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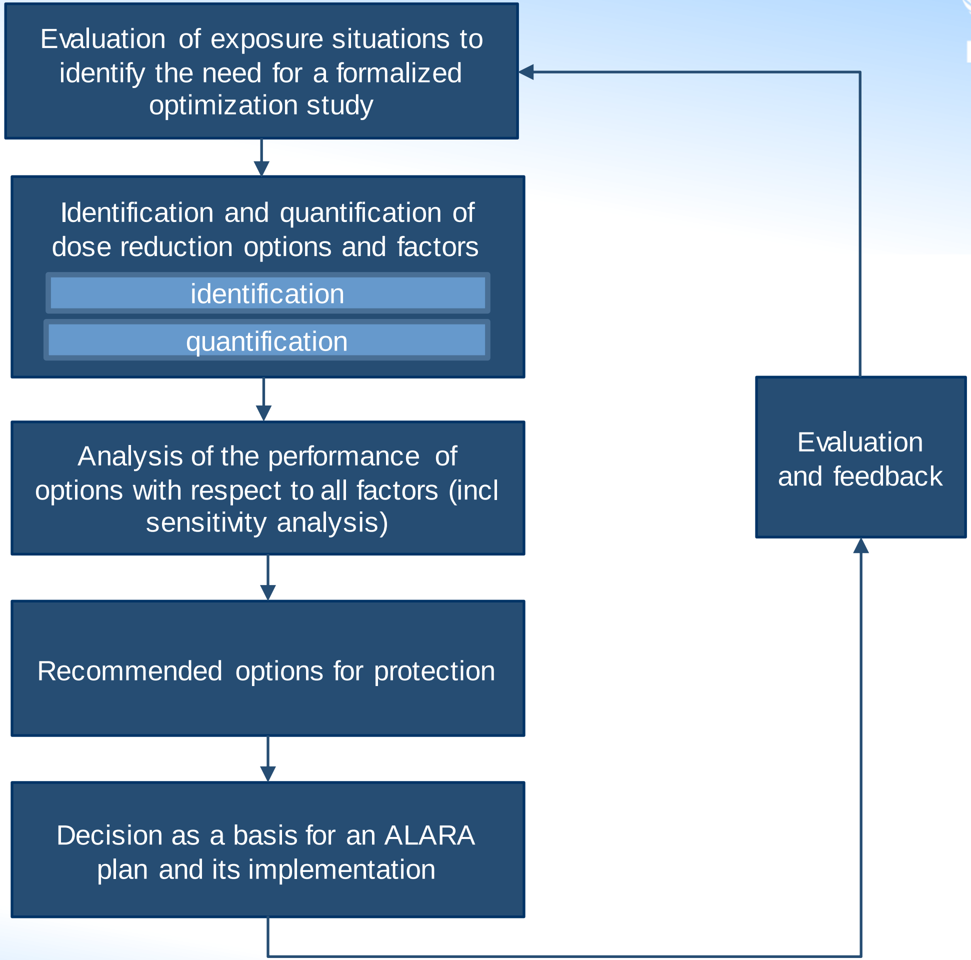
6. Case Study 3: Optimization of occupational radiation protection in the French PWRs Steam Generator Replacements

The case study

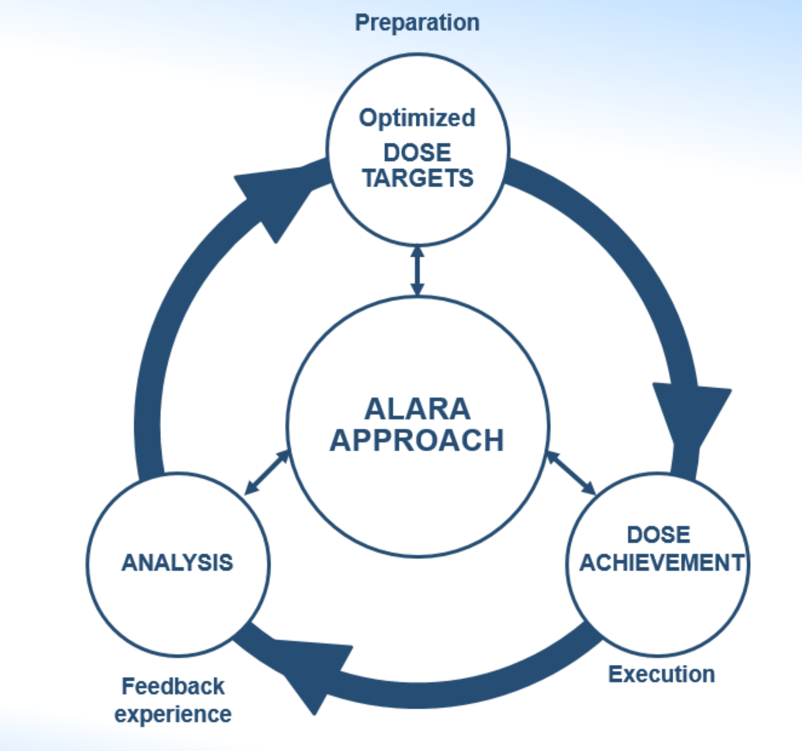
This case will be divided into 3 parts:

1. Why to perform a **steam generator replacement** (SGR)?
    - *What is a steam generator in a Pressurised Water reactor type?*
    - *The inconel 600 tubes Corrosion and Cracking*
    - *The different steps before to be obliged to replace the SG*
2. Implementation of optimization approach/ procedure for the first 900 MWe reactors (3 loops) SGR's
    - *The stakes*
    - *The first French SGR at Dampierre 1 in 1990*
    - *Use of feedback for preparing the next SGR's on 900 MWe units*
3. After more than 20 years, the preparation of the second wave of SGR on the 1300 MWe reactors (4 loops), in an ALARA perspective

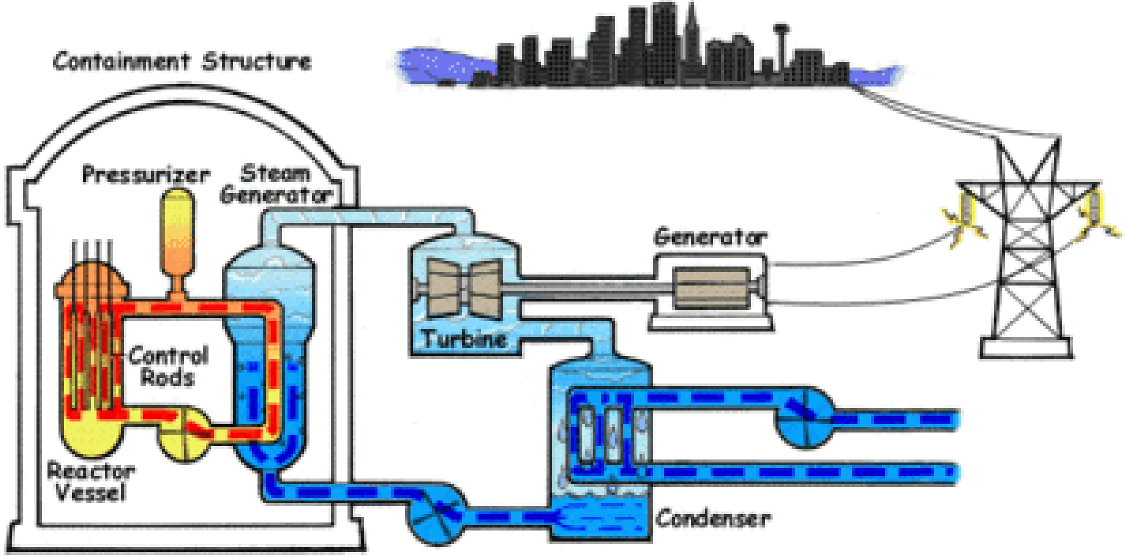
The radiation protection optimization procedure is a simple checklist that structures the efforts to solve problems and reach a decision in radiation protection…



… Within a global ALARA approach following the operational phases of any activity

