XA9642797

THE CANADIAN RESEARCH REACTOR SPENT FUEL SITUATION

P.C. ERNST
McMaster University,
Hamilton, Ontario,
Canada

XA9642797

Abstract

This paper summarises the present research reactor spent fuel situation in Canada. The research reactors currently operating are listed along with the types of fuel that they utilise. Other shut down research reactors contributing to the storage volume are included for completeness. The spent fuel storage facilities associated with these reactors and the methods used to determine criticality safety are described. Finally the current inventory of spent fuel and where it is stored is presented along with concerns for future storage.

1. INTRODUCTION

The storage of research reactor spent fuel in Canada presents a challenge for both sites currently operating research reactors. This summary of the current situation is presented to assist the IAEA in assessing the world wide problem of the storage of spent research reactor fuel.

2. CANADIAN RESEARCH REACTORS AND THEIR FUEL

There are currently two multipurpose research reactors operating in Canada, the NRU reactor belonging to Atomic Energy of Canada Limited, AECL, at their Chalk River Laboratories, CRL, outside Chalk River, Ontario and the McMaster Nuclear Reactor, MNR, at McMaster University in Hamilton, Ontario. In addition there are six SLOWPOKE reactors at various universities across Canada. These latter reactors operate at a maximum of 20 kW and are primarily used for activation analysis. There is no spent fuel associated with these SLOWPOKES since they have essentially lifetime cores.

Shutdown research reactors contributing to the HEU spent fuel inventory include the NRX reactor at AECL-CRL, the Whiteshell Reactor number 1 (WR1) and the SLOWPOKE Demonstration Reactor (SDR) at AECL's Whiteshell laboratories (AECL-WL).

The NRU reactor is a heavy water moderated, light water cooled, tank reactor operating at 65 MW using fuel assemblies approximately 2.9 m long by 7.5 cm in diameter. Originally fuelled with natural uranium, it was first converted to HEU and recently to LEU fuel. The HEU fuel consists of rods of uranium-aluminium alloy extruded in an aluminium cladding. The LEU fuel currently utilises U_3Si in place of the UAl meat.

MNR is a pool-type reactor licensed for 5 MW but operating at 2 MW because of fuel costs. The fuel currently in use is HEU MTR plate-type fuel with an active length of 60 cm and a cross-section approximately 7.5 cm square. The normal MNR fuel consists of assemblies of 18 plates containing 196 g U-235 HEU. Some assemblies, previously irradiated in the PTR reactor at AECL-CRL, consist of 10-plate assemblies containing 160 g U-235 HEU. MNR is currently testing two LEU assemblies with a meat of U_3Si_2 LEU and will be converting to LEU.

All the Canadian enriched spent fuel is of United States origin.

3. SPENT FUEL STORAGE FACILITIES

3.1. MNR

At MNR the reactor pool is quite large and consists of two parts which can be isolated from each other via a gate, Pool #1 where the reactor normally operates and Pool #2 where the spent fuel is stored in racks. The spent fuel storage racks consist of linear arrays of six aluminium tubes 12.5 cm diameter by 60 cm high on 16 cm centres. The second reactor pool at MNR houses 11 of these, locked in place, as shown in Figure 1. These eleven racks provide storage for 66 assemblies. A Spent Assembly Gamma Exposure (SAGE) facility on the pool floor can store a further eight assemblies giving MNR a maximum storage capacity of 74 assemblies.

MNR has assessed the safety of its storage facilities based on empirical data gleaned from criticality measurements on various geometries as presented in a June 1964 United States Atomic Energy Commission document TID 7028 "Critical Dimensions of Systems Containing U-235, Pu-239 and U-233". This paper investigated the storage of MTR elements of the same size and shape as those used at MNR and containing the same loading of U-235.

Its conclusion was that an infinite number of assemblies side by side on a plane in water will be sub-critical. Likewise two such layers of 26 assemblies each were sub-critical when submerged at optimum spacing. Further the paper states that with 5.7 cm spacing between assemblies, i.e. a pitch of 13.3 cm, an infinite array of assemblies would not be critical.

Since the criteria used for criticality safety is empirical rack #10 in the Southwest corner of the pool was raised up, as shown in Figure 2, to avoid any possible criticality problem by bringing a spent assembly into the pool corner adjacent to the racks. Likewise Rack #11 was raised to prevent a possible corner problem and to place it well above the graphite Thermal Column Extension stored in the Southeast corner of the pool.

3.2. AECL-CRL

Spent fuel storage at AECL-CRL consists of water bays at both NRX and NRU, a concrete shielded storage room at NRU, another concrete shielded archive storage block and in-ground tile holes at an on-site waste management area.

