



Steam Generator Replacement of the Belgian Doel 1 unit: follow-up and on site dosimetry



B. Walschaerts*, J. Defloor**, R. Wyckmans**

* *Radwaste management – Decommissioning – Radiation protection, Tractebel Engineering (GDF-SUEZ) -Brussels – Belgium*

CHOOSE EXPERTS, FIND PARTNERS

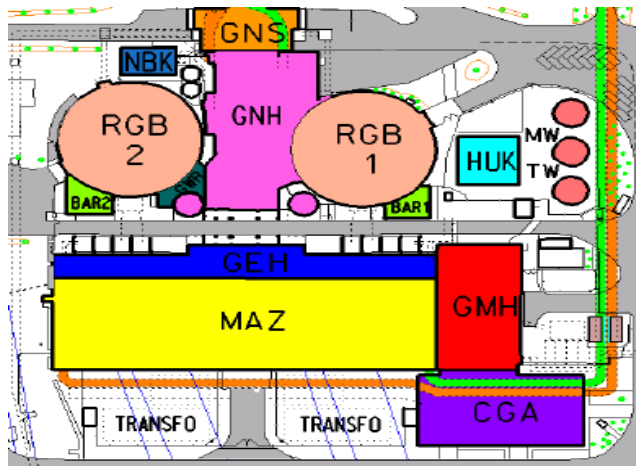
** *Electrabel (GDF-SUEZ) – Doel NPP - Belgium*

TABLE OF CONTENT

- Introduction
- Implementation of ALARA
- ALARA preparation for the Steam Generator Replacement (SGR)
- ALARA follow-up
- Recommendations of the working group
- Dosimetric follow-up
- Return of experience
- Doel 1 SGR compared with others
- Conclusion

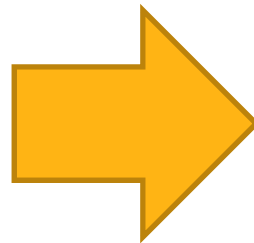
INTRODUCTION

- Doel 1 → 7th SGR project in Belgium
- Doel 1 & 2 = twin reactor
 - Some circuits shared
 - But primary circuits separated → chemistry and deposits are different



INTRODUCTION

- SGR Doel 2: 2004
- Doel 1:
 - SG's in operation for 35 years
 - Possible extended life time

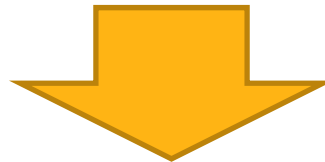


SGR project + power upgrade
of 10%



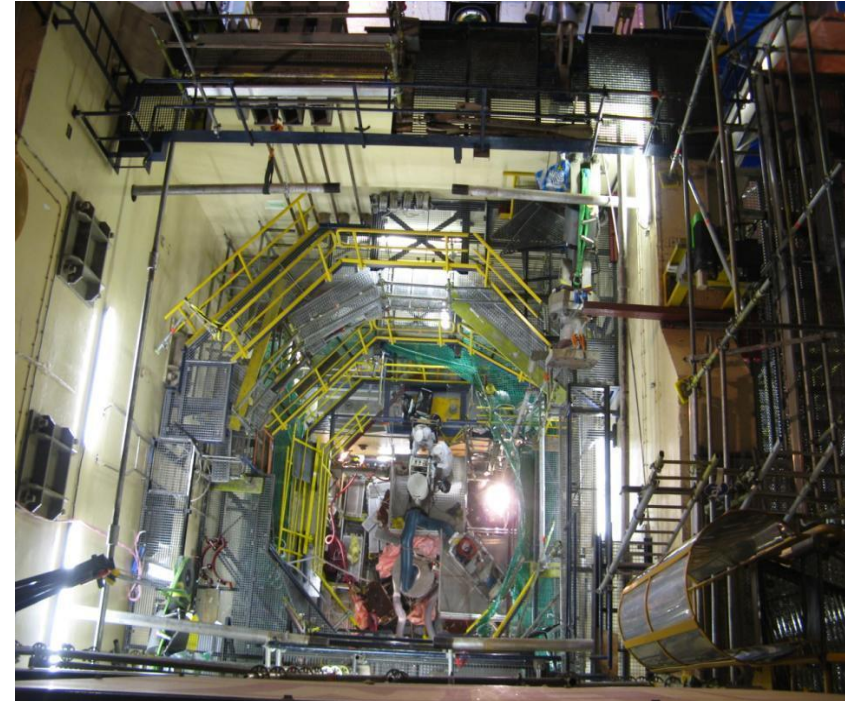
INTRODUCTION

- Problem: Doel 1 built in 1975
 - SGR was not considered in the design of the plant
 - The doors of the reactor building too little
 - Handling inside the reactor building was not considered



Solution:

Lift the steam generators out of their cells through the ceiling of the reactor building !



INTRODUCTION


- This solution demands special ALARA care:
 - Shutdown of the reactor
 - Emptying the core
 - Temporary closure of the reactor building
 - Reactor building always in under pressure



IMPLEMENTATION OF ALARA

- **ALARA working group**
 - People from EBL and TE
 - specialised in radiation protection and implementation of ALARA principle
- **2 tasks:**
 - 1) Pre-study phase:
 - **Actual dose rates during outage**
 - **Possibilities of shielding materials**
 - **Defining objectives**
 - 2) SGR outage:
 - **Regular verification of the radiological status**
 - **Control of the biological protections**
 - **Daily control of the collective and individual doses and comparison with the estimates**
 - **Detect anomalies**
 - **Corrective actions**