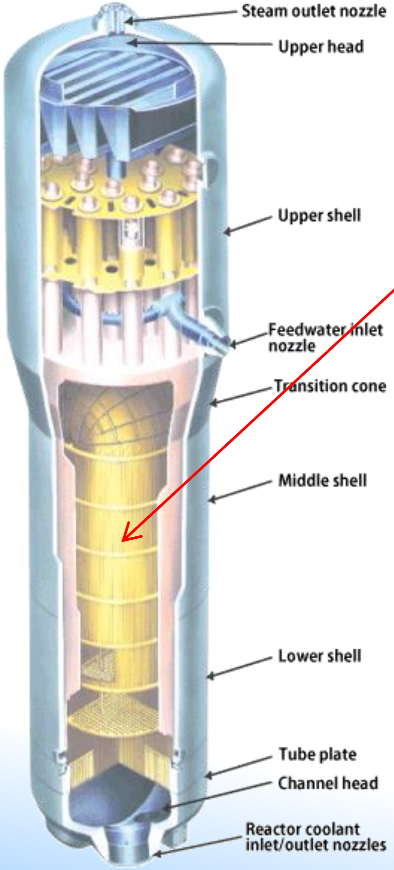


How does a PWR work?



In a PWR, the primary coolant (water) is pumped under high pressure to the reactor core where it is heated by the energy generated by the fission of atoms. The heated water then flows to a steam generator where it transfers its thermal energy to a secondary system where steam is generated and flows to turbines which, in turn, spin an electric generator.

Origin of the problem



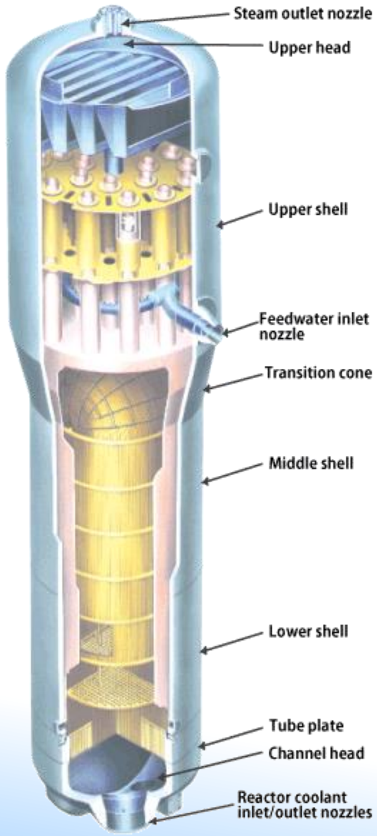
3500 to ± 6000 tubes

Most of the older steam generator tubes were built with a special alloy, the inconel 600.

However after several years of reactor operation, they became corroded and there was a risk of tube cracking, in particular when they were not heat treated.

Any crack in the tube is a break of the first safety barrier, the secondary coolant becomes immediately highly contaminated, and is going outside of the controlled area, which is totally unacceptable from a nuclear Safety point of view.

Why to replace the Steam generators?

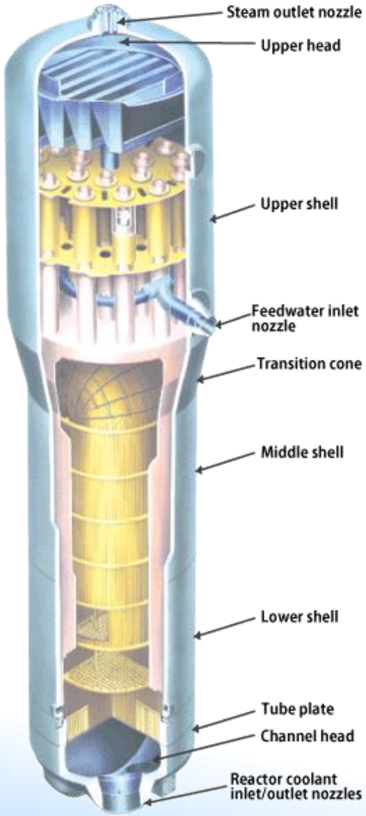


The cracking's may be discovered making use of different non destructive testing methods (ultra sound, …).

When an indication of a starting for a crack is discovered in a tube, it has either to be treated by shot pinning for example to reinforce the tube not to allow the crack going through the tube, or the tube has to be plugged (both side of the water chamber) not allowing any more the primary coolant to go into that tube

During the end of the 80’s in France many shot pinning's have been implemented giving rise to high individual and collective doses

Why to replace the Steam Generators?



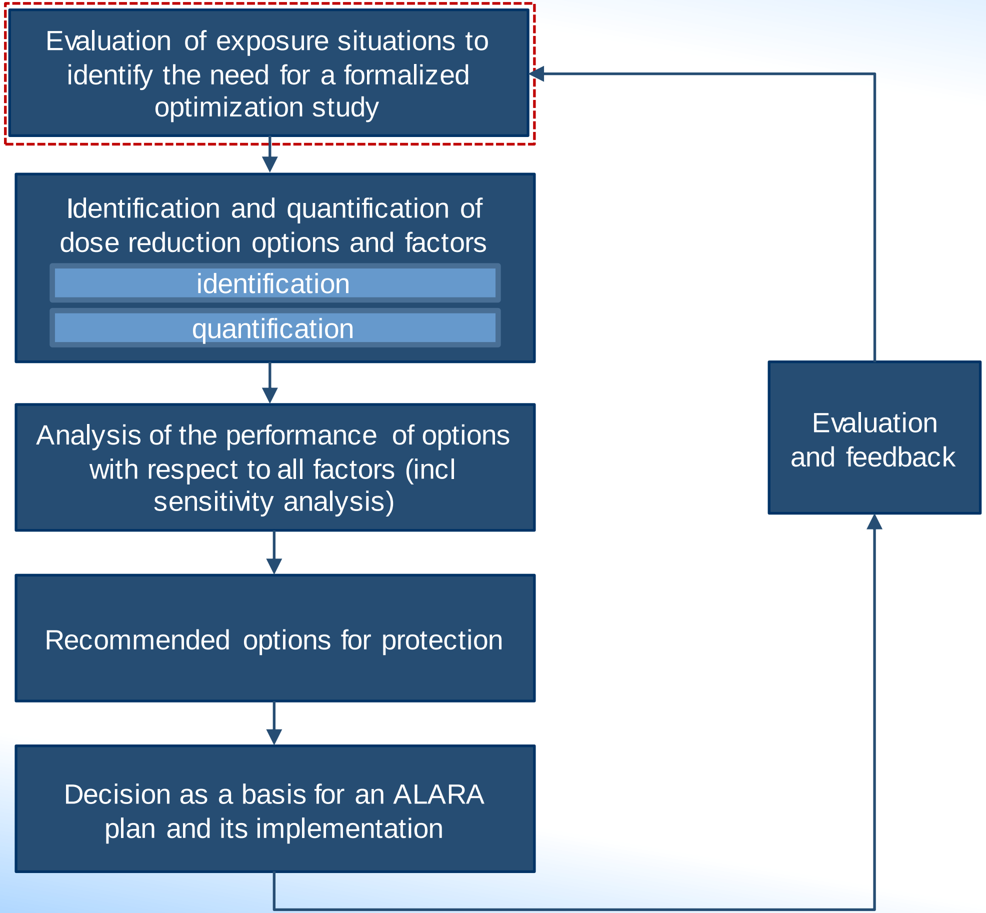
When the number of plugged tubes becomes too important it has an impact on the capacity of the reactor to produce electricity;

It becomes an economical need when 15 % of the tubes are plugged the capacity to generate electricity becomes insufficient from a profitability point of view; therefore the steam generator has then to be replaced.

Some plants have only 2 Steam Generators, some other have 3 or even 4 SGs. When performing a SGR in a reactor building all 2, 3 or 4 SGs are replaced together

In France the older reactors have 3 SGs they are the 900MWe reactors while the more recent have 4 SGs they are the 1300MWe reactors

Implementation of Optimization procedure



For the first 900 MWe Reactor Steam Generator Replacements, we will check what is at stake in order to define the efforts to be first implemented during an ALARA study

What is at stake?

