values of different results. SAFRAN 2 Tutorials



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.

Run exposure model							
Waste component	Nuclide	Activity (Bq)	Distance (cm)	Dose rate (Sv/h)	Calculation	Exposure time (h)	Dose (Sv)
[Packaging] - Waste from produ	c Co-60	1.8E+12	50	1.26E-001	DrumAxial_WithoutShileld wa	2.50E-001	3.14E-002
[Packaging] - Waste from produ	c Cs-137	5E+10	50	6.33E-004	DrumAxial_WithoutShileld wa	2.50E-001	1.58E-004
[Packaging] - Waste from produ	c 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".

- 🐧 Scenarios	<b>'</b>	1	
<ul> <li>Fire in the storage facility</li> <li>Drop of the drum in the Drum</li> </ul>	1000	Link PIE type	
✓ (●) Impacts ✓ ● Impact for scenario Drop		Create impact and link it with this scenario	
	DN-	C	

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:

	Acconnenta	
	Path	Safety assessments/Safety ass
	Situation	Accidental
~	Impact	
	Affecting	Inside
	Radiological consequences	Release to air
~	Impact - quantitative or qualitative a	assessment
	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 wast	e components							
	Selected	Waste component	Nuclide	Inventory of o	N	Inventory (Bq)	Max. release inside (	Screening release inside (Bq)	Hazard Quotient (
•		[Packaging] - Waste f	Co-60	1.8E+12	45	8.1E+13	8.1E+13	164000	4.94E+008
	Image: A start of the start	[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

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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	Shriected 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:



Situation       Accidental         Type       Dose         Inside/Outside       Inside         Unit       Sv             Short name         Short name of the object.             Edit •             DW REL INS             Links             Type       Short name             Name       Path								
General       Description         Name       Dose to worker, release inside         Short name       DW REL INS         Attachments       Path         Safety assessments/Safety assessment 1/Asses         Situation       Accidental         Image: Type       Dose         Inside/Outside       Inside         Unit       Sv								
Description       Dose to worker, release inside         Name       DW REL INS         Attachments       Bate         Path       Safety assessments/Safety assessment 1/Asses         Situation       Accidental         * Endpoint       Type         Inside/Outside       Inside         Unit       Sv	2↓ 🖾							
Name     Dose to worker, release inside       Short name     DW REL INS       Attachments     Path       Path     Safety assessments/Safety assessment 1/Asses       Situation     Accidental       * Endpoint     Type       Type     Dose       Inside/Outside     Inside       Unit     Sv	4 General							
Short name     DW REL INS       Attachments     Safety assessments/Safety assessment 1/Asses       Path     Safety assessments/Safety assessment 1/Asses       Situation     Accidental       • Endpoint     Type       Type     Dose       Inside/Outside     Inside       Unit     Sv	Description	n						
Attachments       Path       Safety assessments/Safety assessment 1/Asses         Path       Safety assessments/Safety assessment 1/Asses         Situation       Accidental         * Endpoint       Type         Type       Dose         Inside/Outside       Inside         Unit       Sv         Short name       Short name of the object.         Edit •       DW REL INS         Links       Type         Type       Short name         Name       Path	Name			Dose to worker, release inside				
Path       Safety assessments/Safety assessment 1/Assessment 1/Assessmental         Situation       Accidental         Inside/Outside       Inside         Unit       Sv             Short name         Short name of the object.             Inside             Inside             Inside             Short name             Short name             Inks             Inks             Type             Name       Path	Short nam	e		DW REL INS				
Situation     Accidental       Fndpoint     Type       Type     Dose       Inside/Outside     Inside       Unit     Sv         Short name       Short name of the object.         Edit •       DW REL INS         Links         Type     Short name         Name     Path	Attachment	s						
Endpoint     Type     Inside/Outside     Unit     Sv      Short name Short name of the object.      Edit     DW REL INS      Type     Short name     Name     Path	Path			Safety assessments/Safety assessment 1/Assess				
Type     Dose       Inside/Outside     Inside       Unit     Sv         Short name       Short name of the object.         Edit •         DW REL INS         Links         Type     Short name         Name     Path	Situation			Accidental				
Inside/Outside Inside Unit Sv Short name Short name of the object. Edit • DW REL INS Links Type Short name Name Path	Endpoint							
Unit Sv Short name Short name of the object.  Edit DW REL INS Links Type Short name Name Path	Туре			Dose				
Short name       Short name of the object.       Edit •       DW REL INS       Links       Type     Short name       Name     Path	Inside/Outsi	ide		Inside				
Short name of the object.	Unit			Sv				
DW REL INS           Links           Type         Short name         Name         Path		the object.						
Links Type Short name Name Path								
Type Short name Name Path	DW REL INS							
	Links							
Criterion Dose limit to worker Regulatory frameworks/National regulations/Accidental situation	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)".



The following table will appear:

🛿 Referesh table 🤚 Reset table 🔒 Lock table 🛛 Row merging 🛛 Auto-filter row Clear filter 📲 Print 🐚 Print preview/export 🛛 Insert in Word Copy to clipboard											
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 ARFs – airborne release fractions for nuclides of waste component.

Click on the first row cell in the column ARF and double click on the "..." button¹⁰.

¹⁰ Alternatively you can select the row and press the button "Identify ARF" located on the toolbar SAFRAN 2 Tutorials Rev. 2020-12-29



ARF	Release inside (Bq)

The first page of Wizard will appear:

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

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).

Airborne Release Fraction (ARF)
Type of the waste Identify type of the waste (solid, liquid, gaseous)
Solids
C Liquids
Surface contamination
C Gaseous

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Click Next.

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

	- Tarbonie Release Haction (Antr)					
	w	aste form type Select row with the relevant waste form type. Use first row as filer, if necessary. If table does not contain correct wast				
		Waste type				
н.	Q					
		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)				
	Þ	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 ^OC fire 1 h duration".

Т	rpe of effect
	Select row with the type of effect. Use first row as filer, if necessary. If table does not
	Type of effect
-	
	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 sho	ws database val	This page shows database (based on the waste form to This page shows database values for ARF for waste form ty				
u			of entire ARF datab				
		ARE	ARE - User				
	Nuclide	ARF database	ARF - user				
	Nuclide	database	defined				
	Nuclide						
•	Nuclide Co-60	database	defined				

# Click Next.

The final page of wizard summarizes the wizard results:

	Con	npleting th	ie wiz	zard		
		ve successfully complete sult modifications for			able	
		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.¹¹

¹¹ 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:

	1 Weit	ourcey assessmental ourcey assessment approximation of a
	Situation	Accidental
$\sim$	Impact	
	Affecting	Outside
	Radiological consequences	Release to air inside the build. and to atmosphere $\bigtriangledown$
$\sim$	Impact - quantitative or qualitative assessment	
	Ousetitative / availitative accessment	Ousetitative

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

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🖃 💽 Relea	se to air (outside) from storage facility
··· 🛄 Re	lease to air, inside
- 🖪 Re	lease to air, outside
📖 🐧 En	dpoints

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
1					

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	2		DW REL OUT
Attachments			
Path			Safety assessments/Safety assessment 1/A
Situation			Accidental
Endpoint			
Туре			Dose
Inside/Outsid	le		Outside
Unit			Sv
Short name	the object.		
Edit •			
W REL OUT			
inks			
Туре	Short name	Name	Path
left 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			
🗐 🔍 Endpoints			
😑 👮 Dose to public, acc release outside			
🖃 🔍 Assessment cases			
😑 🛅 Assesment case 1			
Release to air (inside, accounting ARF)			
Dose (release to air, outside)			
A me humin			

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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)
vsis

The following table will be shown:

ł	Identify ARF Import from similar table	J			
	Waste component	Nuclide	Inventory (Bq)	ARF	Release in:
1	[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.

Identify ARF       Import from similar table         Waste component       Nuclide       Inventory (Bq)       ARF       Release insid         [Packaging] - Waste from producer - [St]       Co-60       8. 1E+13       1.90E-005       1.539E+09         [Packaging] - Waste from producer - [St]       Co-137       2.25E+12       3.00E-004       6.75E+008	🗿 Referesh table 🧧 Reset table 👸 l	.ock table   Row merging Auto-filter row C	lear filter   📑 Print 🚺 Print preview/e	xport Export to Word Copy to clipboa	ird
[Packaging] - Waste from producer - [St]         Co-60         8.1E+13         1.90E-005         1.539E+09	Identify ARF Import from similar table				
	Waste component	Nuclide	Inventory (Bq)	ARF	Release inside (Bq)
[Packaging] - Waste from producer - [St]         Cs-137         2.25E+12         3.00E-004         6.75E+008	[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
	Practaging - waste from producer - 15t.	. (3-13)	2.2JL T12	5.002004	0.7524000

Close the table.

