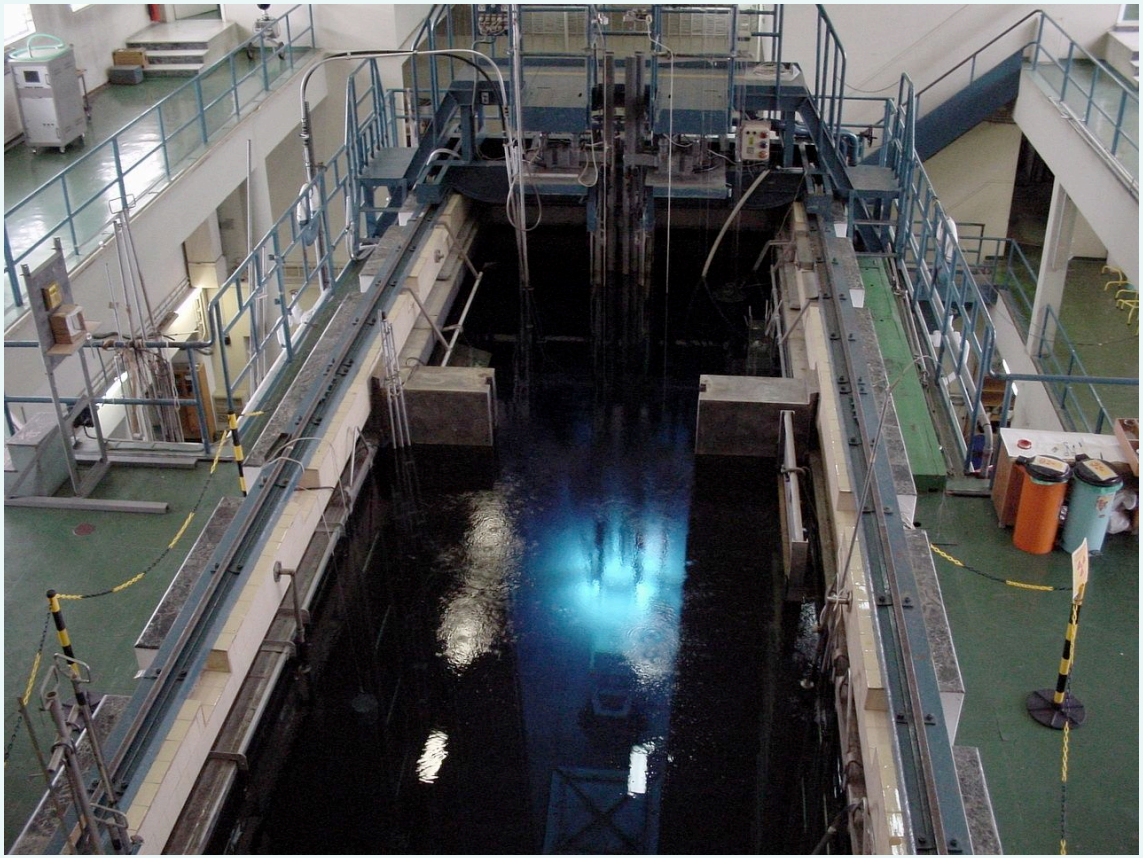
# Application of the ALARA Principle in Dismantling and Disposal of a Research Reactor Primary Cooling System Delay Tank

