VSG D1
KLAAR VOOR DE TOEKOMST !

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

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CHOOSE EXPERTS, FIND PARTNERS

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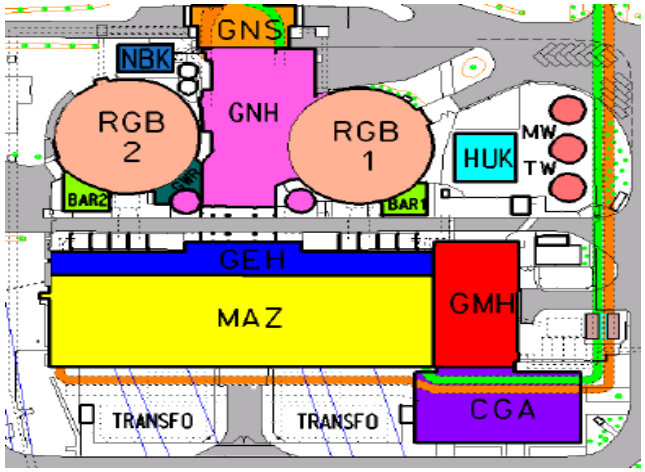
INTRODUCTION

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



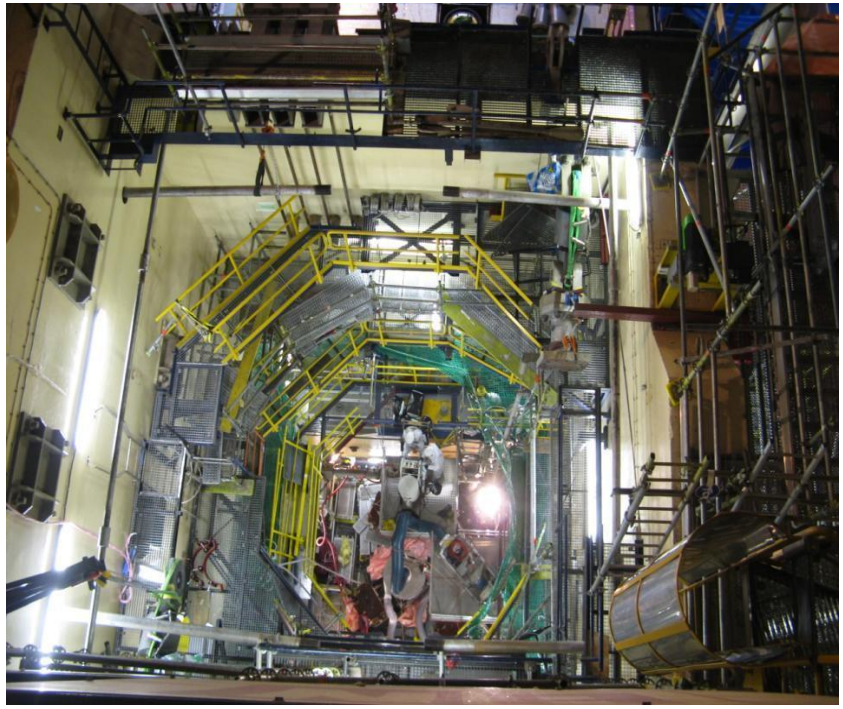
INTRODUCTION

- 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 man.mSv)

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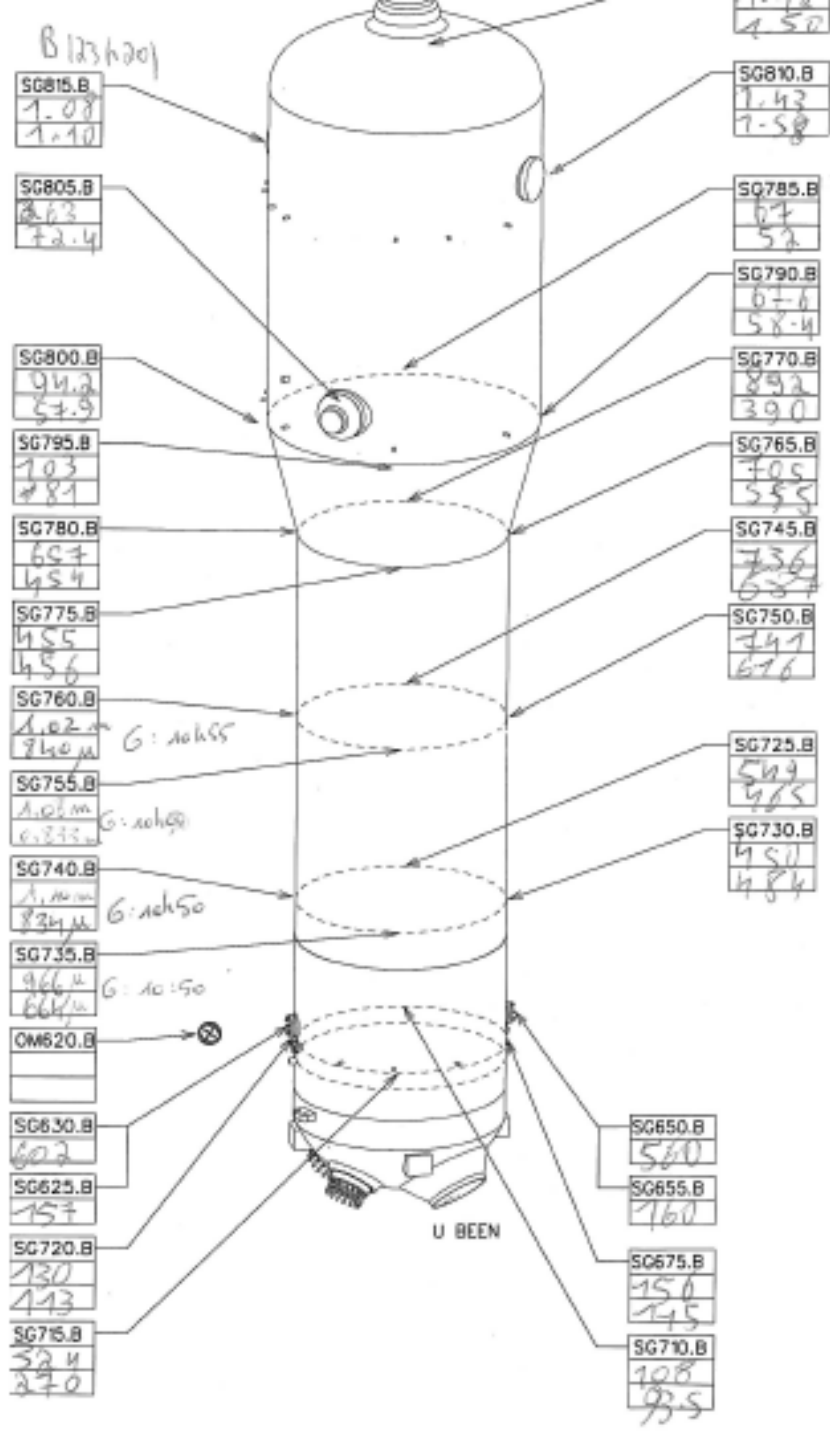
ALARA PREPARATION FOR THE SGR

