International Atomic Energy Agency

Introduction to the Practical Exercises

S. Thierfeldt, Germany

Workshop on Safety Assessment for Decommissioning of Research Reactors

4 - 8 October 2010, Risø, Denmark

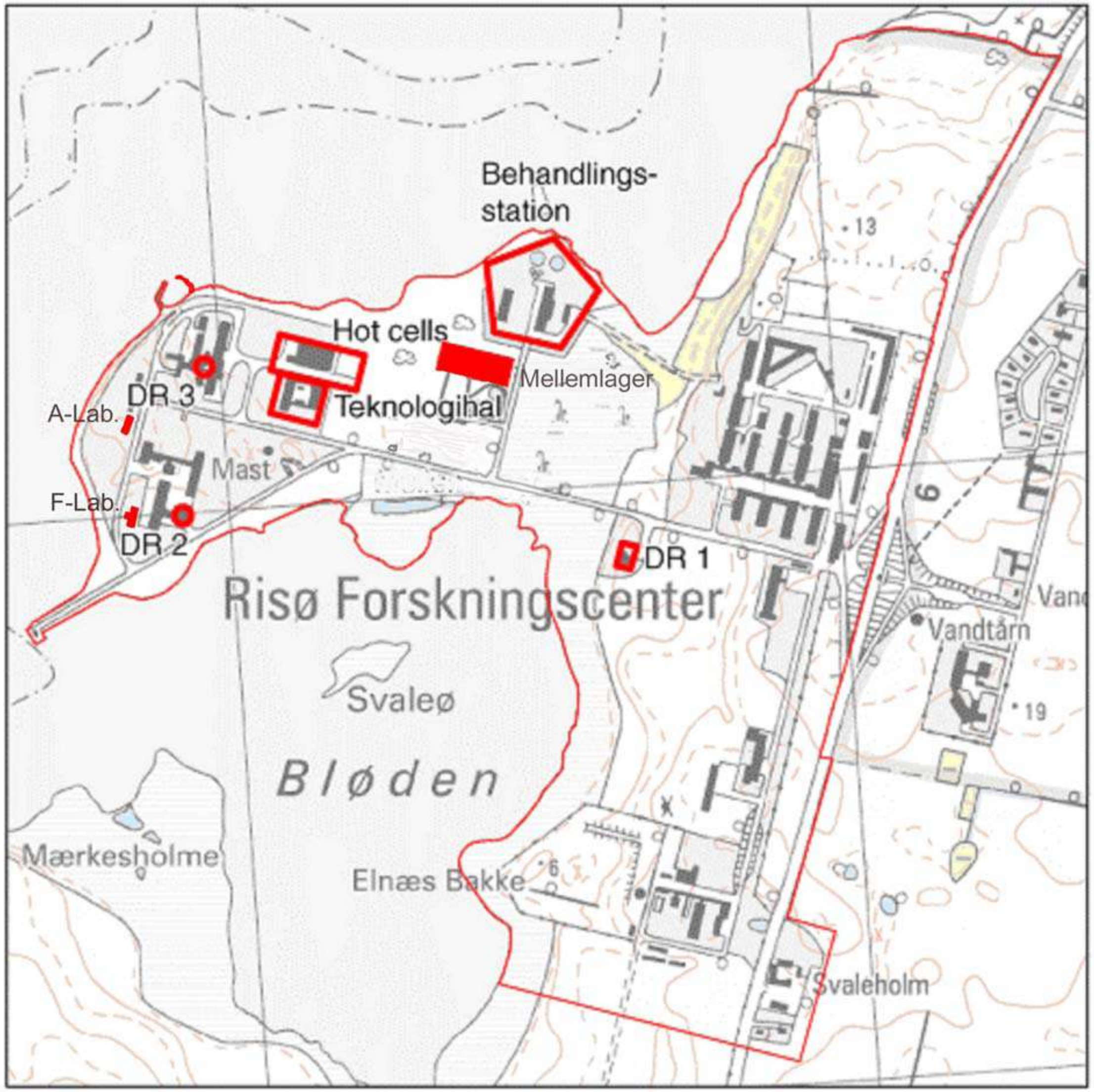
Practical Exercise for Performing a Safety Assessment - Overview

- Performance of hazard identification and risk assessment for specific work steps of the planned decommissioning of the research reactor DR3
  - dismantling of one heat exchanger as a part of primary circuit
  - dismantling of the fuel flask (fuelling machine)
  - demolition of the biological shield (two different techniques)
- Approach:
  - "real-world" example based on real items, drawings, radiological data etc.
  - "hypothetical" calculations as part of safety assessment
    - for illustration purposes only