IMPLEMENTATION OF ALARA

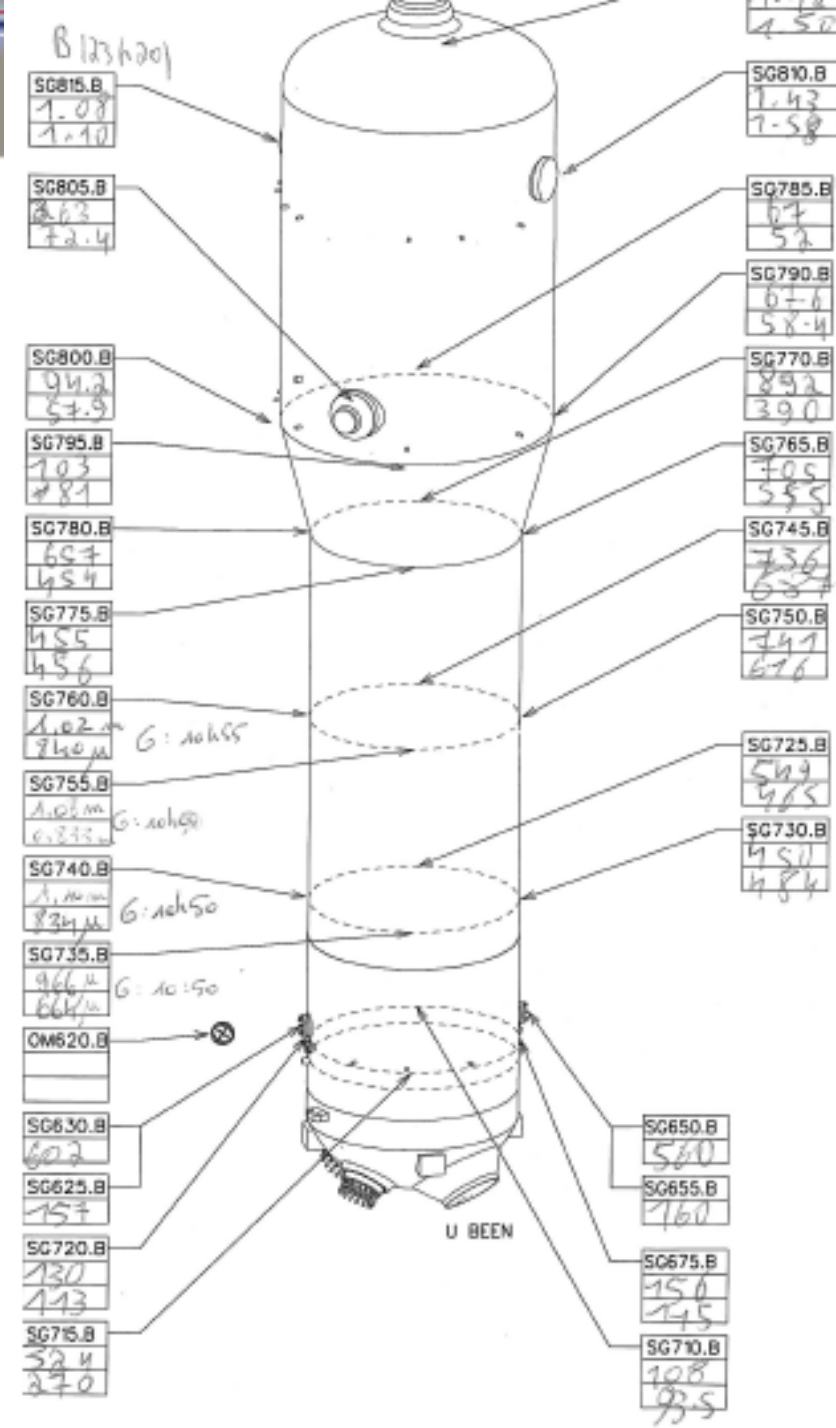
- Long-time based efforts
 - Good maintenance
 - Precautions in the field of radiation protection
 - Reduce contamination
 - The primary circuit
 - Atmospheric contaminations
 - Radioactive waste
 - Site limit of 10 mSv during 52 sliding weeks for EBL personnel
 - The use of local zones  strong dosimetric follow-up

IMPLEMENTATION OF ALARA

- Definition of the objectives
 - 1) No work accident;
 - 2) No nuclear incident;
 - 3) No radioactive contamination incident;
 - 4) SGR radiation dose lower than the radiation dose of the SGR of Doel 2 ($<195 \text{ man.mSv}$)

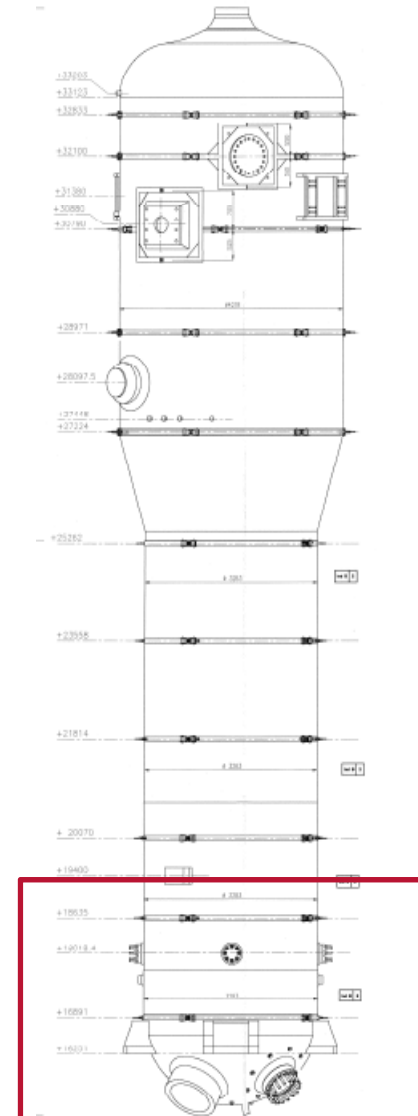
ALARA PREPARATION FOR THE SGR

- Pre-study: create a simple and easy overview
 - Dosimetric phases
 - Work places
 - Task numbers for every activity
 - Measurement points
 - Wipe tests
 - Dose reduction coefficients



