Development of Dissimilar Metal Weld Performance Demonstration System

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1. Introduction

In the early 1980s, many leaks in the piping systems of boiling water reactors in the USA were discovered in piping weld area which had been examined ultrasonically and found to be defect free. To enhance the reliability of ultrasonic testing system, ASME B&PV code section XI adopted the performance demonstration requirements (Appendix VIII) for the ultrasonic examination of nuclear power plant piping weld in the 1989 winter addenda for the first time.

MOST Bulletin 2004-13 was published at 2004.6. Following the MEST Bulletin 2009-37 which was published at 2009.9(formerly MOST Bulletin 2004-13), all nuclear power plants in Korea shall implement performance demonstration of dissimilar metal weld.

The object of this study is to develop the performance demonstration system for dissimilar metal weld ultrasonic testing of nuclear power plant in order to meet ASME Sec. XI Appendix VIII requirements and MEST Bulletin 2009-37. This paper describes the status of the development of dissimilar metal weld performance demonstration system in Korea.

2. Method and Results

2.1 Plant survey results of dissimilar metal weld configurations

Actual surface conditions of dissimilar metal weld such as concave or convex discontinuities can have a serious impact on the effectiveness of ultrasonic examinations. So to know the actual field conditions of plants is very import to inspect dissimilar metal weld reliably. KHNP performed the survey of actual dissimilar metal weld configurations during Sep., 2006 ~ Oct., 2007. The components to be surveyed were supplied by Westinghouse, Framatome, CE, and AECL. The survey results contained the whole nuclear power plant dissimilar metal weld configurations including PHWR type configurations. When the survey was performed, the actual surface condition was also measured by inspection vendor. Total 448 dissimilar metal welds were surveyed and measured by inspection vendor. Configuration data acquired by these plant surveys include thickness, diameter, material, surface contour, photo of weld, design drawings, etc. A series of survey on the configurations of dissimilar metal welds in nuclear power plant was performed in order to design and fabricate the test specimens, which are the important roles for inspecting the weld area.

2.2 Design and fabrication of dissimilar metal weld test specimens

The specimen matrixes and numbers to be used in the KPD program were decided by the plant survey results, as mentioned above, and satisfy the ASME code, 1995 edition with 1996 addenda. Test specimens are categorized small, medium and large depending on configuration's shape and diameters. The specimens have nozzle, safe end and piping section similar to actual plant configuration. KEPCO Research Institute decided the specimen matrixes and numbers considering estimate candidate numbers, plant survey results and ASME code requirements. Also, KEPCO Research Institute determined the representative weld configurations for each dissimilar metal weld configurations to draw the specimen design drawing. Figure.1 shows the example of representative weld configuration.

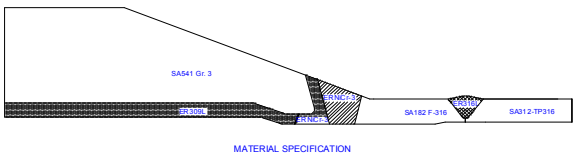

Fig. 1. Generic configuration of dissimilar metal weld test specimen(Example)

After completing the dissimilar metal weld test specimen design, KEPCO Research Institute has started fabrication of the dissimilar metal weld test specimens for the performance demonstration. The specimens include axial and circumferential flaws. Flaw types are fatigue cracks and EDM notches. The specimens including EDM notches were treated by HIP(Hot Isostatic Pressing) processing. Specimens were fabricated in a manner to generally represent the geometry and construction of those pressurized components containing dissimilar metal welds most commonly found in operating nuclear plants.

Fig. 2. Manufacturing of dissimilar metal weld test specimen

To verify that all the specimens have the intended flaws and no other extraneous signal exists, fingerprint for dissimilar metal weld specimens was performed by phased array UT after finishing making test specimens.

Figure 3 shows the on-going fingerprint using automated UT scanner and the UT signal.

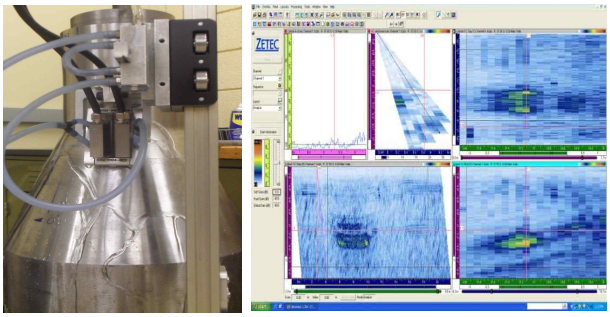

Fig. 3. Finger print of dissimilar metal weld test specimen and ultrasonic signal

2.3 Development of generic examination procedure

After manufacturing test specimens, KPD selected the test sets for developing the generic manual procedure for dissimilar metal weld examination. Normally, procedure qualification requires three personnel demonstration test sets. Generic manual examination procedure(KPD-UT-10) for dissimilar metal weld inspection was developed using KPD dissimilar metal weld test specimens. KPD-UT-10 differs from PDI-UT-10. KPD-UT-10 uses Appendix 1, Appendix 2 and Appendix 3 instead of Table-1 and Table-2. Figure 4 shows the example of Appendix 3.

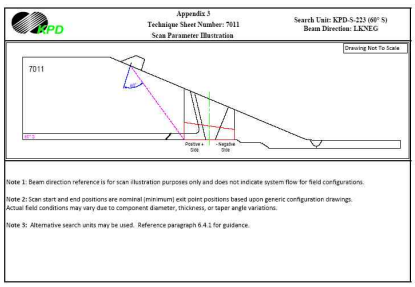

Fig. 4. Technique sheet for scanning (Appendix 3)

2.4 Development of management software for dissimilar metal weld configuration data

To effectively manage the dissimilar metal weld configuration data acquired by plant actual condition, the management software was developed. The management software was developed using access program. The management software program includes weld material, weld dimension, weld configuration, drawings, photos, and etc.

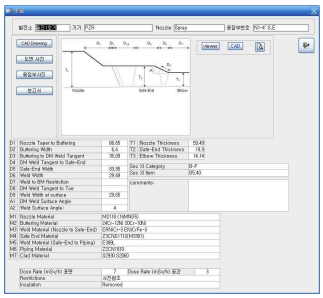

Fig. 5. Management program for dissimilar metal weld configuration data.

2.5 Development of management software for performance demonstration test and grading

KEPCO Research Institute developed the KPD MAP software to manage the flaw true data, to create test set and to grade the test result. This management software program was developed using SQL Server 2000 and MS Access 2007 as a database and VB.net as a developing tool. All the samples are divided by many grading units and each grading unit provides flaw information such as flaw length, type, depth and geometric configurations.

Fig. 6. KPD MAP software program

3. Conclusions

KEPCO Research Institute and KHNP have been preparing KPD System to fulfill the performance demonstration requirements in ASME Sec. XI. Appendix VIII for dissimilar metal weld. In order to complete the KPD System, the following items have been analyzed and developed.

- Surveying plant configurations for dissimilar metal weld
- Determination of the types and numbers of test specimens
- Design and fabrication of test specimens
- Development of examination procedure
- Development of computer software for operating and managing KPD System

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