When started the preparation of the first SGR in France at Dampierre 1, end the 80's, it was obvious that it was a very difficult job to be performed: to take off such a big component, belonging to the primary circuit i.e. heavily contaminated, was not trivial at all, neither from a technical nor from a radiological protection point of view as well as for the importance of workload (tenths of thousands hours) and number of workers involved (some hundreds).

Of course the first thing was to have a look at what has been performed elsewhere. From the doses point of view it confirmed that they were high.

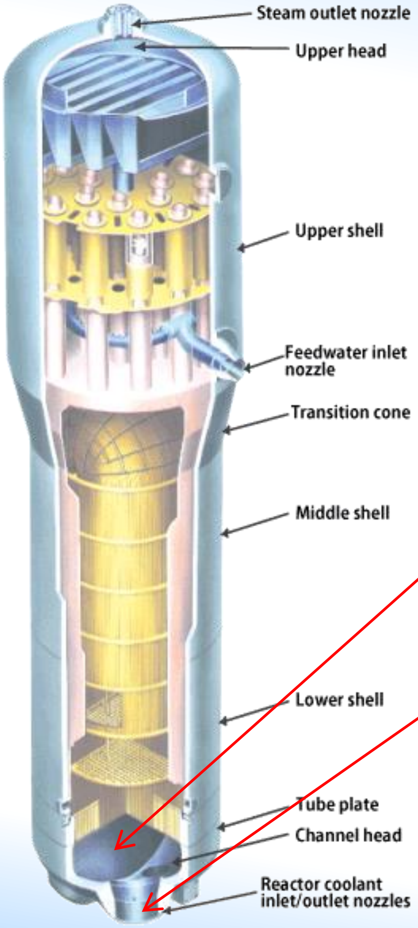
But it also demonstrated that drastic improvements have occurred, and that surely it was possible to go on.

What is at stake?

Previous foreign results collective dose per SG in Man Sv

Plant	Country	Year	Total SGR dose (man.Sv)	Dose per SG (man.Sv)	Nbr Of SG
Surry 2	USA	1979	21,41	7,14	3
Surry 1	USA	1981	17,59	5,86	3
Turkey point 3	USA	1981	21,51	7,17	3
Turkey point 4	USA	1983	13,05	4,35	3
Obrigheim	Germany	1983	6,9	3,45	2
Point beach 1	USA	1984	5,9	2,95	2
Robinson 2	USA	1983	12,06	4,02	3
Cook 2	USA	1988	5,61	1,4	4
Ringhals 2	Sweden	1989	2,9	0,97	3

What is at stake?



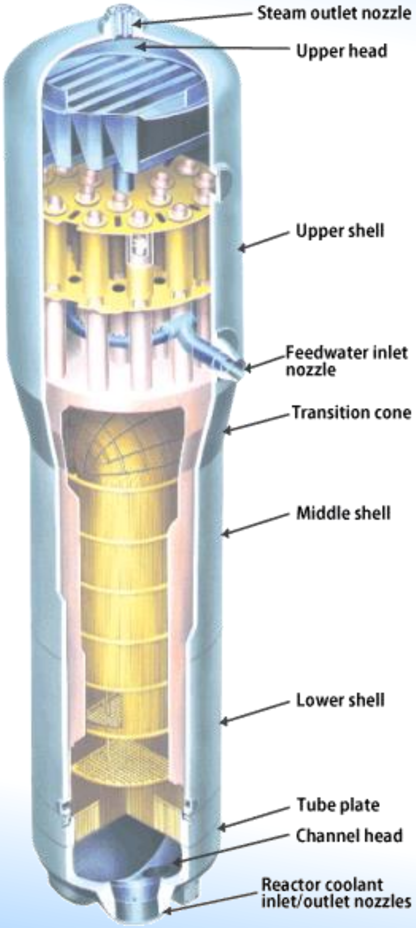
Quite a lot of tasks will have to be performed inside the channel head, or near by the primary pipes with ambient dose rates respectively of 8/12 mGy/hour and 0.1/0.5 mGy per hour.

Staying in the channel head 2 hours would have led to reaching 20 mSv and staying 5 hours, 50 mSv

So, for an SGR, a large part of the work has to be performed in very high dose rate areas, and the workload being very important, the total collective dose was also going to be very important

Therefore implementing formally the ALARA approach was mandatory, putting quite a lot of resources for performing the predictive analysis, the follow up and the feedback analysis

There is a need to implement a formalised study



Evaluation of exposure situations to identify the need for a formalized optimization study

yes

Identification and quantification of dose reduction options and factors
- identification
- quantification

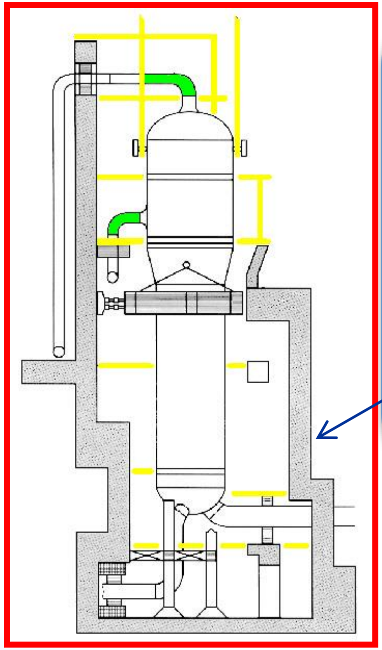
Analysis of the performance of options with respect to all factors (incl sensitivity analysis)

Recommended options for protection

Decision as a basis for an ALARA plan and its implementation

Evaluation and feedback

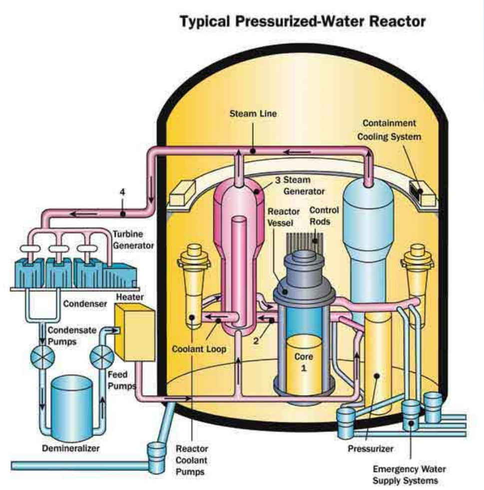
What would you do at that time in order to start implementing Optimization? (1)



A few indications of scale:

* weight more than 500 tons
* height more than 20 meters
* between 100 and 200 kilometres of tubes within a single steam generator.

* Each SG in a concrete bunker
* 3 per reactor building
* other components will remain in place: reactor pool, the rest of primary secondary circuits, pumps,……



What would you do at that time in order to start implementing Optimization? (2)

To go and to look at the feedback experience from others; results, problems, solutions, good practices

Imagine several technical scenarios and for each describe a sequence of operations

Assess dose rates and doses for each operation; but how?

How to implement Optimization for such a huge maintenance work? The first SGR at Dampierre (1)

Looking at the places where the operations had to be performed leaded to determine a few tenths of areas with significantly different ambient dose rates and contaminations risks.

Each scenario comprised about one thousand of elementary tasks

It was possible to precise in which area each task was performed

However many tasks were modifying the dose rate conditions (as well as contamination risks) for example removing the old SG, corresponded to the removal of an important source in the SG containment and also to the removal of a kind of shielding with regards to other sources, in a very complex geometry, what was then the expected results in terms of dose rates?

How to implement Optimization for such a huge maintenance work? The first SGR at Dampierre (2)

This led to a quite long ALARA preparation phase and the development of several specific analytical tools and software's, for estimating dose rates, and collective doses per task, per specialty, per area…

And that in order to be able to answer to the questions

Who? When? Where? and How?