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

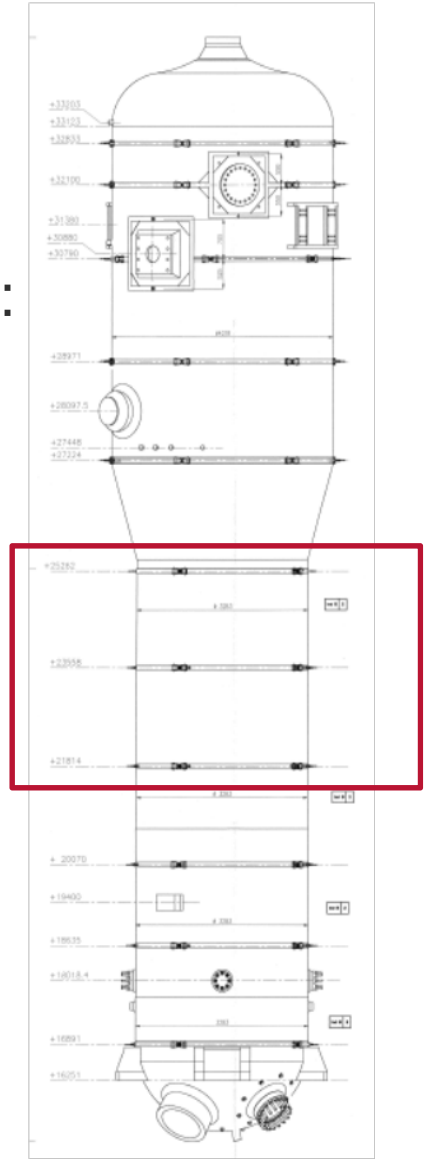


ALARA PREPARATION FOR THE SGR

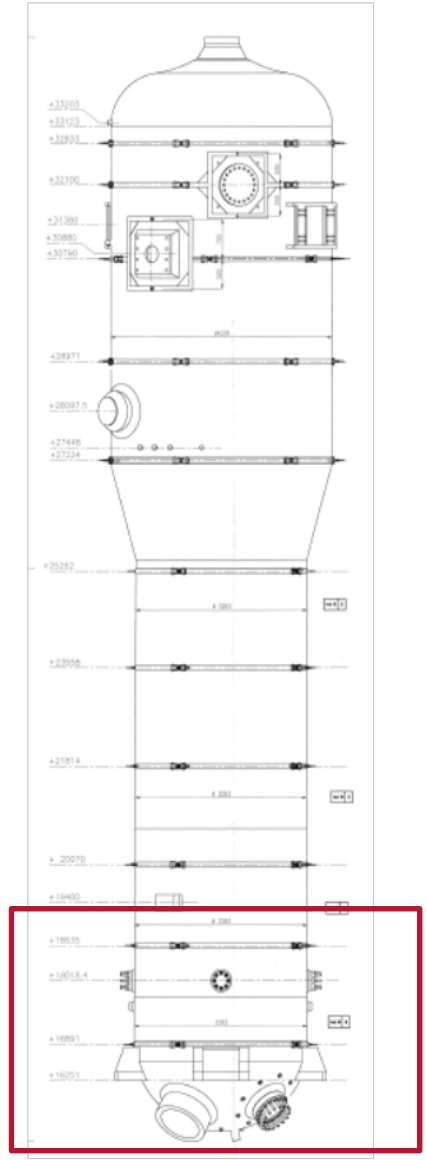
- Results
  - Not always possible to measure all the dose rates during the measuring campaigns
    - **QAD-CGGP software → missing dose rates were calculated**
    - **Validation by the measured values**
- Doel 1 30% higher doses compared to Doel 2
  - Biological shielding : 110 tons of Lead shielding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