Open table "Dose (release to air, outside)". SAFRAN 2 Tutorials



🖳 💐 Assessmen	t cases
🖃 🛅 Assesm	ent case 1
	ase to air (inside, accounting ARF)
- Dos	e (release to air, outside)

▶ Co-60         1.539E+09         9.00E-001         1.54E+008         5.27E-013         8.11E-	🔋 🖻 Referesh table 🎐 Reset	t table 🔒 Lock table   Row m	nerging Auto-filter row C	lear filter 🛛 🖶 Print 🛝 Print	preview/export Insert in V	Vord Copy t
	Nuclide	Release inside (Bq)	Filtration efficiency	Release outside (Bq)	DCFair,acc (Sv/Bq)	Dose (Sv)
Cs-137 6.75E+008 9.00E-001 6.75E+07 2.03E-013 1.37E-	▶ 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-	Total					9.48E-005

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

Close the table.

### End of advanced exercise

# Safety assessment diagrams

Select in the object browser the node "Fire in the storage facility".



The tab "Context-dependent diagram" will contain the diagram showing the scenario as well as all relevant impact and PIE type and PIE which was the reason for this scenario (make this window wider and/or click "Zoom to view", if necessary):

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Alachometa Alachomet				s/Safety assessment 1/Assessments for accidents/Scenarios and impacts/Scenarios/Fire in the storage facility)	× Actions
Name     Fire in the storage facility       Image: Spring decryption     Spring decryption       Image: Spring decryption     Description       Image: Spring decryption     Description       Image: Spring decryption     Spring decryption       Image: Spring decryption     Spring decryptin       Image: Spring decryption     <	( 🗈 🏘 🗙 📑 🕘 📑 🔯	Properties Links Errors Com	ments   Tasks	Context-dependent diagram Links diagram	1 🔁 🛓
Name         Cancerel         Price in the storage facility           • Mundy         Secretorian         Free in the storage facility           • Og Rogdberg Assessments         Secretorian         Free           • Og Rogdberg Assessments         Secretorian         Free/Assessmentof Rocol	fresh Expand all Collapse all 🛞 Show description	21 21 21		Zoom + Zoom - Zoom to view	Link
<ul> <li>Wanne Frein the storage facility Short name in Iniced FIE True Short name is Inice</li></ul>					A Set Link PTE tune
Constraints     Constrain	Tutorial	Name	Fire in the storage facility		
<ul> <li>Brits descendence</li> <li>Shots name</li> <li>Shots name</li></ul>		Description		RELINS	Add
Attachments     Attachmen			Fire		Create impact a
<ul> <li>Statistical address</li> <li>Statist</li></ul>				Lightning felfect on Lightning felfect on Fina	
Statistic assessment 1     Statistic production assessment 1				facility] facility]	Edit
Propose     Conserved or protocol allity     Scenario - protocol - protocol allity     Scenario - protocol - protoc			Accidental		Conv.
Score     Is same as in interdel PIE     True     Cut       Approxibility     Some and so			-	Release to air (outside)	
Acrosch     Acrosch     Submits / Uniter familie / Unit				Trom storage ramy	Cut
Assument for normal question       Assume for normalquestion					
<ul> <li>Massement for academits         <ul> <li>Value (qualitative)</li> <li>Value (qualitative)</li></ul></li></ul>			% during the life time of facility		X Delete
In prace of postulated initiating events (PE types)          Scenarios and inpacts         Scenarios and inpacts         Scenarios         Scena			1		Rename or char
Relevant     Relevant     Relevant       Common endpants     Relevant     Reoder       Dutristication if not relevant     Dutristication if not relevant     Year       Description of models     1     Prescription of models     Prescription of models       Different field properties     1     2     Prescription of models     Prescription of models       Different field properties     1     2     Prescription of models     Prescription of models       Different field properties     1     2     Prescription of models     Prescription of models       Different field properties     1     2     Prescription of models     Prescription of models       Different field properties     1     2     Prescription of models     Prescription of models       Different field properties     1     2     Prescription of models     Prescription of models       Different field properties     1     2     Prescription of models     Prescription of models       Modelsatorie     5     2     Prescription of models     Prescription of models     Prescription of models       Modelsatorie     1     1     Prescription of models     Prescription of models     Prescription of models       Different field properties     1     1     1     Prescription of models     Prescription of models <td></td> <td></td> <td>LOW</td> <td></td> <td></td>			LOW		
- ① Screarios and impacts     Justification if not relevant     View       - ② Screarios     - User-defined properties     - Office       - ③ Screarios     - Office     - Office       - ⑤ Screarios     - Office     - Office       - ⑥ Modifications     - Office     - Office       - ⑥ Condurions     - Office     - Office			Palayant		Reorder
• Devalued instants Events (FEI)       • User-defined properties       • Instants Events (FEI)       • User-defined properties       • Instants       •					10
Internet the storage facility     2       Drog of the durum in the Drum storage room     3       Drog of the durum in the Drum storage room     4       Drog of the durum in the Drum storage room     4       Decomment     0       Modifications     5       Conductors     5       Decomment     5		1			Propeties
Drog of the druin the Druin storage room     3     00 everyloy     Arabysis     5     00 everyloy     Conclusions     Conclusions     Conclusions		2			Decument
Som PE-5 Conclusors Show PE-5 Library5		3			
A Maryles     -     Diagram       Q Modications     Show PIE-Sc       Q Conclusions     Show PIE-Sc		4			Overview/print/
Show PIE-Sc LibraryS		5			Diagram
Library5-					Show PIE-Scena
	Condusions				
					LibraryS

Note that hovering of mouse over diagram's node shows the tool-tip with the node's text (useful when diagram's nodes are small). For example:



Click on different elements of assessment (PIE type, PIE, Scenario, Impact) – the browser will navigate to the relevant element and diagram window will stay the same (for PIE type, PIE, Scenario) or change (for Impact). Right-click on element opens property window.

Right-click on the "Fire in the storage facility" and select menu item same diagram is available with the "Show PIE-Scenario-Impact diagr.".



Common endpoints Common endpoints Common and impacts Common and impact	nts (P	IEs)
Drop of the drum in t	P	Link PIE type
Conclusions	₽ <b>X</b>	Create impact and link it with this scenario Copy Cut Delete Rename or change description
	<b>*</b>	Reorder Propeties Overview/print/export as table Show PIE-Scenario-Impact diagr.

The full-screen view of the same diagram as shown in context-dependent window will appear.



In this window both left and right click of the mouse open properties window. Close this window.

Select the tab "Links diagram" (next tab to the "Context-dependent diagram")





Note the difference between Context-dependent diagram (above) with the diagram shown in the "Links diagram" tab. This diagram contains only the direct links of the scenario and therefore does not contain PIE type (which is linked to PIE), but contains all the links and therefore contains link to the Drum storage room. Click on the "Drum storage room" will produce the following diagram:





# Analysis

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



🗏 🚺 Ar	nalysis
🕀 🖳	Normal operation
⊡·≷)	Accidental situation
	💹 Comparison of hazards inside
	Comparison of hazards outside
	Comparison of doses inside
	Comparison of doses outside
	Discussions

	Show as chart					
	Scenario	Impact	Probability - quantitative	Probability - qualitat	Impact - quantitative	Impact - qualitative
Þ	<u>Fire</u>	Release to air (inside) i		Low	5.03E+008	Very High
	Drop	Increased external exp		Medium	6711	Very High

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

空区県市	Settings					
Very High –	-	Prefikelesse to ar (inside) in the Drum storage room	(Drog/Increased external exposure)			FrenRielesset to at (resids) in the Drum storage roo     Drop/Increased external exposure
High -						
Medium -						
Low -						
Very Low -						
	Yery Low	Low	Medium Probability	High	Very High	

Close chart and table.