ALARA PREPARATION FOR THE SGR

- Results
 - Not always possible to measure all the dose rates during the measuring campaigns
 - QAD-CGGP software → missing dose rates were calculated
 - Validation by the measured values
- Doel 1 30% higher doses compared to Doel 2
 - Biological shielding : 110 tons of Lead shielding
 - Keeping water chambers filled up as long as possible



ALARA PREPARATION FOR THE SGR

- Insulation problem : possible presence of asbestos fibres

Asbestos works

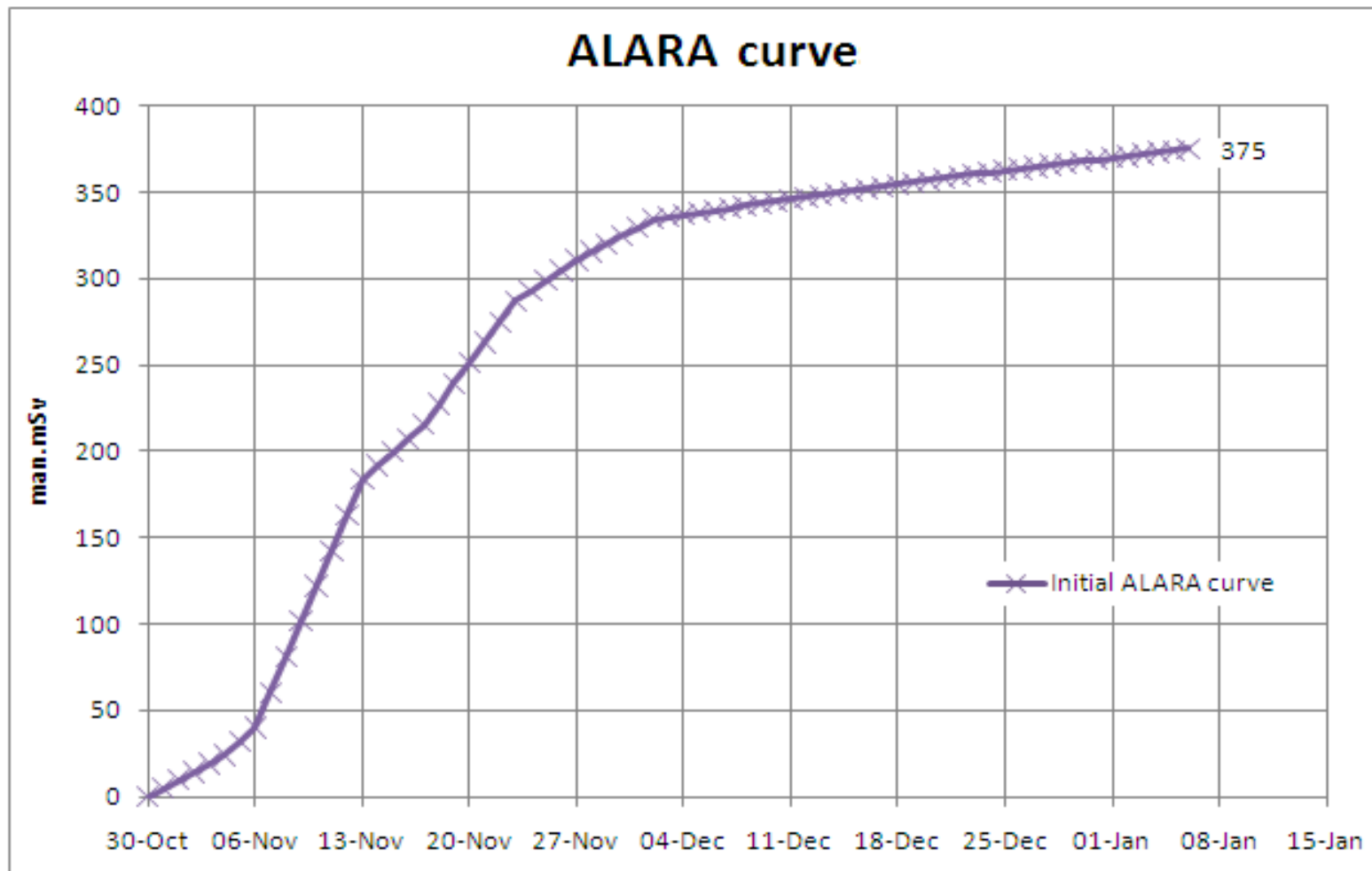


- Never done before in Belgian unit
- This specific job demands more work, more people and more time
- Negative influence on the dose objective



