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COGEMA-ANSTO MANAGEMENT OF THE ACCEPTANCE PROCESS OF HIFAR SPENT FUEL

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ABSTRACT

The Australian Nuclear Science and Technology Organisation (ANSTO) has operated the 10 MW DIDO class High Flux Materials Test Reactor (HIFAR) since 1958. Refuelling the reactor produces about 38 spent fuel elements each year.
In 1999, ANSTO signed a contract with COGEMA for the management of all non-US origin spent fuel, and two shipments to La Hague have been completed to date.
Prior to a fuel shipment, ANSTO provides COGEMA with the spent fuel characteristics. Together with ANSTO, COGEMA has developed criteria for acceptance of HIFAR spent fuel at La Hague. These include visual inspections, testing of fuel that may be unsound, and a final check of a gas sample drawn from a filled transport cask.

Introduction

The Australian Nuclear Science and Technology Organisation (ANSTO) has operated HIFAR, the 10 MW High Flux Australian Reactor, since 1958. HIFAR fuel assemblies are presently 100mm outside diameter concentric cylinders, 2 metres long with a fuelled section of 600mm. The fuel plates are aluminium clad with an aluminium-uranium HEU core. Refuelling the reactor produces about 38 spent fuel assemblies each year. During each shutdown, three or four fuel assemblies are removed from the reactor, and stored in a cooling pond for about three years. During this time, the top and bottom nozzles are removed using an underwater cropping saw, assemblies are then stored as long as necessary in storage ponds or dry store. At the time of their shipment overseas, they are taken back to the transport cask loading pond for under water cask loading.
The HEU fuel for HIFAR is manufactured at Dounreay using UK or US origin enriched uranium. Spent fuel was originally sent to Dounreay, UK for reprocessing but this plant was definitely shutdown in 1998. ANSTO has a contract with COGEMA for the reprocessing of non-US origin fuel and also participates in the US Foreign Research Reactor Spent Fuel Return program.
In January 1999, ANSTO signed a contract with COGEMA for the management of all its non-US origin spent fuel, both from HIFAR and from the Replacement Research Reactor under construction. The contract includes transport of spent fuel, reprocessing at La Hague, conditioning of the waste into a stable form and return of ILW residues to Australia. The contract for HIFAR provides for about 1300 fuel assemblies to be shipped in four shipments. Two shipments with a total of 668 fuel elements have been completed to date. The contract provides also that any shipped spent fuel is structurally sound and non-leaking – basic acceptability criteria for both transport and La Hague facilities. Leaking and non sound spent fuel can be accepted subject to special conditions.
We will see how the COGEMA-ANSTO jointly developed fuel inspections and tests, together with the final controls on each loaded cask, enables us to cope with most fuel in a simple manner, without expensive additional measures and especially without special canning.

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Fuel Types:

HIFAR has operated with three different types of HEU fuel elements. Mark II fuel assemblies consist of 10 parallel curved fuel plates fitted into an open ended aluminium box. These were used in HIFAR between 1958 and 1971. Mark III fuel assemblies, consisting of 10 curved plates fitted as spiral fins in the annulus between inner and outer aluminium tubes, were also used during the period. Since 1970, the Mark IV/ Mark VI design of four concentric fuel tubes has been utilised.
The different types require different handling arrangements, both on site and abroad. When the Mark IV/ Mark VI fuel is cropped to length, the four tubes are loose and are clipped together for transport. A tag is required for identification. For Mark II, a handling adaptor is fitted to the cropped assembly.
Spent aluminium fuel stored in carefully controlled conditions can remain in a good physical condition for many years. There are fuel elements in storage at ANSTO, removed from the reactor more than 30 years ago, that are still in good condition. Such fuel is structurally intact, sound and non-leaking.
A small number of fuel elements were subject to destructive examination including dismantling and cutting in the fissile part, so are obviously severely damaged.
A small number of fuel elements that show stains or marks of limited corrosion attacks will be subject to detailed examinations.