Open table "Comparison of doses inside".

a C	Comparison of doses in	side Safety assessment	s/Safety assessment 1/Ar	nalysis/Accidental situ	ation					
1	😰 Referesh 🧕 Reset f	🔓 Lock table \mid Auto-f	ilter row Clear filter Ro	w merging   Insert in	n Word document 🛛 🛕	Print/export 📭 Cop	/			
I	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	

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<mark></mark>	ettings					- ¤ ×
6.00E-002 -						Fire/REL INS/DW REL INS     Drop/Impact for scenario Drop/Dose to worker, acc. – increased exposure
5.70E-002		•				
5.40E-002 -						
5.10E-002						
4.80E-002 -						
4.50E-002						
4.20E-002						
3.90E-002						
3.60E-002						
() 3.30E-002 3.00E-002						
g 3.00E-002 -			•			
2.70E-002						
2.40E-002 -						
2.10E-002						
1.80E-002						
1.50E-002						
1.20E-002						
9.00E-003						
6.00E-003						
3.00E-003						
0.00E+000			· · · · · · · · ·	L		
	Very Low	Low	Medium Probability	High	Very High	

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.

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

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. 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 assessments
  - Database
  - ▶ 🥏 Safety assessment

and observe the categories of the database tables.



Derive site-specific database values

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 ..."



🖃 🔍 Database	
🚊 💐 Normal operation -	hazard screening
📄 💐 Momentary brea	thing rate (in m3/h) for adult male depending on level of physical activity (normal operation
	reathing rate (Normal operation) for adult male depending on level of physical activity
🚊 💐 Screening dose	rate for normal operation
Screening do	se rate for normal operation
🚊 💐 Screening relea	se rate to the atmosphere for normal operation conditions
Screening re	lease rate (Bq/y) to the atmosphere for normal operation conditions
🚊 💐 Screening disch	arge rate for normal operation conditions
Screening di	scharge rate (Bq/y) for normal operation conditions
🛓 💐 Normal operation -	dose assessment
🗄 🔍 Accidental situation	- hazard screening
🛓 💐 Accidental situation	- dose assessment

# The table will appear:

Show undefined Ma	ake conv of selected	rows Export to Excel Imp	ort from Excel Undate wi	th new nuclides 🚔 Print 👔	Print preview/export	Insert in Word	
Parameter	nuclide	Value(Bq/y)	Data source	Default	Reference	Comment	_
7							
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	$\checkmark$			
ScreeningReleaseRate	At-211	1.75E+008	SAFRAN DB	$\checkmark$			
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	$\checkmark$			
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	~			
ScreeningReleaseRate	Cs-136	1.13E+008	SAFRAN DB				
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	$\checkmark$			
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			
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	$\checkmark$		
	0: 040	1.075.000	0.000.000			

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 2 Tutorials



SAFRAN assessment table receives from database when query value (in this case screening release rate for the given nuclide).



# Tutorial 9. Sealed sources – system description

Start SAFRAN

Create new SAFRAN project with the title "Sealed sources" and save it with the same name

The "Project properties" dialog will appear

Pro Nuclides Sources 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 "Add row") enter the following information:

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	Depleted Uranium and lead

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

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.



			Add ne	ew Facility	/		-	
Name								
Mobile	Hot Cell for the m	anagement	of high activi	ty DSRS				
Descrip	tion							
posses activity shield viewin crane use in a nega The lo	possible to handle is a hot cell and rr DSRS and allow was designed and g work in progress to handle and lift ifting heavy object tive pressure with ng term storage c the biological shi	emote handl for the trans constructe s inside the s various obje cts in and ou in the hot co ontainer for	ing equipmer sfer of the so d. The facility hield. It mak cts within the t of the biolo ell to contain the encapsu	nt. A mobile h urce from its y consists of a es use of mas hot cell. The gical shield. / and prevent lated high ad	ot cell facility Original Sour a biological s ster-slave ma ere is a cran An extract ve the possible ctivity DSRS	which can ce Shield to hield with a unipulators a outside the entilation sys spread of c will be cou	handle a stora windov and an in e shield stem ma ontamir	high age v for ntemal for intains nation.
(	К						Can	cel

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			
1				
	ОК	Can	cel	

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



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



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



•	Add new WM activity 🚽 🗖	
	,	
	News	
	Name	
	Descention for interduction into and	1
	Preparation for introduction into cell	
	Description	
	Description	
	OK	
	Cancel	

The process diagram will change:



Right-click on the node "Preparation for introduction into cell" in the browser 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:



For the diagram in the right part click "Zoom to view" and it will looks like:







Close the process diagram window.

Note that new activities are appeared in the browser:
- 🐧 Facilities
👻 Mobile Hot Cell for the management of high activity DSRS
Measured or estimated data
🗸 🖏 Waste management activities and processes
Overview of WM activities and processes
Management of the High Activity Sources in the Mobile Hotcell
🧭 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
Waste components
🖌 🕅 Safety elements

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

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

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

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# The wizard will appear

e	Review/modify external dose rate data 🛛 🚽 🗖 💌
o ≉	Welcome to the wizard
n F	This wizard simplifies the verification and modifiaction of the external dose rate data for the system description objects.
a M	for the system description objects.
ĸ	To continue, dick Next
fe o	< Back Next > Cancel
ew or way activities and processes	

Click "Next"

Enter data according to the table above

			Review/modify externa	l dose rate data	>
Ext	ernal dose rate (Sv	/y)			
Dra	ag a column header he	re to group by that column			
	Facility	Room	Area	WMActivity	External dose rate (
	MHC HAS			Preparation for introduction into cell	
	MHC HAS			Lift original source shield into cell and dos	
	MHC HAS			Remove source and characterize	2.20E-005
	MHC HAS			Encapsulation and testing of High Activity	4.10E-005
2.	MHC HAS			Transfer encapsulated HAS into the draw	
	MHC HAS			Remove Long Term Storage Shield (LTSS)	
				< Back Ne	xt > Cancel

Click "Next" and then "Finish"

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

1	Dbj∈	ect ex	cplor	er (tree
	ŧ.	š	間	ale )
	<b>\$</b> 1	Refr	esh	Expan
	Na	me		

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

# SAFRAN 2 Tutorials



Expand node "Remove source and characterize"



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



Click Ok or Cancel

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

# Waste components

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



1	SAFRAN 2.2.0.14 - C:\Users\Dmitry\Documents\SAFRAN2\Sealed sources.safx
Fi	le Edit View Tools Window Help
F	
Ob	oject explorer (tree view)
	e X (2) 🕸 🗡 (2) (2) 🖉 🔕
	Refresh Expand all Collapse all 🍋 Show description
ľ	Name
•	🛛 📜 Sealed sources
	👻 📷 System description
	🐧 Site features
	💐 Safety elements
	🕨 💐 Facilities
	Waste management activities and processes
	👻 💐 Waste components
	Overview of waste componenents
	List of sources
	📊 List of containers, packages, capsules
	📷 Incoming waste
	🖏 Waste streams
	🙀 Regulatory frameworks
	💐 Safety assessments

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

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

Double-click on the waste component node



The form for assigning sources to the waste component will appear





Click on the "+-Source" button

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

Assign/unassign sources to waste component – 🗖 💌							
	View/modify list of available source	25					
	Name	Total number of sources	Present in waste component	Number of sources in waste compon			
	Irradiator	10					
I	Radiotherapy sources	10					
~							

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

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

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

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	s		
	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										-	0	×
I	+- Source   Type of conta	iner		- +	Number of waste componer	its 1 A	ccount 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)			
•	Radiotherapy sources	In their working shield, Cat I		Co-60	7.4E+13	2014-04-03	1		7.4E+13			

(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"

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Type of contai	ner			-	+
irce ^Ŷ	Desc	cription of source	Category	Nuclide	

Select "Working shield for high activity sources"

Type of container	Working shield for high	activity sourc	es	-	+
ce 🌱 Des	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 com	nponents <mark>10</mark>	Account		
Init. activity in one sou	rce ( Date for initial act	ivity Nu		
7.4E+13	2014-04-03	1		

Finally the waste component description will looks like:

•					Waste componen	t				
	+- Source Type of conta	iner Working shield for high	activity source	es 🔹 +	Number of waste componer	its 10 Ac	count decay to date	31		
	Name of source	Description of source	Category	Nuclide ⁹	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.

