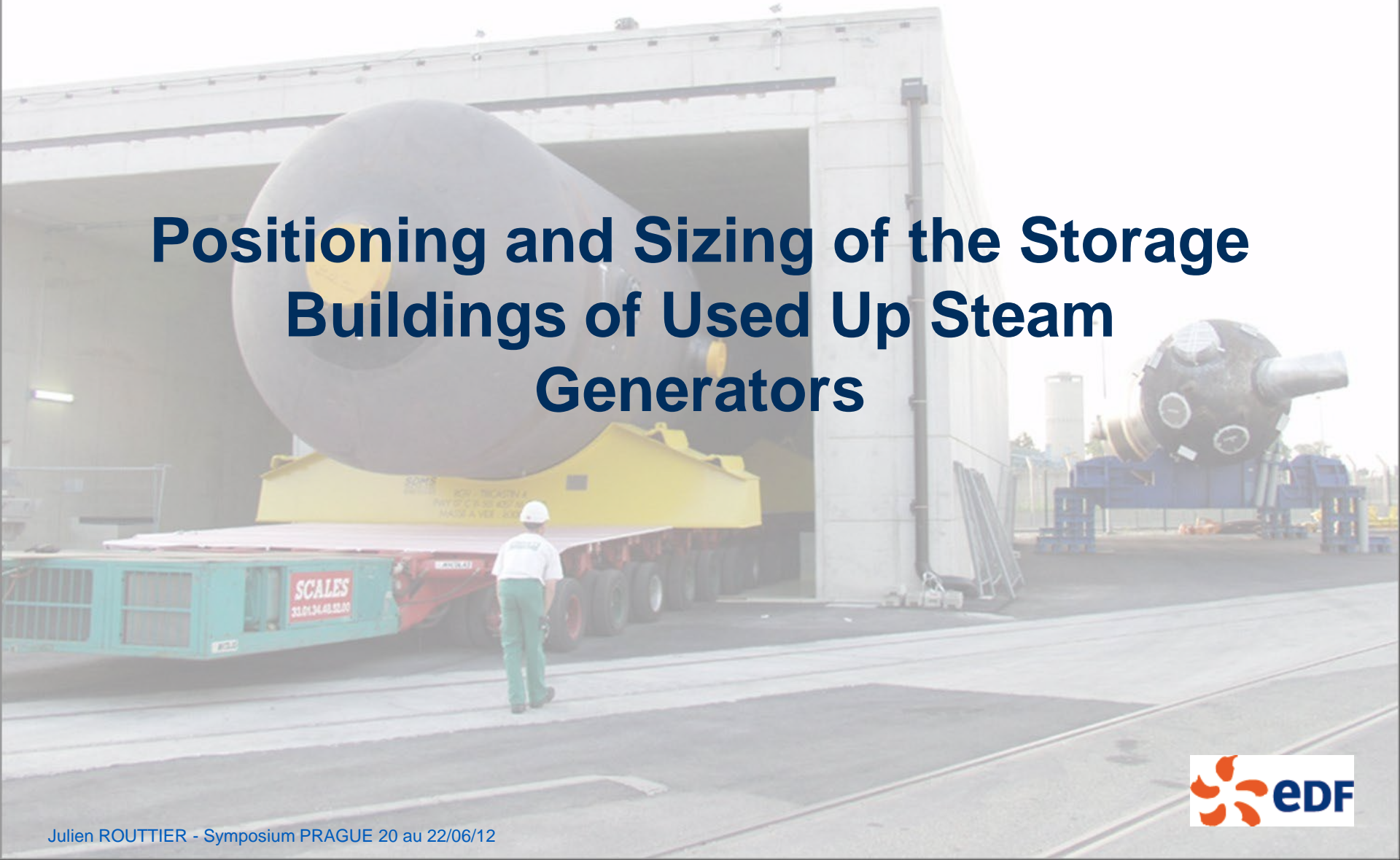


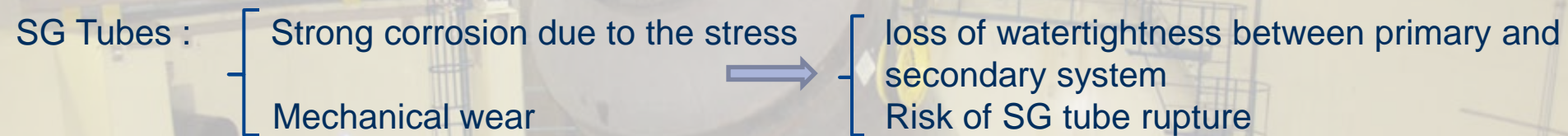


Positioning and Sizing of the Storage Buildings of Used Up Steam Generators



Replacement of Steam Generators : Why?

➤ Starting point:



➤ Short term Solution:

Plugging of the defected tubes...BUT...maximum plugging rate limited to 10-15%

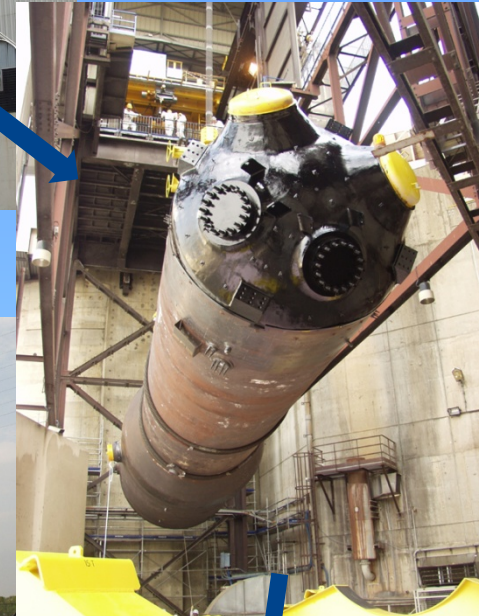
➤ long term Solution :