The tile holes used at AECL-CRL are shown in Figure 3. These are considered as recoverable storage with relatively easy access to the stored assemblies. Concrete tracks are cast parallel to the rows of holes to support flask adapters and flasks used to transfer the fuel to the storage holes.

AECL uses various computer codes to assess the safety of their storage facilities.

3.3. *AECL-WL*

All the fuel from the WR1 reactor, including some HEU experimental fuel, is stored in seal-welded, carbon steel baskets placed in above-ground concrete canisters. This dry storage technology was developed for the storage of CANDU power reactor fuel but is equally adaptable to research reactor fuels.

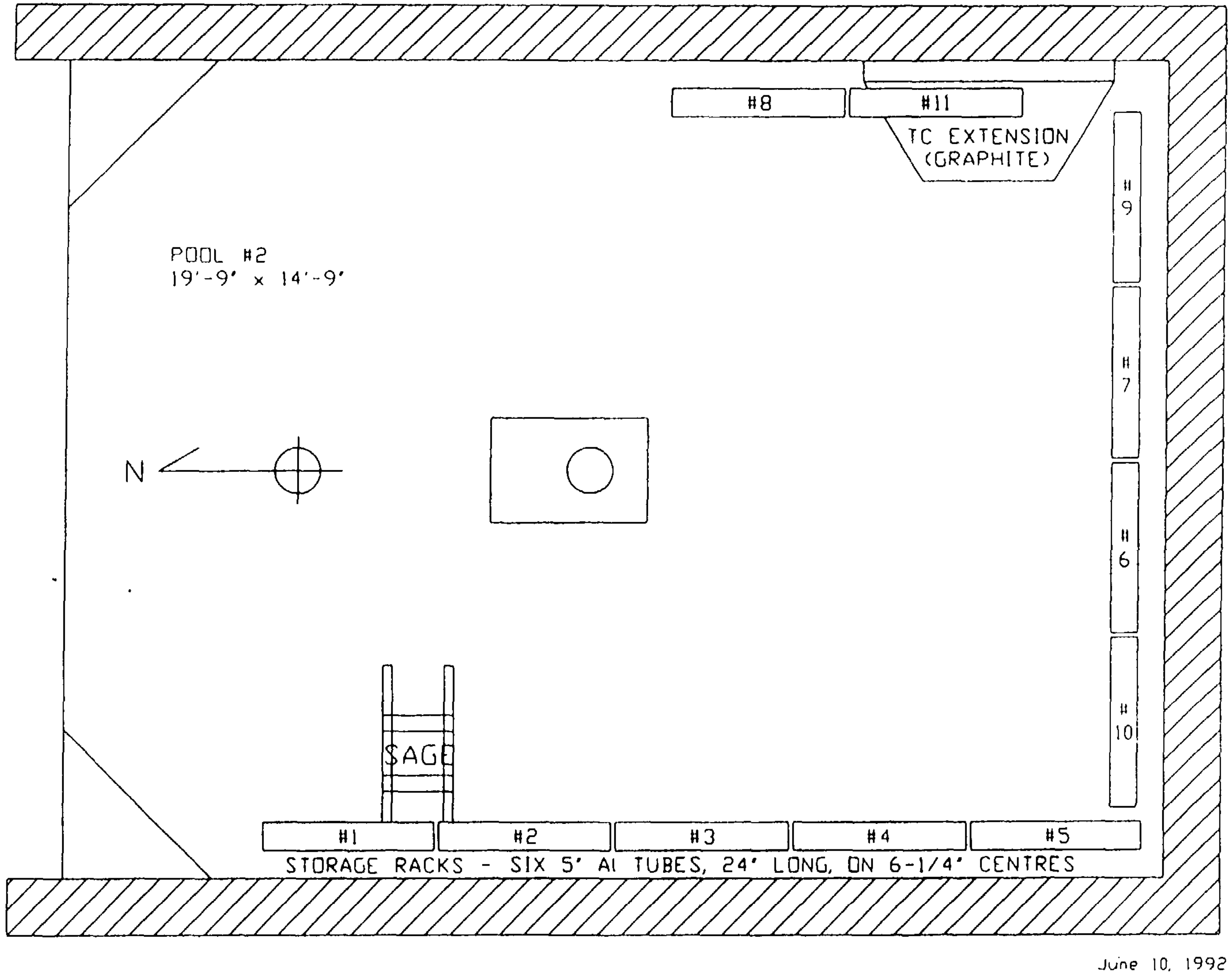


Figure 1. MNR Pool #2 Plan View of Spent Fuel Storage

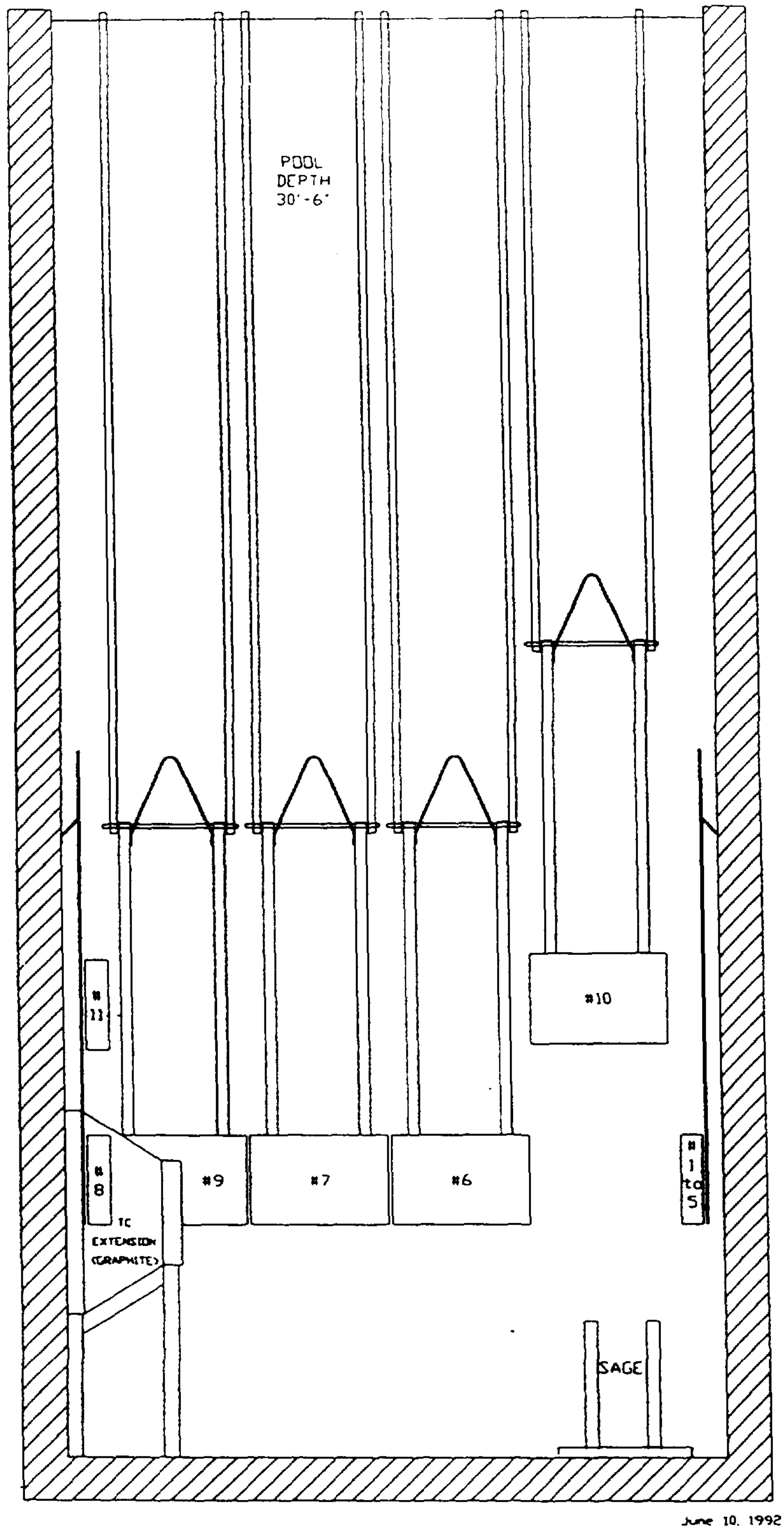
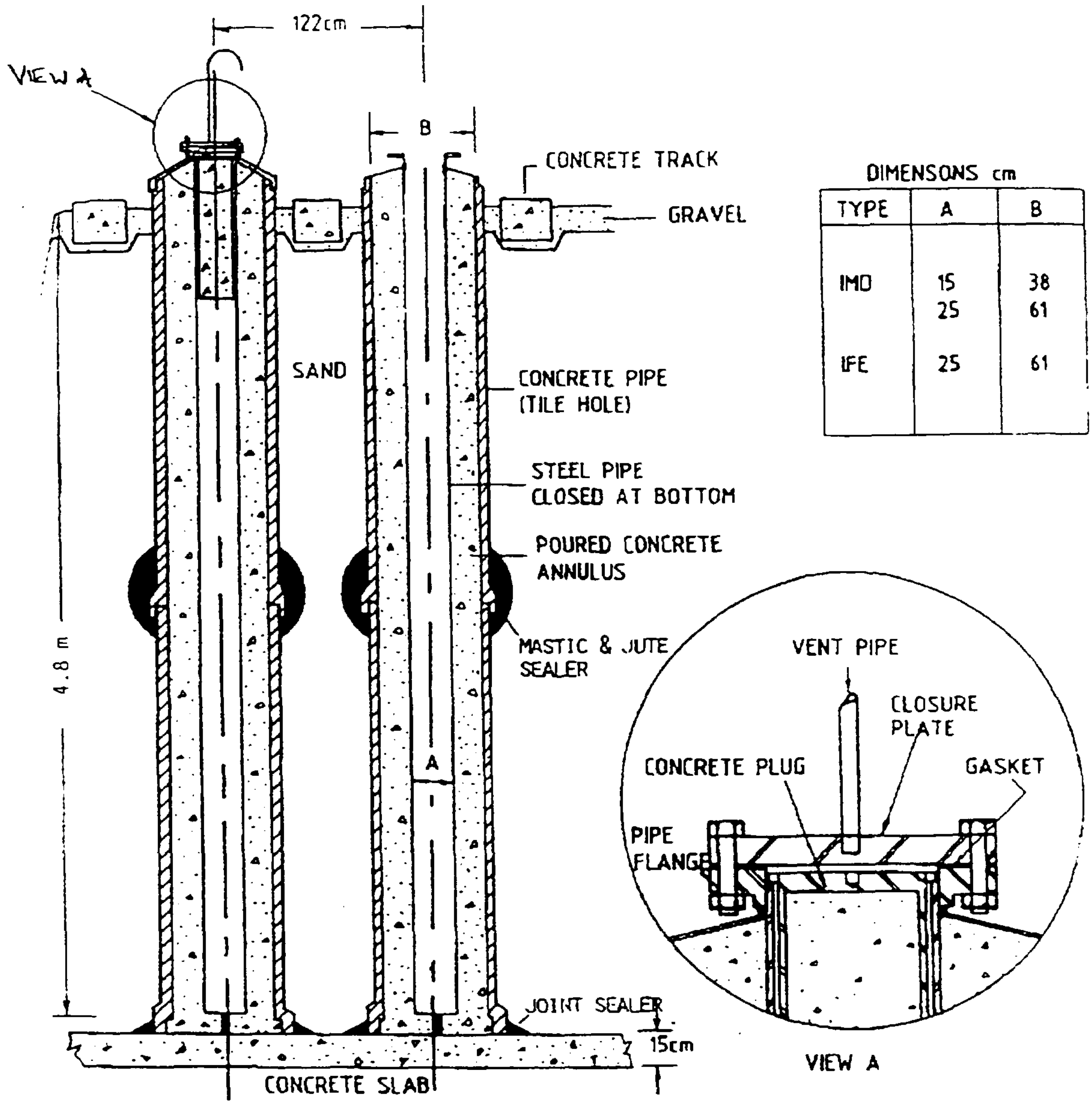


