Transactions of the Korean Nuclear Society Autumn Meeting
Busan, Korea, October 27-28, 2005

Phased Array Ultrasonic Examination of NPP Low Pressure Steam Turbine Blades

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1. Introduction

As the increase of turbine running age in nuclear power plant, cracks have been found in the straddle mount(GE) type blade root area. The Nondestructive examination in the blade root area has been done by manual ultrasonic examination during overhaul period but because of necessity to improve the reliability, KEPRI has been developing automated phased array ultrasonic examination system and technique. To verify the availability of the developing automatic ultrasonic examination technique, low pressure steam turbine blades of standard nuclear power plant were examined using phased array ultrasonic examination.

2. Experiments

In this section UT specimen, UT technique, experiment setup and results are described.

2.1 UT Specimen

5 different size low pressure turbine blades are used in the experiments. These 5 different size blades are the blades that are used in Standard NPP low pressure steam turbine stage 1 ~ 5. Figure 1 shows these turbine blades in real geometry including blade and figure 2 shows UT specimens that have same blade root geometry but do not include blade because it is out of interesting area. Figure 3 shows EDM notch in UT specimen. Each different size blade has 3 different size EDM notches in each hook. Notch sizes of #1 is 5.0×0.2×0.3, Length×Width×Depth in mm, 45°), #2 notch is 0.5mm depth, #3 notch is 1.0mm depth and other dimension, length and width, are the same.

Figure 1. Low pressure steam turbine blades (1 ~ 5 stage) of standard nuclear power plant.

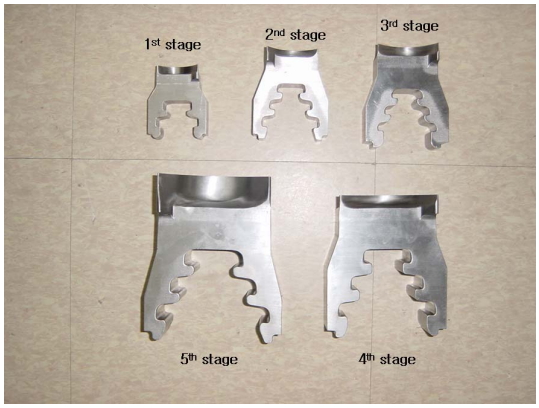

Figure 2. Low pressure steam turbine blades (1 ~ 5 stage) UT specimen.

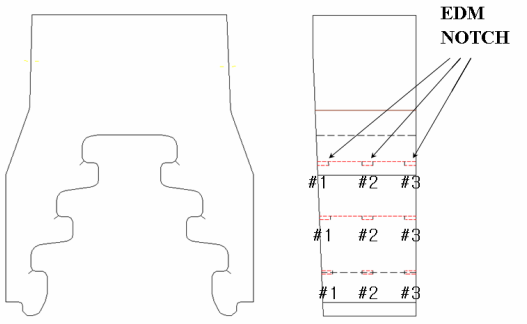

Figure 3. EDM notch in UT specimen.

2.2 UT Technique

In the experiment, 2 different UT techniques are used.

Conventional UT technique uses pre-determined sound beam angle by procedure to detect cracks in each specific stage and hook like shown in figure 4. So many different wedges or transducers are needed to make pre-determined sound beam angle in blade and to detect crack.

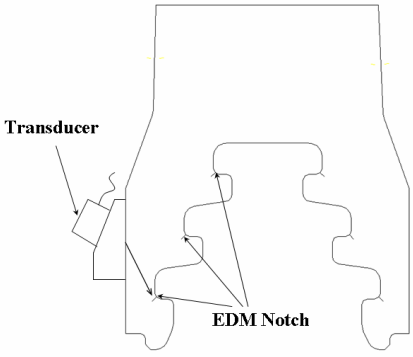

Figure 4. Conventional UT technique used in blade examination.

Phased array UT technique can make certain range of sound beam angle like shown in figure 5. The advantage of Phased array UT technique is interested area is examined at once. Phased array UT transducer and conventional UT transducer are all 10 MHz and shear mode is used.

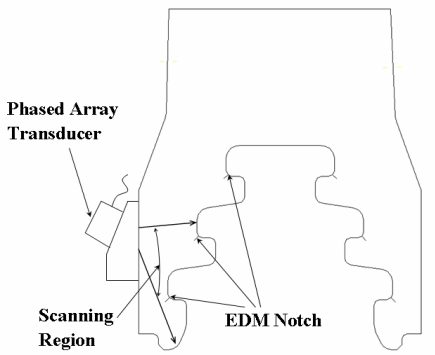

Figure 5. Phased array automated UT technique used in blade examination.