Mark II mock-up fitted with a handling adaptor

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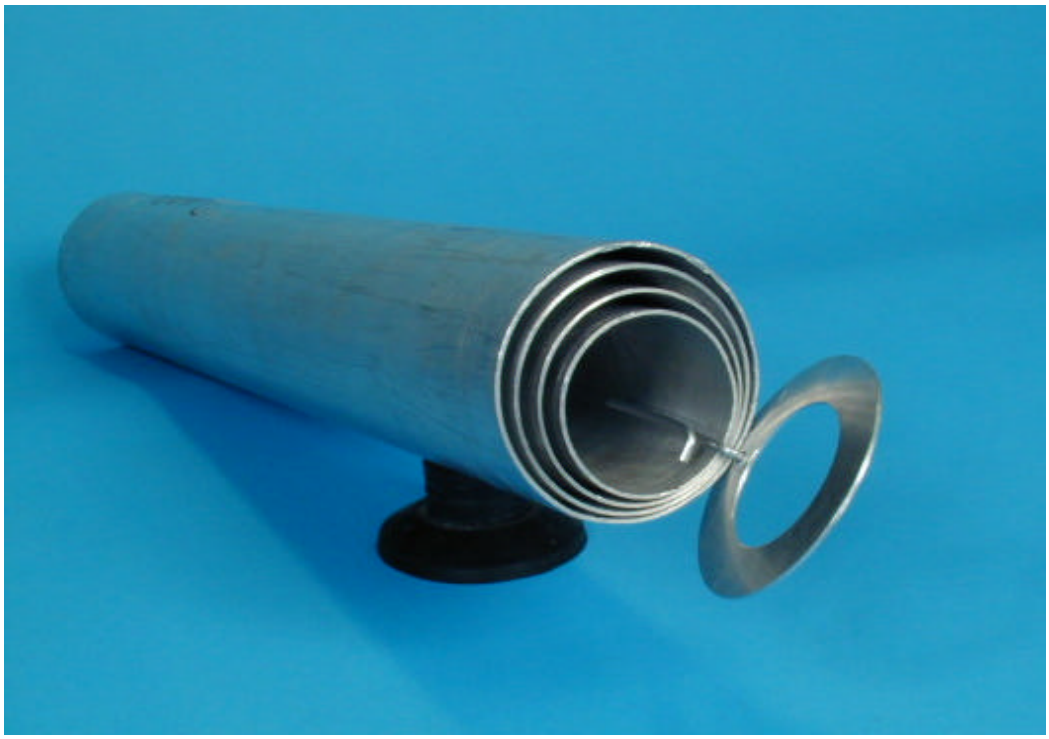

Mark IV / VI mock-up clipped and tagged

Fuel acceptance for transport and reprocessing at La Hague:

Using the precise pre- and post-irradiation characteristics provided by ANSTO for each spent fuel assembly, COGEMA has to verify its particular characteristics can be managed in full compliance with all safety rules at every step in a complex process including transportation, reception, unloading, storage and treatment in the La Hague plant. The first verification stages are based on documents, long before the fuel is shipped.

General criteria for the acceptance of sound spent fuel relate to:

- Geometry and mechanical integrity after cropping:
  - The spent nuclear fuel must not be bent or deformed – i.e. basically no interference when loading/unloading into the cask basket. Each fuel element is individually handled to check that it is structurally sound.
  - The spent fuel must be structurally sound such that there will not be any material dissemination during handling and transport.
- Non leaking:
  - The spent nuclear is declared as non leaker by the reactor operator
  - When the fuel is handled after unloading from the reactor, the operator must re-confirm the integrity of the fuel and provide pool water inspection characteristics and any other documents with supporting information concerning conditions in the last place of storage.
- Cooling time: 1 year minimum at the time of shipment and in compliance with the requirements of transport casks to be used
- Gas checking in loaded cask: the $\beta\gamma$ activity (excluding tritium) of a gas sample from each loaded spent fuel transport cask shall not exceed 0.37MBq/m^3
- Final visual check that each assembly is structurally sound and as documented: this last verification is performed by a COGEMA representative assigned at the reactor to monitor the fuel during cask loading. In case of any doubt during inspection, electronic images are taken and are transmitted together with dimensional data to COGEMA experts in France for a final decision.