ALARA PREPARATION FOR THE SGR

Doel 1:



Doel 2:



ALARA PREPARATION FOR THE SGR

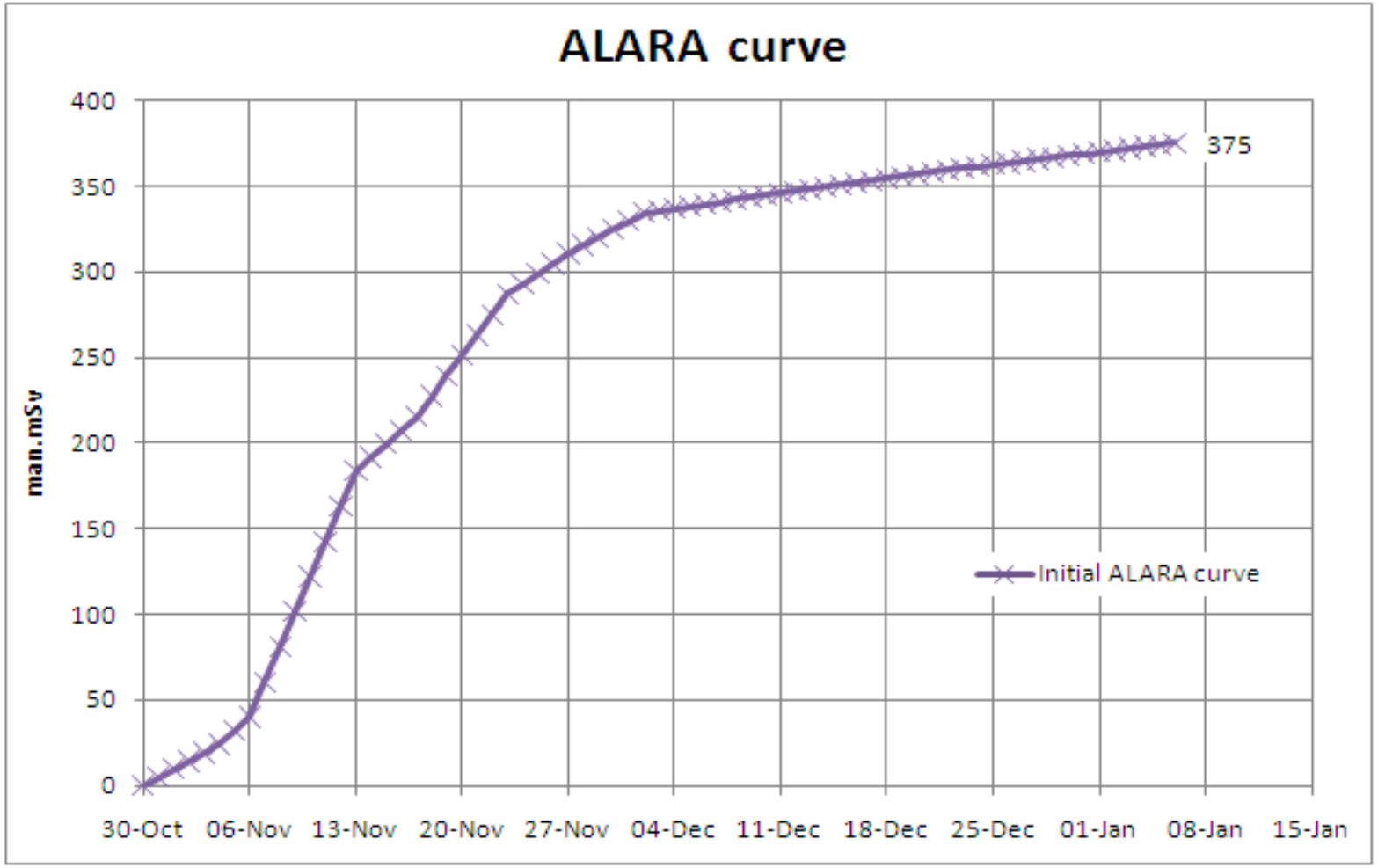
- Insulation problem : possible presence of asbestos fibres

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**

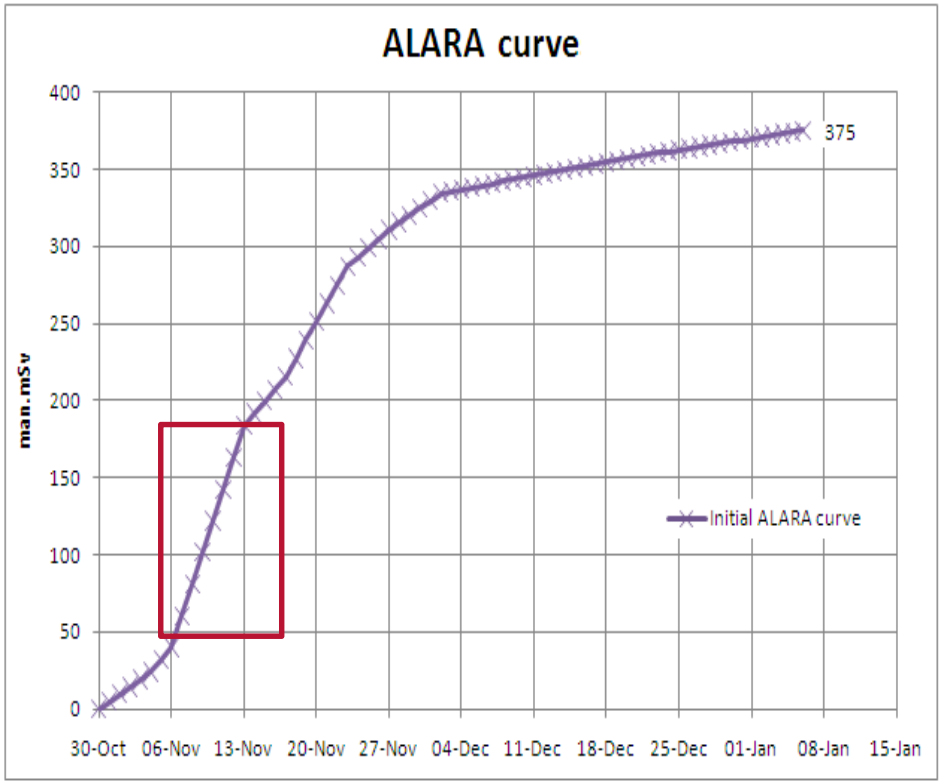
Calculated total dose objective: 375 man.mSv