The Risø Site
Relevant Data of DR3

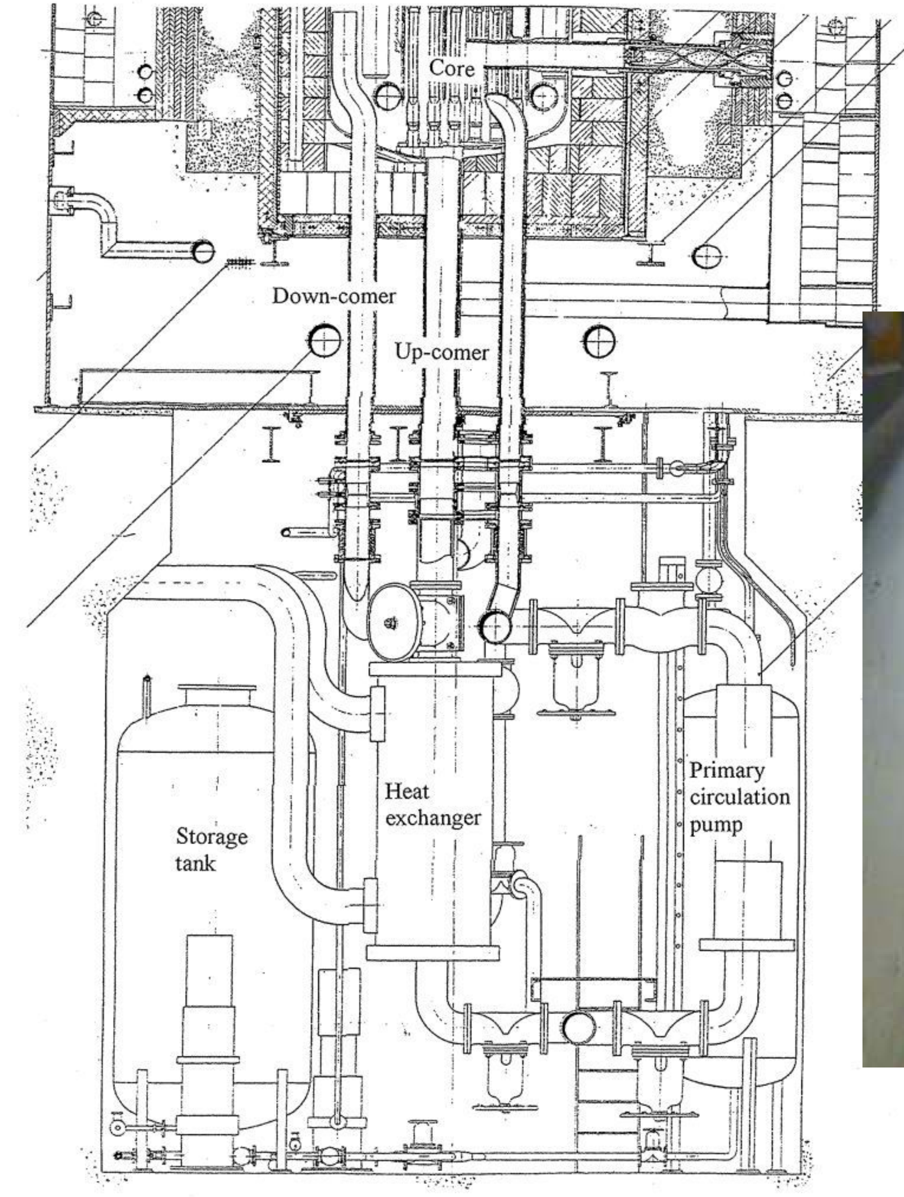
Surroundings of the Site

Layout of the Site



The Three Exercises

Dismantling of a Heat Exchanger (1)