Replacement of used up Steam Generators with new ones

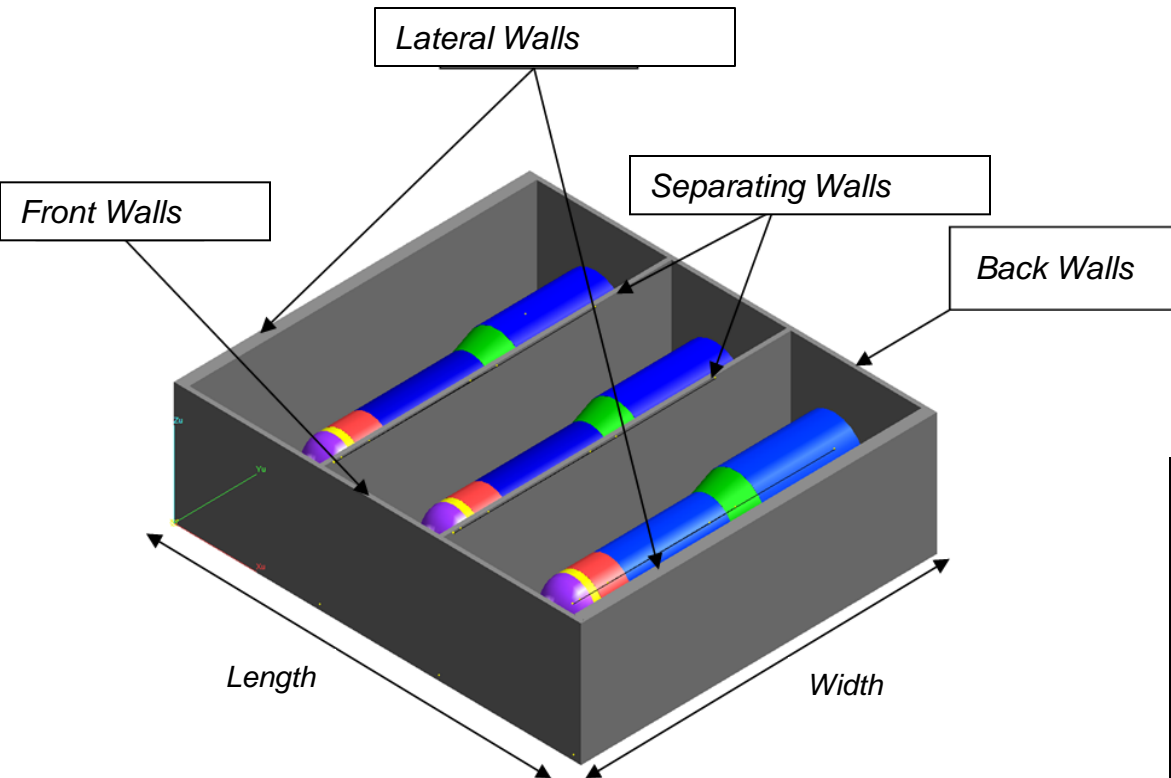
➤ Outcome:

Used SG radioactive with radioactive deposits = transfer to a storage building

TRANSFER KINEMATICS



WHAT ABOUT THE SG STORAGE BUILDING ?



900 Mwe Storage Building Size :

Length : 29 m

Width : 25 m

Height : 9 m

Lateral walls thickness : 80 cm

Front and Back side walls thickness : 30 cm

Separating walls Thickness : 30 cm

Roof thickness : 40 cm

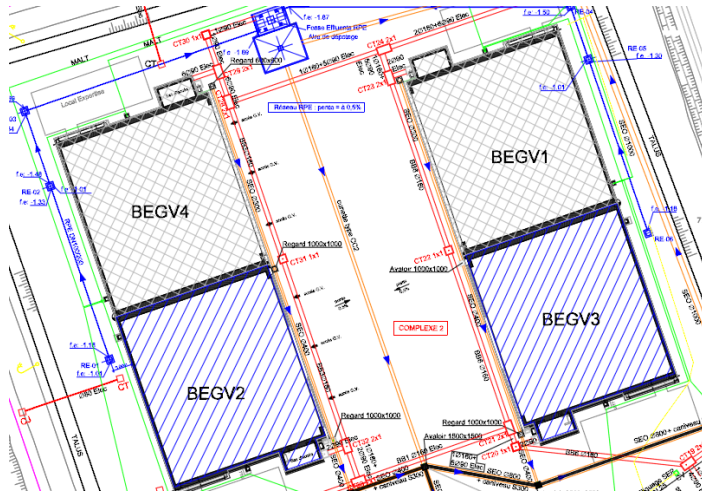
Matériau : Concrete

PROBLEMATIC AND GOALS OF THE STUDIES

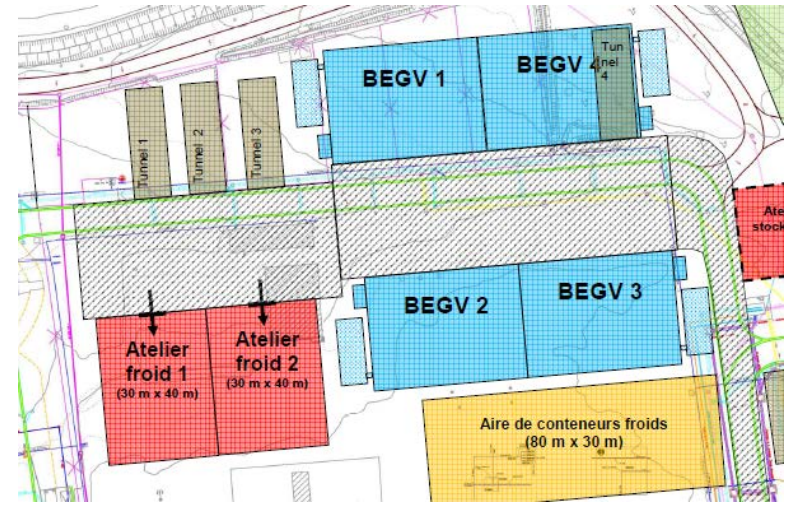


SG Replacement acceleration process:

- 9 SGR 900 MWe from 2011 to 2016, 14 SGR 1300 MWe from 2015 to 2021
- Commissioning of several SG Storage Buildings on a same nuclear site in a short period