Who will undertake the doses?
When will they undertake these doses (at the occasion of which task(s)?)
Where (In which area)?
And how (in which dose rate and working conditions context…)?

Try to answer to these questions is mandatory for finding the most adapted radiation protection actions

We will not focus on these software's now as they are not available on the market. Available tools will be presented in another case study.

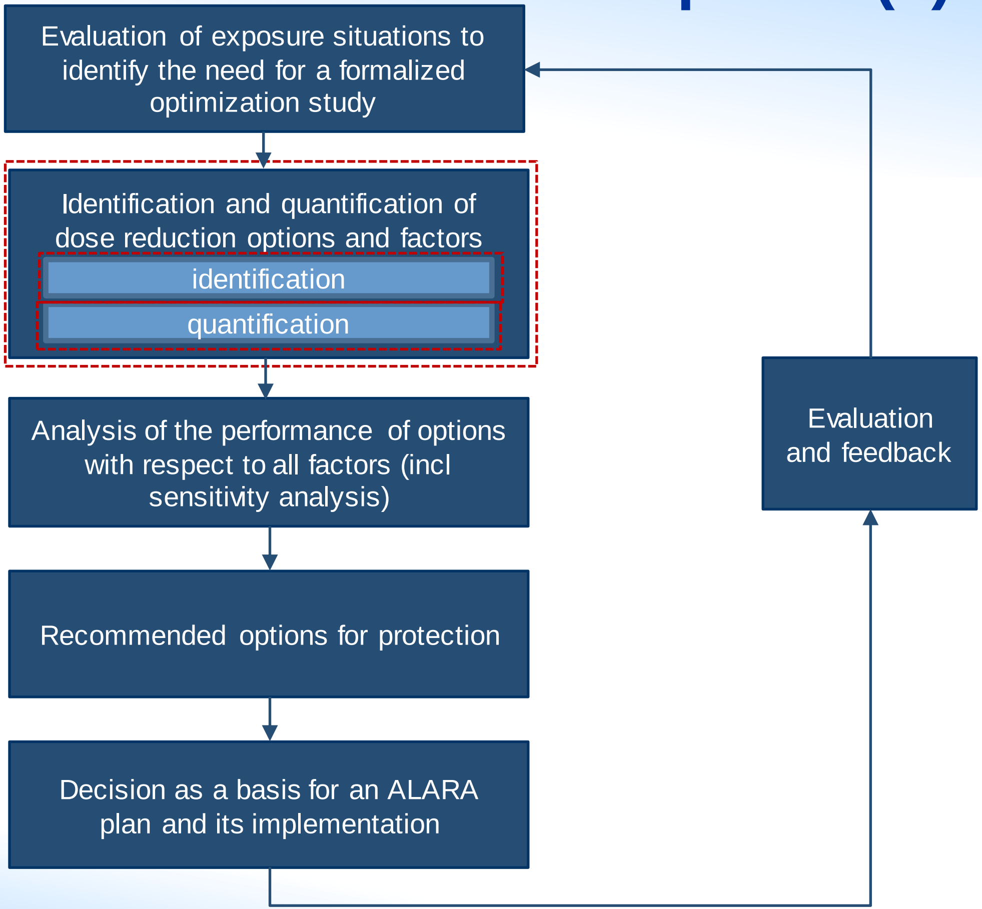
How to implement Optimization for such a huge maintenance work? The first SGR at Dampierre (3)

Who?

When?

Where?

and How?



How to implement Optimization for such a huge maintenance work? The first SGR at Dampierre 1 (4)

It is not then surprising that the burden of the ALARA study exceeded several man-years, it started several years before the SGR performance.

A special team was set up with engineers from EDF, Framatome the main contractor and provider of the new SGs and from an ALARA expert team (CEPN)

The doses of each task, area, worker specialty were estimated, and then several project reviews were made to brainstorm and propose radiological protection actions

A first lesson is that a few tenths of tasks were considered as un-useful and then scratched; many other options were envisaged, dealing with:

1. Suppressing sources in the containment by decontamination
2. Dismantling some small contaminated pipes
3. Installing biological shielding

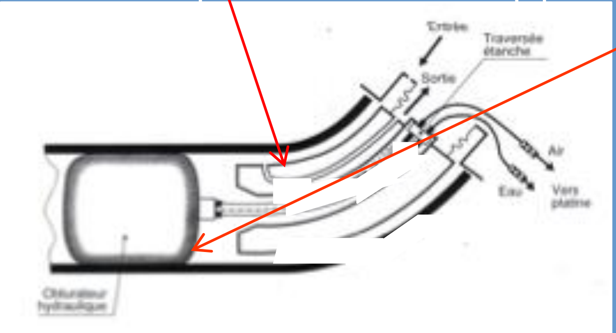
How to implement Optimization for such a huge maintenance work? The first SGR at Dampierre 1 (5)

Removal of sources through decontamination

Two methods were proposed

-A soft chemical decontamination (LOMI) to be performed on the primary pipes with the old SG still in place

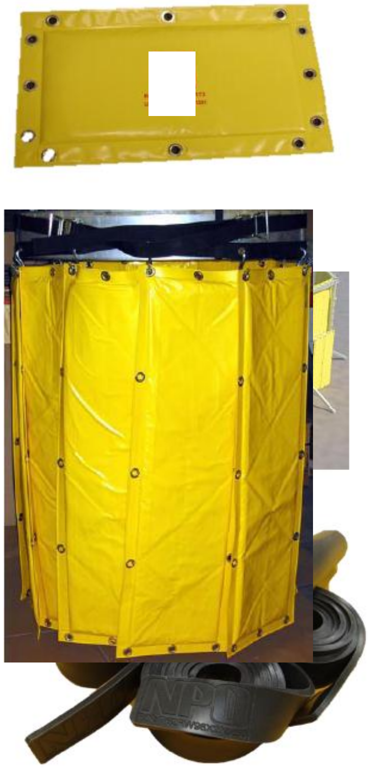
-An electro-decontamination on the remaining primary pipes loops after the old SG removal with or without the use of inflatable balloons into the primary pipes for allowing to restrict the decontamination to a specific portion of these cut pipes.



As it was a first, it was decided to test both methods without waiting for ALARA results: the second on one SG the other on the two remaining

On the contrary, the use of the balloons was only agreed on after comparing the ratio cost/dose savings to the EDF reference value of 1300 € per avoided man mSv

How to implement Optimization for such a huge maintenance work? The first SGR at Dampierre 1 (6)



Biological shielding : 56 tons for that first SGR

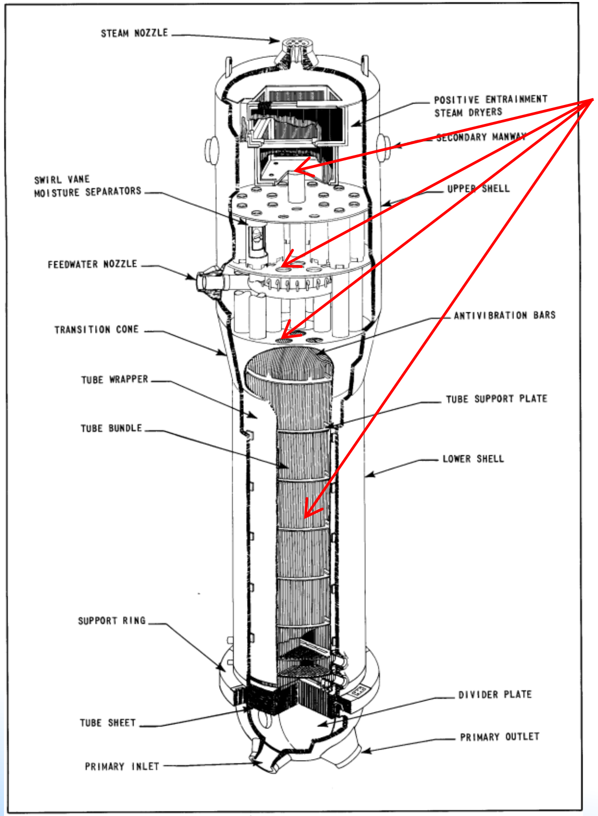
They had to follow some criteria:

- It had to be easy to handle and compatible with the tools in use;

- It has to have a long life in terms of mechanical resistance and an optimal influence on the dose reduction.

