14-1 Remote Nondestructive Examination of Steam Generator (SG) Heat Transfer Tubes

— SG Heat Transfer Tubes Integrity Confirmation by Eddy Current Test, Visualization and Gas Leak Tests —

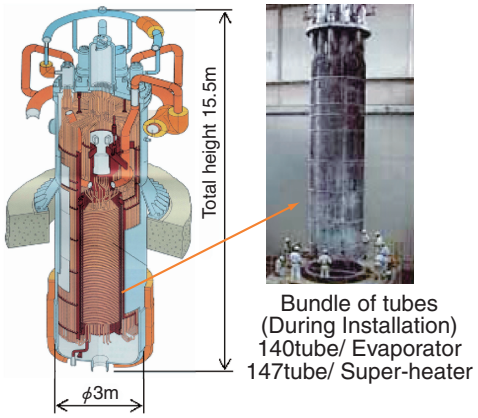

Fig.14-1 Steam Generator (Evaporator)

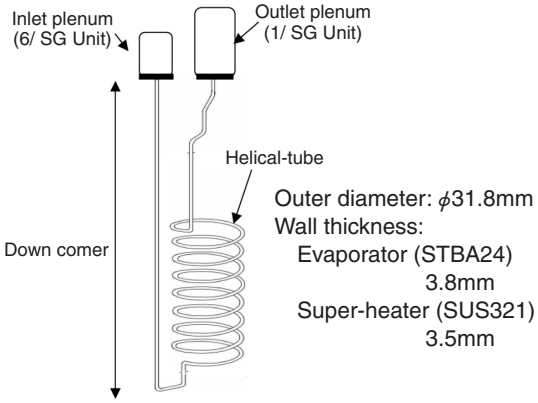

Fig.14-2 Steam Generator Tube (1 Tube)

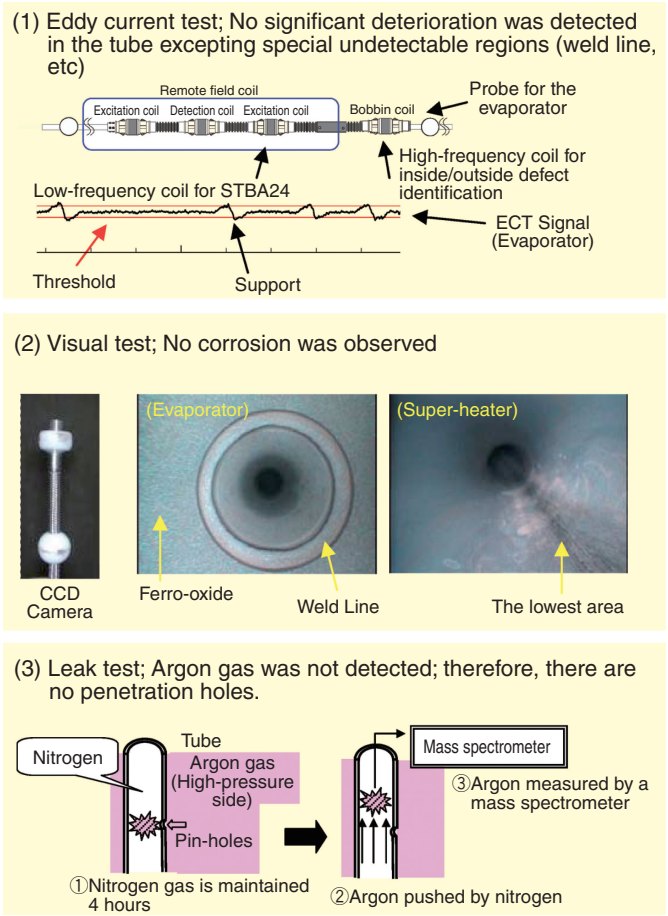

Fig.14-3 Three types of tests

The confirmation of "MONJU" system and its component integrity in preparation for the restart of "MONJU" was planned and started in 2006. Confirmation of the steam generator heat transfer tube integrity using remote nondestructive examination equipment was carried out from November 2007 to March 2008. The steam generators consist of 3 evaporators and 3 super-heaters. The evaporator is shown in Fig.14-1 while Fig.14-2 presents the heat transfer tube specifications.

The outer surface of the heat transfer tube is surrounded by a sodium inert argon gas environment. It was confirmed that corrosion of tube material in sodium and argon gas is almost negligible. However, there is water/steam inside the tube during operation, therefore to confirm both corrosion and wall thinning were carried out an eddy current test (ECT), a visual test (VT), and a leak test, as shown in Fig.14-3.

The ECT detection performance was improved using exciting frequencies optimized for evaporator and super-heater tubes using a technique based on improvements made in noise reduction tests. Also, the correlation between ECT signal and tube thickness was checked by using test pieces. By comparing test results with records of the inspection at the time of manufacture, it was confirmed that no wall thinning occurred since the last inspection.

The visual test using CCD camera was improved by increasing the camera resolution, by a better lighting, and by enhancing its insertion-ability. The CCD camera fixed speed insertion mechanism was newly developed to obtain accurate sensor location. The heat transfer tube down-comer area including welds was inspected as a typical heat transfer tube because its environment is the same as the other steam generator area. This test confirmed that there was no significant corrosion or defect.

In the leak test, the argon gas concentration in a heat transfer tube was measured by a mass spectrometer. Argon gas was not detected, showing that there were no penetration holes.

In these three tests, no significant deterioration of SG heat transfer tubes were observed, and the integrity of tubes were confirmed, taking us a step closer to restart of "MONJU".

Reference

Takahashi, K., Shiina, A. et al., Inspection of the Steam Generator Heat Transfer Tubes for FBR MONJU Restart, Proceedings of 17th International Conference on Nuclear Engineering (ICONE 17), Brussels, Belgium, 2009, ICONE17-75904, 9p., in CD-ROM.