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

# SAFRAN 2 Tutorials



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		
ne	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	$\checkmark$	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.

### SAFRAN 2 Tutorials



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

# Linking waste components to the waste management activities

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

select "Link WM activity" from the menu.

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

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

Select object of the type WM activity using List view or Tree view and click "Link selected object" button. If necessary you can add new objects or modify objects' properties using Tree view.

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 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,Normal operation,Dose,Sv/y (Regulatory frameworks/National regulations/Normal (		
💵 🔏 🛍 🌵 🗙 🔛 🕘 🚰 💫 🗄 Show description	Properties		
B + -	24 🗉		
Name	<ul> <li>General</li> </ul>		
🖓 Tutorial	Description		
😑 🖙 System description	Name	Dose limit to worker	
- Site features	Short name		
- Safety elements	Attachments		
6 Tecilities	Path	Regulatory frameworks/National regulations/Normal or	
waste management activities and processes	Situation	Normal operation	
in Waste components	<ul> <li>Criterion</li> </ul>		
🔲 🖄 Waste streams	Application	Worker	
ws1	Limit	0.02	
Regulatory frameworks	Туре	Dose	
in the second se	Unit	Sv/y	
🔅 🔍 Normal operation			
Dose limit to worker			
Accidental situation			
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.

P	roperties					
0	2↓ □					
	General					
	Description					
	Name	Dose limit to public	Dose limit to public			
	Short name					
	Attachments					
	Path	Regulatory frameworks/National regulations/Normal operation/				
	Situation	Normal operation				
	Criterion					
	Application	Worker	$\mathbf{\mathbf{v}}$			
	Limit	Worker				
	Туре	Public				
	Unit	5V/ 9				

### 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.

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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 📃 🗖					
<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 management systems</li> <li>Identify requirements for record keeping</li> <li>Identify requirements for physical protection</li> </ul>					
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	
Tree view (to add new objs.) List view		
List	Туре	Name Pa
Gi	<b>a</b>	
, obj	Regulatory framework	National regulations Re
new		
bbe		
w (to		
e vie		
⊒ ⊥		
	Link selected object	Cancel
Se	lect object of the type Regulatory framework using List view	or Tree view and click "Link selected object" bu

#### 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 activity¹²:

#### Table 10.1

Activity	External exposure dose rate Sv/h	Working time hours/per year
Preparation for introduction into cell	Will be estimated based on the waste components inventory	20
Lift original source shield into cell and close cell	Will be estimated based on the waste components inventory	10

¹² 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)



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

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.

	- Approach
	🗐 🔍 Assessments for normal operation
	😑 💐 Common endpoints
•	Dose to worker
	Impacts
	🕀 🔍 Assessments for accidents
	🕀 🗹 Analysis
	Modifications

Set the properties of the endpoint:

- Type *Dose*
- Inside/Outside Inside

Situation	Normal operation
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".

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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 Nes	d >	Cano	P

Click "Next"

## The page of wizard showing all the activities will appear

#### 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.

Select all Unslect all				
WM Activity	Facility	Room	Area	Impact(s) already exist
<ul> <li>Preparation for introduction into cell</li> </ul>	MHC HAS			no
<ul> <li>Lift original source shield into cell and close cell</li> </ul>	MHC HAS			no
<ul> <li>Remove source and characterize</li> </ul>	MHC HAS			no
<ul> <li>Encapsulation and testing of High Activity Sources (HAS)</li> </ul>	MHC HAS			no
✓ Transfer encapsulated HAS into the drawer to the Long Term Stora	MHC HAS			no
Remove Long Term Storage Shield (LTSS) to Storage facility	MHC HAS			no

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

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Add normal operation impacs



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

pacts Specify endpoint and other properties of impacts.				
Assign the same for all rows				
✓ Endpoint	<ul> <li>Radiol. conseq.</li> </ul>			
✓ Affecting	Dose rate option			
Allocality				
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	
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 Shie	Dose to worker	Inside	Direct external exposure	Calculate dose rate
	Remove Long Term Storage Shield (LTSS) to Storage facility	Dose to worker	Inside	Direct external exposure	Calculate dose rate

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

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### Finally the table should look like:

Affecting Calculate dose rate				
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.



٣	<b>N</b>	, cu		лт спиропть
Ŧ	3	In	npa	cts
	$\overline{\mathbf{v}}$		Pre	paration for introduction into cell
			-	External exposure dose rate for each waste component
		Ŧ	8	Endpoints
			Ŧ	Dose to worker
				👻 💐 Assessment cases
				Assessment case 1
	-		Lift	original source shield into cell and close cell
			Ē	External exposure dose rate for each waste component
		Ŧ	8	Endpoints
			$\overline{\mathbf{v}}$	👰 Dose to worker
				👻 💐 Assessment cases
				Assessment case 1
	-		Rei	move source and characterize
			m	External exposure
		Ŧ		Endpoints
			-	👰 Dose to worker
				🚽 💐 Assessment cases

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.







Observe the properties of this impact:

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	r aan	ouncey assessments/ouncey assessments/hosessments
	Situation	Normal operation
$\sim$	Impact	
	Affecting	Inside
	Radiological consequences	Direct external exposure
	Dose rate options	Dose rate is known
~	Impact - quantitative or qualitative assessm	ent

Double-click on the table "External exposure".

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

💋 Referesh 🧕 Reset 🔒 Lock table	e   Auto-filter row Clear filter Row me	ging 📋 Insert in Word document 🛛 🙇 Print/export  睹 Cop
Ext dose rate (Sv/h)	Screening dose rate (Sv/h)	Hazard Quotient (HQ)
▶ 2.20E-005	5.00E-008	440

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



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

•	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 docu	ment 🛕 Print/export 瞎 Copy
In	npact	Exposure time (h/year)	Dose rate (Sv/h)	Annual dose (Sv/year)
► R	emove 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

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- 0 ×

- 0 ×



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:

🛃 Review/modify dose rate and exposure time

Enter exposure time or press button '...' in dose rate cell to assign/modify dose 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)
۲	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  $10.1^{13}$ .

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	
Lift original source shield	Inside External dose rate	Lift original source shield	Dose to worker	Assesment case 1	Working shield for high a		10	
Lift 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
Transfer encapsulated H	Inside External dose rate	Transfer encapsulated H	Dose to worker	Assesment case 1	Capsule large with IRR-Cs		5	
Transfer 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".

🖳 Review/modify dose rate and exposure time

¹³ 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.



Remove source and characterize
External exposure
🚽 🔍 Endpoints
👻 👳 Dose to worker
🚽 🏹 Assessment cases
👻 🛅 Assesment case 1
Dose from external irradiation or/and inhalation
Encapsulation 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 inhalation Safety assessments/Safety assessment/Assessments for normal operation/Impacts/Remove source and charact	-	×
😰 Referesh 🔹 Reset 🔒 Lock table   Auto-filter 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.



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

osure dose rate for each waste component Safety	assessments/S	afety assessme	ent/Assessme	ents for norm	al operation/	Impacts/Prep	aration for i	ntro —		$\times$
🗕 Reset 🔒 Lock table   Auto-filter row 🛛 Clear fi	lter Row merg	jing   Insert ir	n Word docu	ment 🛕 Prii	nt/export 🖷	Сору				
t waste components Run exposure model										
Waste component	Nuclide	Activity (Bq)	N	Total acti	Distance (	Dose rate	Calculation	Screening	HQ	
Working shield for high activity sources-IRR-Cs	Cs-137	2.6E+13	10	2.6E+14				5.00E-008		
Working shield for high activity sources-RT-Co	Co-60	7.4E+13	10	7.4E+14				5.00E-008		
Total								5.00E-008		
	Reset      Lock table   Auto-filter row Clear fi twaste components Run exposure model Waste component Working shield for high activity sources-IRR-Cs Working shield for high activity sources-RT-Co	Reset	Reset	Reset	Reset	Reset	Reset	Reset       Cock table       Auto-filter row       Clear filter       Row merging       Insert in Word document       Print/export       Copy         twaste components       Run exposure model         Waste component       Nuclide       Activity (Bq)       N       Total acti       Distance (       Dose rate       Calculation         Working shield for high activity sources-IRR-Cs       Cs-137       2.6E+13       10       2.6E+14       Image: Calculation         Working shield for high activity sources-RT-Co       Co-60       7.4E+13       10       7.4E+14       Image: Calculation	t waste components Run exposure model Waste component Nuclide Activity (Bq) N Total acti Distance ( Dose rate Calculation Screening Working shield for high activity sources-IRR-Cs Cs-137 2.6E+13 10 2.6E+14 S.00E-008 Working shield for high activity sources-RT-Co Co-60 7.4E+13 10 7.4E+14 S.00E S.00E-008	Reset       Cock table       Auto-filter row       Clear filter       Row merging       Insert in Word document       Print/export       Copy         twaste components       Run exposure model       Nuclide       Activity (Bq)       N       Total acti       Distance (       Dose rate       Calculation       Screening       HQ         Working shield for high activity sources-IRR-Cs       Cs-137       2.6E+13       10       2.6E+14       S.00E-008         Working shield for high activity sources-RT-Co       Co-60       7.4E+13       10       7.4E+14       S.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)