Figure 2. MNR Pool #2 Cross-section, Looking South



DIMENSONS cm

TYPE	A	B
IMD	15 25	38 61
IFE	25	61

Figure 3. Typical Fuel Storage Tile Holes

4. SPENT FUEL INVENTORIES

4.1. MNR

MNR currently has 66 spent fuel assemblies in storage, 51 of these are normal MNR assemblies and 15 are PTR assemblies. MNR has room for only 8 more assemblies before running out of storage. This is only slightly more than a year's worth of fuel usage at current operating levels.

4.2. AECL-CRL

CRL currently has 1578 research reactor spent fuel assemblies in storage. The fuel stored in the fuel bays consists of 162 HEU assemblies at NRX with a further 105 HEU and 291 LEU assemblies at NRU. The NRU dry storage room contains 16 LEU assemblies.

There are 1004 assemblies stored in tile holes; 80 natural uranium assemblies, 818 HEU assemblies and 106 SDR assemblies. The latter contain a mixture of HEU and SEU (slightly enriched uranium) special nuclear material.

In addition there are 16 HEU booster rods in the archive storage which come from the Gentilly 1 power reactor.

5. CONCLUSIONS

Both MNR and AECL would like to reduce their spent fuel inventories by returning the enriched fuel to United States under the Return of Foreign Fuels Policy currently being reactivated by the United States. MNR's main concern is the timing in that we are rapidly running out of storage space. Any expansion of the storage space will require re-licensing with all its attendant difficulties.

ACKNOWLEDGEMENT

Assistance provided by Mr. F. Keeling of AECL-CRL in compiling the inventory is gratefully acknowledged.