ALARA PREPARATION FOR THE SGR

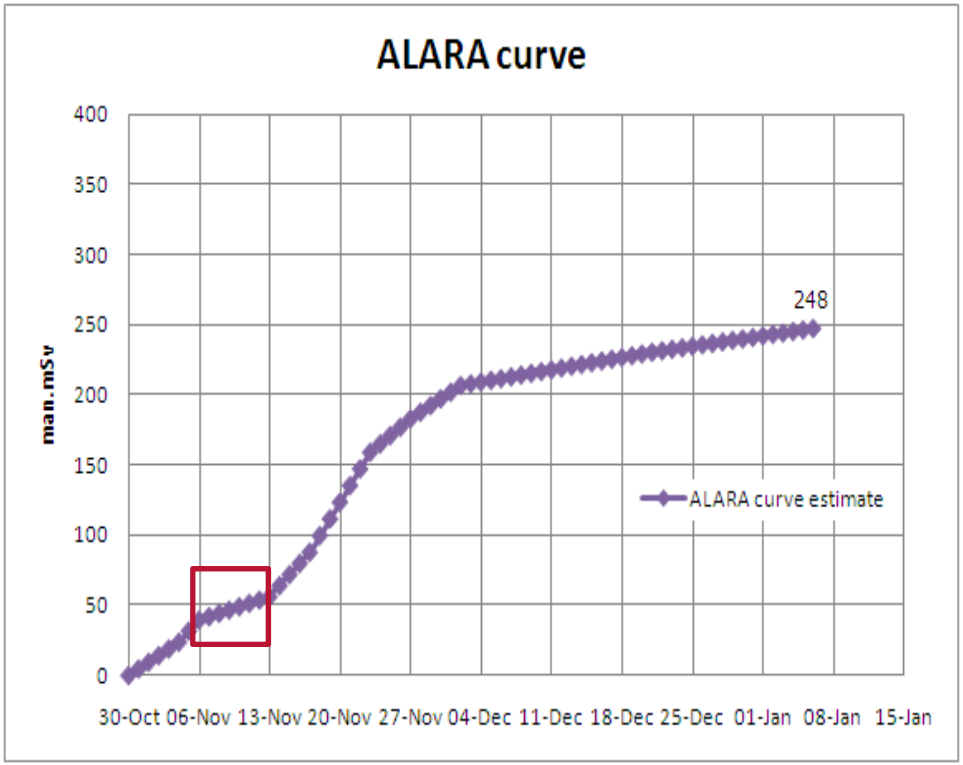


ALARA PREPARATION FOR THE SGR

- With asbestos works

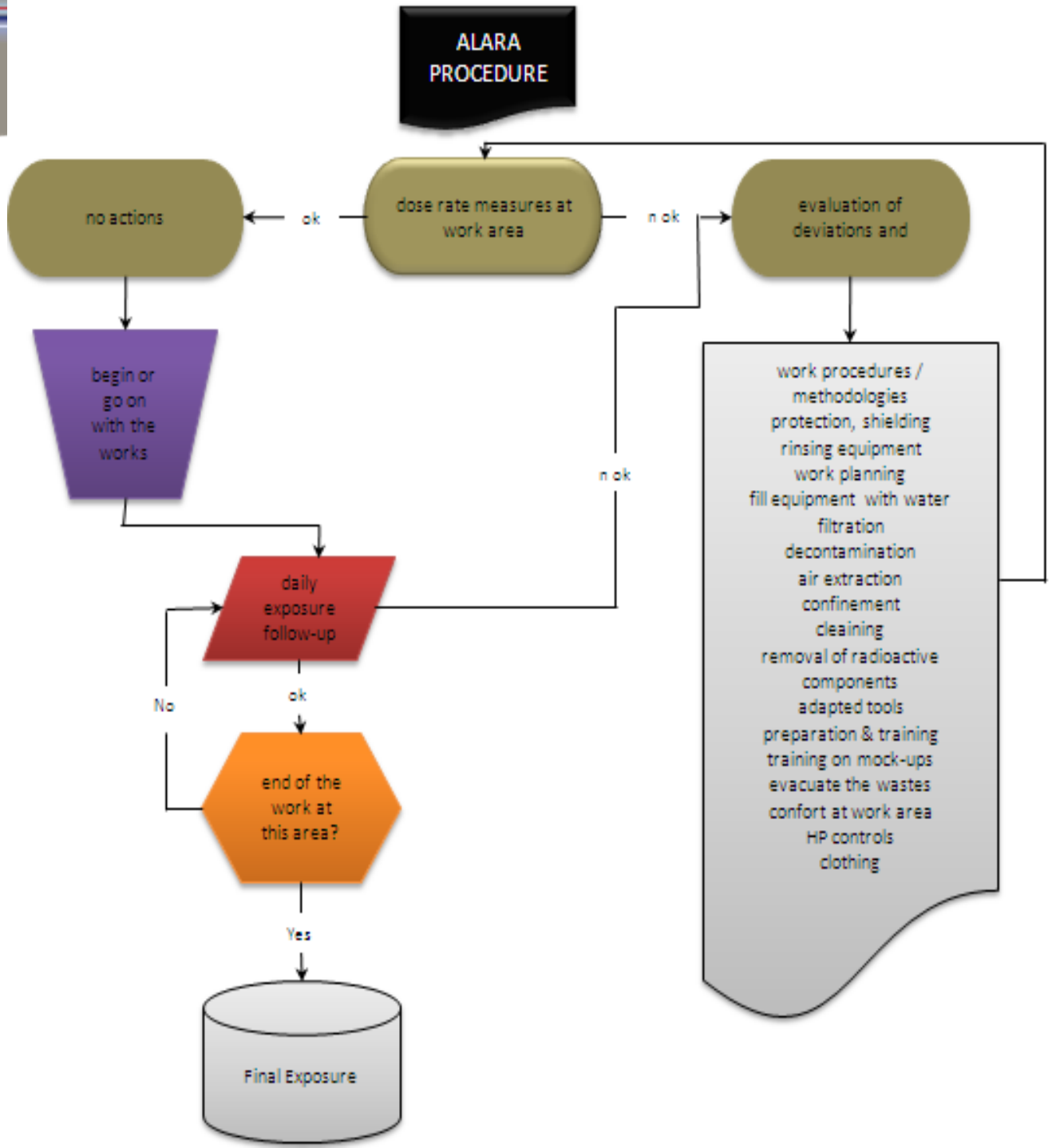


- Without asbestos works – normal insulation works



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 PROCEDURE
dose rate measures at work area
ok
no actions
n ok
evaluation of deviations and
begin or go on with the works
n ok
work procedures / methodologies
protection, shielding