Sele	ected	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)

S	elect/unselect	waste components	Run exposure r	nodel					
5	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							

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 water shield Point source without shielding Cube, concrete shield Cube, water shield Cube, without shielding Disc, concrete shield Disc, concrete shield Disc, bad shield Disc, bad shield Disc, water	Drum radial,concrete shield     Drum radial,lead shield     Drum radial,water shield     Drum radial,without shielding	OK Cancel
<	>	

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		
Description		
Point_Lead waste component: Working shield for high activity sources-IRR-Cs		
		, 
ок	Cancel	

Click OK

The SafCalc2 window will appear

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Å.	SafCalc2 - Po	oint_Lead	<b>!</b> *	-	×
<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> <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	n		
SAFRAN calculation tool	1000	Errors	Source	Object	Description

Maximize it and select the "Parameters" tab

¥.			SafCal	c2 - Point_Lead*				-	-	×
Context C Model C Parameters C Database t Export to Excel Help Contents	i7A	Donson Name activity Sub-system Description		Symbol Unit Bq			name ogory		Brief	Full
	Name Search Q Category - All categories - V Sub-system	Cs-137	Value 0.050 2.6E13	Min	Мак	PDF	Unit Bq Bq	Comment		Coggle

There is a list of parameters including "activity", "distance", "height" and "slabThicknes". SAFRAN 2 Tutorials Rev. 2020-12-29



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:

			Salcalcz
'arameters	Information		
activity	Name		
distance	activity		
exposureTime height iZA	Sub-system		
MatNo	Description		
slabThicknes			
	Data		
	Data		
	Radionuclides	Value	Min
	Default	0.0E0	
	Cs-137	2.6E13	

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



height iZA MatNo slabThicknes	Description Thicknes of shielding between :
0	
	Data Value
	5.0E0

Click on the "Simulation" tab:

Tarameters	F
Result tables	8
Simulation	
<ul> <li>Simulation Settings</li> <li>Probabilistic Settings.</li> </ul>	
Return to SAFRAN Help Contents	(
Report	× N

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

	8 I	Basic settings		Simulation -
Model	8 	Start time 0.0	Years	
Parameters (		End time	Tears	Information
Result tables	8	100.0	Years	
Simulation	٨	Type of simulation	. cure	
Simulation Settings		Best estir	mate	

Wait until simulation will be finished



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

A.		SafCalc2 - Point_Lead*			
Context ©	Results ● dose ● dose Rate ● dose Rate Total ● slab Maternal	Quick View Dose rate			
To Parameters	• slabMaterial	Nuclide	dos	seRate	
Result tables		Cs-137	1.8	8E-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		

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

	enness of the								
	SafCalc2 -	Point_Lea	pint_Lead_4_1_1* – – – ×						
© © 	distance	Name slabThic Sub-syst				Symbol Unit cm	Brief Full name Category	Full	
el	iZA	Descript	ion			cm			
(	MatNo slabThicknes	Thicknes of shielding between source and target							
C		Data —							
		Value	Min	Max	PDF	Unit	Comment	8	
		1.0E1				cm		1	
Mer Co	Name								

The final assessment table will looks like:

ē	External exposure dose rate for each waste component Safety assessment/Preparation for introduction into cell –									
T	🛱 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
💐 Discussions
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 🖷 Copy

🛿 Referesh 🍯 Reset 📸 Lock table   Auto-hilter row Clear hilter Row merging   Insert in Word document 💽 Print/export 🖷 Copy						
Show as chart						
Impact	Endpoint	Assessment case	Dose (Sv/year)	Criterion	Limit (Sv/y)	
Preparation for introduction into.	Dose to worker	(+)Assesment case 1	5.22E-001	Worker	2.00E-002	
Lift original source shield into cell.	Dose to worker	(+)Assesment case 1		Worker	2.00E-002	
Remove source and characterize	Dose to worker	(+)Assesment case 1	5.50E-004	Worker	2.00E-002	
Encapsulation and testing of Hig	. Dose to worker	(+)Assesment case 1	1.23E-003	Worker	2.00E-002	
Transfer encapsulated HAS into	Dose to worker	(+)Assesment case 1		Worker	2.00E-002	
Remove Long Term Storage Shie.	Dose to worker	(+)Assesment case 1		Worker	2.00E-002	
Total	Dose to worker		5.24E-001	Worker	2.00E-002	

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

Click on the "Discussion" cell. The "Discussions" dialog will appear.



🖳 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.

			141 malana	
Edit discussion		-		>
Name	ose for Preparation for introduction into the cell	ОК		
Description	Dose for this activity is over the limit. It is not	Cancel		
	possible to increase the shield, so the working time have to be limited.			
Show links of				
discussion	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
    - 🚽 🧝 Dose to worker
      - 🗸 💐 Assessment cases
        - 👻 🛅 Assesment case 1
          - Dose external exposure for each waste component and inh. exposure
- If original source shield into cell and close cell.

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	
0K Cancel	

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

$\overline{\mathbf{v}}$	Dose to worker	
	See Assessment cases	
	→  and Assessment case 1	
	Dose - external exposure for each waste component and inh. exposure	
	→	
	Dose - external exposure for each waste component and inh.	



🔜 (	🔛 Dose - external exposure for each waste component and inh. ex 🗕 🗖 📉 🗙					
: 2	🕯 Referesh table 🏼 😐	Reset table 🛛 🔒 Loc	k table   Row merg	jing Auto-filter rov	v Clear filter	
V	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	
<u>v</u>	Norking shield for hi	0	2.42E-002	20	4.85E-001	
]	<u>Fotal</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 – 🗖 🗙					
Image: Second state       Reset table       Reset table       Row merging       Auto-filter row       Clear filter       Image: Second state       Clear filter       Clear filter<					
	Working shield for hi		1.88E-003	4	7.52E-003
	Working shield for hi	0	2.42E-002	5.00E-001	1.21E-002
	Total				1.96E-002

Click on the assessment case node



Dose - external exposure for each waste component and inh. exposure
 Shorter time
 Dose - external exposure for each waste component and inh. exposure

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
۵	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.

			Co	omparison of doses insi	de Safety assessment			_ 0
	🖞 Referesh table 🏼 🥥 Reset table	: 🔒 Lock table   Row merg	ng Auto-filter row Clear fil	lter 🛛 🚽 Print 🛛 🙇 Print previ	iew/export Export to Word	Copy to clipboard		
1	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 this activity is over	
	Preparation for introduction into	Dose to worker	Shorter time(+)	1.96E-002	Worker	2.00E-002		
	Lift original source shield into cell	Dose to worker	Assesment case 1(+)		Worker	2.00E-002		
	Remove source and characterize	Dose to worker	Assesment case 1(+)	5.50E-004	Worker	2.00E-002		
	Encapsulation and testing of Hig	Dose to worker	Assesment case 1(+)		Worker	2.00E-002		
	Transfer encapsulated HAS into	Dose to worker	Assesment case 1(+)		Worker	2.00E-002		
	Remove Long Term Storage Shie	Dose to worker	Assesment case 1(+)		Worker	2.00E-002		
	Total	Dose to worker		2.02E-002	Worker	2.00E-002		

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

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

•	🗄 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	Inhalation dose r	External dose rat	Exposure time (h/	Dose (Sv/year)							
Þ	Working shield for hi	0	1.88E-003	2	3.76E-003							
	Working shield for hi	ing shield for hi 0		5.00E-001	1.21E-002							
	<u>Total</u>				1.59E-002							