- located in the heavy water room below the reactor block

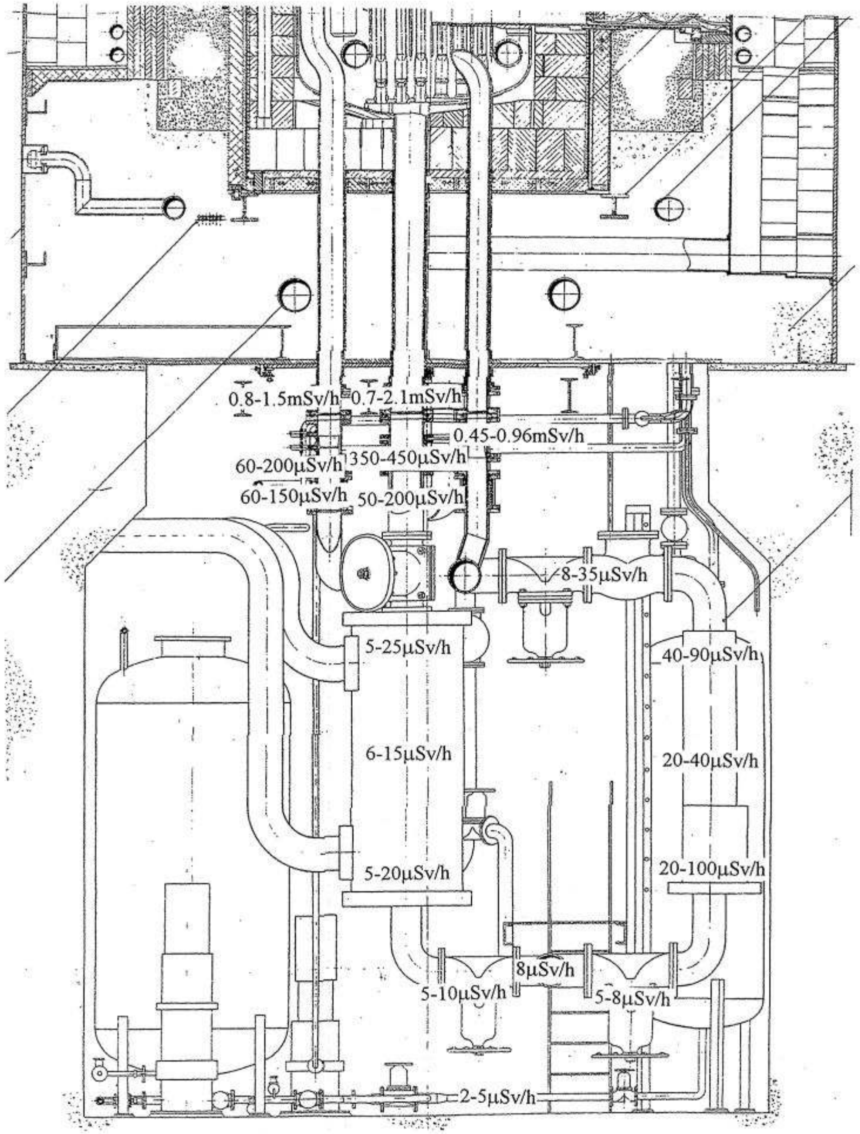
Dismantling of a Heat Exchanger (2)

- Dose rates (μSv/h) at various points
  - of the primary circuit and
  - of the heat exchanger

Section	Up-Comers			Down-Comers			
	UC1	UC2	UC3	DC1	DC2	DC3	DC4
Top section	2100	1800	700	800	1300	1500	1100
Second Section	1300	1500	950	450	650	960	600
Third section	350	450	350	60	150	200	100
Bottom section	200	50	200	60	150	60	70

Part of component	Heat exchanger 1E1/1	Heat exchanger 1E1/2	Heat exchanger 1E1/3
Top of heat exchanger	10-20	10-25	5-25
Middle of heat exchanger	8-15	8-11	6-10
Bottom of heat exchanger	7-20	10-15	5-10
Valve at heat exchanger inlet	10	8	5

Dismantling of a Heat Exchanger (3)



- Contamination caused by Co-60 and Zn-65
  - up to 10^4 Bq per test
- no Cs-137 detected

Dismantling of the Fuel Flask (1)