Position of future SG Storage buildings in Cruas



Position of future SG Storage buildings in Paluel

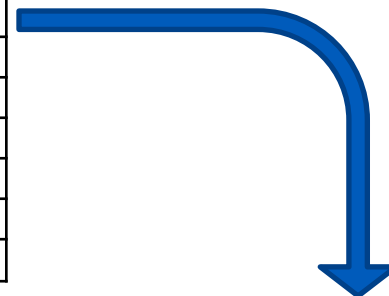


Designing of Tools in order to justify respect of Radioprotection Requirements

SG STORAGE BUILDINGS STUDY APPROACH

1/ RECALL / RADIOPROTECTION REQUIREMENTS

	Limits en (µSv/h)	
Public Area (110 nSv/h)	0	0,11
Nuclear Site public Area (0,5µSv/h)	0,11	0,5
Monitored Area	0,5	7,5
Green Controlled Area (7,5µSv/h)	7,5	25
Yellow Controlled Area (25µSv/h)	25	2000
Orange Controlled Area (2mSv/h)	2000	100000
Red Controlled Area (100mSv/h)	100000	



Site Boundary:

Dose Rate on the site Boundary = Natural radioactivity + Dose Rate added by other nuclear buildings < 110 nSv/h

Around Storage Building:

Dose Rate < 0,5 µSv/h

(Restricted monitored Area around SG Storage Building can be authorised (if marked) according to feedback)

Used SG Transfer:

Temporary radiological zoning regulation Setting up

SG STORAGE BUILDINGS STUDY APPROACH 900 MWe

2/ USED COMPUTER CODES

PANTHERE V1

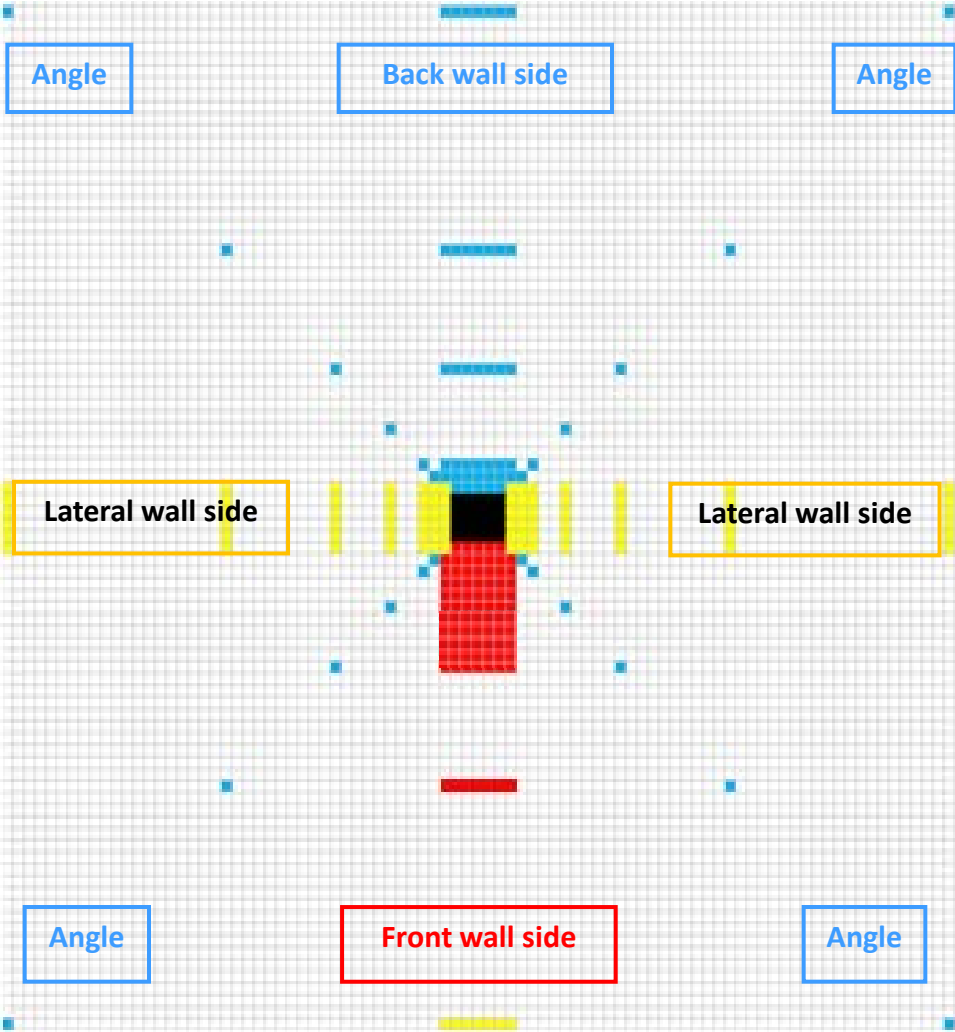
- Calculations of direct dose rate
- Straight line attenuation code

MICROSKYSHINE 2.11

- Dose rate calculations of sky shine effects

TRIPOLI 4.6

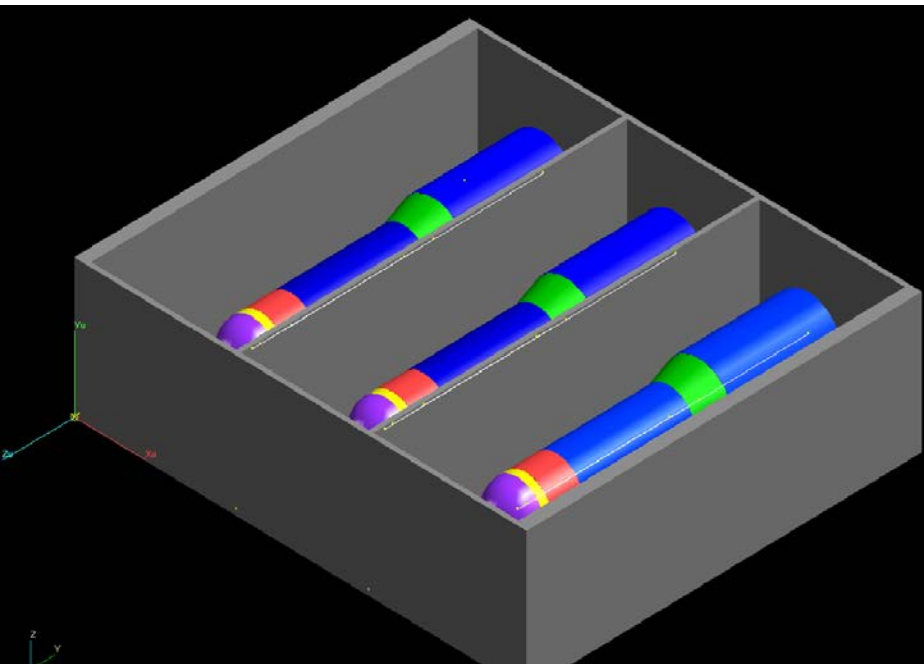
- General Monte Carlo 3D code dedicated to transportation of both neutrons and photons