2.3 Experiment setup & results

Figure 6 shows UT specimens installed in rotor section and just one of the specimens has EDM notch. Automatic scanner with phased array UT transducer and encorder is used to get the information of signal, location and other data.

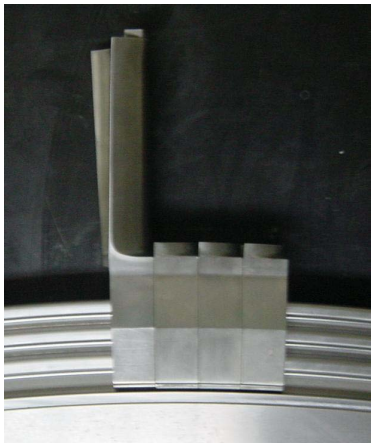

Figure 6. Low pressure turbine blades UT specimen installed in rotor section.

Figure 7 shows conventional UT signal (A scan) from 1.0mm depth EDM notch and figure 8 shows phased array UT signal (Sector scan) from 1.0mm depth EDM notch. Comparing these two figures, the advantage of phased array UT technique is definite because of sector scanning. Figure 9 shows collected phased array UT signal using encorder (B scan) from UT specimen installed in rotor section. From the signal shown, it is easy to distinguish the notch signal from other geometry signal and the length estimation and depth estimation will be possible using encorder location data shown below and signal amplitude shown by color.

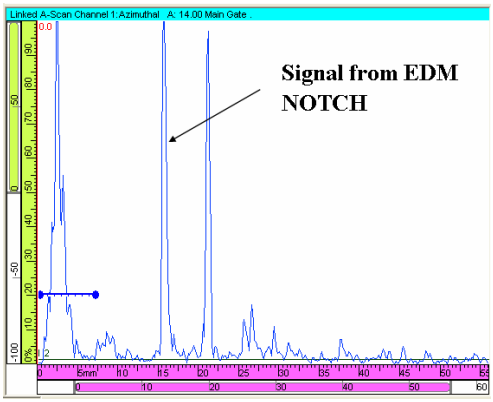

Figure 7. Conventional UT signal from EDM notch

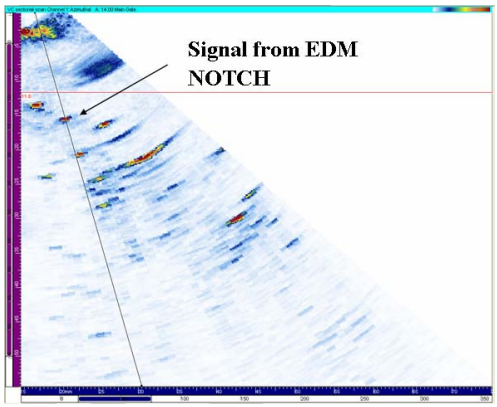

Figure 8. Phased array UT signal from EDM notch

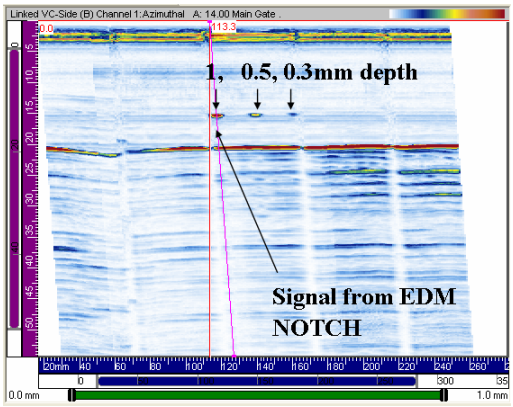

Figure 9. Automated phased array UT signal from EDM notch.

3. Conclusion

Automated phased array UT technique can increase the detectability, availability and reliability in low pressure steam turbine blade root area examination of standard nuclear power plant compared to conventional UT technique.

REFERENCES

[1] “Inspection of Turbine Disk Blade Attachment Guide”, EPRI-TR-104026, 1994
[2] “Guide to Optimized Nuclear Low-Pressure Turbine Rotor Inspection”, EPRI-TR-107480, 1997
[3] “Round-Robin Turbine Blade Attachment Inspection Program”, EPRI-TR-106749, 1997