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Fuel Rod Mechanical Behavior under Dynamic Load Condition on High Burnup Spent Fuel of BWR and PWR

It is assumed that the characteristics of high burnup fuel, such as the increase of hydrogen contents and hydrides radially precipitated in cladding, would affect the fuel integrity at cask drop accident during dry storage and transport.
For the assessment of high burnup spent fuel integrity at the cask drop accident, the mechanical behavior of the fuel rod such as deformation, failure and pellet dispersion under the dynamic load condition was examined using BWR fuel rods (56GWd/t, Zry-2/Zr liner cladding) and PWR fuel rods (52-55GWd/t, MDA cladding).
In order to acquire the dynamic mechanical properties of BWR and PWR fuel cladding, dynamic tensile tests (strain rate: up to 10^2 s^-1) were performed to obtain axial tensile strength and elongation using cladding coupon specimens, and dynamic ring compression tests (compression speed: up to 4000 mm/s) were performed to obtain ring compressive strength and failure flattening ratio. In order to evaluate the dynamic behavior of BWR and PWR fuel rod, the axial and lateral dynamic load impact tests were performed to obtain the failure load and mode on axial and lateral compression using fuel rodlet specimens. After the tests, fracture area and surface were examined by fractography and metallography, and the weight and particle size distribution of dispersed pellets were measured to evaluate the failure behavior of the fuel rod. In the dynamic ring compression tests and the lateral dynamic load impact tests, influence of hydride orientation was also evaluated using hydride re-orientation treated claddings.
In the axial dynamic load impact tests, shearing breakage caused by initial impact or buckling breakage were observed. In the lateral dynamic load tests, different failure mode and strength were observed between “with” and “without”pellet. Based on these test results, the threshold of fuel rod mechanical failure under dynamic load condition has been evaluated, and the pellet dispersion data have been prepared for safety evaluation such as criticality and radiation exposure at the cask drop accident during dry storage and transport.

Country/ int. organization

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