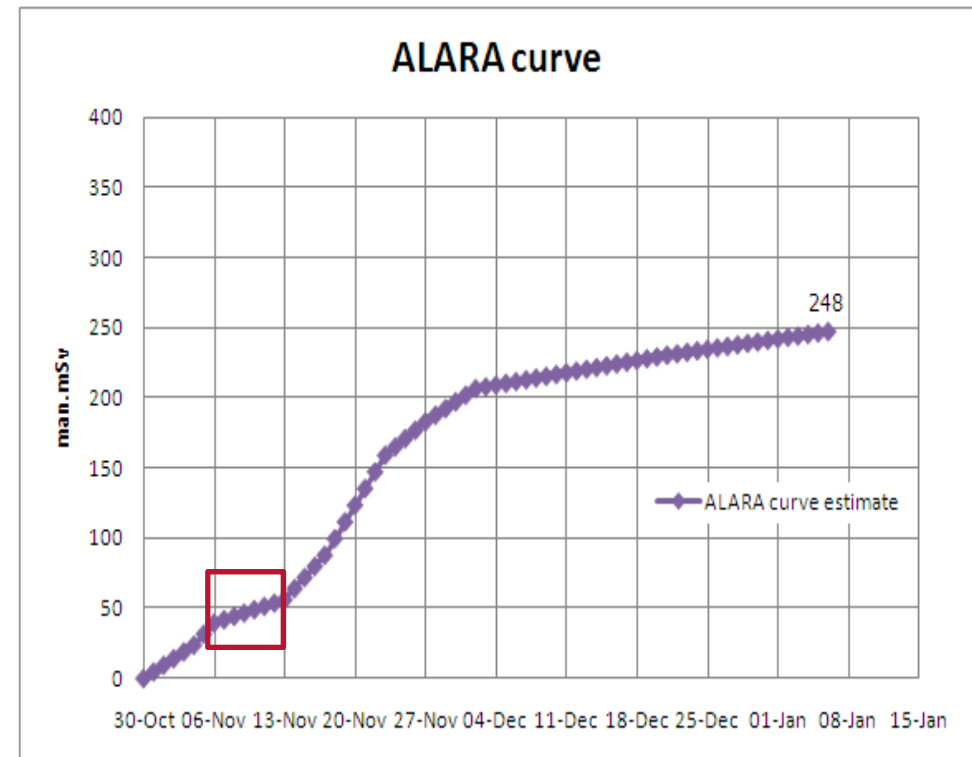
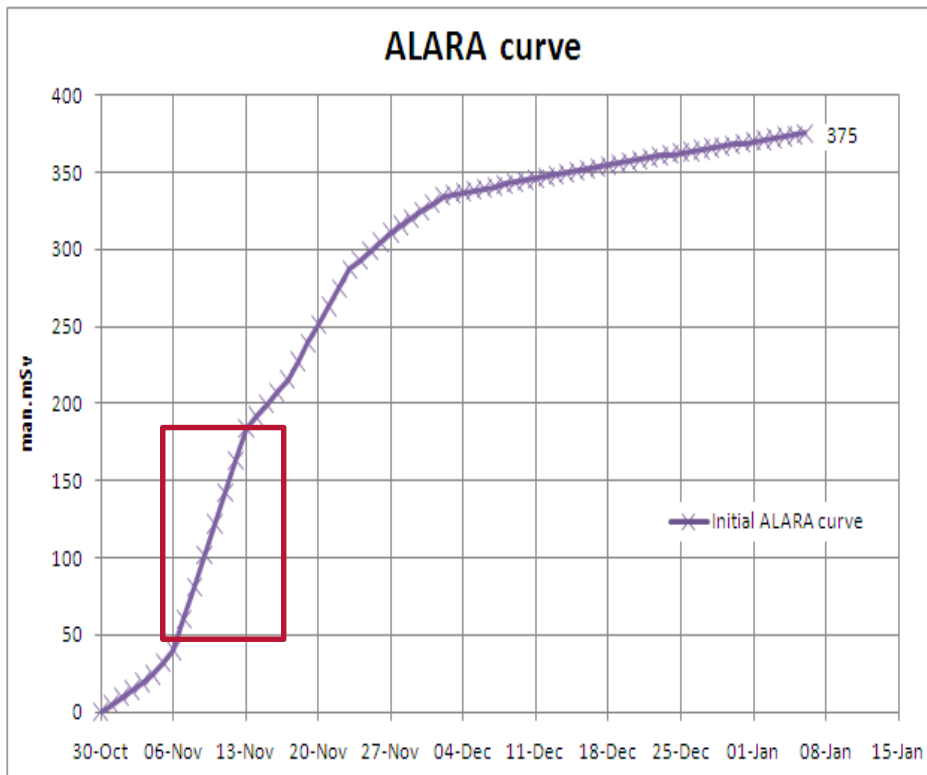
Calculated total dose objective: 375 man.mSv

