KNF-
SF-01

Fuel Poolside Examination(PSE)

PRODUCTION MANAGEMENT DEPT.

Youngdo Lee
T. 042-868-1889
E. leeyd
@knfc.co.kr

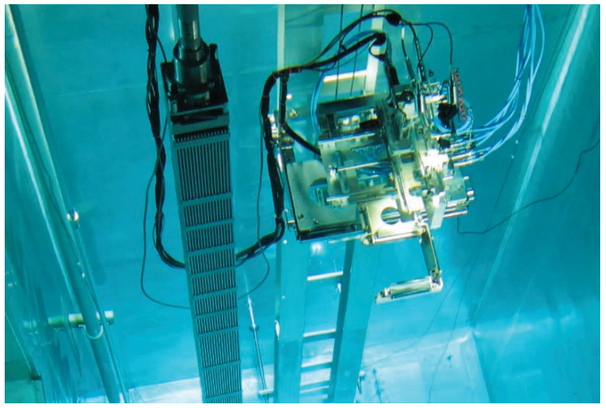
The figure of nuclear fuel is changed by neutron irradiation during the nuclear fission process at high temperature and high pressure as a burnup process inside of the reactor. PSE is to evaluate the irradiation performance in the reactor by measuring deformation / change of a burned nuclear fuel and a fuel rod.

This examination measures a dimension and deformation state of assembly by analyzing video image, and a grid width and fuel rod diameter with LVDT method. Furthermore, it measures oxide layer thickness of fuel rod clad with ECT method.

Description

✱ Purpose and Necessity

- PSE is required to reflect the following things on the design and fabrication : proving reliability on irradiation performance in the fuel reactor, certifying suitability of fuel rod design code and model and producing irradiation performance data in the indispensable reactor for fuel development.



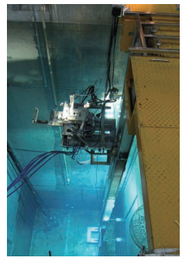
✱ Inspection Item

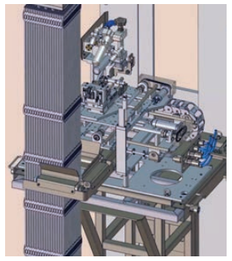
- Dimension measurement of nuclear fuel
  - Assembly irradiation growth : For length change of an assembly, evaluate irradiated assembly length after producing measured value by analyzing video.
  - Fuel rod irradiation growth : Save a video about pitch between the end-plug and the top nozzle assembly, and evaluate irradiated fuel rod length by analyzing video image.
  - Assembly bowing : For each spacer grid between the top nozzle and the bottom nozzle, evaluate assembly bowing by analyzing video.
  - Assembly twist : For twist angle between the top nozzle and the bottom nozzle, evaluate deformed assembly by analyzing video.
  - Fuel rod bowing : For pitch of each fuel rod, evaluate irradiated fuel rod bowing by analyzing video.
- Measurement of grid width
  - Measurement of grid width is performed by closing 2 jaws of equipment to spacer grid. It's measured by LVDT method which converts the jaw distance into voltage.
- Measurement of fuel rod diameter
  - Fuel rod diameter is measured as inserting the outer fuel rod between two finger probes. LVDT method is used to convert the probe distance with fuel rod inserted in it into voltage.
- Measurement of oxide layer thickness
  - Measurement of oxide layer thickness of fuel rod cladding is performed by passing an ECT probe between the fuel rods. Probe touches the fuel rod cladding surface, and probe evaluates the oxide layer thickness and produces result value after sensing changed impedance of probe coil.

✱ Constitution of Equipment

PSE equipment consists of a manipulator and control system that controls and operates it with a program.

- Manipulator
  - Manipulator device can move to the X-Y-Z directions and directly touches the nuclear fuel. It is equipped with a camera which can obtain video footages.
  - Nuclear fuel inspection is performed by several devices installed on X-Y inspection table. The X-Y inspection table is operated by air pressure motor and the installed devices are used to measure assembly dimension, outer fuel rod diameter, grid width and oxide layer thickness of cladding.
  - PSE is performed in a spent fuel pool as nuclear fuel hanging in the water. To get a video data, underwater camera and light are installed on X-Y-Z inspection table. To measure each inspection items of assembly, LVDT(Linear Variable Differential Transducer) and ECT(Eddy Current Technique Instrument) methods are used. During the PSE, temperature change and location of nuclear fuel can be monitored.





- Control System
  - Control system consists of a computer system that can analyze measured signal and video image, and Amplifier, PLC, camera controller and real-time monitoring device. The program enables an inspector to get a reliable test result through a certain algorithm of equipment calibration, measurement and verification process, and these test results can be printed out immediately once the measurement is completed.

Distinctiveness

✱ Characteristics

- Nuclear fuel decomposition is not necessary since the inspection is performed in the spent fuel pool
- Equipment is relatively small and various inspections are available by replacing some devices
- The PSE is proven efficient by multiple inspections

✱ Benefits

- Improve stability of the power plant operation by producing irradiation performance in reactor data
- Improve nuclear fuel capability by giving design feedback to irradiation performance in reactor data
- Reduce cost from burnout capability in reactor inspection by performing the inspection in the plant

Experience

- Provide LTA and commercialized fuel inspection to verify irradiation performance after developing fuel, material, etc.
- Exported 1 set of PSE equipment to Nuclear Power Institute of China(NPIC)

Deliverables

- Perform inspection service for burnout capability in reactor of nuclear fuel
- Supply inspection equipment for burnout capability in reactor of nuclear fuel

TECHNOLOGY READINESS LEVEL(TRL)

- Actual system proven through operation

BUSINESS MODEL

Technology Transfer
Licensing
Joint search
Service Execution
Others