Now the Analysis table looks like:

2	Comparison of doses inside Safety assessment										
😰 Referesh table 🛛 😐 Reset table	🗟 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 ac					
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)

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



	Select Discussion								
List view									
		Туре		Path					
- vi	٩								
v obj	×	📃 Discussion	Dose for "Preparation for introduction into the cell"		Safety assessment				
Tree view (to add new objs.]									
		Link selec	ted object Cancel						
		t object of the type Disc dify objects' properties	ussion using List view or Tree view and click " using Tree view.	ink selected object" button. If no	ecessary 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 🔒 Lo	ck 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 int	Dose to worker	Assesment case 1	5.22E-001	Worker	2.00E-002	Dose for Preparation for		
Preparation for introduction int	Dose to worker	(+)Shorter time	1.59E-002	Worker	2.00E-002	Dose for Preparation for		
Lift original source shield into ce	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



- 🖏 Waste management activities and processes
📊 Overview of WM activities and processes
🔠 Management of the High Activity Sources in the Mobile Hotcell
🗹 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 Shie
🥳 Remove Long Term Storage Shield (LTSS) to Storage facility
the last sector of the sector

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

Put the description:			
🖳 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 hours and for Co-60 sources more than 30 min.	more t	nan 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 Analysis



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Right-click on it and select "Link to objects"

Link the discussion with the "Limit and condition" object.

	Ø		
	Туре	Name	Path
٩	•		
)	Simit and condition	Limit and condition	System description/Fa
	🖶 Safety function	Filtration	System description/Fa
			-,,

The context-dependent diagram for this discussion is:



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

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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.

	te (Bq/y) to the atmospher			h new nuclides  🖶 Print 底	Dript proviou/ovport	Incort in Word
Parameter	nuclide	Value(Bq/y)	Data source	Default	Reference	Comment
		C 1975				
ScreeningReleaseRate	Ac-228	6.71E+	SAFRAN DB			
ScreeningReleaseRate	Ag-110m	5.01E+006	SAFRAN DB			
ScreeningReleaseRate	Am-241	3.99E+005	SAFRAN DB	$\checkmark$		
ScreeningReleaseRate	As-76	4.57E+009	SAFRAN DB	$\checkmark$		
ScreeningReleaseRate	At-211	1.75E+008	SAFRAN DB	$\checkmark$		
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	×		
ScreeningReleaseRate	Bi-212	5.95E+008	8			23
ScreeningReleaseRate	Br-82	8.53E+008				
ScreeningReleaseRate	C-14	7.81E+009	5			
ScreeningReleaseRate	Cd-109	1.13E+008	5			
ScreeningReleaseRate	Ce-141	5.64E+008		e values provided with SAF	RAN. Make a copy of th	e row
ScreeningReleaseRate	Ce-144	3.39E+007	and mark it as o	lefault		
ScreeningReleaseRate	Cm-242	3.47E+006	5			
ScreeningReleaseRate	Cm-244	6.44E+005	5			
ScreeningReleaseRate	Co-58	4.71E+007	5			ОК
ScreeningReleaseRate	Co-60	7.70E+005	\$			
ScreeningReleaseRate	Cr-51	3.39E+009	٩			
ScreeningReleaseRate	Cs-134	3.22E+006	SAFRAN DB			
ScreeningReleaseRate	Cs-135	3.85E+008	SAFRAN DB	×		
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	~		

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 copy of selected rows Export to Excel Import from Excel Update with new nuclides 🖶 Print 📐 Pr											
	Parameter	nuclide	[∀] Value(Bq/y)	Data s	ource	Default						
2		Cs-137										
	ScreeningReleaseRate	Cs-137	1.97E+006	SAFRA	N DB	$\checkmark$						

Click somewhere in the row to select it.



_	Screening release rate (Bq/y) to the atmosphere for normal operation conditions Export to Excel Import from Excel Update with new nuclides Print Print Print preview/export Insert in Word										
	Parameter	nuclide	1	Data source	Default	Reference	Comment				
8	ScreeningReleaseRate	Cs-137 Cs-137	1.97E+006	SAFRAN DB							
						1/11/11/11/11/11/11/11/11/11/11/11/11/1					

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

d Make copy of selected rows Ex nuclide ♀

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 nuclides 🚽 Print 🔖 Pri										
	Parameter	nuclide	∀ 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.

	05 157		
ScreeningReleaseRate	Cs-137		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

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## 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>⊟</mark> 2 - 6	~    <del>~</del>	_	_		_	
F	ile Hom	ie Inser	t	Page Layo	ut	Formula	s
Pas	te		Cal B	ibri <i>I</i> <u>U</u> →		• 11 •	A [*]
	Clipboard	5		1	For	nt	
	A1	•	(	f		nuclide	_
	А	В		С		D	
1	nuclide	Screenin	gF I	Reference	С	omment	
2	Ac-228	6,71E+0	8				
3	Ag-110m	501000	0				
4	Am-241	39900	0				
5	As-76	4,57E+0	9				
6	At-211	1,75E+0	8				
7	Au-198	2,63E+0	9				
8	Bi-206	1,66E+0	8				
9	Bi-210	1,97E+0	8				
10	Bi-212	5,95E+0	8				
11	Br-82	8,53E+0	8				
12	C-14	7,81E+0	9				
13	Cd-109	1,13E+0	8				
14	Ce-141	5,64E+0	8				
15	Ce-144	3390000	0				
16	Cm-242	347000	0				
17	Cm-244	64400	0				
18	Co-58	4710000	0				

Change the values for first 3 nuclides.

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

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

Close Excel file.

Click on the button "Import from Excel" located on the table's toolbar.



el	Import from Excel Updat
	Data source

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

Import from MS Excel		
File Worksheet	Browse.	OK Cancel
Baramoto	s pusido Valuo(Ba/	N Data course

Select the Excel file and worksheet "ScreeningReleaseRate".

🖳 Import from N	/IS Excel		
File			
C:\Users\D	nitry\Desktop\Test.xlsx	Browse	ОК
Worksheet	ScreeningReleaseRate	•	Cancel

Click OK.

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

Scroll to the end of the table.

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

ScreeningReleaseRate	Ac-228	6.81E+008	user		
ScreeningReleaseRate	Ag-110m	5.11E+006	user	V	
ScreeningReleaseRate	Am-241	4.09E+005	user	$\checkmark$	

Note that rows were already marked as default.

Close the database table and database window.

End of advanced exercise



## **Tutorial 14. Reuse library objects**

### **Advanced exercise**

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 library¹⁴

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".

¹⁴ 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.
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🖃 🔍 Safety assessments			
🖃 🧼 Safety assessment 1			
🖃 🔍 Purposes			
- Scope			
- Approach			
🖃 🖏 Assessments for normal operation			
Assessments for accidents			
🖃 🖏 Types of postulated initiating events	(PIE ty	ypes)	
- Common endpoints			
Scenarios and impacts			
🖃 🔍 Postulated Initiating Events (PIEs)			
Scenarios			
Fire in the storage facity	P	Link PIE type	
Drop of the drum in the Drum	7		
_ 🖃 🔍 Impacts		Create impact and link it with this scenario	
⊕ elease to air (inside) in the D ⊕ € Release to air (outside) from s		Сору	
<ul> <li>Increased external exposure</li> </ul>		Cut	
🗄 🗹 Analysis	X	Delete	
- Modifications		Rename	
		Reorder	
		Print/Export	
ouble-click on tree node for default action: right-	TICK	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	<b>#</b> × ∎
ᄩ 🏄 🏨 🏨 🗙 🔡	Advanced calculations		Manage library	P
	Safety requirements			·
: 🖻 + -	Document project with MS Word add-in			
Name	Import/Export			
📄 🆓 Storag 🕀 🕅 Mea	Options	•		
🕀 🔍 Waste r	nanagement activities and processes			
🕀 🕅 Waste d	•			
📃 🔅 🖉 Safety e	elements			
⊕ Nooms				

The "Library" window will appear¹⁵.

¹⁵ In this tutorial the library distributed with SAFRAN was initially empty. If library already contains some objects they will be shown.
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ame	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)		
Ha ≾ Ha 小 Y   20   2   B + -	Show description	
Name TestL System description Site features Safety elements Waste man Waste com Waste strea Regulatory fra Safety assessr	Add Facility Add User-defined folder Reorder 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".