rinsing equipment
work planning
fill equipment with water
filtration
decontamination
air extraction
confinement
cleaining
removal of radioactive components
adapted tools
preparation & training
training on mock-ups
evacuate the wastes
confort at work area
HP controls
clothing
daily exposure follow-up
No
ok
end of the work at this area?
Yes
Final Exposure

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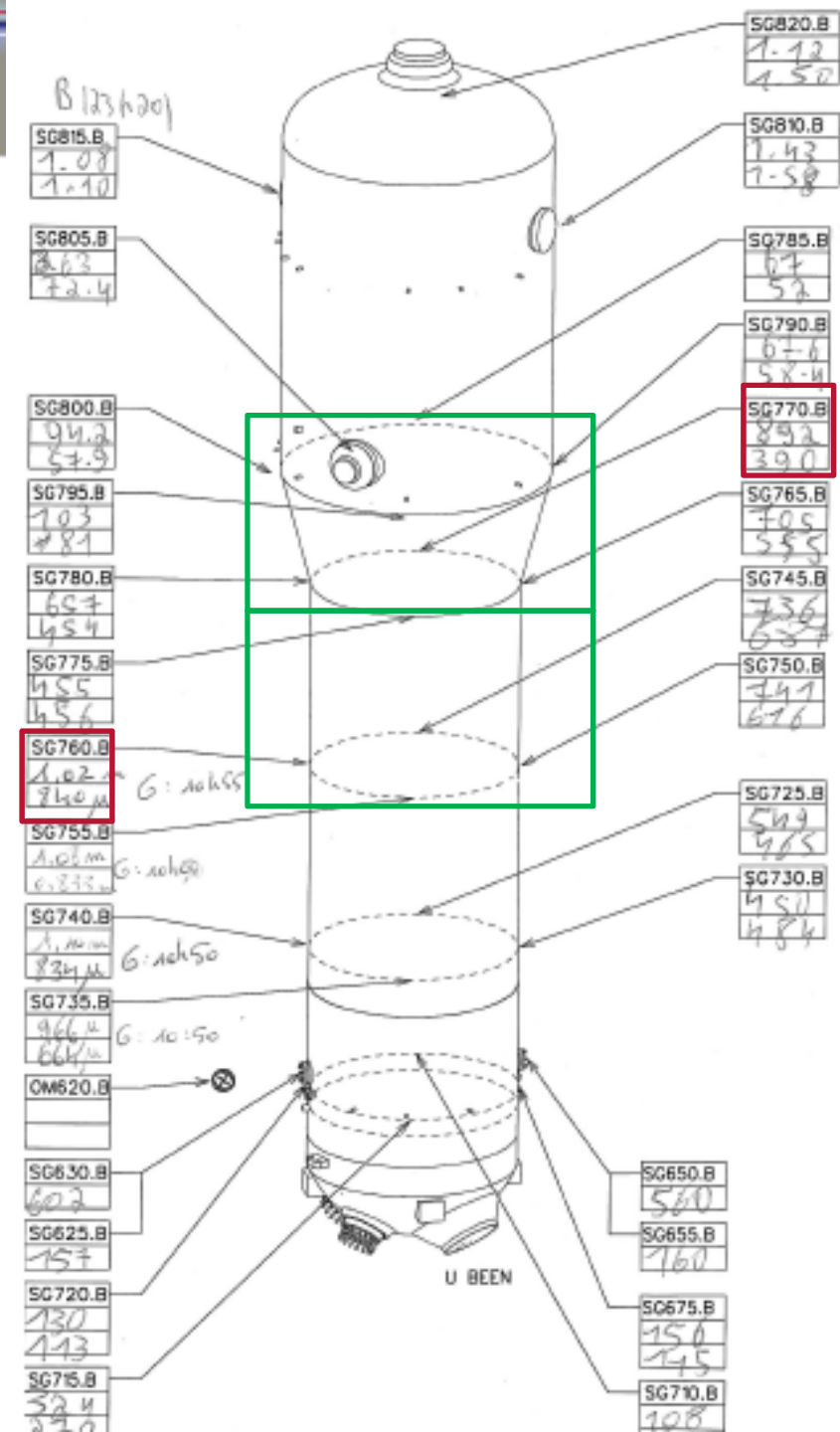
ALARA FOLLOW-UP