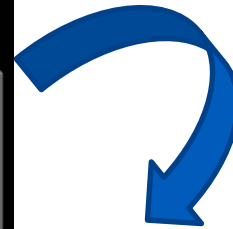
Résultats	
	MICROSKYSHINE
	PANTHERE + MICROSKYSHINE
	TRIPOLI 4.6

SG STORAGE BUILDINGS STUDY APPROACH 900 MWe

3/ PRESENTATION OF RESULTS: EXCEL TOOL



Panthere modelisation



Excel Tool

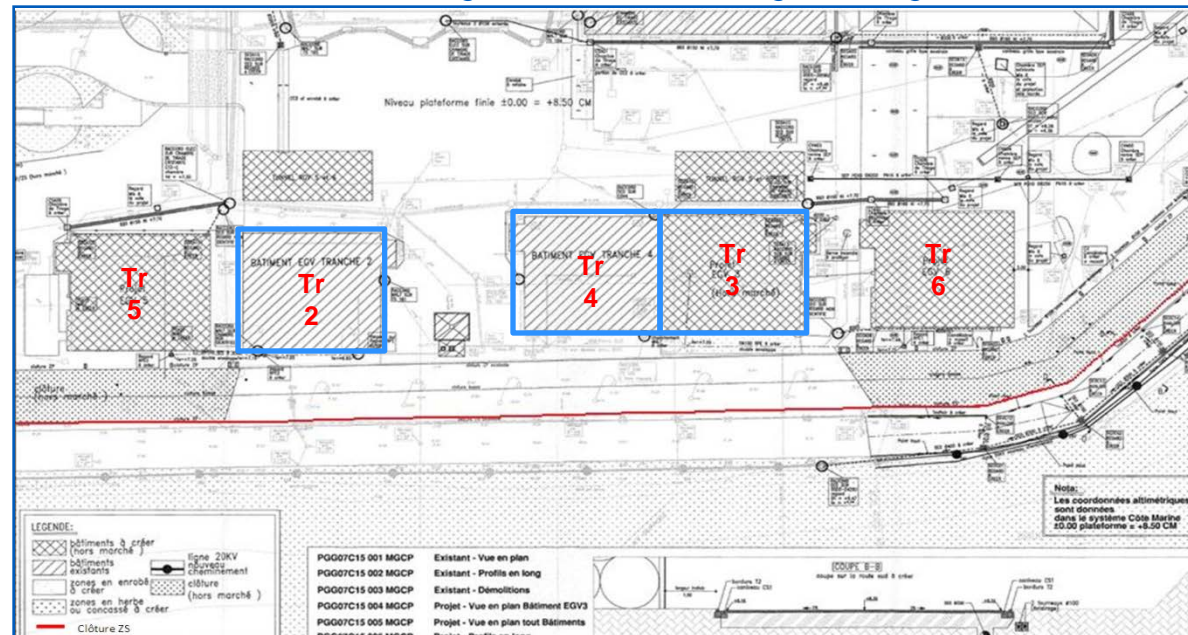
The Excel Tool interface consists of a form on the left and a large data grid on the right. The form is titled "Créer 1 BEGV ou 2 BEGV accolés" and includes fields for "Intitulé du BEGV", "Type de configuration" (radio buttons for "1 BEGV seul" and "2 BEGV accolés"), "Coordonnées (Angle bas gauche (côté BAE) du BEGV)" with "Abscisse" and "Ordonnée" fields, "Date de mise en service des BEGV (Ex 10 janvier 2011)" with "BEGV n°1" and "BEGV n°2" fields, and "Activités enveloppes des sources du BEGV n°1 en GBq/m2" and "Activités enveloppes des sources du BEGV n°2 en GBq/m2" with "Co60", "Faisceau tubulaire", and "BAE" fields. At the bottom, there is a note: "A renseigner uniquement si Type '2 BEGV accolés' sélectionné". The data grid on the right is a large table with columns numbered 0 to 215 and rows numbered 0 to 165. The grid contains numerical values, with some cells highlighted in yellow and others in black, representing data points for the storage buildings.

