# Priority Evaluation of Nuclear Materials Aging and Degradation Management

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## 1. Introduction

According to increasing years of nuclear power plant operation, nuclear materials degradation has emerged as a key issue for a long-term operation and periodic safety evaluation. Therefore, the status of the material degradation management in advanced nuclear power nations was investigated to determine the level of research and development gap. Five national experts involved in the evaluation of materials degradation in reactor coolant system (RCS) of Korean Standard Nuclear Power plant (KSNP). Based on this evaluation, the priorities of materials degradation management were determined in KSNP.

## 2. Review of Overseas Nuclear Materials Degradation Evaluation

Nuclear materials degradation evaluation results performed by international experts panel in NUREG/CR-5923 report was reviewed in this paper. The most susceptible and least known degradation mechanisms in RCS, engineered safety feature & emergency core cooling system (ESF & ECCS) and steam & power conversion system are shown in Fig. 1.

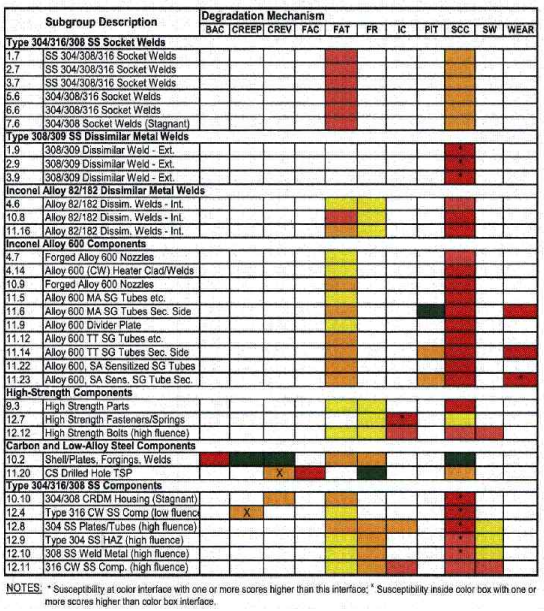


Fig. 1. Degradation Mechanism considered in the Subgroup

This information was used in priority evaluation of degradation management of RCS in KSNP performed by five national experts.

## 3. Priority Evaluation of Degradation Management

Five national experts involved in the evaluation of materials degradation in RCS of KSNP. Priority evaluation results of degradation in RCS are shown in Table 1.

Table. 1. Evaluation Results of Degradation Management in RCS

| Component | Subgroup | Degradation Mechanism Consider | Expert Rating Rank | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | T |
| **Type 304/316/308 stainless steel socket welds** | 1.7, 2.7, 3.7, 5.6, 6.6, 7.6 | •Fatigue<br>•Stress corrosion cracking | 3 | 3 | 3 | 3 | 3 | **3** |
| **Type 308/309 stainless steel** | 1.9, 2.9, 3.9 | •Stress corrosion cracking of the external surface | 5 | 7 | 6 | 4 | 4 | **5** |
| **Alloy 82/182 stainless dissimilar metal welds** | 4.6,10.8, 11.16 | •Stress corrosion cracking | 1 | 2 | 1 | 1 | 2 | **1** |
| **Alloy 600 components** | 4.7, 4.14, 10.9, 11.5, 11.6, 11.9, 11.12, 11.14, 11.22, 11.23 | •Stress corrosion cracking<br>•wear | 2 | 1 | 2 | 2 | 1 | **2** |
| **High Strength Components** | 9.3, 12.7, 12.12 | •Fatigue<br>•Reduction in fracture resistance<br>•Irradiation creep<br>•Stress corrosion cracking<br>•Swelling | 7 | 5 | 5 | 7 | 6 | **6** |
| **Carbon and Low Alloy Steel Components** | 10.2, 11.20 | •Boric acid corrosion<br>•Flow-accelerated corrosion | 6 | 6 | 7 | 6 | 7 | **7** |
| **Type 304/308 Stainless Steel Components** | 10.10, 12.4, 12.8, 12.9, 12.10, 12.11 | •Reduction in fracture resistance<br>•Irradiation creep<br>•Stress corrosion cracking<br>•Swelling | 4 | 4 | 4 | 5 | 5 | **4** |

A management priority order is as followings;
1) SCC of Alloy 82/182 stainless dissimilar metal welds

2) SCC of Alloy 600 components
3) Fatigue of Type 304/316/380 stainless steel socket welds

## 4. Evaluation of the Domestic Nuclear Materials Degradation Management Measures

The evaluation results of the domestic measures of reactor coolant system in KSNP and research status are shown in Table 2.

Table. 2. The evaluation results of the reactor coolant system of domestic measures and research Status

| | SCC of Alloy 82/182 stainless dissimilar metal welds | SCC of Alloy 600 components | Fatigue of Type 304/316/380 stainless steel socket welds |
|---|---|---|---|
| **Domestic measures** | •Executing of the MRP(Material Reliability Program)<br>•Suggestion of measuring term and method for Alloy 600 in MRP<br>•Alloy 600 instrument Comprehensive Management Plan / Pre-Management | •SGMP(Steam generator integrated management program) performed<br>•SGMP performed in all areas of the steam generator<br>•Executing reliability of the MRP | •Establishment of measures to improve nuclear safety welding |
| **Research Status** | •Surface stress distribution of the reactor head inspection system development underway<br>•LBB application of dissimilar metal weld integrity assessment of the PWSCC underway<br>•Ultrasonic testing of nuclear piping dissimilar metal weld build skills verification system underway<br>•Non-destructive inspection systems for nuclear verification service skills performing | •nozzle base metal and weld residual stress assessment data produced<br>•BMI Mockup defective control technology as part of the hydrogen and temperature control technology, variable defects is in development<br>•Boric acid concentration simulations underway<br>•High Nickel Alloy Welding Residual Stress Analysis of Dissimilar Metal Siding<br>•Structural Integrity Assessment of Welding Defects<br>•Degradation of mitigation program implementation | •Ultrasound guided technique under development<br>•Non-destructive inspection systems for nuclear verification services skills Perform<br>•Small enough to mitigate the degradation of nuclear piping are promoting for the facility improvement projects<br>•UT-socket weld pipe small enough nuclear equipment and evaluation technology development tasks performed |

Research on non-destructive examination (NDE), water chemistry, maintenance techniques related to Alloy 82/182 stainless dissimilar metal welds and on improved inspection techniques for fatigue of type 304/316/380 stainless steel socket welds are being performed.

## 5. Conclusions

According to the experts' evaluation results, alloy 82/182 dissimilar metal welds is the most susceptible components and should be managed first among various components and piping system in KSNP.

There are currently many researches performed for this dissimilar metal weld in Korea, but the endeavors should be still collected in worldwide nuclear fields.

## REFERENCES

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