The areas where to put shielding were selected according to their contribution to the predicted collective dose and to their dose rates; then a cost effectiveness analysis was performed for each area to determine the thickness and quantities of the shielding to be used.

How to implement Optimization for such a huge maintenance work? The first SGR at Dampierre 1 (7)



Westinghouse STEAM GENERATOR
MB 3593

Maintaining the secondary pipes filled with water as long as possible.

Why?

The cost of that option is nil; it has just to be inserted into the planning.

However it was not obvious as a decision, as it needed to modify some behaviours from the plant operators. Therefore quantifying the expected dose savings (more than 3 man Sievert) was very important to reach the decision.

How to implement Optimization for such a huge maintenance work? The first SGR at Dampierre 1 (8)

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It can be mentioned that no option was envisaged dealing with exposure time, which was considered as a technical constraint.

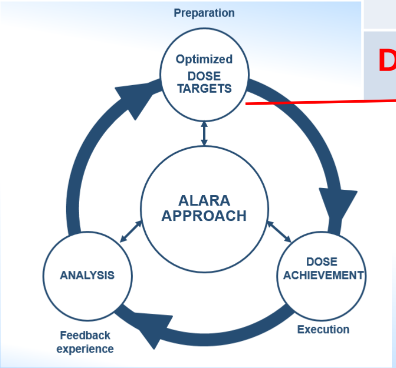
However motivating workers was an explicit objective; its impact of **E**xposed **W**ork **T**ime and doses was considered as very difficult to estimate belonging to what was considered as a subjective domain.

But an important motivation strategy was elaborated (pre job training, ALARA sensitisation at arrival, suggestion boxes, real time information on doses per task with comparison with expected ones……)

Therefore the EWT which was more than 100000 man hours at Dampierre, decreased quickly to around 70000 in the following SGRs.

Progression towards an optimum

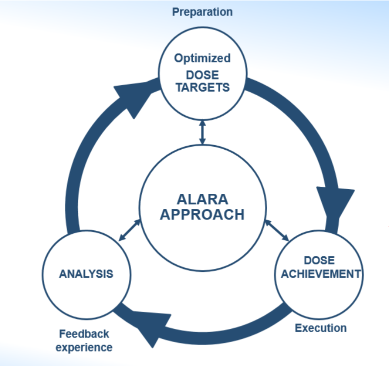
Type of action	Action decided						
Decontamination		X	X	X	X	X	X
Secondary pipes filled with water			X	X	X	X	X
Primary pipes with balloons				X	X	X	X
Dismanting of a very active small pipe					X	X	X
ALARA (behaviours)						X	X
Biological shielding							X
Dose prediction (Man Sv)	**10,21**	**9,6**	**6,23**	**6,12**	**6,03**	**5,97**	**4,73**



Follow up during the SGR itself

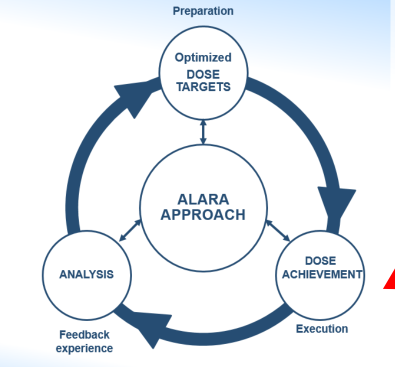
An adequate follow up of doses was set up allowing to compare the dose per tasks, per area…and to check in real time the evolution of actual doses versus predicted.

All mishaps were recorded



A specific structure was installed with an ALARA team and an ALARA coordinator, which discussed regularly with all team leaders in particular before they leave the site after their job, to collect all information on problems and proposals for improvements.

The results and explanation of the difference with the optimised prediction



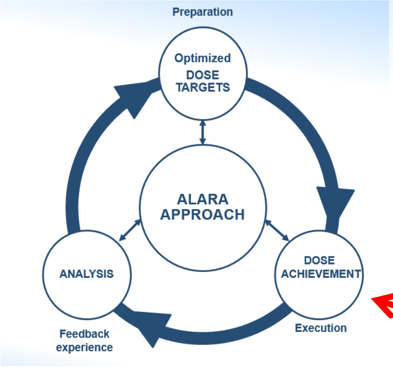
2,13 man Sv instead of 4,73 (minus 2,6!)

Actions	Excess impact Man Sv
1/ Biological shielding	- 0,484
2/ Water level in secondary pipes	- 0,9
3/ Decontamination with balloons	- 0,695
4/ Dismantling	+ 0,05
5 /Total observed	- 2,6
Estimated ALARA impact (5-(1+2+3+4))	*0,6*

What is important then is not to say « we are very good » but to try to understand what explain the difference.
This will be useful for preparing the future SGR

Most of the difference can be explained by overestimation of dose rates; the remaining has been attributed to the modification of behaviour: reduction of un-useful EWT, green spots for reading the procedures, proposal boxes, …

The costs of the avoided doses; were they reasonable?



Actions	Cost of the avoided man mSv €
1/ Biological shielding	600
2/ Water level in secondary pipes	0
3/ Decontamination with balloons	1500* to 3600
4/ Dismantling	No dose savings
Estimated ALARA impact	*500*

* Without mishaps and with a single technique

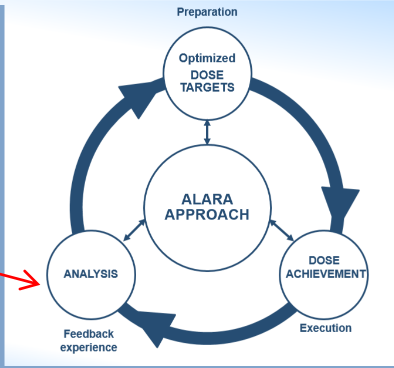
With regards with the maximum value acceptable at EDF at the end of the 80's:

What was reasonable?
What was not?

Feedback experience analysis and preparation of next SGRs

During 6 months an analysis of the collected data was performed

One global feedback database making use of the analytical preparation software has been created to allow producing analytical assessments and analysis, which have shown where some improvements might be expected for the future



An exhaustive feedback report was produced with studies proposals for the next SGRs

This has been used for modifying the technical scenario (the new optimization study lasted 7 months) as well as modifying the protection options for each elementary technical “dossier” during the whole preparation phase of the next SGR in Bugey 5 (1993) and Gravelines 1 (1994) Nuclear Power Plants.

Main principles and objectives as defined before to start again the optimization process

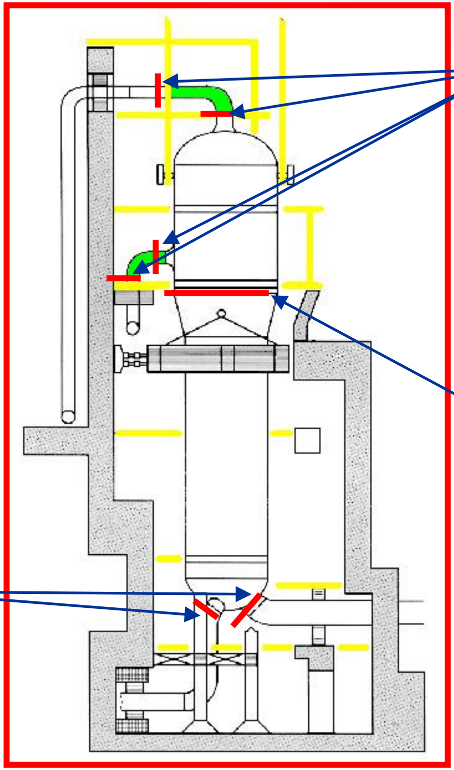
In order to define a standard SGR for all 900 MWe pressurised water reactors (PWRs) in France (more than 20) it was decided to make use of the Dampierre 1 feedback experience in all domains, with a new set of objectives decided by the management:

- doses not exceeding those of Dampierre 1
- conventional safety : 0 accident as in Dampierre 1
- reduction of all costs
- reduction of the duration of the replacement
- simplification of processes,
- maintaining the nuclear safety level

Two optimization studies were performed in parallel: the technical-economic one and the doses one. One feeding the other and vice versa.

