A Study on Performance Evaluation of Safety-Related Protective Coating for Yonggwang Unit 1&2

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1. Introduction

Protective coating inside nuclear power plants could find its origin from NRC Reg. Guide 1.82(Rev. 3) [1] regarding current issue for the regulation of foreign materials inside containment building.

The current issue for the regulation of foreign materials inside containment considered/determined the current issues only regarding the blockage of sump screen by foreign materials such as coating material, insulator, and other materials, while safety-related coating is separately managed by NRC Reg. Guide 1.54(Rev. 1) [2]. In this study, we performed field walk-down to evaluate the as-is condition of protective coating inside containment building which was classified as for structure and for equipment with applying the requirement for safety-related coating.

2. Methods and Results

General field walk-down for emergency core cooling system(ECCS) sump is performed based on NEI 04-07 and 02-01, while the walk-down for coating material is performed based on the methods and procedures of USNRC Reg. Guide 1.54(Rev. 0).

In particular, following ASTM 4537 [3] which is the requirement for coating inspector, the personnel qualified as Level III participated in the walk-down to inspect the type and amount of coating material for equipment and structure inside containment building. Area calculation method per equipment was written to calculate the coating area for equipment and structure and the size of equipment was measured and the area was calculated according to the calculation method. Also, calibrated Elcometer 456 DFT gauge was used to measure coating thickness. Based on SSPC PA requirement, different parts of equipment and structure were measured for five times and their mean value was applied.

2.1 Details of Walk-down

For the field walk-down of coating inside containment building of Yonggwang Unit 1&2, total 3,406 points were inspected in the order of EL 148 ft, 125 ft, and 100 ft to inspect the type and amount of coating materials for equipment (equipment, control panel, step, grating, flat plate, supports, and so on) and structures (wall, concrete floor, and liner plate). Manual handle valve and H-beam from equipment supports which were not inspected during walk-down for Kori Unit 3&4 were additionally included at the inspection list. Construction package for Yonggwang Unit 1&2 was achieved before the start of the walk-down to identify the type and area of coating materials of main equipment and structures in advance and it was identified/applied to walk-down. Figure 1 shows the representative mapping of main equipment located at containment building 100 ft.

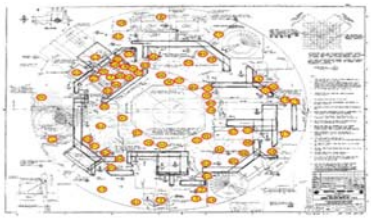

Figure 1. Location of Equipment and Structures Located at Containment Building 100 ft of Yonggwang Unit 1&2

2.2 Polar Crane

It was impossible to measure the size of polar crane because it was located at inaccessible area due to its structure, so its surface area was calculated reflecting the information from FSAR and drawing. Also, as shown in Figure 2, we took its picture and measured coating thickness directly. Measured values were 174, 182, 188, 192, and 77 ㎛ (162.6 ㎛ Average). It was coated with Penoline paint and the coating of polar crane inside containment building was identified as qualified coating. Its details are described in FSAR Table 6.2-30 of Yonggwang Unit 1&2

Figure 2. Polar Crane located at Upper Side of Containment Building of Yonggwang Unit 1&2

2.3 Hatch

Equipment hatch is classified as personnel, Equipment, and emergency hatch. The personnel hatch and emergency hatch were coated with inorganic zinc + epoxy (Amercoat) while equipment hatch was coated with inorganic zinc only. A coating thickness gauge was used to measure minimum five points, which

results in average value of 245.2 ㎛ (253, 332, 199, 252, 190 ㎛) for coated personnel hatch. Current status of coating was generally fine and the coating of the hatch was identified as qualified coating.

2.4 Liner plate & Concrete Wall & Floor

The coating thickness for wall could not be measured by the coating thickness gauge as its material is non-metallic, but estimated its coating thickness as 100 ㎛ for internal wall of concrete and 73 ㎛ for floor. Liner plate (Figure 4) was measurable and mean value of 124 ㎛ (123, 111, 133, 141, 112 ㎛) was measured for minimum five points. The coating of wall was identified as qualified coating, but some evidences of maintenance coating were found. Thus, we requested analysis of sample collected for more accurate analysis of composition. It is expected to be coated with epoxy.

Figure 4. Liner plate, Wall and Floor of Containment Building of Yonggwang Unit 1&2

2.5 Tanks

Various kinds of storage tanks (Figure 4) are located inside containment building and they are used for different purpose. Accumulator tank, Pressurizer relief tank, and RCP oil tank are typical examples of the tanks. The coating system consisted of inorganic zinc + epoxy and it was in good status. The coating thickness of accumulator was measured to average 500 ㎛ (498, 502, 505, 492, 503 ㎛).

Figure 4. Tanks inside Containment Building

2.6 Result

Total amount of coating materials painted for Yonggwang Unit 2 was 103.930 ft^3. 67.981 ft^3 of them were qualified coatings and 35.949 ft^3 of them were unidentified. Most of the structures are qualifiable through FSAR and construction package for Yonggwang Unit 1&2, while some of the equipment and structures are classified as unconfirmed due to the lack of materials. Table 1 shows type and total amount of coating identified by field walk-down for Yonggwang Unit 1&2.

Table 1. Total Amount of Coating per Type inside containment building of Yonggwang Unit 1&2

Item	DFT (㎛)	Coating (ft^3)	Comment
Polar Crane	163	4.266	Qualify
Hatch	245	0.660	Qualify
Plate, Wall, Floor	124	50.819	Qualify
Refueling Mach.	93	1.265	Qualify
Supports	82	16.036	Unconfirmed
Grating, Ladders	109	7.287	Unconfirmed
HVAC	108	5.022	Qualify
Tanks	500	3.754	Qualify
Motors, Pumps	332	1.144	Qualify
Valves	122	1.342	Qualify
Panel Boxes	92	10.626	Unconfirmed
etc. debris	101	1.739	Unconfirmed
Sum Total		103.930	
Qualify Coating		67.981	
Unconfirmed Coating		35.949	

3. Conclusions

When evaluating NPSH flowing to sump screen from total amount of coating based on USNRC Reg. guide 1.82(Rev. 3), the coating materials inside GOI 4D in anticipated breakage part in the occurrence of accident among qualified coating materials are the origin of debris irrespective of their identification. According to the test result of NRC, some of the qualified coating materials damaged maintains the same fracture strength as that of un-damaged after the completion of maintenance. Comparing with Kori Unit 3&4, coating materials of equipment are qualifiable with considerable amount of identifiable EQ documentations (MOV, AOV, SOV etc.) while considerable number of coating materials of electric panels and structures(stair, grating, support, ladder) are classified as unconfirmed coating materials due to the lack of documentations. Almost all of the structures of Yonggwang Unit 1&2 did not go through maintenance coating after the occurrence of damages.

Some of the coating damages were found for equipment such as MOV and AOV, but it seems not to be an issue as qualification documentations for coating are acquired.

REFERENCES

[1] USNRC Reg. Guild 1.82(Rev. 3) Water Sources for Long-Term Recirculation Cooling Following a Loss of Coolant Accident, 2003
[2] USNRC Reg. Guild 1.54(Rev. 1) Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plant, 2000
[3] ASTM D4537, Establishing Procedures to quality and Certify Personnel Coating Work Inspection in Nuclear Facilities.