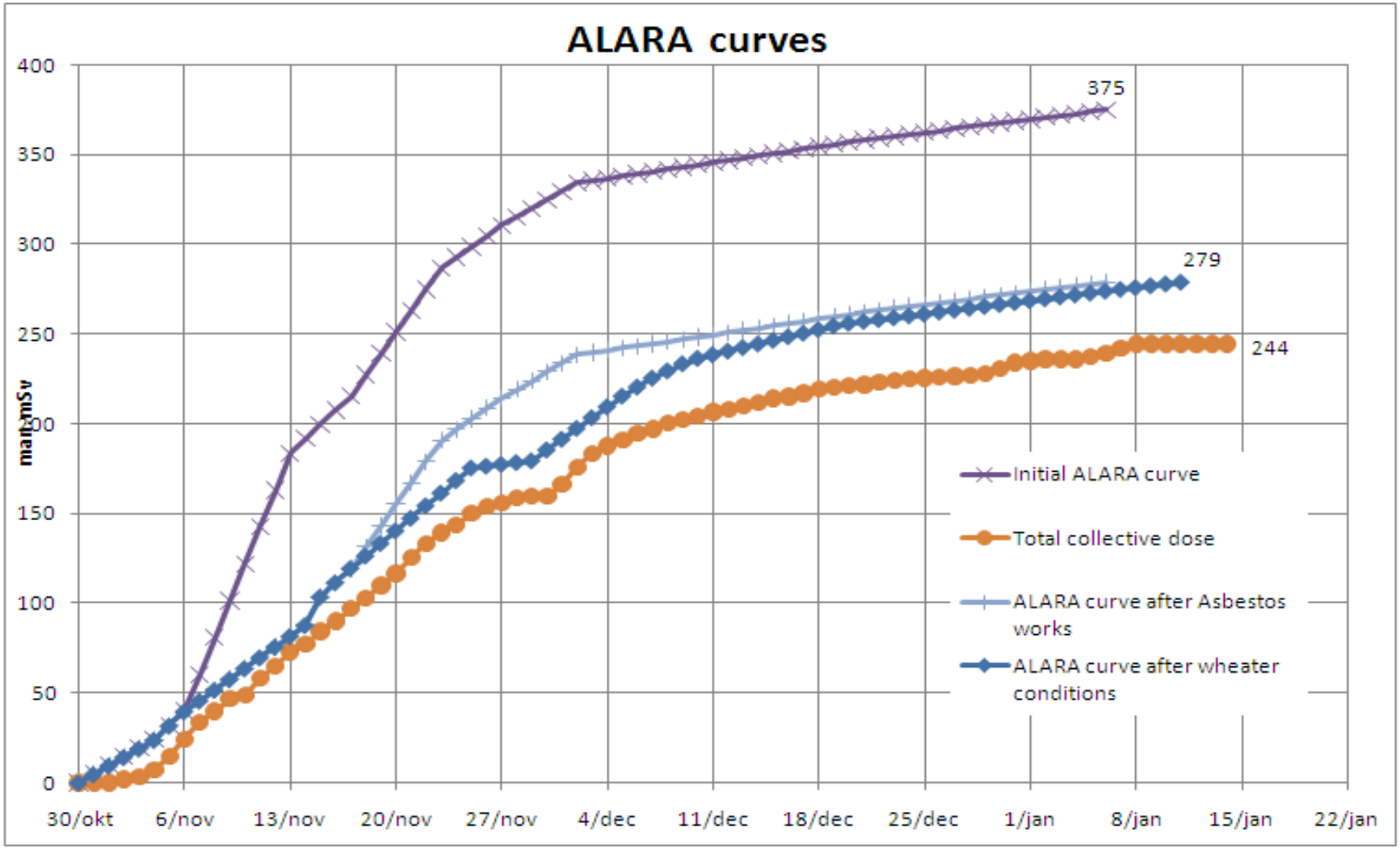
- Example:
  - Before starting to lift:
    - **Control of the dose rates at certain spots**
    - **Last wipe test to see if there is no removal contaminations**
  - If the results were OK
    - **Final sign for lifting was given**



