The preliminary study on the treatment of Damaged CANDU Spent Fuel

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1. Introduction

A draft plan for the decommissioning of Wolseong Unit 1 has been developed and activities to respond to licensing are on-going. As the decommissioning of Wolseong Unit 1 becomes more and more visible, the taking spent nuclear fuel (SNF) out of SFB (Spent Fuel Bay) is emerging as a pending issue. In Wolseong, infrastructure such as Canister (Silo) and MACSTOR (Modular Air Cooled STORage, KN-400) to store spent nuclear fuel is established. However, according to Wolseong Units 1 FSAR, SNFs that can be transported/stored by Canister (Silo) and MACSTOR are undamaged with an average burn-up of 7,800 MWD/MTU less, and the minimum cooling period is 6 years. That is, for the taking damaged spent nuclear fuel out of SFB, it is necessary to apply for permission to change the operation through FSAR change. Therefore, in this paper, the application documents for permission for operation change were reviewed. In the future, KHNP will apply the operation change permission based on the reviewed documents.

2. Methods and Results

The SF transport/storage work is done in order of the work transferring the SF to the basket, the work lifting the basket to shielding workplace, the work drying and welding the basket, the work inserting the basket with the SF into the shielding flask, the work transferring the shielding flask outside, the work transporting to the dry storage facility (DSF) and the work transferring inside the DSF. Therefore, the present author has reviewed the contents related to the handling of the SNF out of Safety Analysis out of Canister Safety Analysis Report (SAR), MACSTOR Safety Analysis Report, Final Safety Analysis Report. Some implications for future work to take the damaged CANDU SNF out of SFB have been deduced.

2.1 FSAR [1] Review

FSAR chapter 9.1 of Wolseong unit 1, the storage and handling of fuel, has been reviewed line by line. The main contents are like follows;

Facilities and equipment related to dry transfer and storage of SNF consist of Canister, MACSTOR, SNF transfer baskets, radiation shielding workshops, basket carrying flasks, gantry cranes, and transport containers (HI-STAR63). The target SNF that can be handled in Canister and MACSTOR is undamaged spent fuel with the average burnup less than 7,800MWD/MTU. Minimum cooling time is 6 years. The damaged fuel shall not be put into the basket from the beginning because the fuel to be transported/stored to the dry storage facility is like above target SNF. However, if SNFs in the basket stored in the dry storage facility is damaged due to an event, the following action is described in Canister SAR and MACSTOR SAR. For the handling of damaged SNF, separate device/tools and place are provided. Separate place is Carousel where damaged SNF is temporarily stored. Also, separate devices/tools include damaged SNF storage container, lifting tools, tool to handle storage container and storage container cover rack, tool to handle storage container, tool to lift storage tray, tray of storage container with damaged SNF, etc.

2.2 Canister SAR [2] Review

The main contents of the reviewed SAR are like follows; 300 Canisters have been built and operated since 1992. A Canister can contain the 9 baskets with 60 SFs. According to the design specification of the Canister, it can contain the SNF that burn-up is less than 7,800 MWD.MTU, undamaged with 6 years cooling time under the condition that the outer wall of the Canister is painted white to reflect sun's heat. The mainly design criteria the tool/equipment to transport/transfer SNF are used as they are. Safety Analysis is performed under assumption that undamaged SFs is stored.

2.3 MACSTOR SAR [3] Review

The contents related to SNF handling and safety analysis out of SAR were reviewed. The main contents are like follows; 14 MACSTORs have been built and operated since 2010. 1 MACSTOR consists of 40 storage cylinders that can contain 10 baskets with 60 SFs. Also, it was designed to store the CANDU SF that is undamaged fuel after 6 years of cooling with average burn-up of 7,800MWD/MTU like the Canister. In case that damaged SNF is confirmed through the containment surveillance, the damaged SF shall be inserted from the basket and stored in the SFB. The tool/equipment to transport/transfer SF are used as they are. For normal condition, abnormal condition and accident condition, Safety analysis was performed under assumption that undamaged SFs is store.

2.4 The status of damaged CANDU SFs

The damaged CANDU SNF is temporarily stored in a carousel for enough cooling period, sealed in a stainless steel container, and stored in a separate tray. The damaged SNF storage tray is located in the spent fuel bay, and in the case of Wolseong Unit 1, they are stored in a separate storage bay.

2.5 Considerations to transport the damaged SF to DSF

According to FSAR, Canister SAR, and MACSTOR SAR, damaged CANDU cannot be transferred to dry storage facilities. If damaged SNF is identified, the basket should be dismantled and moved into the SFB for storage. Therefore, to transport and store the damaged SNF to a dry storage facility such as Canister and MACSTOR approval from the licensing authority is required, and revision of the documents reviewed above must be conducted before anything else. In this section, revisions (drafts) of the documents and considerations for taking the damaged SNF out of SPB were drawn to provide the basis for transport/storage of damaged SNF to Canister or MACSTOR, a dry storage facility. The derived content is as follows.

- It is necessary to revise the specifications for the target SNF specified by FSAR, Canister SAR, and MACSTOR SAR. In other words, the target SNF should include damaged SNF.
- For dry storage of SNF, there are shielding walls of pellets, cladding, basket, storage containers, and most of the damaged SNFs have damaged cladding, so one or more shielding walls should be conservatively considered for handling. Accordingly, KHNP is considering encapsulation of damaged SNF for shielding and containment.
- In order to encapsulate damaged SNF, because it is difficult to handle it with existing equipment/equipment, during the encapsulation process, the tools necessary for handling of damaged SNF and capsules, the tools to be used when inserting damaged SNF into capsule, and the internal configuration of the basket should be considered.
- Since the safety analysis was performed on the premise that the undamaged fuel is stored in MACSTOR/Canister, the safety analysis should be performed again on the premise that the damaged SNF is stored.

3. Conclusions

There is no basis for storage of the damaged SNF in the Wolseong dry storage facility, but the taking damaged SNF out of SFB is now a pending issue as decommissioning becomes visible. Therefore, in order to provide a basis for this issue, FSAR, Canister SAR, and MACSTOR SAR were reviewed briefly in terms of target fuel specifications, safety analysis, handling of damaged SNF, and handling equipment/tools when transporting/storing them to dry storage facilities. The contents reviewed in this paper will be used as basic data when applying for operation change permission. Additional detailed reviews will be conducted on the change of operation permission while designing and manufacturing of CANDU encapsulation equipment [4] in KHNP in the future.

REFERENCES

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