Development of Automated UT Scanner for NPP Dissimilar Metal

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1. Introduction

Inconel material such as alloy600 82/182 used in Nuclear power plant primary system. Recently, Leak from hot leg nozzle weld at V.C Summer and axial cracks in hot leg nozzle welds at Ringhals 3 and 4 were took placed at the dissimilar metal weld zone. Root cause analysis shows that degradation mechanism is Primary Water Stress Corrosion Cracking (PWSCC)[1].

Conventional UT was being used for inspection of dissimilar metal weld(DMW), but this method has a limitation for signal quality because ultrasonic should transmit through the three metal layer. Recently, Phased Array method is being used to overcome shortage of conventional UT.

It is impossible to avoid radiation exposing that many of DMW components are located in high radiation area; therefore, In order to minimize radiation exposing and maximize signal quality, we developed the automated DMW UT scanner and conducted field application.

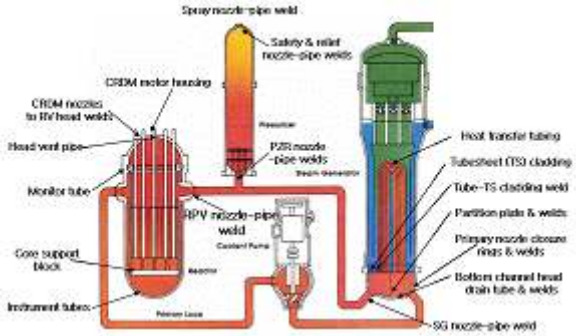

Fig 1. WH alloy600 materials(include weld) in PWR NPP

2. Methods and Results

2.1 Design concept

We consider a matter in all its aspect to design UT scanner.[2] Basic consideration contents are as follows;

- Enough pressing force for phased array transducer
- Easy installation and removal for scanner
- No slip in scanner and track
- Remote controlling of scanner
- Easy removal for radioactive contamination

2.2 Track design

Track was consists of two parts and it supplies guide rail of UT scanner. We made several size of tracks, one track can cover nominal pipe size from -4 inch to +4inch. Figure 2 shows 4 inch DMW scanner track.

Pipe OD (inch)	Applicable size (inch)	Pit Size (inch)
4	2~6	1~2
8	6~10	1~3
12	10~14	1~3
16	14~18	1~3
30	28~32	1~3

Fig 2. Track for DMW scanner

2.3 Scanner design

We adapt easy frame for removal and installation. Scanner has two motors for circumferential and axial driving including encorders and wireless control system Fig 3,4 shows developed drawing and UT scanner

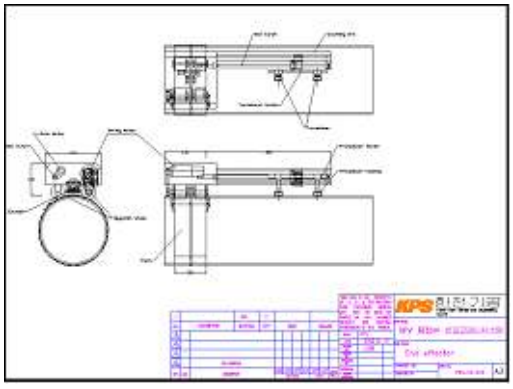

Fig 3. Developed UT scanner drawing

Fig 4. DMW inspection

Fig 4 shows DMW UT system which consists of track, UT scanner and PA OmniScan.

2.4 Field application

We applied to YG#1 nuclear power plant primary system during 17th outage. Fig 5 shows field application for reactor vessel inlet nozzle DMW area. We have no choice to modify scanner's guide rail because inspection space was so small. Environmental situation of Most DMW was similar to inlet nozzle.

Fig 5. Field application for reactor vessel inlet nozzle of YG#1

We suffered some troubles for scanner and track during field application. Trouble contents are as follows;

- Some time greater than 20 minutes to install track due to state of piping surface
- Difficulty to install on elbow and curvature piping
- Shorten guide rail because of small inspection space
- Transducer did not contact with pipe surface perfectly
- Slip of driving roller
- Bad signal due to scanner vibration during operating

2.5 Scanner Modification

We modified scanner's elements & function. Fig6 shows modified DMW PA Scanner. Contents are as follows;

- Strengthening driving power using servomotors
- Elevating a friction force using tire material exchange
- Adjust guild rail length
- Quick operating lever
- Guide roller for prevent bending of scanner
- Improving transducer contact

Fig 6. Modified DMW PA scanner

3. Conclusions

We developed DMW PA scanner and applied to YG#1 during 17th outage. After field application, we found some problems with scanner and track. Some parts of scanner are modified to solve the troubles. Laboratory performance test result of modified scanner was good. Scanner shows stable operating and transducer contact. We have a plan to apply to NPP primary system in some day. We made a conclusion developed-scanner can be useful tool for DMW inspection.

REFERENCES

[1] Primary System Piping Butt Weld Inspection and Evaluation Guidelines, MRP-139
[2] Development of Repair and Inspection Technology for RPV Nozzle