ALARA PREPARATION FOR THE SGR



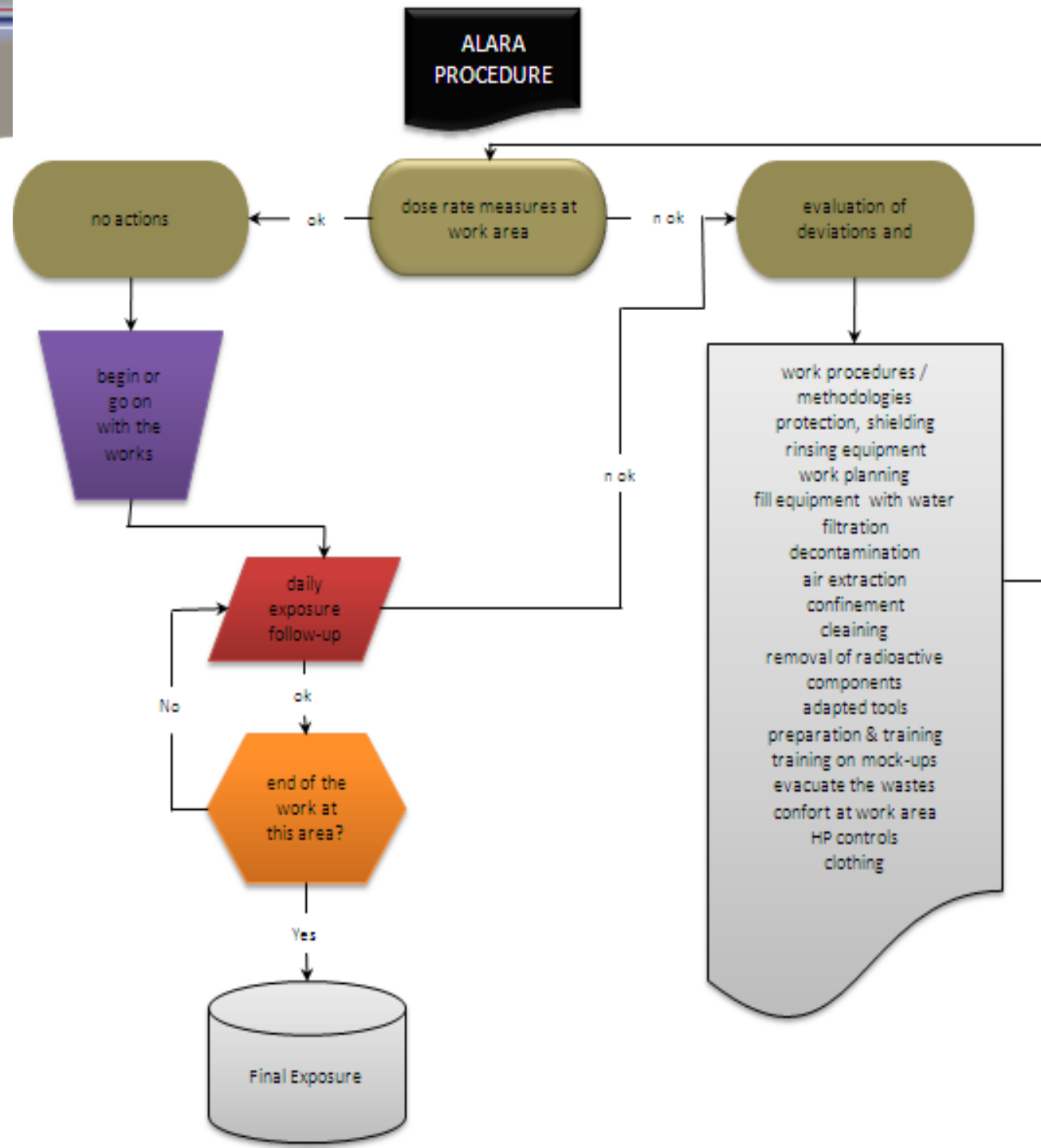
ALARA PREPARATION FOR THE SGR

- With asbestos works
- Without asbestos works – normal insulation works



ALARA FOLLOW-UP

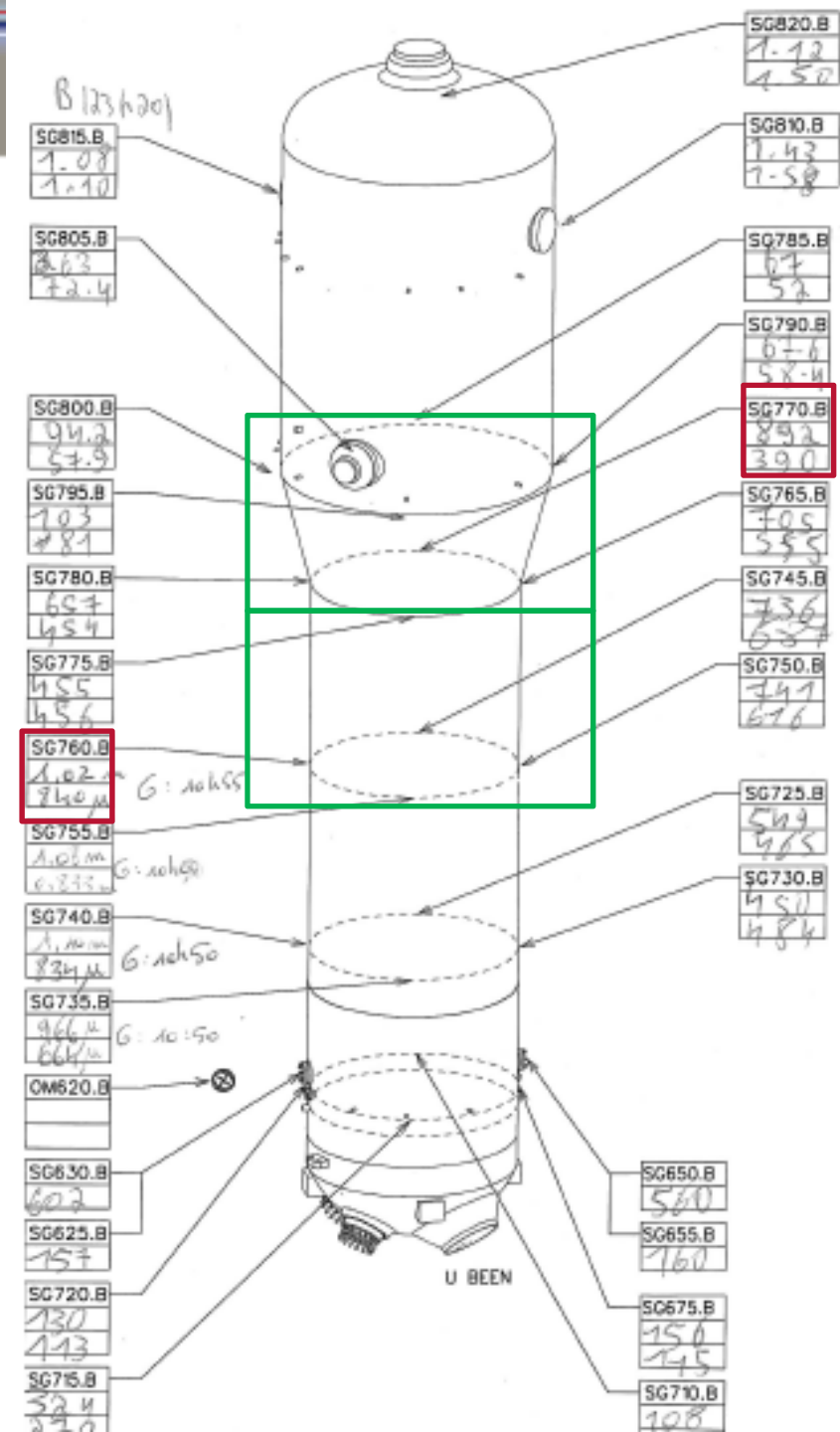
- On site follow-up
 - TE ALARA team on site (2 – 3 members)
 - **Direct link with EBL radiation protection team**
 - **Follow-up of the dose rates and dosimetric conditions on the work floor**
 - **Verification of the biological protections**
 - **Daily control of the personal and collective doses → adaptation of the estimates**
 - **Verification of the recommendations were applied by the contractors**
 - ALARA procedure