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



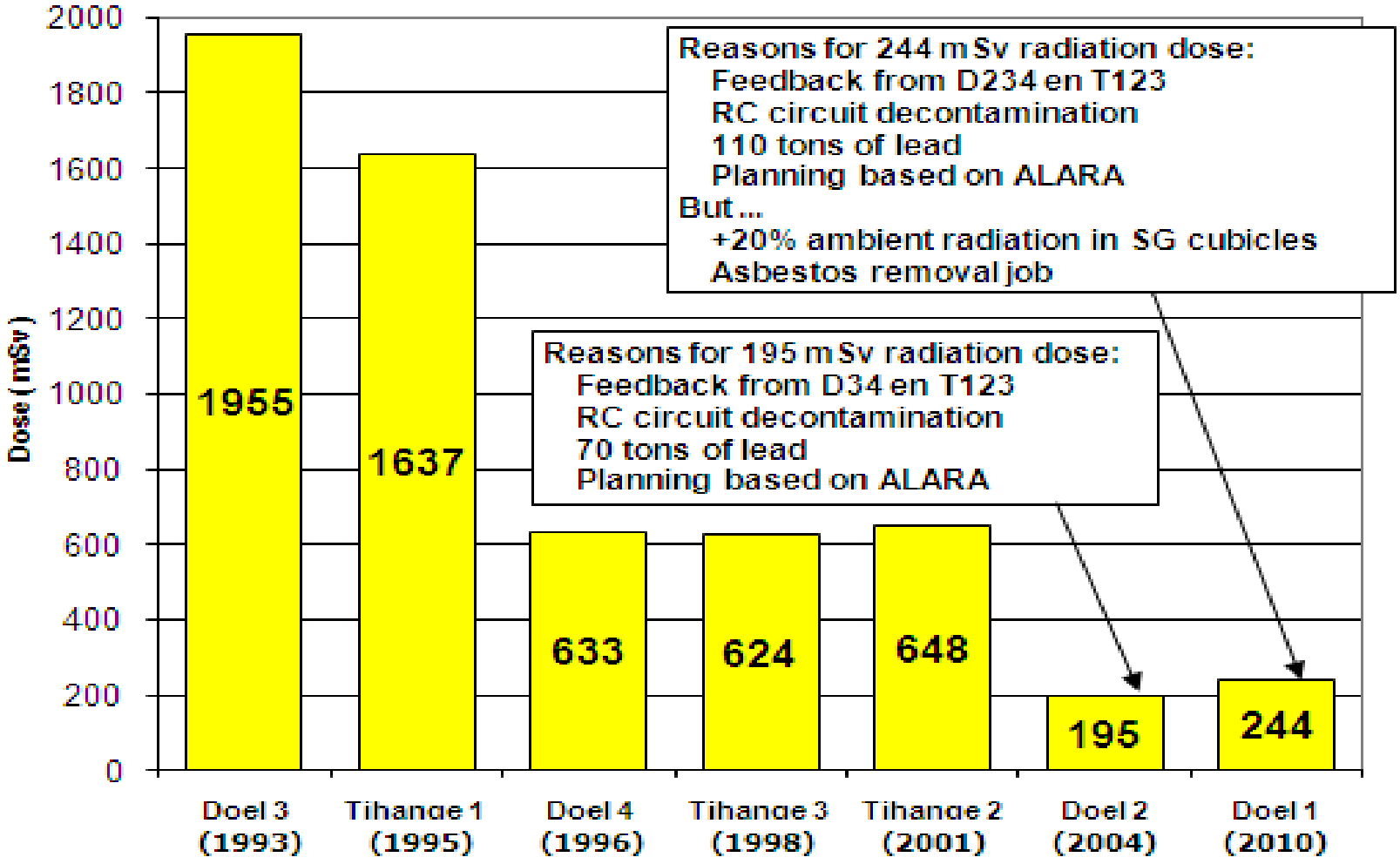
DOSIMETRIC FOLLOW-UP

- 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**

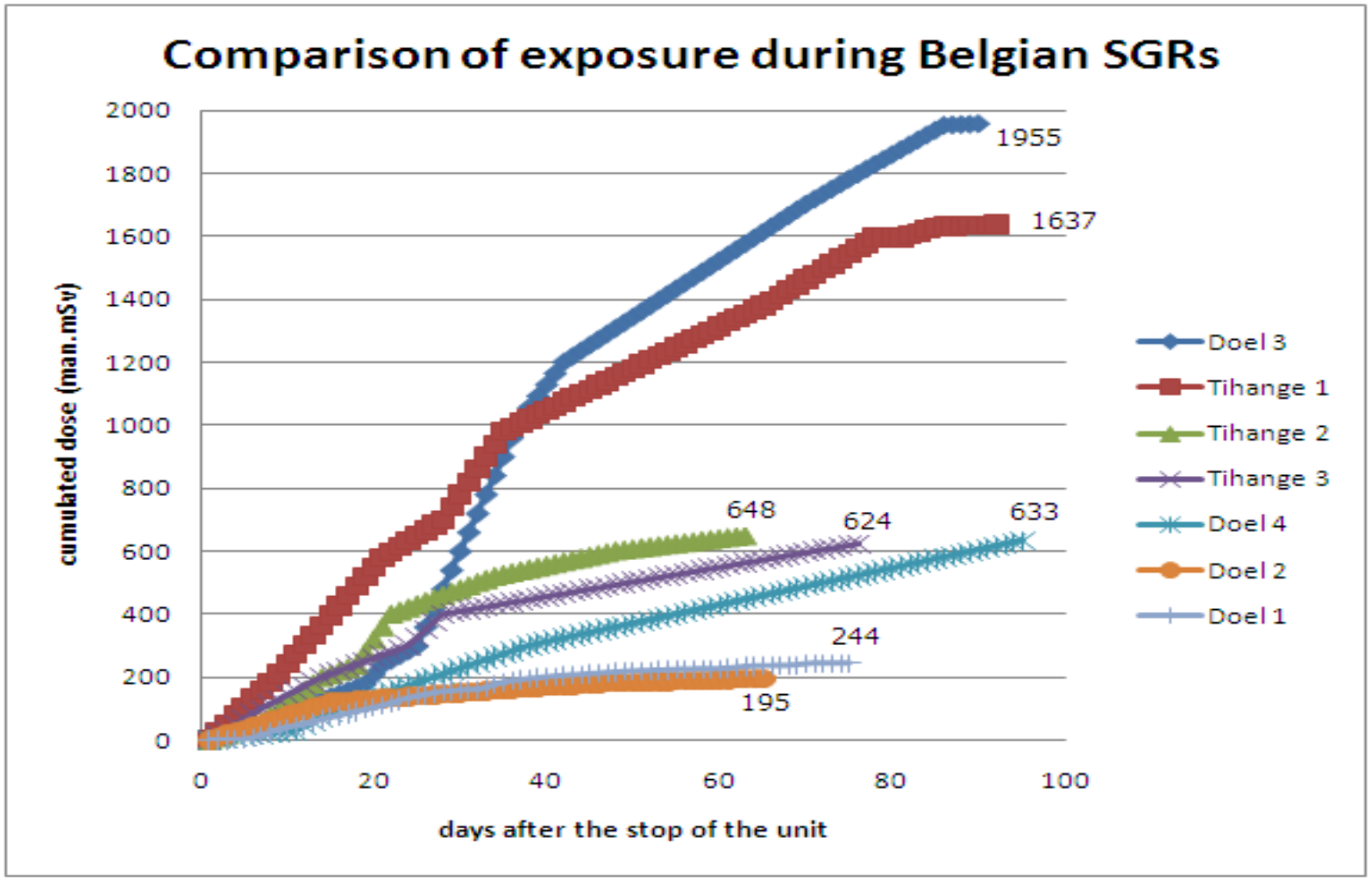
RETURN OF EXPERIENCE