A. Savidou, F. Tzika, S. Hatzidakis, I.E. Stamatelatos

Institute of Nuclear Technology Radiation Protection,
NCSR Demokritos

11 th European ALARA Network
Workshop

# GREEK RESEARCH REACTOR (GRR-1)



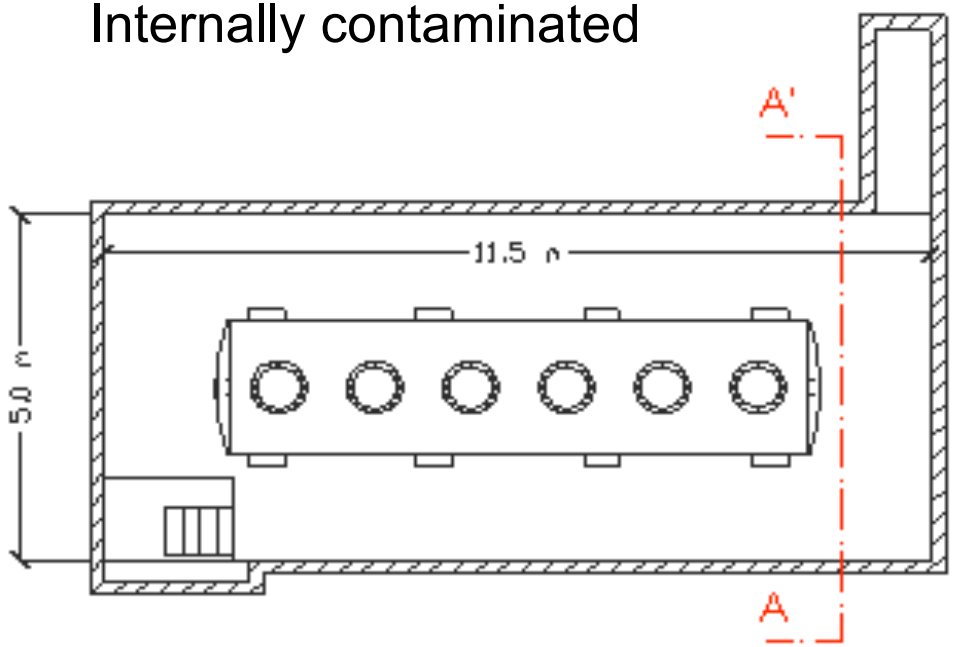
- 5 MW
- Open pool type
- Low enrichment uranium (19.75%)
- Be reflector
- First criticality 1961
- Refurbishment plan started in 2007

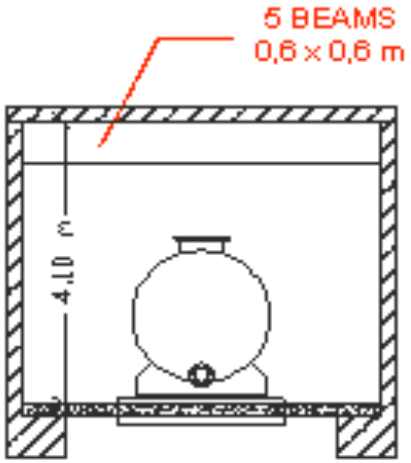
# *GRR-1 pump room and tank*

vol.: 25 $m^3$

Mass: 5.5 Mg

Internally contaminated




SECTION A - A'

## The main tasks of this project are:

- Radiological Characterization
- Radiation Protection Program
- Radiological accident analysis
- Project plan approval (Safety Review Committee, Greek Atomic Energy Authorities)
- Training
- Decontamination
- Dismantling
- Waste management
- Final area status survey

## Radiological Characterization

- Direct measurements for gamma and beta radiation using portable radiation monitors
- *In situ* gamma ray spectrometry using a portable NaI detector system
- Smear sample analysis for measuring transferable alpha and beta-gamma contamination
- High resolution gamma ray spectrometry using a HPGe detector system and a total beta measurements to analyze the activity in fragments of paint.