ALARA FOLLOW-UP

• Example:

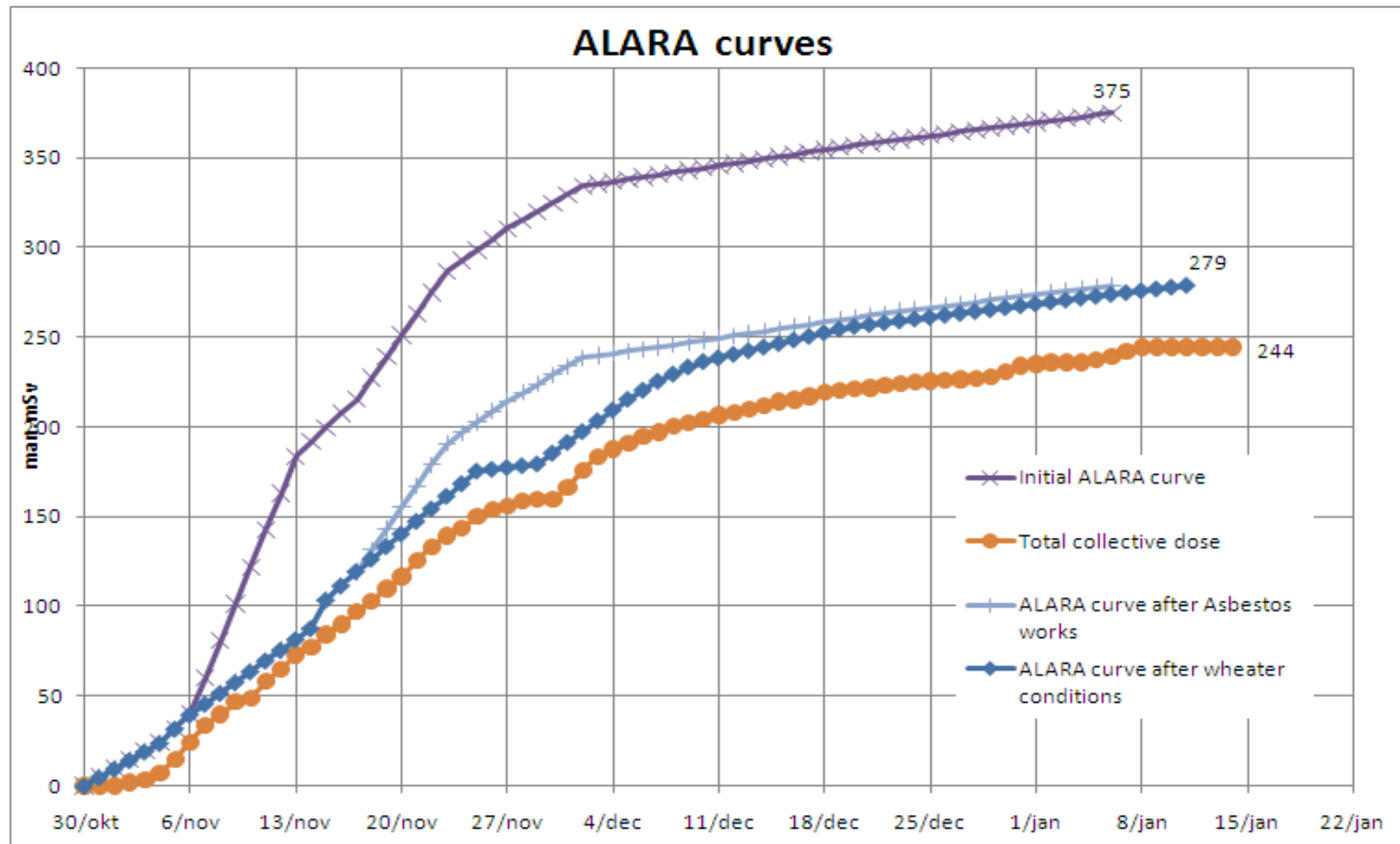
- Before starting to lift:
 - Control of the dose rates at certain spots
 - Last wipe test to see if there is no removal contaminations
- If the results were OK
 - Final sign for lifting was given



ALARA FOLLOW-UP

- Recommendations by the working group
 - Optimisation of the chemistry of the primary circuit during the shutdown sequence of the plant
 - **Cobalt peak scheduled**
 - Optimisation of the maintenance of the primary and secondary circuit
 - Specific lead shielding
 - A specific daily ALARA follow-up to prevent situations with high doses and to assure a quick and adequate intervention if needed

DOSIMETRIC FOLLOW-UP



DOSIMETRIC FOLLOW-UP

- Good asbestos results

- Collective dose = 40,44 man.mSv / Estimate = 116 man.mSv
- Asbestos fibres were found in good conditions
 - Reduced cleaning time