- 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)

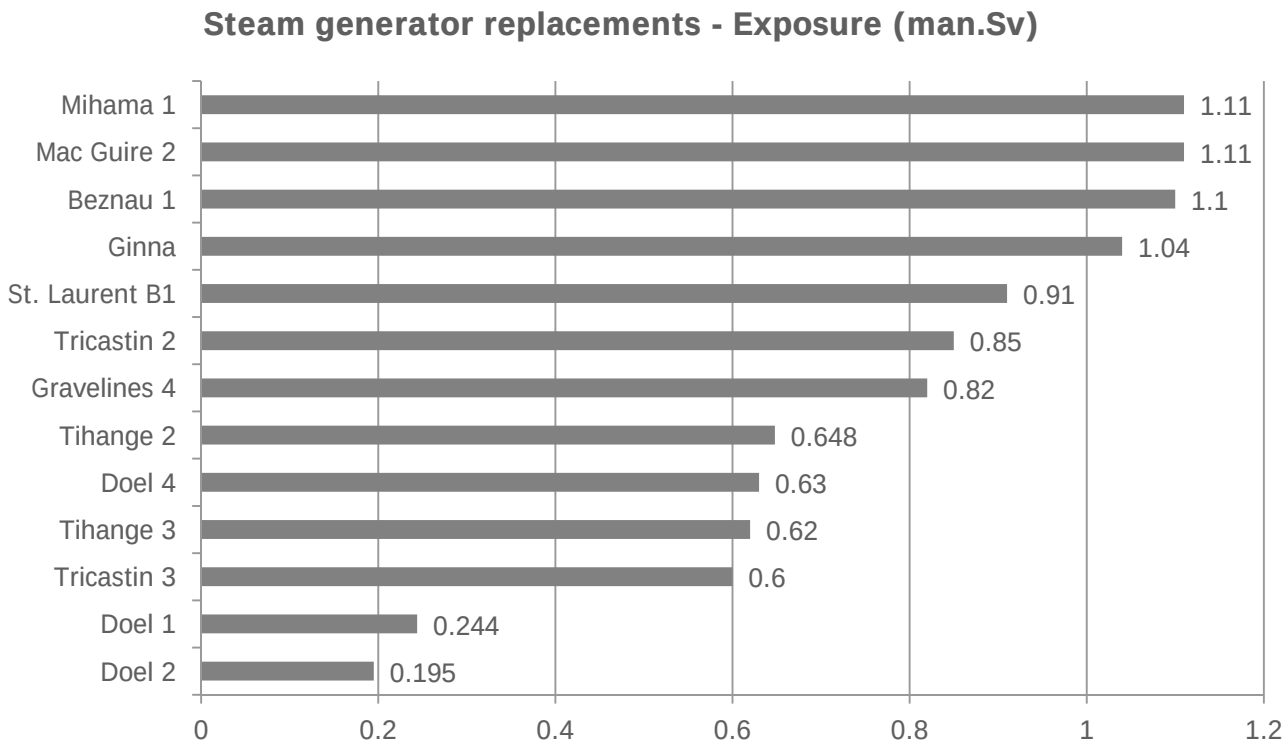
DOEL 1 SGR COMPARED TO OTHERS



DOEL 1 SGR COMPARED TO OTHERS



INTERNATIONAL RESULTS



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**