

Current Situation of OECD/NEA, Preparatory Study on Analysis of Fuel debris (PreADES) Project

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1. Introduction

In recognition of the broad international interest in learning from post-accident examinations and other activities related to the Fukushima Daiichi (1F) Nuclear Power Station, Japan recommended, to the CSNI in 2013, that they identified and followed up on opportunities to address safety research gaps. The CSNI set up the Senior Expert Group (SEG) on Safety Research Opportunities post-Fukushima (SAREF). The SEG on SAREF held its first meeting in 2013. The subsequent SEG research proposals addressed the highest priorities for Fukushima (e.g., debris sampling), even if its feasibility in terms of technical details, cost, etc. was not, known. Therefore, the proposals were “long-term considerations”, the details of which were to be discussed when sufficient information became available. Typically, this information was the conditions in, and accessibility to, the inside of primary containment vessel (PCV), reactor pressure vessel (RPV) and so forth. In some cases, it was not very feasible to get the desired information, or it was very challenging in terms of cost or worker dose. Another consideration is the anticipated timing for the proposed examinations. Therefore, attention turned to “near-term projects” which can start relatively quickly in a preparatory phase. An example is to collect and analyse basic information and track information on the damaged state and maintain information channels between the CSNI and relevant Japanese organisations, and monitor the feasibility of extraction, transportation, examination, etc. of the samples to be taken.

As a result, “Preparatory Study on Analysis of Fuel Debris” (PreADES) project was recommended by the SEG on SAREF as a “near-term project”. The PreADES project will summarise the collected knowledge and expertise of debris characterisation and identify the needs for debris analyses that will most contribute to the decommissioning of 1F. The project also aims to improve the understanding of severe accidents and reactor safety assessments as well as creating appropriate and optimal methodologies for future debris sampling, retrieval, and storage. Consequently, the project provides important input for a future international project of sample examination based on “long-term considerations”.

2. Outline of PreADES project

PreADES project launched discussions among interested organisations at the preliminary meeting in July 2017 about the objectives, scope, output, and direction of the project. The contents of the project were agreed as the 3 following tasks:

(1) Task 1: Joint study on fuel debris' expected properties and characterisation

This information was assimilated as a) “Figure of debris' location” (Task 1-1) which predicts the end state of debris in 1F units; b), “Characteristic table for debris” which summarises the characteristics of debris obtained from the Three Mile Island Unit 2 reactor vessel (TMI-2), Chernobyl Nuclear Power Plant Unit 4 (ChNPP4) knowledge, 1F related experiments, 1F analytical efforts, and engineering judgement

(Task 1-1). These Characteristic Table was put into two summary tables. These were the macro-properties of debris; which was defined as the properties of the debris from real accidents (TMI-2, Chernobyl), major in-pile tests (Phébus PF) or other large testing facilities. The second table was the Characteristic Table for debris micro-properties: these data were determined on pure phases or samples in small-scale testing principally to determine the properties of the single compounds (e.g., UO_2 , (U, Zr) O_2 , 316 stainless steel). These tables were for use by other tasks' activities. The second task (Task 1-2) was for assessing which properties are important for understanding the accident and for decommissioning and for collecting this information on debris characteristics.

(2) Task 2: Identifying needs and major issues for future fuel debris sampling, retrieval, and analyses

The Analytical Table (Task 2-1) arranges the sample items by priority, considering cost, availability and timing of the decommissioning work in practice. In addition, for each sample type and location, the major analytical techniques necessary/desirable were listed. The target samples are listed in order from the first (currently available) samples to samples requiring a long period for acquisition such as debris in the RPV.

In addition there was Task 2-2, which was to consider the major operational and methodological problems related to particular sample extraction (e.g., heat removal, containment and radioprotection issues or H_2 generation and to consider the best removal or analytical procedures to ensure these issues are optimised (e.g., minimum risk of re-criticality, best efficiency for containment of radioactive aerosols, and minimum exposure of workers during a sample removal). Task 2-3 considered the availability of all possible facilities for the cutting and preparation of samples and for analysis of radioactive samples from 1F.