- Delay due to the weather

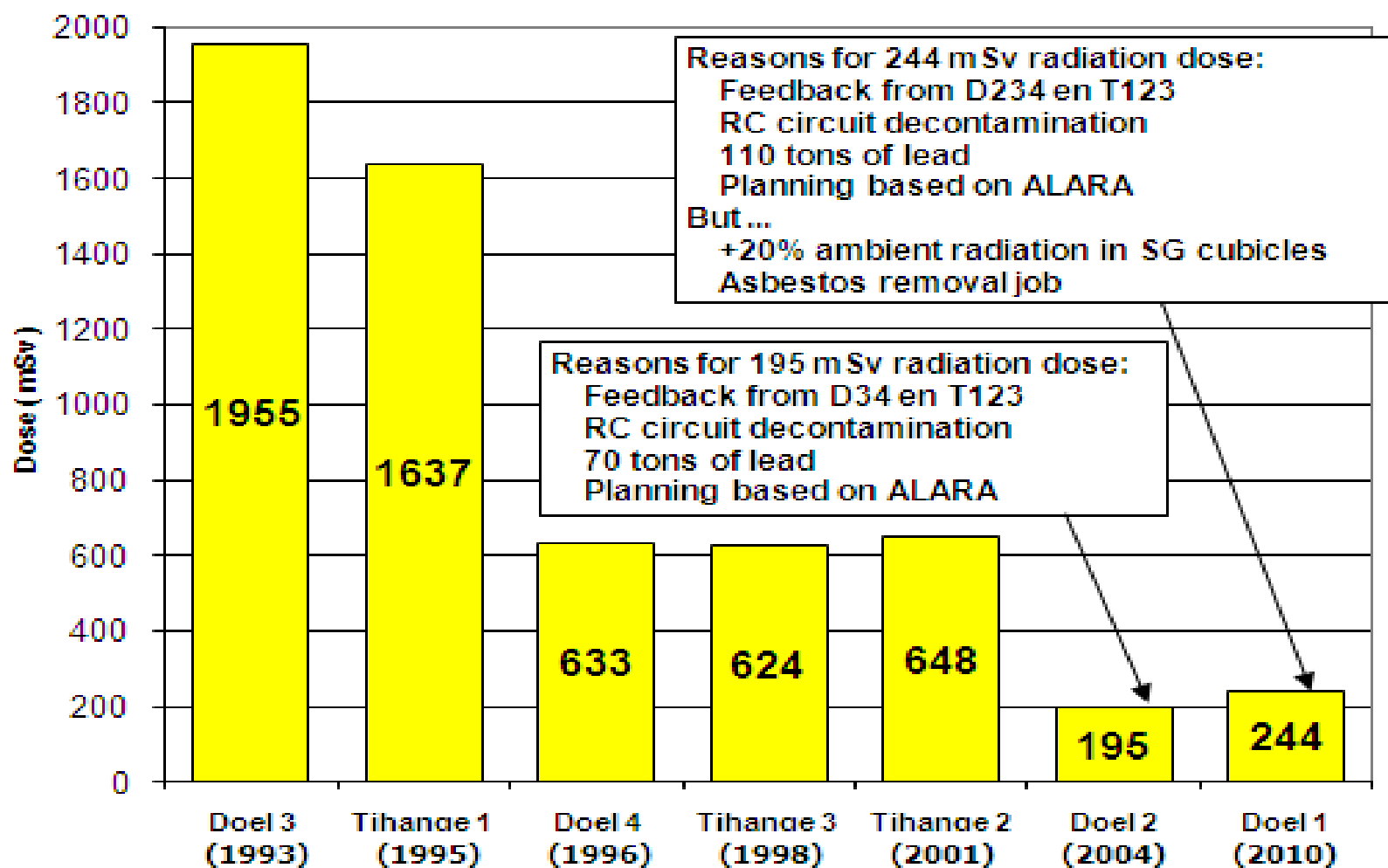
- Worst weather conditions in the last 10 year
- Speed of the wind excited 10 m/s
 - Lifting was not possible → to many risks
 - Negative influence on the dose → open RGB and primary circuit → daily control had to be carried out