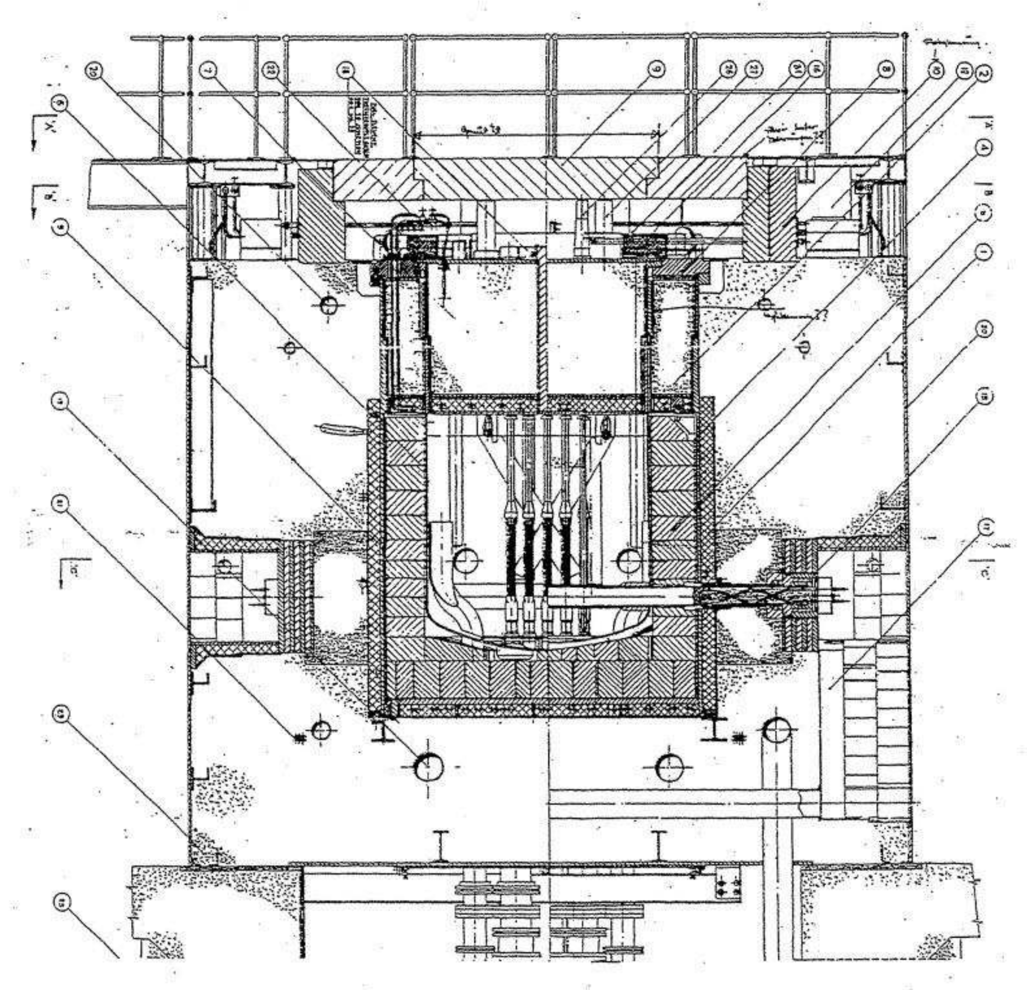
- Fuelling machine for
  - loading and unloading fuel elements from reactor core
  - transport of fuel elements to fuel container

Dismantling of the Fuel Flask (2)

- Contamination and dose rates at and inside the flask
  - dominated by Co-60

Measurement	Location	Value
Contamination measured by smear test	exterior surface of the flask	4 Bq/m^2
	bottom of the flask	19 Bq/m^2
	bottom at the guideway	262 Bq/m^2
	inner surface of the flask	$<1 \cdot 10^4$ Bq/m^2
Dose rate measured by dose rate meter	at closed bottom door	0,6 µSv/h
	20 cm inside the flask	17 µSv/h
	ca. 180 cm inside the flask	750 µSv/h

Demolition of the Biological Shield (1)