(3) Task 3: Planning of future international R&D framework

Based on the developments of the two above tasks, preliminary proposals for a future international R&D framework of 1F sample analysis are to be made. At the moment, a round robin for analysis of two natural U -containing corium samples are being organised in parallel with this Task 3 in order to test the various facilities and be able to cross-check the performance/accuracy of differing techniques and of similar techniques at different sites.

The schedule, structure, the chosen chairs and leaders of the project are shown in Figure 1. The project uses meetings and workshops to discuss its progress and also ensure on-going interaction between international safety research experts and representatives from Japanese organisations, and coordination with other related activities (e.g., such as parallel projects such as OECD TCOFF project on thermodynamic data needs for improved severe accident understanding and prevention).

3. Activity of 2017-2018

Three PreADES meetings have been held during 2017-2018, and a brief description of the Figure of debris' location, the Characteristic Table, and in addition discussions for criticality control in the Analytical Table are summarised below.

(1) Figure of debris' location

The project reviewed available information and got consensus input from examinations that enabled a graphical depictions of the debris end states at 1F. Three steps were completed. First, relevant knowledge from the severe accident at TMI-2 and ChNPP4 test, along with 1F related experiments, 1F analytical efforts, and engineering judgement (Task 1-1), was reviewed to glean insights that may help the future decommissioning work at 1F. Second, the current debris end state figures for the three units were

constructed with available videos and other preliminary information. Finally, these results were used to develop recommendations for future examinations at 1F that could facilitate successful decontamination & decommissioning, but also reduce uncertainties related to accident progression and enhance reactor safety.

(2) Characteristic Table

The project arranged characteristics of the various types of debris expected to exist in the Figure of debris' location. Debris Characteristics Tables were then constructed to summarise data, such as mechanical and thermal properties. These were organised in two forms: microscopic table (pure compound data from material properties databanks) and macroscopic table (data on severe accident materials, such as corium). The selected characteristics are important for the decommissioning work; especially, removal of debris as well as SA research. There is a possibility that a data shortage is noted for a particular location/characteristic in the figure or table, which will be an important analysis need in Task 2.

(3) Criticality control issue in the Analytical Table

The Analytical Table (for debris analyses needs) was made following four major decommissioning criteria: a) "Establishing containment function", b) "Maintaining cooling function", c) "Criticality control", and d) "Reducing occupational radiation exposure". The project is currently discussing the debris analyses needs for the 'Critical control' issue as this directly affects the conditions and procedures for sample and debris extraction. This issue has to consider the expected decommissioning schedule and its cost and timing. Furthermore, this activity provides opportunities to have dialogue between PreADES members and Japanese organisations involved in the decommissioning work and also discuss the significance and priorities of the current sampling work at 1F and so respond to the decommissioning needs better and more quickly.

(4) Planning of 2019

In 2019, two PreADES meetings are planned to be held in a) Paris, France in January and Tokyo, Japan in July. Task 1-2 continues to collect new knowledge of debris' characteristics. The Analytical Table of Task 2-1 continues the discussions of the following three groups: (1) Establishing containment function; (2) Maintaining cooling function; (3) Reducing occupational radiation exposure. In parallel, Task 2-2, 2-3, and 3 activities are launched during 2019. The objectives, scope, output, and direction of the project will be updated according to the progress made in these tasks.

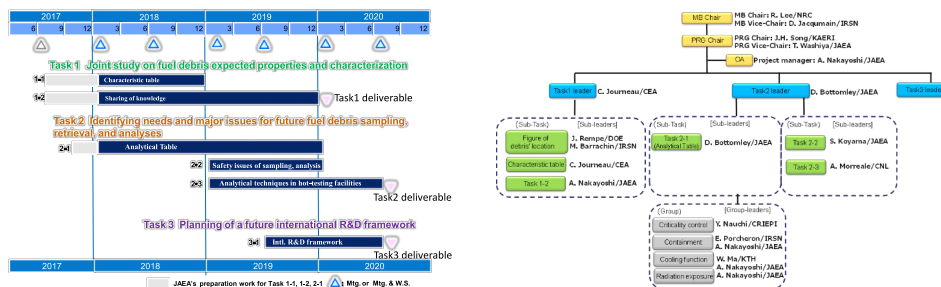


Figure 1. The schedule, structure, the chosen chairs and leaders of the project

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