SG STORAGE BUILDINGS STUDY APPROACH 900 MWe

4/ CASE STUDY: SGR GRAVELINES 3 in 2012



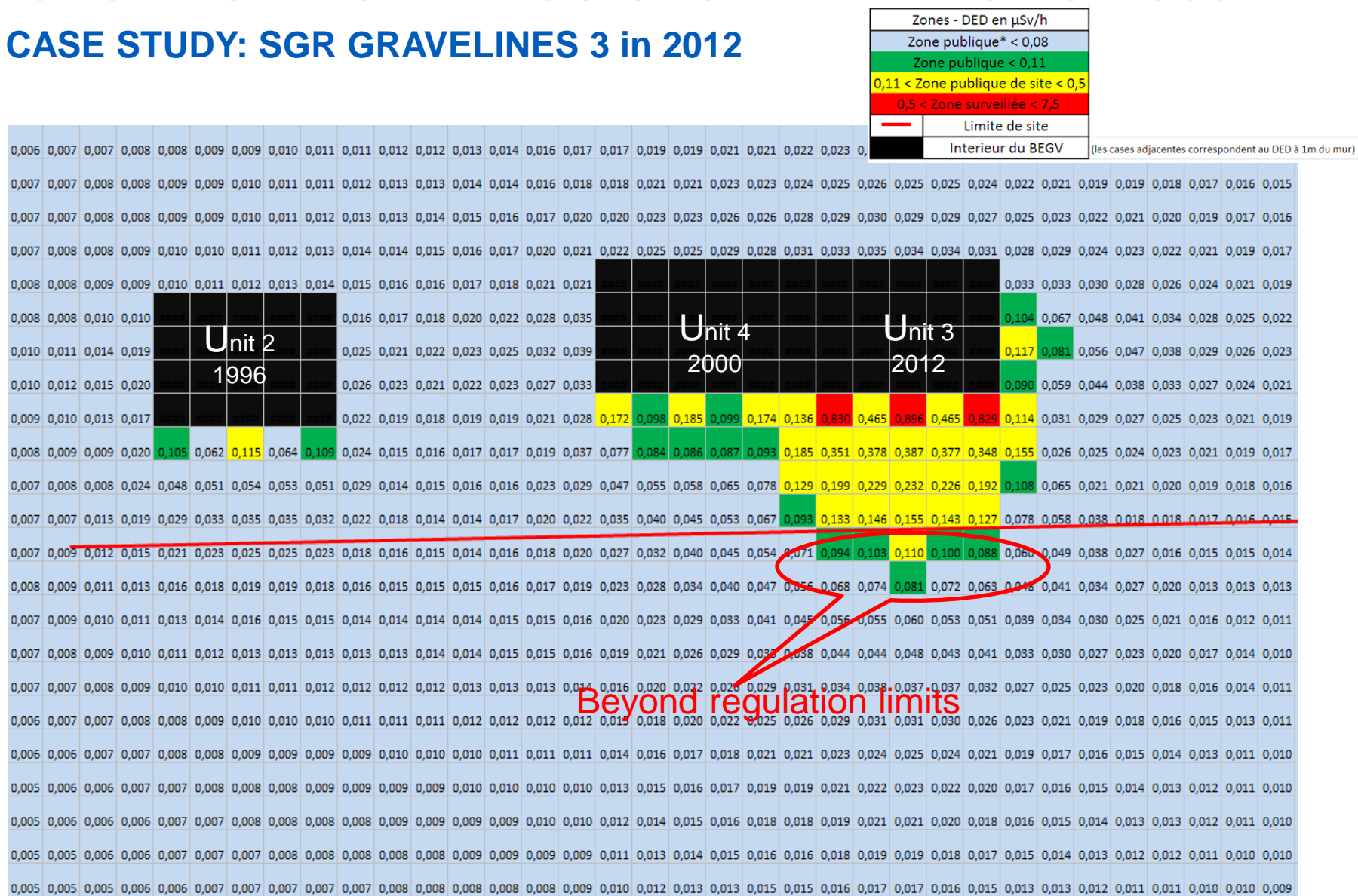
Position of existing and future SG Storage buildings



Gravelines		
n° Nuclear unit	Date	Constructed
1	1994	Yes
2	1996	Yes
3	2012/04	Yes
4	2000	Yes
5	2016/07	No
6	2016/10	No

Construction

4/ CASE STUDY: SGR GRAVELINES 3 in 2012



Isodose Curves of Gravelines Storage Buildings

4/ CASE STUDY: SGR GRAVELINES 3 in 2012

Chosen Solution

Decrease of Dose Rate coming from Nuclear plant's other outfits and activities (Storage Building non included)

How ?

Transfer of the surrounding low level waste Area (TFA) in 2011/12

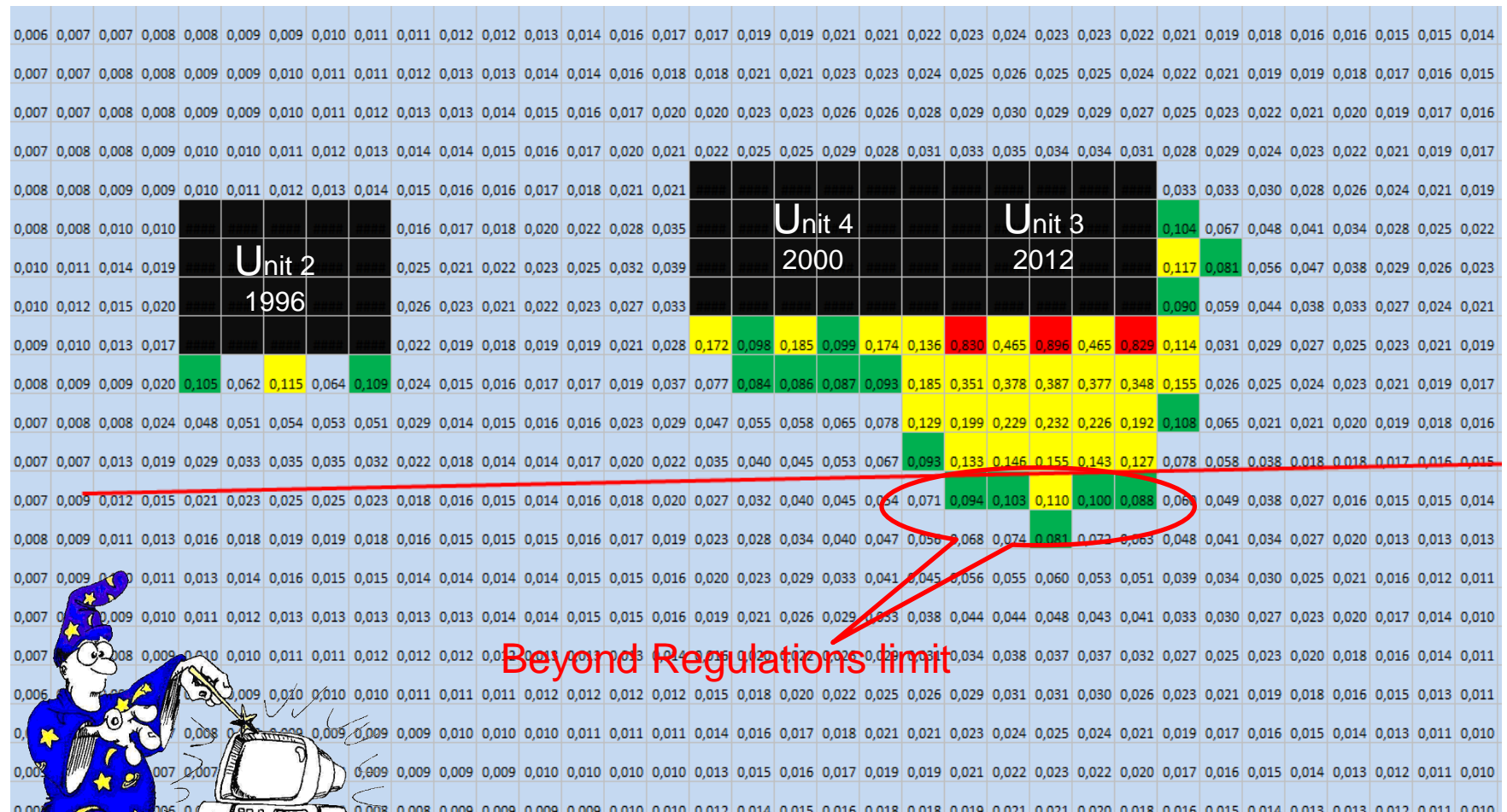
Outcome ?