Positions of cutting and welding

Positions of Cutting and welding on the secondary pipes



Positions of Cutting and welding on the primary pipes

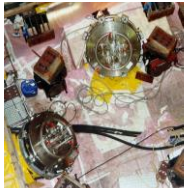
Position of cutting the SG (when needed for room reason in the reactor building) for withdrawal in two parts (oldest plants)

Technical scenarios envisaged

Different technical scenarios were envisaged mainly dealing with the cutting of the primary pipes, the decontamination process of the remaining pipes, the welding of the new SG with the pipes

	1	2	3
CUTTING	plasma cutting	simple mechanical cutting	mechanical cutting with chamfers
DECONTAMINATION	no decontamination	decontamination before old SG removal	decontamination after old SG removal
WELDING	Manual welding	TIG Orbital in V welding (TOV)	TIG Orbital with Narrow Chamfer welding (TOCE)

The reference being the SGR Dampierre 1 type, there were 27 other scenarios to be assessed, after discussion with the main contractors, according to all criteria already mentioned in terms of duration, costs, doses.



Doses assessments

Starting with the dose database from Dampierre 1, and making use of the analytical software the collective dose was estimated for each of the the 27 scenarios

Taking into account all technical impact of each modification in terms of task duration, number and positions of the workers

As well **sensitivity analysis** were performed for the level of contamination of the circuits i.e. the expected **dose rates** from the primary circuit; with a **factor 3** between the less contaminated reactor and the most contaminated.

As well the question of what do we agree to pay for avoiding one man mSv was also raised through a **sensitivity analysis** with a range of single values from **150 € to 1500€** (1990 values)

Dose estimations (man Sv) for the 27 possible scenarios

		Plasma cutting			Mechanical cutting			Chamfers cutting		
Welding	Deconta.	*37*	*65*	*100*	*37*	*65*	*100*	*37*	*65*	*100*
TOV	No	**2,12**	**2,49**	**2,96**	**2,02**	**2,34**	**2,73**	**1,99**	**2,30**	**2,68**
	Bef. rem	**1,82**	**1,94**	**2,09**	**1,79**	**1,88**	**2,01**	**1,78**	**1,87**	**1,99**
	Aft. rem	**1,78**	**1,97**	**2,20**	**1,70**	**1,84**	**2,02**	**1,69**	**1,83**	**2,00**
TOCE	no	**2,00**	**2,39**	**2,87**	**1,90**	**2,23**	**2,64**	**1,87**	**2,20**	**2,60**
	Bef. rem	**1,70**	**1,82**	**1,98**	**1,66**	**1,76**	**1,89**	**1,65**	**1,75**	**1,88**
	Aft. rem	**1,66**	**1,85**	**2,08**	**1,58**	**1,72**	**1,90**	**1,57**	**1,71**	**1,88**
Manual	No	**2,08**	**2,54**	**3,09**	**1,98**	**2,38**	**2,87**	**1,96**	**2,34**	**2,82**
	Bef. rem	**1,72**	**1,86**	**2,04**	**1,69**	**1,80**	**1,95**	**1,68**	**1,79**	**1,94**
	Aft rem	**1,69**	**1,90**	**2,16**	**1,61**	**1,77**	**1,97**	**1,60**	**1,76**	**1,96**

No: without decontamination
Bef.rem: decontamination before removal of the old SG
Aft.rem.: decontamination after removal of the old SG

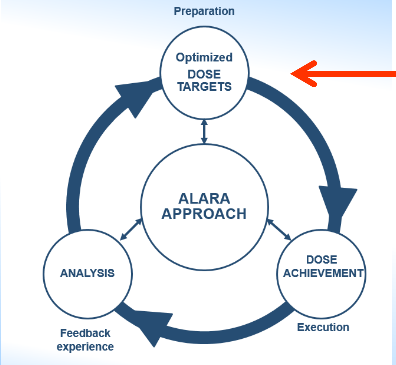
37;65;100: three contamination levels of the primary circuit inducing three levels of dose rates

The selected scenario (1)

Making use of all decision criteria (duration, costs, doses including the use of man Sv monetary value), the selected scenario has been:

- Mechanical cutting
- Decontamination after removal of the old SG with a soft chemical process (even if not totally "reasonable", this was decided for social peace)
- TOCE welding

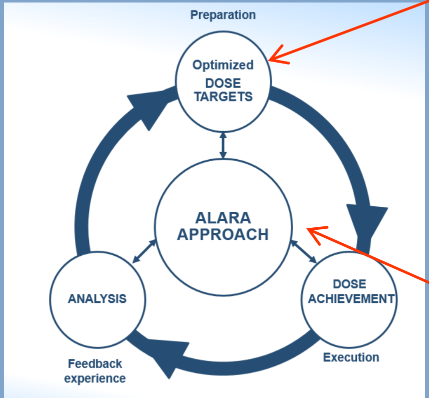
This has led to a first set of collective dose objectives for a technically optimised SGR:



- 2 man Sv, for the first generation of 900MWe reactors
- 1.5 man Sv for the second generation of 900 Mwe reactors

The selected scenario (2)

While the SGR was considered as technically optimised there still remain potential improvements in reducing:



* doses during individual movements into the reactor building (good training and knowledge; good mapping of dose rates,…)

* the global duration of the outage (which automatically reduce reduce s all servicing doses (HP, cleaning…))

* the total number of individuals in the reactor building (suppressing all not useful visitors , through video camera, inside and screens ,…)

With that, the objective became, in average, 1.5 and 1 man Sv per SGR
After each new SGR, the process was again and again re implemented: questions were always where can the duration and costs be reduced? where can the doses still be optimised?

Organization and Structures

It is important to note that all this progresses have been achieved in a context were some **specific structures** were set up.

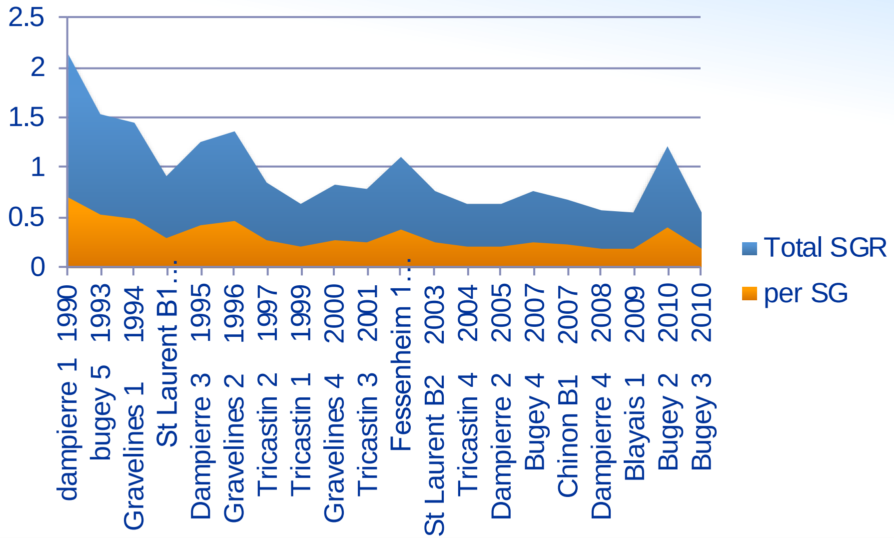
Firstly: **an ALARA team** leaded by the engineering department, with representatives of the NPP and of the leading contractor is in charge during the preparation phase of proposing the technical and managerial options and to analyse the feedback after the operation.