Library			
Name	Туре	Description	Select Cancel
Scenario Fire in storage facility Facility	Scenario		
🗱 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.



ijŽ↓   □					
• 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				
<ul> <li>Impact</li> </ul>					
Affecting	Inside				
Radiological consequences	Release of radionuclides to air				
<ul> <li>Impact - quantitative or qualitative assessment</li> </ul>	Impact - quantitative or qualitative assessment				
Quantitative/qualitative assessment	Quantitative				
Category of impact (for qualitative assessments)					
Impact - relevance					
Relevance	Relevant				
Relevance - justification (if not relevant)					
<ul> <li>Bounded by another impact</li> </ul>					

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.

End of advanced exercise



# **Tutorial 15. Complex waste streams. Check for clearance.**

#### Advanced exercise

The waste stream which was created in Tutorial 4 was intentionally made very simple. In the current tutorial, this 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.

Open Tutorial.safx project created during the performing Tutorial 5. Such file is available as Tutorials 1 - 7. safx at safran.facilia.se with menu Resources->Shared projects.

## 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



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 (located under browser window) – change the value for property "Name same as input" to "False"



•	Sorting		
1			Zoom + Zoom - Zoom to view
	Sorting Compactable waste		Sorting Sorting (Name and type - same as input in waste stream>
Pr	operties Links		
	3. 2↓ □		
	✓ General		
	Name	<name -="" and="" as="" in="" input="" same="" stream="" type="" waste=""></name>	
	Description	Made fr. process diagr. as input to Compaction.	
	Short name		
	Attachments		
	Path	System description/Facilities/Processing facility/Rooms/Sorting room/Waste manage	
1	✓ Data		
	Type of waste component	Not defined - same as input	
1	✓ Other		
	Check for clearance info		
	Name same as input	True v	
1	✓ User-defined properties	True	
	1	False	
	2		
	3		1

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

۱ 🔳	Waste component: <name -="" and="" same<="" th="" type=""><th>me as input in waste stream&gt; (System description/Facilities/Processing facility/Rooms/Sorti 🗴</th></name>	me as input in waste stream> (System description/Facilities/Processing facility/Rooms/Sorti 🗴
Pre	operties	
	2↓ 🖻	
4	General	
	Description	Made fr. process diagr. as input to Compaction.
	Name	Compactable waste
	Short name	
	Attachments	

Note that name was changed in the diagram.



Zoom + Zoom - Zoom to view
Sorting
Compactable waste

Click "Refresh" button located in toolbar to refresh also browser window:





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



🖶 Sorting	
🗯 + -	🚰 🖷 💰 🛍 🗙
E- Sorting	
	Add output with type 'same as input'
	Add output with type 'sources'
	Add output with type 'solid waste'
	Add output with type 'liquid waste'
<b>~</b>	Link safety element
*	Add Limit and condition

The new output will be added to Sorting:



Select this output. With the same steps as listed above rename it to Non-compactable waste.

Finally the browser window should looks like:



and diagram:





Close the window "Sorting"

## 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 – "Compactable waste" and "Non-compactable waste".

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 located in the left part of the window and select "Edit reduction factors" from the menu.





	🖳 Changing factors					
Recalculate factors						
$\bigcap$	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 node "Non-compactable waste" in the diagram window. 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.

## Add "check for clearance" activity to the waste stream

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



A dialog box will appear:

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🖳 WS1

Recalculate waste componnets data			
🖻 + - 🚰 🍇 🛍 💥		Zoom +	Zoom
WS1			
🛃 Add new Ch	eck for clearance — 🗌	×	
Name Check for clear Description	arance		Г
ок	Cancel		V

Leave the default name "Check for clearance" and click OK.

Note the changes in the browser and diagram– the new activity "Check for clearance" was added with two outputs.







First of the outputs starts branch for waste which can't be cleared. This is shown by the colour of the waste component but also in properties window:

	Properties	Co-60 Cs-137	
~	Other		
	Check for clearance info	Starts branch for waste which can't be cleared,	
~	User-defined properties		
	1		
			11

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

Right-click on the first (red) output and select the name "Non-compactable, non-cleared":

	Waste from producer	Ron-compactable waste —	×
		Name and description         Properties         Links         Attachments         Specific properties           Name         Non compactable, non-cleared	rthe Na
	Process 1	Description	
ompactable waste			
		Apply	
	Non- compactable waste	waste	

Click "Apply" button

Change the name for the second output to "Non-compactable, can be cleared".

The diagram will appear with new names:

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Click on the "Refresh" button **to** update names also in browser window:



# Perform check for clearance

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



The following window will appear:

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User's decisio			ОК	
<ul> <li>Waste car</li> <li>Waste car</li> </ul>	be cleared		Cancel	
Activity cond	centration val	ues (Bq/g)		
Nuclide	waste component	Criterion	]	
Co-60	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.



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".

User's decisio	ОК		
<ul> <li>Waste car</li> </ul>	Cancel		
Activity cond	centration value	ues (Bq/g)	
Nuclide	component	Criterion	
Co-60	3.09E+006	1.00E-001	
	8.59E+004	1.00E-001	
Cs-137			

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



Reset check for clearance

### Merge outputs of several activities in the same waste stream

To finalize modifications in the waste stream, it is necessary to indicate that the waste which can't be cleared will be packaged are stored in the same Drum storage room as already used in stream (using activity Storage already existing in stream).

Right-click in the browser on the Packaging and select from menu "Add waste component to merge":



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



	3			
	Туре	Short name	Name	Path
٩	2			
,	🕨 🚱 Waste component		Compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Cor
	<ul> <li>Waste component</li> </ul>	Non compactable, non-cleared	Non-compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Nor
	<ul> <li>Waste component</li> </ul>	Non-compactable, can be cleared	Non-compactable waste	System description/Waste streams/WS1/Waste from producer/Process 1/Sorting/Nor

Select the row with "Non compactable, non-cleared" as shown in the picture above. Click "Link".

Na Na	:	<b>a</b>			
List view		Туре	Short name	Name	Path
bis. I	٩	<b>A</b>			
Tree view (to add new objs.	ŀ	Waste component Waste component	Non-compactable, non-cleared	Compactable waste Non-compactable waste	System description/Waste streams/WS1 System description/Waste streams/WS1
io add		<ul> <li>Waste component</li> </ul>	Non-compactable, can be cleared	Non-compactable waste	System description/Waste streams/WS1
iew (					
lree v					
-					

Note the changes in the browser window and diagram:







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Close the waste stream window.

#### SAVING THE FILE:

Save the project.

#### End of advanced exercise



# **Tutorial 16. Multiple waste streams. Merging of the streams.**

Advanced exercise

Open project for Tutorial 15 (if closed) and save it as Tutorial 16.safx

## Prepare second stream

Add new waste from producer "Waste1"



Double-click on Waste 1 and provide data for this waste component:



饕 Show data for waste component

📕 Waste 1
-----------

	parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment
	duration		5.00E+000		year	
	annual volume of waste		1.00E+001		m3/y	
•	total volume of waste			5.00E+001	m3	
	annual mass of waste				kg/y	
	total mass of waste				kg	
	type of container					
	internal volume of container				m3	
	mass of waste in one container				kg	
	annual number of waste components				per year	
	total number of waste components					
	volumetric concentration	Co-60	1.26E+012		Bq/m3	
	volumetric concentration	Cs-137	1.30E+010		Bq/m3	
	mass concentration	Co-60			Bq/kg	
	mass concentration	Cs-137			Bq/kg	
	activity of one waste component	Co-60			Bq	
	activity of one waste component	Cs-137			Bq	
	total activity	Co-60		6.30E+013	Bq	
	total activity	Cs-137		6.50E+011	Bq	
	annual activity	Co-60		1.26E+013	Bq/y	
	annual activity	Cs-137		1.30E+011	Bq/y	

Add new waste stream WS2:



Double-click on WS2 to build diagram for new waste stream:



🔜 WS2	
Refresh diagram Recalculate waste componnets data	
2 + - 2 単 2 単 2 単 2	Zoom + Zoom - Zoom to view
<b>A</b> WS2	ws2

Right-click on WS2 node in the tree located in the left part of diagram and select Waste 1 as starting component:



Right-click on the Wastel and select "Add new activity":