Ambient measure DR= Natural DR + Existing Storage Building DR + Other Buildings DR



SG STORAGE BUILDINGS STUDY APPROACH 900 MWe

4/ CASE STUDY: SGR GRAVELINES 3 in 2012



Beyond Regulations limit

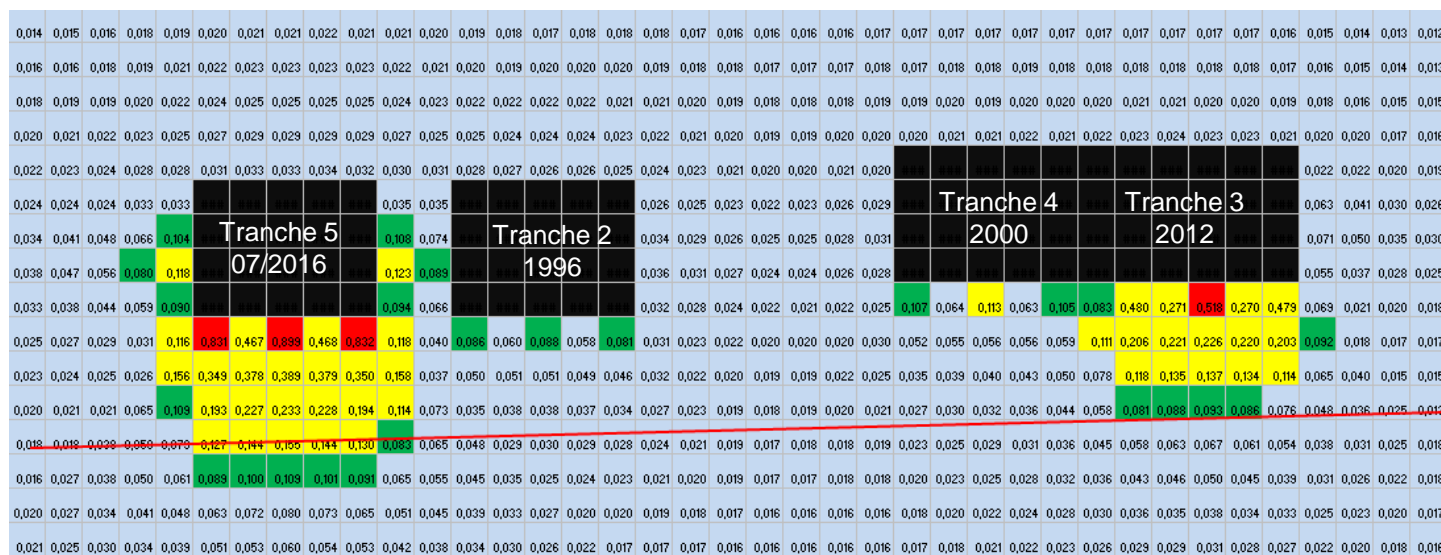


Close survey of Gravelines Storage Buildings After Siting of Storage Buildings in low level waste Area

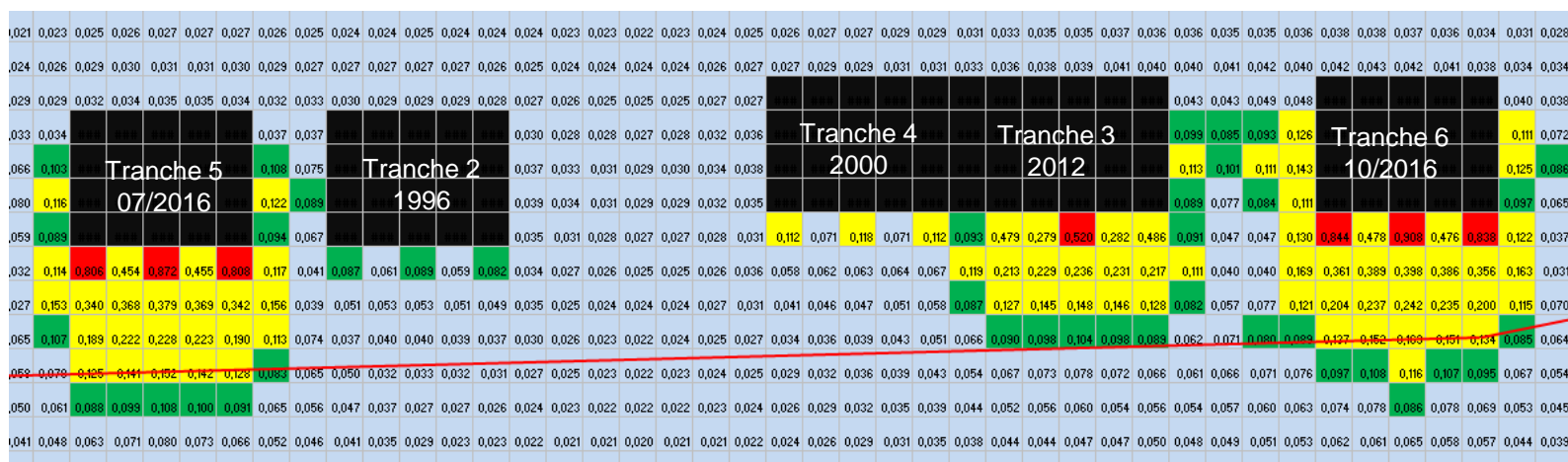
SG STORAGE BUILDINGS STUDY APPROACH 900 MWe