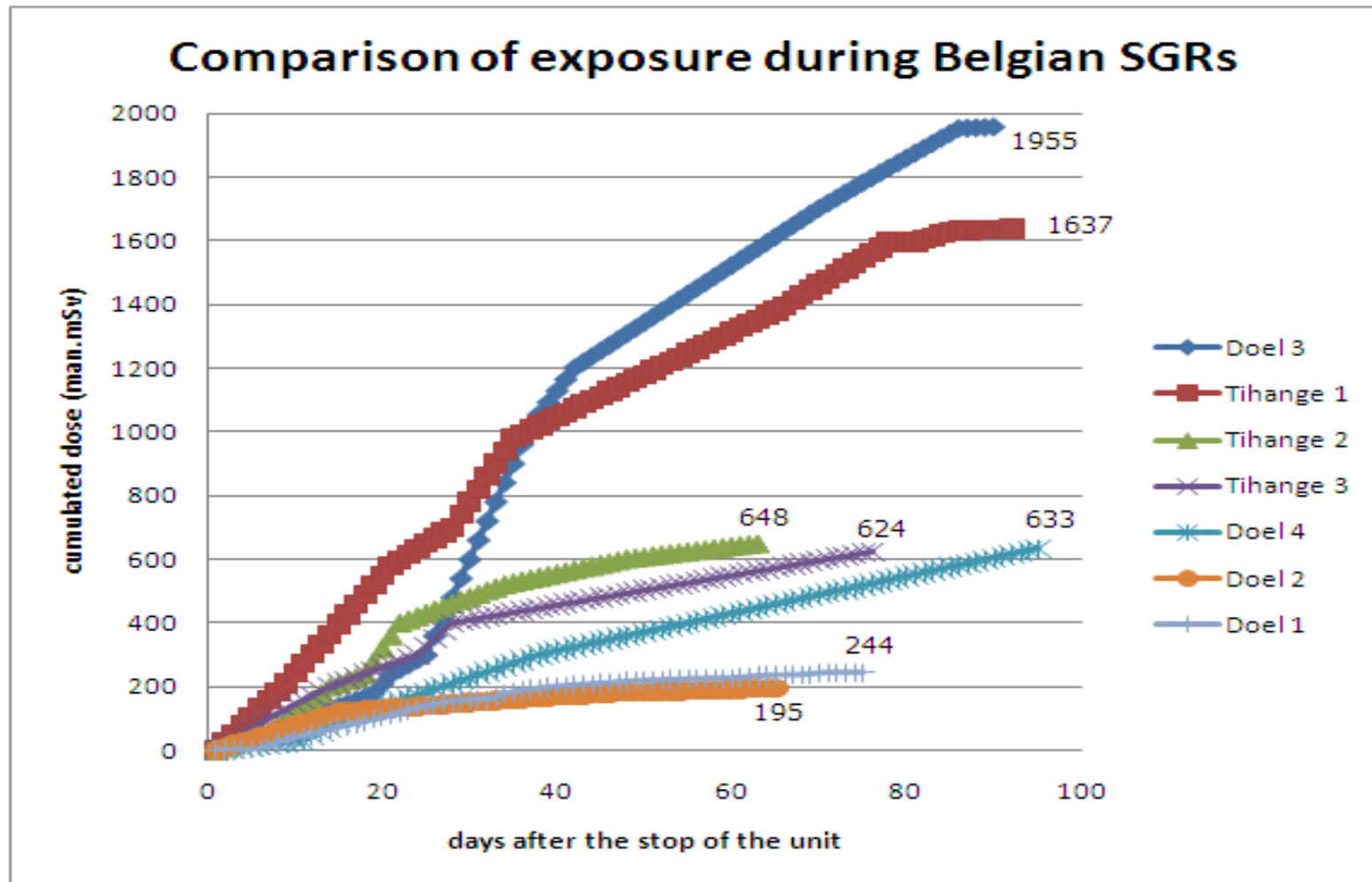
RETURN OF EXPERIENCE

- The adaptation of the configurations of the steam generators regarding the planning lead to lower the doses. The steam generators stayed as long as possible filled up with water
- The steam generator opening was delayed until all preparation works were done
- Visual control by means of local cameras by radiation protection and safety team
- The use of lead walls instead of lead shielding in contact
- Decontamination of the primary circuit by abrasive sponges (very effective and not dose consuming)

DOEL 1 SGR COMPARED TO OTHERS

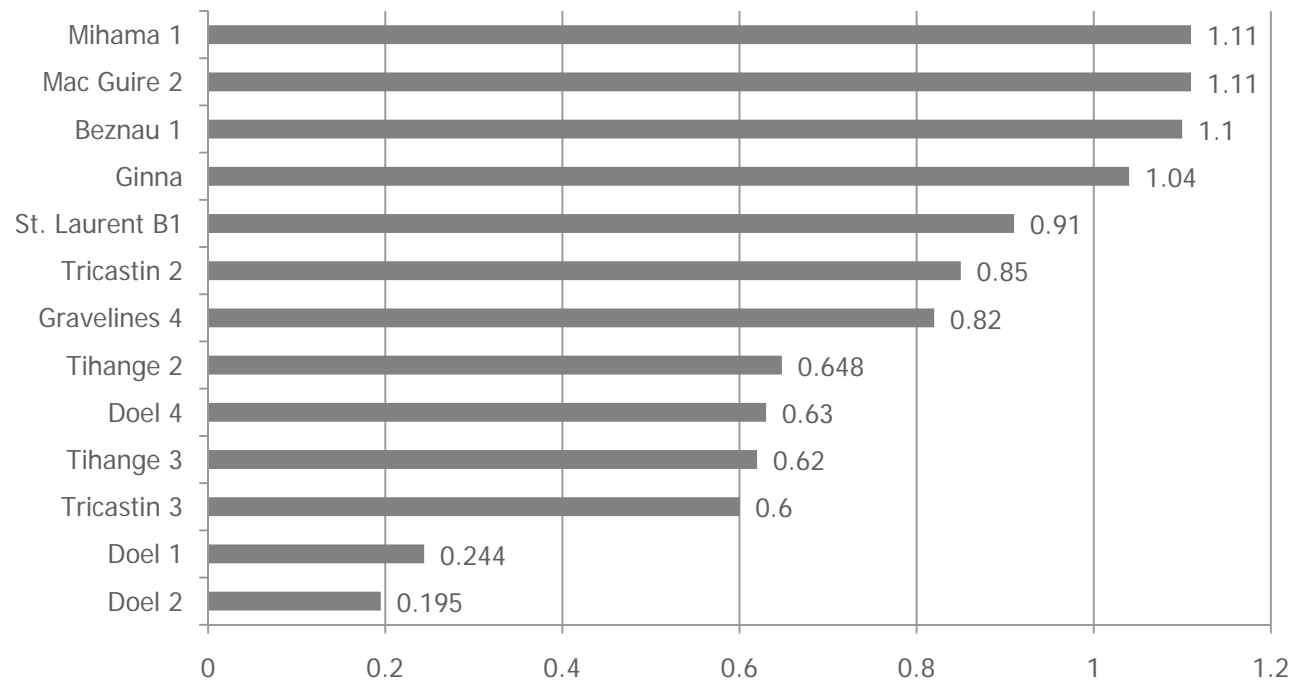


DOEL 1 SGR COMPARED TO OTHERS



INTERNATIONAL RESULTS

Steam generator replacements - Exposure (man.Sv)



CONCLUSIONS

- Over the years
 - More experience
 - **Better dosimetric results**
 - **Shorter outages**
 - But Doel 1 still higher then Doel 2
 - **Asbestos works**
 - **30% higher dose rates and on different radioactive deposits**