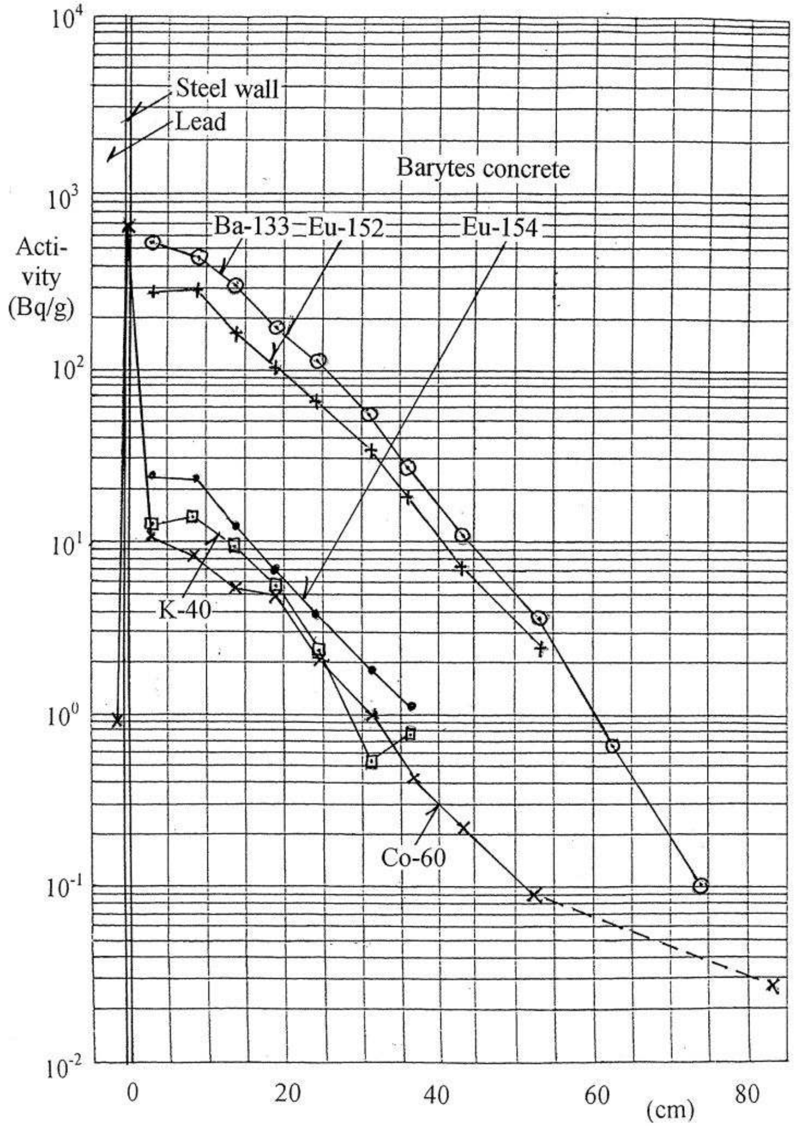


Reactor block
- shape of a box
- length 6.5 m, height 5.4 m
- volume 230 m³

steel tank
- with thermal shield, graphite reflector, reactor tank and the reactor lid
- volume 30 m³

barite concrete
- in remaining volume 190 m³
- density 3.4 g/cm³
- weight 650 Mg

Demolition of the Biological Shield (2)



- Radiological characterisation by various drilling cores

Demolition of the Biological Shield (3)

- Estimation of the activity contents of the concrete of the biological shield:

Radionuclide	Activity [GBq]
H-3	7,000
Fe-55	70
Co-60	40
Ni-63	20
Ba-133	460
Eu-152	320
Eu-154	32

Airborne Releases from Decommissioning

Airborne Releases

- HEPA filters retain about 99.9% or more from the activity released into the plant atmosphere
- Estimate for releases to the environment:

H-3:	0.36 GBq/a	and 1,000 GBq/a from heavy water in graphite
C-14:	0.002 GBq/a	
Co-60:	1 GBq/a	
Ba-133:	0.02 GBq/a	
Eu-152 and Eu-154:	0.02 GBq/a	

- Specific releases from use of segmenting techniques

Execution of the Practical Exercise

The Questions

- For each of the three topics, questions on the following subjects have been formulated:
  - radiological consequences to workers, normal operation
  - radiological consequences to workers, incidents/accidents
  - radiological consequences to public, normal operation
  - radiological consequences to public, incidents/accidents
  - implementation of the results
  - summary
- Detailed questions guide through each subject

How to Perform the Assessments (1)

- Required documents:
  - DeSa report of IAEA
  - Safety Report Series No. 19: “Generic models for use in assessing the impact of discharges of radioactive substances to the environment” of IAEA
  - documentation of DR3 as provided by Risø
- The expected outcome:
  - a short report dealing with all questions that provides dose estimates and the rationale for these calculations
  - a short presentation on the assumptions, methods and results of the assessment

How to Perform the Assessments (2)

- Imagine: You are a health physicist and your plant manager asks:
  - "Could we perform this particular decommissioning task without radiological problems for our workforce and for the general public in the neighbourhood? Which of the two (or three) cutting techniques would be better in your opinion from a radiological point of view? And do we need any additional shielding or other kind of protection?"
- Give him a concise yet comprehensive answer in your report.
  - And be careful: he will only be convinced by hard facts and comprehensible calculations!

Practical Hints

- Choose one of the three groups
  - all 3 cases are similar concerning the types of calculations and the complexity of the safety assessments
- When visiting DR3, pay attention to the possible workspace, waste escape routes, ventilation etc. and imagine how you would segment the component
- Choose the complexity of your methods commensurate with the problem (graded approach!)
  - a simple screening method is enough - describe why!
- Solutions will be provided on Friday

Good luck!