4/ CASE STUDIES: SGR GRAVELINES 3 in 2016

Isodose curves in
2016/07



Isodose curves in
2016/10



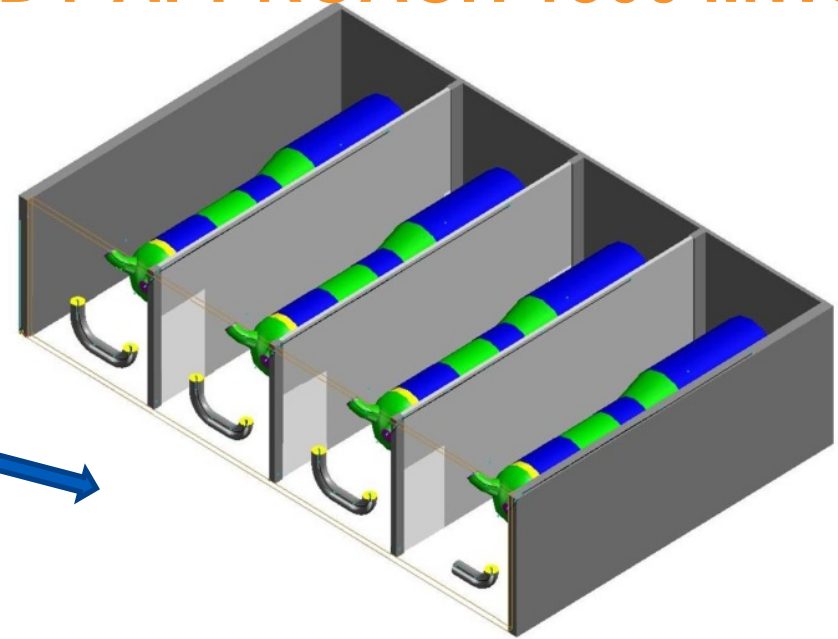
SG STORAGE BUILDINGS STUDY APPROACH 1300 MWe

1/ SIZING OF THE BUILDING

➤ Requirements found after Studies:



- ✓ *Thickness: 55cm for the lateral walls and the roof, whatever the configuration*
- ✓ *Paluel's specificities: thickness 55 cm for front walls / stored cross over leg*
- ✓ *Other 1300 MWe nuclear Units: thickness 40 cm for front walls (preserving configuration)*



PALUEL Unit 2 : Storage of 4 used SG
With primary elbows and 3 + ½ cross over legs

1

On the site boundary, no restraint (110 nSv/h respected beyond 5m)

2

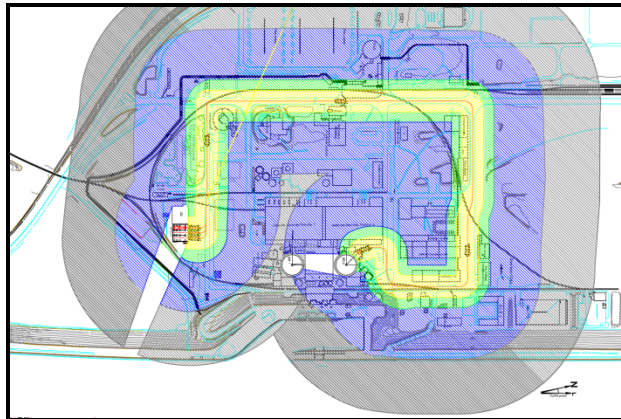
On the building surroundings, sizing is required in order not to go higher than 0,5 µSv/h

3

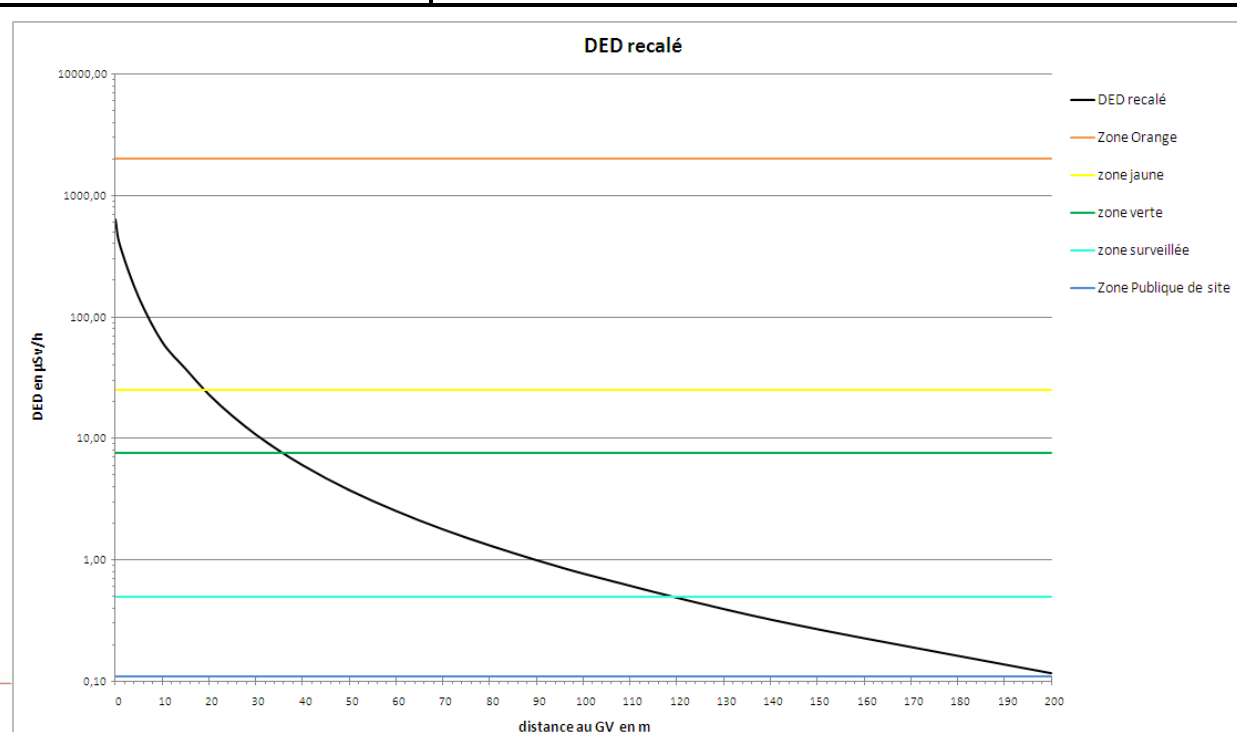
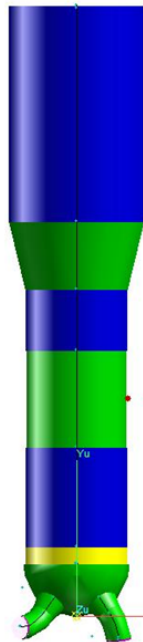
Following work on isodose curves

