Transactions of the Korean Nuclear Society Autumn Meeting
Jeju, Korea, October 21-22, 2010

Development of Nuclear Materials and Degradation Database

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1. Introduction

There are about 440 operating nuclear power reactors in the world including 20 units from Korea. The average age of the reactors is more than 20 years and many of them are approaching to their original 30 or 40 years licensing terms. Even though some failures were reported in components or pipes of nuclear power plants (NPPs), these NPPs are considered to be too valuable to stop their operation at the end of design life. Therefore, the long-term operation of NPPs has become a worldwide trend based on technical and economic consideration. In order to ensure safe long-term operation of NPPs, it is increasingly necessary to adopt new approaches to deal with nuclear materials aging and degradation. Proactive Material Degradation Assessment (PMDA) is one of the key elements of these new approaches. Many kinds of background information such as materials and degradation history of components or piping in NPP plant are also needed for PMDA by the experts.

Nuclear Materials and Degradation Database is being developed as a part of Nuclear Technology Revolution Project (NTRP) funded by the Ministry of Knowledge Economy (MKE).

2. Materials and Degradation Information Database of KSNP

There are several thousands of parts in Korean Standard Nuclear Power plants (KSNP). A part consists of a continuous, uniform section of the same material that experiences the same stressors. Where there are multiple parts in a system of the same material, geometry, and product form that experience the same stressors (temperature, stresses, radiation, chemical environment, etc.), these parts are considered as a single part. In order to present information on thousands of parts, it is convenient to divide each system into groups. Each group is defined to make the display of data as comprehensive as possible. Some of the grouping is obvious. Some of the grouping is done to take advantage of the fact that drawings are available for a portion of the system. The result is that the reactor coolant system of KSNP is described in terms of 12 groups of components/parts. They are cold leg piping, crossover leg piping, hot leg piping, pressurizer spray piping, pressurizer surge piping, pressurizer piping to Power Operated Relief Valve (PORV), pressurizer piping to Safety Relief Valve (SRV), pressurizer, reactor coolant pump, reactor pressure vessel, steam generator and reactor vessel internal.

Table. 1. Spreadsheet of grouped parts information of nuclear power plant

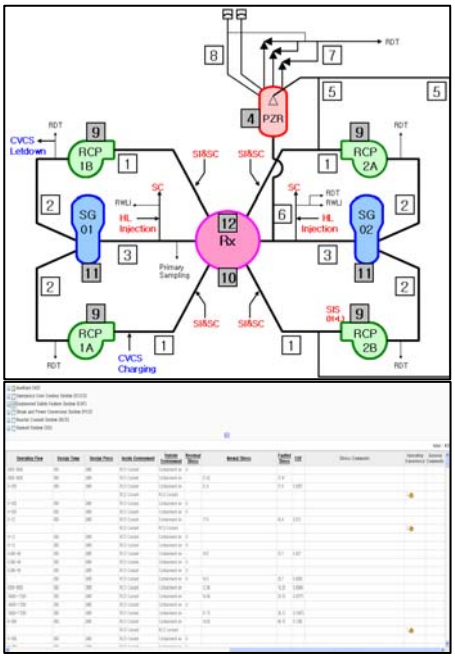

Fig. 1. PMMD-DB with information on parts and drawings of NPPs

For each group a spreadsheet was provided with information on all components/parts in that group. For each part, there were above 20 types of information provided. Each type is listed in Table 1. The most

relevant information is the material/fabrication of the part and its environment. This background information collected for use by the experts is systematically collected in PMMD-DB as shown in Fig. 1. The DB contains information on parts and drawings of KSNP.

3. Materials Degradation Evaluation System

For Korean PMDA, the On-line Materials Degradation Evaluation System (OnMDE-SYS) was developed. The System is based on the Phenomena Identification and Ranking Table (PIRT), which has been used by United States Nuclear Regulatory Commission (U.S.NRC).

The PIRT process is shown in Fig. 2, which complements the explanation of the each step to carry out the process.

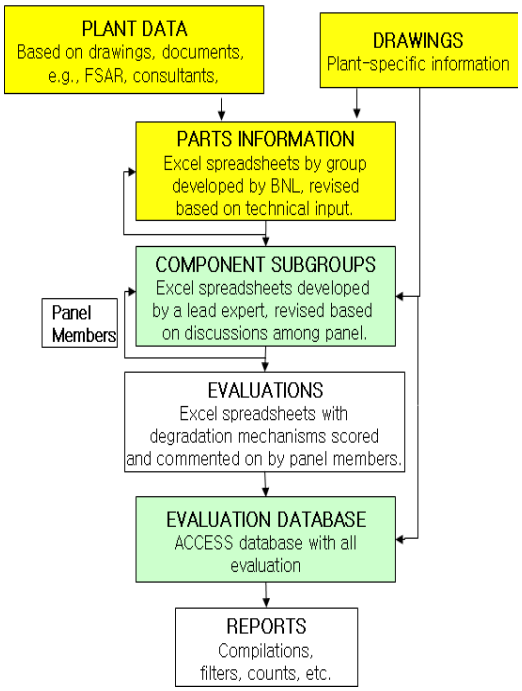

Fig. 2. Flowchart for the evaluation of aging priority of nuclear power plant major components

The experts examine the information database described in section 2 and evaluate the potential for future materials degradation. Experts can give their judgment on the following two attributes such as implementation factor and importance factor for each component/part with a score for each attribute to denote the degree to which that judgment is made. The scores 1, 2, and 3 are interpreted as low, medium, and high, respectively. The evaluations are directly performed by each expert with information provided by PMMD-DB.

4. Conclusions

The database (PMMD-DB) was constructed for design information of KSNP RCS piping and evaluation platforms for PIRT of material aging. Database was developed for web-base system. This database can provide integrated information to important decision makers about plant operation, nuclear regulation and research program management. The On-line Materials Degradation Evaluation System was developed and the potential for future materials degradation in RCS of KSNP can be evaluated by the experts with PMMD-DB information.

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