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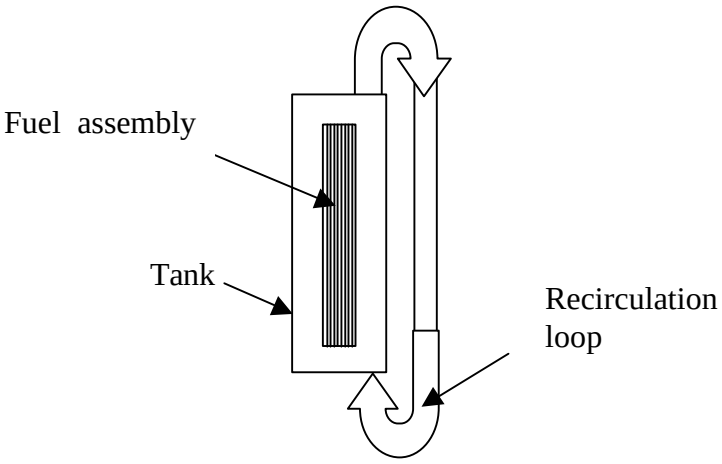
It may happen that some fuel is rejected (subject to further investigations) at any stage of the acceptance process, including the final visual check at the time of loading. Consequently, the list of fuel undergoing acceptance on documents, and the fuel prepared for shipment comprises an adequate number of spare fuel elements. With such provisions, even a last minute rejection does not affect the economy of the shipment and shipped casks can be fully loaded.

Questionable fuel acceptance for transport and reprocessing at La Hague:

Fuel that meets the sound fuel criteria above is generally accepted. Fuel that does not meet one or more of the above criteria and which is not heavily damaged is considered as "questionable". This fuel may eventually be accepted and transported without canning in standard casks, provided that further detailed examinations are conducted. COGEMA-ANSTO jointly developed fuel inspections and tests, together with the final controls on each loaded cask, enables us to cope with most of the unsound fuel in a simple manner.
Supplementary criteria have to be met:

- The spent fuel must be physically sound, ie there must be no material dissemination during handling or transport
- If the fuel is geometrically and mechanically sound but there are signs of corrosion, the fuel may be accepted subject to a satisfactory radioactivity release rate measured by a specific sip test.

wet sipping scheme:



The sip test procedure as implemented by ANSTO is:

- The individual fuel assembly is transferred to the sip test tank in the hot cells and immersed in demineralised water overnight to remove readily removable surface contamination prior to the commencement of the test
- 10 litres of water is continuously circulated through the covered sip test tank
- Samples are taken at the start and regularly over a 100 hour period
- Samples are analysed for Cs-137, Cs-134, Co-60, Co-58, gross alpha, gross beta

For the purpose of classifying HIFAR spent fuel for shipment, an indicative soundness threshold of 10kBq/hr gross beta has been derived.

Pond gross beta activity is also a useful indication of fuel condition. All HIFAR spent fuel that has been in long term dry storage releases accumulated surface radioactivity when transferred to wet storage. Any increase in pond activity is normally of short duration.

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Heavily damaged fuel acceptance

Heavily damaged fuel

This category includes fuel that has been destructive tested and fuel that has undergone significant corrosion that exposes extensive areas of the fissile material and/or that has destroyed the geometry or mechanical integrity of the assembly or its elements. It also includes dismantled fuel.

The precautions taken for extensively damaged fuel usually involve canning fuel assemblies or elements. Can design and the canning process is defined jointly by the reactor operator and COGEMA in order to obtain the best possible solution combining reactor and La Hague plant requirements.

The canning process must also allow for constraints related to transportation in the cask employed. It is important to note that the use of organic sealing agents, such as epoxy resins, is totally prohibited. No organic material shall be introduced in the treatment process implemented in the La Hague plant.
Heavily damage fuel has to be studied on a case by case basis.

Dismantled Fuel

Sound elements from dismantled fuel assemblies may easily be managed by reconstructing a pseudo-assembly that meets the La Hague transportation and receivability criteria.
A case has been studied in detail between ANSTO and COGEMA and may be implemented in the future if necessary.

Conclusion

The importance assigned to the preparatory work designed to determine whether spent fuel assemblies are acceptable for transport to, reception, unloading, storage and treatment at the La Hague reprocessing plant guarantees trouble-free management despite the intrinsic diversity of fuel assemblies. This approach also enables full compliance with safety requirements and limits specified by the competent safety authority.

This joint approach with ANSTO takes advantage of COGEMA's experience and provides economic solutions for managing fuel assemblies, regardless of whether they have been declared sound or unsound.

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