## The measurements results showed that:

- Contamination is present at internal surfaces
- The contamination is due to $^{137}Cs$, $^{60}Co$, $^{108m}Ag$ & $^{152}Eu$
- The surface specific activity for the sum of these isotopes is below the surface specific clearance level for recycling and above the clearance level for direct reuse (RP89)
- The total beta surface specific activity is above the contamination free level of 0.4 Bq/cm$^2$ (national regul.)
- The estimated activity over the total inner surface of the tank is ~4 MBq
- Uranium isotopes contamination ~$10^{-4}$ Bq/cm$^2$, (alpha spectrometry on smears, GAEC)

# Maximum measured surface specific activity on fragments of paint

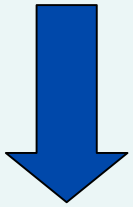
| Nuclide | Half Life (y) | Measured surface specific activity ($Bq/cm^2$) | Total surface activity (kBq) | Surface specific clearance levels ($Bq/cm^2$) |
|---|---|---|---|---|
| $^{137}Cs$ | 30.17 | 1.3 | 1170 | $10^{+}$ |
| $^{60}Co$ | 5.27 | 1.0 | 900 | $1^{+}$ |
| $^{152}Eu$ | 13.33 | 0.6 | 540 | $1^{+}$ |
| $^{108m}Ag$ | 418 | 0.15 | 135 | $1^{+}$ |
| Total β | - | 4.6 | 4140 | $0.4^{*}$ |
| Total α | - | $10^{-4}$ (smear) | $10^{-1}$ (smear) | $0.04^{*}$ |

+) Clearance level for direct reuse [RP89]

*) Contamination free level ref. [National Regulation]

After the radiological characterization

**The problem is determined**



Selection of the processes and methods that will be used to **decontaminate**, **cut**, **dismantle**, **remove** and **release** of the delay tank materials

# Radiation Protection Program (1)

- Process or other engineering controls will be the preferred methods for maintaining exposures to radiation and radioactive materials ALARA.
- Determination of the necessities for control of occupational exposure and for the area monitoring
- Revision and enhancements to GRR-1 radiation protection program to support decommissioning activities

## Radiation Protection Program (2)

- The collective radiation dose to complete the task of decommissioning of the tank is 230 μSv (external exposure)
- The average estimated dose per person is 15.3 μSv (15 persons)

- **The higher dose to an individual is assumed to be 3X15.3 = 46 μSv (because of large variations in individual doses)**

## Radiological Accident Analysis

The worst accident is that of **a fire in radioactive waste** that arises from decontamination and cutting processes

For the examined fire suppression scenario the collective dose to the personnel will be **12 μSv**

The committed effective dose to a member of the public at a distance of 500 m from the release point was estimated [IAEA-TECDOC-1162] to be **$10^{-1}$ nSv**

## Training

- Decommissioning personnel will receive training in accordance with the potential hazards to which they may be exposed
- Personnel performing special processes will be qualified according to specific codes and standards and/or in accordance with national regulations and IAEA safety guides and reports.

## Decontamination

- The tank will be filled up with the NaOH solution 0.1 M and will be left to act at least for 24 h.
- A submersible water pump will be used to drain the tank
- The drained solution will be monitored and disposed off in accordance with the administrative discharge limits specified by GAEC for the NCSR “Demokritos”
- Residue at the bottom of the tank will be collected after draining the tank by a specialized vacuum pump for sludge and treated as solid radioactive waste
- A radiological characterization will be realized in order to demonstrate the level of decontamination

## Dismantling and cutting techniques

The sawing technique will be used to cut the tank

During dismantling, the operator will act according to a ‘cut map’. All pieces will be numbered, radiologically characterized, segregated and a database will be realized for the needs of the potential consequent waste management activities

## Radioactive Waste Management

- Contaminated water may be released to the public sewage system provided that the allowable administrative discharge limit is satisfied.
- Fragments of paint and other solid material that will be collected after decontamination of the tank will be moved to the NCSR “Demokritos” interim storage facility where they will be solidified in cement
- Material that can be further dismantled and decontaminated will be handled onsite
- Material that cannot be decontaminated will be placed in iron drum containers by taking into account the contamination levels and type of waste

# Final area status survey

- Scans to identify locations of residual contamination
- Direct measurements of gamma and beta activity
- Measurements of removable beta surface activity
- A report describing the survey procedures and findings will be prepared


# Thank you for your attention

Acknowledgment: Many thanks to the personnel of the GRR-1 for their valuable cooperation