During the operation that structure is enlarged and rely on several cells with more individuals

Secondly: **an ALARA committee** has been set up in each Nuclear power plant; its role is to validate the proposals from the ALARA team and make decision when needed for providing resources or deciding new studies. It always comprise at least the Plant deputy director.

Therefore ALARA implementation appeared as a managerial will, earlier than a regulatory body requirement (quite recent in France)

Collective dose results (man Sv) for the 20 first French SGRs



It is clear that implementing ALARA has led to a continuous improvement of the occupational exposure; the objectives have been reached and new more ambitious were regularly set up.

One might also note that the two peaks in 2002 and 2010 correspond to two units of the first generation i.e. the more contaminated ones due to design features

SGR for 1300 MWe reactors : the context

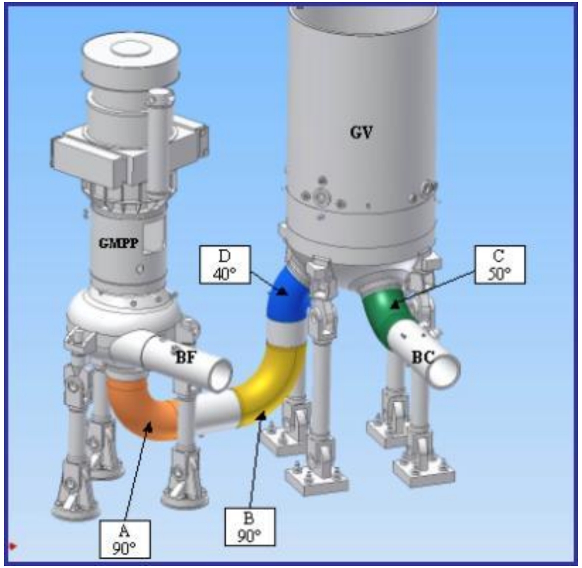
After more than 20 years, the preparation of the second wave of SGR on the 1300 MWe, in an optimization perspective.

As SGR's have been performed on nearly all 900 MWe, the oldest reactors, it is now time to think about the newest ones the 1300 MWe reactors. 27 SGR's will have to be performed from 2015 to 2030.

The main difference between 900 and 1300 MWe reactors being the number of loops for the primary circuit; 3 for the 900MWe, 4 for the 1300MWe, it implies 4 Steam generators instead of 3.

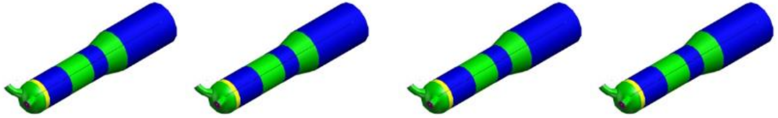
While the average collective dose since 2005 is 700 man mSv for the French SGR 's on the 900 MWe reactors; it is on the same period 1700 man mSv for the 4 loops reactors.

SGR for 1300 MWe: what has to be replaced?



The replacement of the U branch has nothing to do with the SGR itself; it only takes an opportunity and allows a technical and radiological protection optimisation

4 SG 1300 with their D et C welded bents



+3 complete so called U branches (bent A, bent B + horizontal section) for some reactors)

+ 1 ½ BU (bent B + straight section)

SGR 1300 MWe a first rough estimation

4 SG 1300 with their D et C welded bents

Feedback SGR 900 (3 SG)

- first > 2000 man.mSv
- record = 540 man.mSv

Estimation SGR 1300 (4 SG)

(4/3) *600 = 800 man.mSv

3 complete so called U branches (bent A, bent B + horizontal section)

Estimation SGR 1300

- first studies : 200 man mSv per U branch
- 3*200 = 600 man .mSv

1 ½ BU (bent B + straight section)

No significant impact on doses

First prediction:

1400 man.mSv

Start of the study, making use of the feedback experience from the 900 MWe reactors SGR’s

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Start of the study-phase 3 years in advance (N-3) by the ALARA team within engineering department under the leadership of that department and with participation of operational departments from the plant, and from the contracting leader.

Looking first at all good practices from the 900 MWe.

Identifying the workplaces in the 1300 MWe plant, the tasks to be performed in each workplace, and their EWT

Modelling with PANTHERE the 1300 MWe plant, providing theoretical dose rates according to expected sources

Modelling with analytical software the dose per task and area making use of theoretical optimiszed EWT

Implementing radiological surveys of both workplaces dose rates and sources contents during the outages N-3, N-2/, which allow to run PANTHERE again with better data

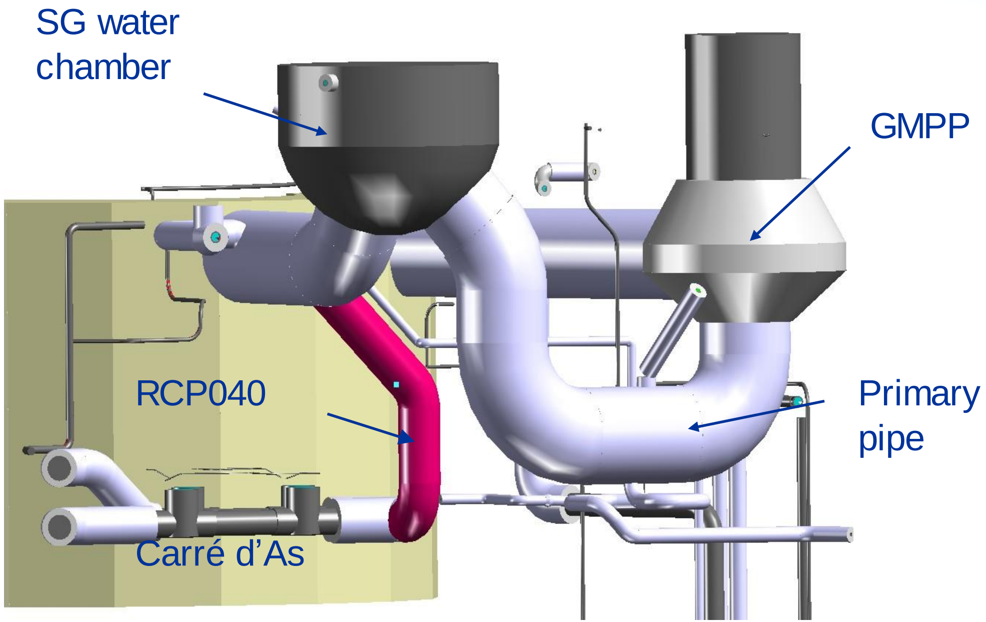
Optimising each workplace starting with the highest doses

Looking first at all good practices on the 900 MWe

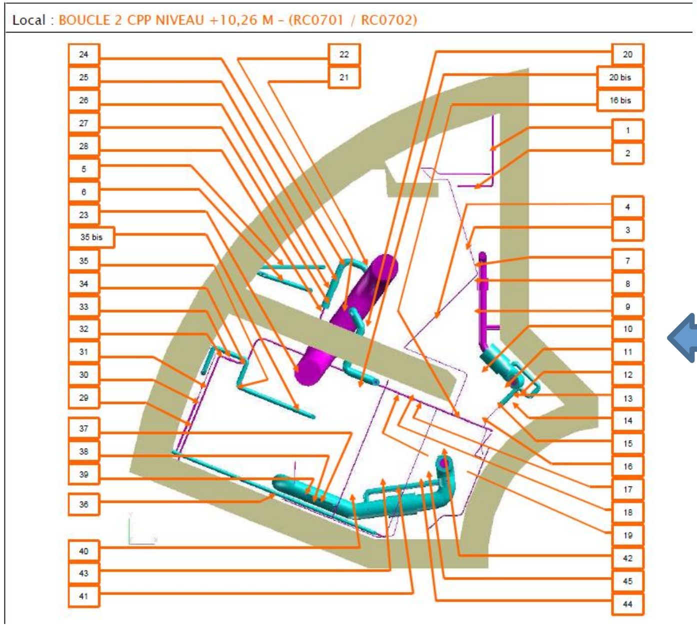
A feedback analysis document with nearly 40 good practices dealing with ALARA implementation has been issued; we will just select a few:

Optimization :
…
Good practice number 3 to install magnetic lead shielding on the bottom of the Steam generator (outside of water chamber) for reducing dose rate
…
Good practice number 9 to install balloons inflatable with water in the primary pipes , and after the soft chemical decontamination to finish the decontamination of the pipes with high pressure water jet (more efficient than a manual finishing)
…
Good practice number 12 to make use of shielded boxes for transporting and keeping the samples to be analysed by chemists
…
Good practice number 13 to make use of a new remote surveying tool for measuring dose rates in the primary pipes (reading outside)
…
Good practice number 25 to install in advance removable insulation for reducing the EWT during the SGR
…
Good practice number 27 to track in real time the gaps between predicted and actual dose and EWT for immediate analysis and corrective actions
…
Good practice number 29 To sensitise all workers particularly for withdrawal (from) and cleaning of the workplaces

Then modelling the environment with PANTHERE

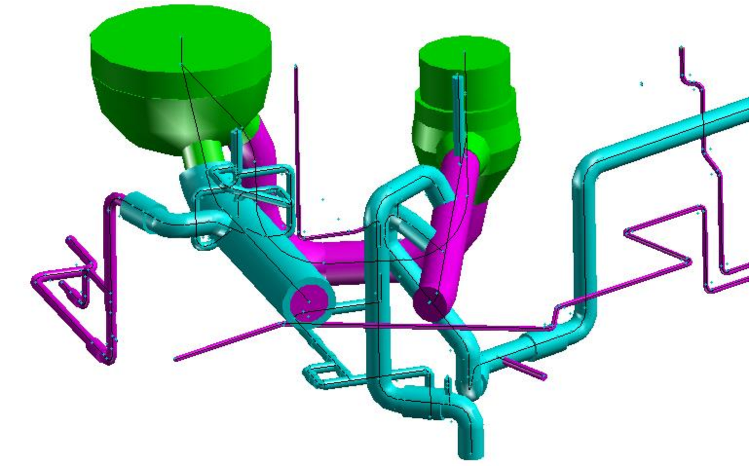


Then recalculating the PANTHERE hypothesis and results making use of the surveys results



Radiological survey mapping

Inserting these results in PANTHERE

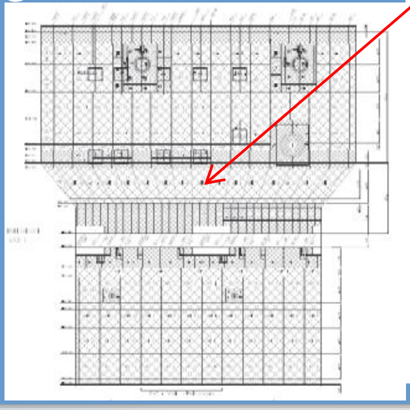


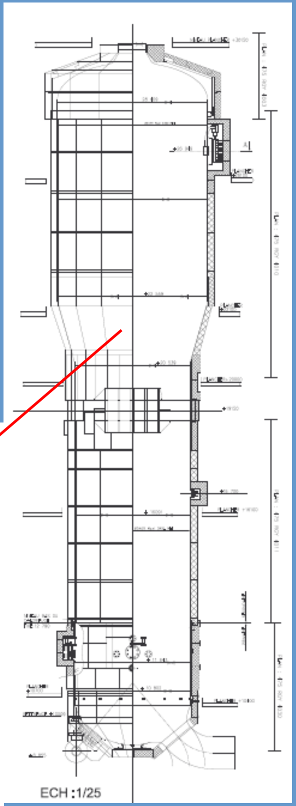
Dossier Insulation

When ALARA was implemented for the first time at EDF, the insulation was not a main concern; but very quickly it appeared that insulators belonged to a very exposed category with individuals exceeding 20 mSv a year and therefore a national ALARA group was set up to envisage solutions for reducing their doses.

The steam generators as well as primary pipes are covered with insulation. These have partially to be removed from the old SG and from the pipes at least where there will be cuttings.
They have to be reinstalled on the new SG and pipes after welding.

Lot of time will be saved with easy to remove and clipping install insulation that has been developed during the last decades





Dossier Biological shielding (I)

- Nowadays more than100 tons of lead shielding are installed during an SGR 900
- They allow reducing by 30 and 45% of the total dose; which in average allow a reduction of 300 man mSv

Example of BUGEY 2 (first 900 generation)

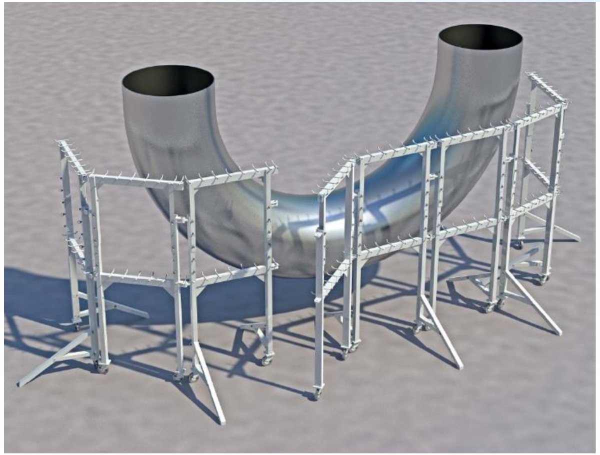
- biological Shield. manipulation: + 52 man.mSv
- Dose savings**:** - 510 man.mSv

- One important problem to be solved are the **co activity** problems (interference). looking at the planning should lead to better organisation and communication between the different specialties leaders ASAP
- Transport into and within the reactor building **can be optimized**
- The installation technique **can still be optimized**
- The shielding might be regularly **decontaminated between two operations**

Dossier Biological shielding making use of new techniques (II)

Magnetized mattress on mock up

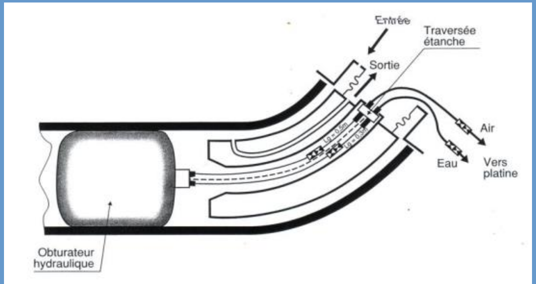
Silicon and tungsten



Mobile support modules allowing six layers of mattress

Dossier decontamination of primary pipes

The process is now optimised with the EMMAC soft chemical technique



Finishing with high pressure water jet (more efficient than a manual finishing) and avoiding important individual dose in case of mishaps.

The average savings are of the order of **250 man.mSv.**

More precisely the saving are 30 à 40 % for work places near by the primary pipes and 20, 30% near by the by-pass SG.

- The process is optimised however the technology is evolving and a new laser process will be, may be, qualified soon.

However feedback from 900 MWe is not enough

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It is not enough: the environment is different:

- The room available in the bunkers is different
- The geometry of each room is different
- The removable walls have different sizes and positions
- Going from one place to another follows different paths
- The dose rates are different (generally lower)
- Some radiological risks are different

Therefore it is needed to:

- Rebuilt the PANTHERE model as a whole
- Check the possibility to use the already developed tools
- Prepare a totally different shielding plan…

Conclusion

The main lesson to be learned from that more than 20 years history is that ALARA is a never ending process

At a time an asymptote may be reached, but with the evolution of the technological, and managerial context another lower asymptote appears.

It shows also clearly that the technical component while being essential is not the only one: commitment of workers and all what is dealing with work management is essential too for reducing the exposures ALARA

It also shows that when the stakes are very important, the resources for implementing ALARA shall become important and impact as well the managerial structures (ALARA coordinator- ALARA team- ALARA Committee) and the workload devoted to the ALARA studies, the ALARA follow up and the ALARA feedback analysis.