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DECOMMISSIONING OF CESNEF L-54M RESEARCH REACTOR: RADIOLOGICAL PRE-CHARACTERISATION OF GRAPHITE AND BIOLOGICAL SHIELD

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Abstract: The L 54M thermal research reactor was commissioned by Politecnico di Milano to Atomic International in 1958. It was shut down in 1979 after around 20 years of operations for research purposes. Subsequently it was put under Safe Storage. Several operations have to be managed in order to restore the reactor site to the status of "unrestricted re-use", the so-called "greenfield"status.
This work concerns the preliminary radiological characterization of graphite and concrete, which are the main constituents of the moderator/reflector and the biological shield respectively. The main purpose of this work is the assessment of conventional and radioactive wastes volumes in view of the final decommissioning. In this context, the key radionuclides deriving from neutron activation are: 3H, 14C, 60Co, 152Eu. The first part of the research was based on neutron diffusion theory for the computational evaluation of the activity of these activation products. The second part of the work was focused on Non-Destructive Analyses (NDA) and DA of few graphite and concrete representative samples [1].

1. INTRODUCTION

The first step of decommissioning consists in the Historic Site Assessment (HSA) in order to acquire a complete outline of the L-54M reactor during its operational life [2]. Thanks to this analysis, the main reactor components involved in the activation process are identified, as reported in Table 1 [3]. Consequently, a preliminary radiological characterisation has to be performed not only to acquire the knowledge on the radiological inventory (fingerprint) but also to quantify the specific activity of the individual radionuclides.

Table 1 Main reactor components

Components DIMENSIONS Material Mass [kg]
Supplementary Shield h = 1616 mm
∅ = 558.8 mm Alluminium
Reflector V = ~ 7 m3 Nuclear graphite ~ 11000
Core R = 200 mm
Smin = 1.73 mm Steel 9.071
Control rods Internal cladding ∅int = 21 mm Alluminium
External cladding Steel 0.2336
Irradiation channels Iron ~ 3200
Fuel Vsol = 27.4 l UO2SO4 + H2O 1.3358
Biological shield ~ 189 m3 Barite concrete
(ρ = 3.66-3.82 g⁄cm-3) ~ 700000

2. METHODS

The computational evaluation was performed by means of Matlab codes supported by Monte Carlo simulations [4]. 60Co and 152Eu specific activities were measured by HPGe gamma spectrometry, while 3H and 14C were analysed by liquid scintillation after suitable sample pre-treatment in a furnace.

3. RESULTS

The preliminary results on graphite bricks are summarised in Table 2. The average specific activity of key radionuclides in the three main components are reported in Table 3.

Table 2 Main radionuclides in graphite bricks (distances are from the external surface of the reflector)

Specific activity [Bq⁄g-1]
Depth [cm] 14C 3H 152Eu
0 4.1 ± 0.3 51.5 ± 3.4 4.1 ± 0.3
40 37.5 ± 2.6 811 ± 54 34.3 ± 2.3
120 370 ± 25 9170 ± 597 253.9 ± 18.8

Table 3 Summary of activated materials

Material Volume [m3] Mass [kg] Nuclide Activity [GBq] Specific average activity [Bq⁄g-1]
Graphite (moderator + irradiation facility) 9.5 16100 3H 37.44 2.3·103
14C 1.58 98.1
152Eu 1.19 73.9
Barite concrete (estimate of activated quantity) 4.1 15700 60Co 0.09 6.0
152Eu 0.58 37.0

Steel (core) - 20 60Co 1.97 9.9·104

1. CONCLUSIONS The analyses performed in bricks at different depths confirmed that the whole graphite is completely activated. Thus it has to be considered as a radioactive waste. Contrariwise, the concrete seems to present only a limited activation in the inner part. REFERENCES [1] IAEA, Technical Report Series no.44622, Decommissioning of Research Reactors: Evolution, State of the Art, Open Issues, 2006. [2] NRC, EPA, DoE, DoD, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), 2000. [3] Sergio Terrani, Il reattore e gli impianti nucleari del CeSNEF: Rapporto di Sicurezza, Politecnico di Milano, 1961. [4] Mario Terrani, Il reattore L54-M del CeSNEF. Misure di flussi neutronici e determinazione della potenza, 1960.

Country or International Organization

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