#### SAFRAN 2 Tutorials



🚽 WS2						
Refresh diagram	n Re	calculate waste componnets data		-		
📓 + - 🗐 I	<u>8</u> 4	e X 🛍 X		Zoom +	Zoom -	Zoom to view
WS2	1		_			
•		Data	1 1		WS2	
		Rename	I I		waz	
		Add process	I I			
		Add existing activity	I I		Ů	
		Add new activity	1 1			
		Add check for clearance				
		Сору		<b>S</b>	•	
	1	Properties			Vaste 1	
		Overview/print/export as table				
			-			

Note that you can also right-click in the "Waste 1" node of diagram – same menu will appear:





Give name A1 to new activity

Refresh diagram Recalculate was	ste componnets data	
2 + - 2 階階 ※ 鑑う		Zoom + Zoom - Zoom to view
WS2 ••••••••••••••••••••••••••••••••••••		WS2
		Waste 1
roperties Links		
€ 2↓ E		
© Ž↓ E ✓ General		
Ceneral Name	Waste 1	
<ul> <li>♣ 2↓ □</li> <li>General Name Description</li> </ul>	Waste 1	
Seneral Name Description Short name	Waste 1	
2↓     Image: Constraint of the second	Waste 1 System description/Waste components/	
<ul> <li>2↓ □</li> <li>General Name</li> <li>Description</li> <li>Short name</li> <li>Attachments</li> <li>Path</li> <li>✓ Data</li> </ul>	System description/Waste components/	
2↓     Image: Constraint of the second		

Close window for editing waste stream diagram Select in main SAFRAN menu "View-Waste streams":



The window containing both streams defined in your project will appear:

## SAFRAN 2 Tutorials





Click in some waste component node of stream diagram to preview waste component data, for example:

Path			Zoom	+ Zoom-	Zoom to view			
System description/Waste streams System description/Waste streams								
🖉 Show data for waste component							οx	
								W82
Waste 1	_							
Add/remove nuclde View Copy to clipbo	ard WYSIV	/YG export to Excel I	Data 👻 Insert in Wo	rd document				
parameter	nuclide	user-defined value (prioritized)	SAFRAN suggests	unit	comment		^	
duration		5.00E+000		year				
annual volume of waste		1.00E+001		m3/y				u Vac∎ 1
total volume of waste			5.00E+001	m3				
annual mass of waste				kg/y				
total mass of waste				kg				
type of container								
internal volume of container				m3				
mass of waste in one container				kg				
annual number of waste components				per year				A1
total number of waste components								
volumetric concentration	Co-60	1.26E+012		Bq/m3				
volumetric concentration	Cs-137	1.30E+010		Bq/m3				
mass concentration	Co-60			Bq/kg				× ×
mass concentration	Cs-137			Bq/kg				· · · · · · · · · · · · · · · · · · ·
activity of one waste component	Co-60			Bq				Waste 1
activity of one waste component	Cs-137			Bq				
total activity	Co-60		6.30E+013	Bq				
total activity	Cs-137		6.50E+011	Bq				
annual activity	Co-60		1.26E+013	Bq/y				
		1		-			<u> </u>	
				Compac	tion	Check fo	r clearance	

Close waste component data window.



Click in check-boxes located near the stream names in the list located in the left part of the window to show/hide particular stream:

Click on the name of the stream you like to preview in the list below					
Stream	Path				
₩S1	System description/Waste streams				
₩S2	System description/Waste streams				

#### Merge streams

Now you can "merge" these two streams (with the next steps you will specify that Waste 1 which is out put of the activity A1 of the second stream will be input of the activity Storage of the first stream)

Select the name WS1 in the list and press toolbar button "Modify waste stream"

🔛 Waste streams	
Click on the name of the st	ream you like to preview in the list below Modify waste stream
Stream	Path
✓ WS1	System description/Waste streams
WS2	System description/Waste streams

The "Edit waste stream diagram" for waste streams WS1 will appear.





Note that this way to open waste stream window in only shrortcut - you could also open it by right-click menu for WS1 in Object browser tree as you did in previous tutorials.

Right-click on the Storage node:



릚 WS1			
Refresh diagram Recalculate waste componnets	data		
🖻 + - 🛛 🚰 🛍 🔏 🛍 🗙		Zoom +	Zoom - Z
WS1 WS1 Sorting Compactable waste Compaction Compactable waste Market Compactable waste Market Compactable waste Market Compactable waste Market Compactable waste Market Compactable waste Market Compactable waste	Non-compactable, non-deared Rename Edit reduction factors Add Waste component to mer Copy Cut Delete Properties	ge	
	Overview/print/export as table		

Select "Add Waste componet to merge" and (in the window which will appear) select "Waste 1" with the path "System description/Waste streams/WS2/Waste 1/A1"

The							
	<ul> <li>Waste component</li> </ul>	Non-compact	Non-compactable waste	System description/Waste streams/WS1/Waste from produc			
	😯 Waste component		Waste 1	System description/Waste streams/WS2			
,	😯 Waste component		Waste 1	System description/Waste streams/WS2/Waste 1/A1			

The tree in the left part of the screen will be modified:



Waste stream diagram will be modified also – the new node linked as input to activity Storage will appear (name of the node contains name of the relevant stream WS2):





You can click the toolbar buttons Zoom to View (or Zoom -) to see how the entire diagram was modified:





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Note that name of the output from activity storage was also modified:

You can see the properties of the new input the same way as for all other components in sttram – either by left-click on the new diagram node:

	, 200		Zoom to view					
e waste 19 pactable was Storage	te +Vion-compactable, non-cleared	l Waste (strean P/	1 (52)			ws	31	
Compacta	ble waste+Non-compactable, non-cle	_						
compact	Show data for waste component						- 0	ı x
iste nce imme								
table, nd	Waste 1					1		
able, ca	Add/remove nuclde View Copy to clipbo	nuclide	VG export to Excel user-defined value (prioritized)	Data • Insert in W SAFRAN suggests	ord document	comment		4
	duration		5.00E+000	suggests	year	_		
	annual volume of waste			1.00E+001	m3/y			
	total volume of waste			5.00E+001	m3			
	annual mass of waste				kg/y			
_	total mass of waste				kg			
_	type of container							
_	internal volume of container				m3			
	mass of waste in one container				kg			
Stora	annual number of waste components				per year			
	total number of waste components							
	volumetric concentration	Co-60		1.26E+012	Bq/m3			
Syste	volumetric concentration	Cs-137		1.30E+010	Bq/m3			
	mass concentration	Co-60			Bq/kg			
	mass concentration	Cs-137			Bq/kg			
No	activity of one waste component	Co-60			Bq			
	activity of one waste component	Cs-137			Bq			
	total activity	Co-60		6.30E+013	Bq			
	total activity	Cs-137		6.50E+011	Bq			
	annual activity	Co-60		1.26E+013	Bq/y			

Or by using "Data" menu item in the "right-click" menu for this item:

#### SAFRAN 2 Tutorials



stream	Zoom + Zoom - 2	Zoom to view	
	Waste 1 (strean	Reorder	WS1
			Waste from producer

## Common diagram of merged streams

Now you can preview two steams WS1 and WS2 together.

Close the window for editing waste stream. If you have reached it from the "View->Waste streams" main menu, you will immediately see diagram of two streams. Otherwise open "Waste streams" window with the "View->Waste streams" main menu.





Note the link from the Waste 1 component of the WS2 stream to the Storage activity of the WS1 sttream. Scroll vertically down and use Zoom - to see the relevant part of diagram:





Use "Zoom to View" toolbar button to preview the entire diagram:

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2020-12-29



Note that gray node with waste component and waste stream name shown for the WS1 when we edited it alone did not appear because tow sttreams are present on the screen. This node will appear if you will hide WS2 with check-box in the list located in the left window.



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You can also use the same window to preview each individual stream.

Unclick "WS1" in the left window – diagram will be updated and will show only stream WS2. Note that for stream WS2 a new node (not present when both steams are shown) is added when steam WS1 is not shown. This new node presents waste management activity Storage of steam WS1 to which component Waste 1 is merged.



Unclick "WS2" and click "WS1" – stream WS1 will be shown and addional node presnting its merging to stream WS2:

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Close the "Waste Streams" window.

SAVING THE FILE:

Save the project.

End of advanced exercise