SG STORAGE BUILDINGS STUDY APPROACH 1300 MWe

2/ ISODOSE CURVES REALIZATION

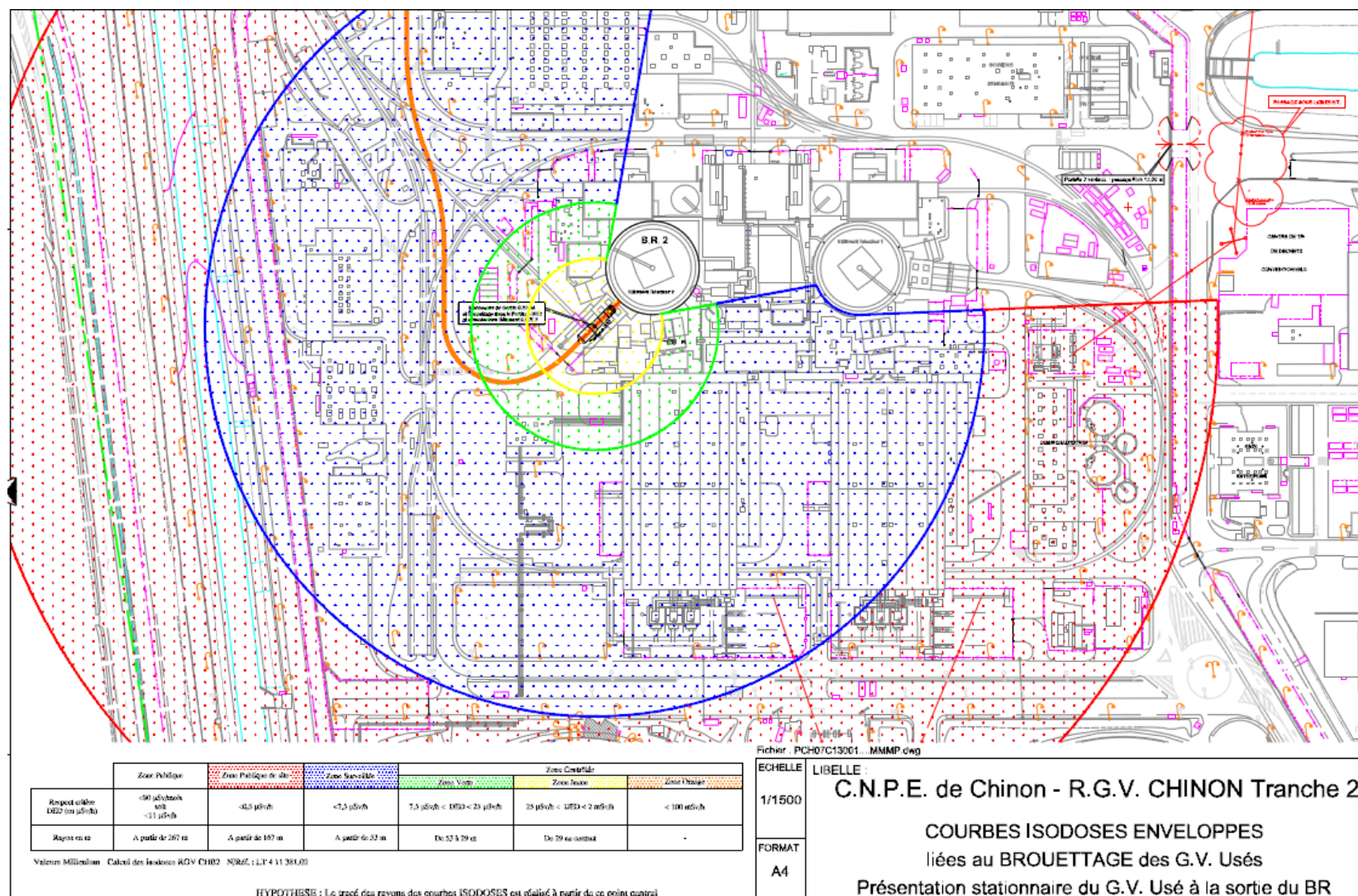


	Limits en ($\mu\text{Sv/h}$)	
	0	0,11
Public Area (110 nSv/h)	0	0,11
Nuclear Site public Area (0,5$\mu\text{Sv/h}$)	0,11	0,5
Monitored Area	0,5	7,5
Green Controlled Area (7,5$\mu\text{Sv/h}$)	7,5	25
Yellow Controlled Area (25$\mu\text{Sv/h}$)	25	2000
Orange Controlled Area (2mSv/h)	2000	100000
Red Controlled Area (100mSv/h)	100000	



SG STORAGE BUILDINGS STUDY APPROACH 1300 MWe

2/ ISODOSE CURVES REALIZATION



SYNTHESIS



1

Site Boundaries:

900 MWe Storage Buildings: Use of the Excel Tool to resolve the Dose rate overtaking problematic on the site boundaries

While Storage Building is stuck to the enclosure, it is necessary to remove all kind of surrounding radioactivity source.

1300 MWe Storage Buildings: The sizing calculations in order to respect the surrounding regulation is enough to make sure it never goes higher than 110 nSv/h on site boundaries



2

Around Storage Building:

1300 MWe Storage Buildings: Sizing calculations in order to respect public area Dose rate limit lower than 0,5 μ Sv/h



3

Used SG Transfer:

1300 Mwe Storage Buildings : designing of a tool allowing visualisation of temporary isodose curves on the site during used SG transfer

CONCLUSIONS



PRACTICAL AND USER-FRIENDLY EXCEL TOOL HIDING COMPLEX MODELISATION CALCULATIONS UNDER SEVERAL CALCULATION CODES



TOOLS ARE AVAILBALE FOR BOTH NUCLEAR PLANTS WORKERS AND NUCLEAR ENGINEERING UNITS, AND ABOVE ALL FOR NON RADIOPROTECTIONIST USERS



EFFICIENT REINFORCED LINKS BETWEEN RADIOLOGICAL PROTECTION CALCULATION DOMAINS AND OTHER TECHNICAL PROFESSIONS OF THE NUCLEAR DOMAIN

THANK YOU FOR YOUR ATTENTION