BWR Concrete Irradiation Assessment

Steve Swilley
EPRI

NRC Public Meeting on GALL-SLR
July 28, 2016

BWR Vessel Support Irradiation

SLR-SRP 3.5.2.2.2.6 and Table 3.5-1 item 97: Reduction of Strength and Mechanical Properties Due to Irradiation of Concrete and Further evaluation

- Based on existing research, radiation fluence limits of $1x10^{19}$ neutrons/cm^2 neutron radiation and $1x10^{10}$ rad gamma dose are considered conservative radiation exposure levels beyond which concrete material properties may begin to degrade markedly.

- A plant specific aging management program is required to manage the aging effects of irradiation if the estimated (calculated) fluence levels or irradiation dose received by any portion of the concrete from neutron radiation or gamma dose exceeds the respective threshold levels during the SLR period of extended operation.

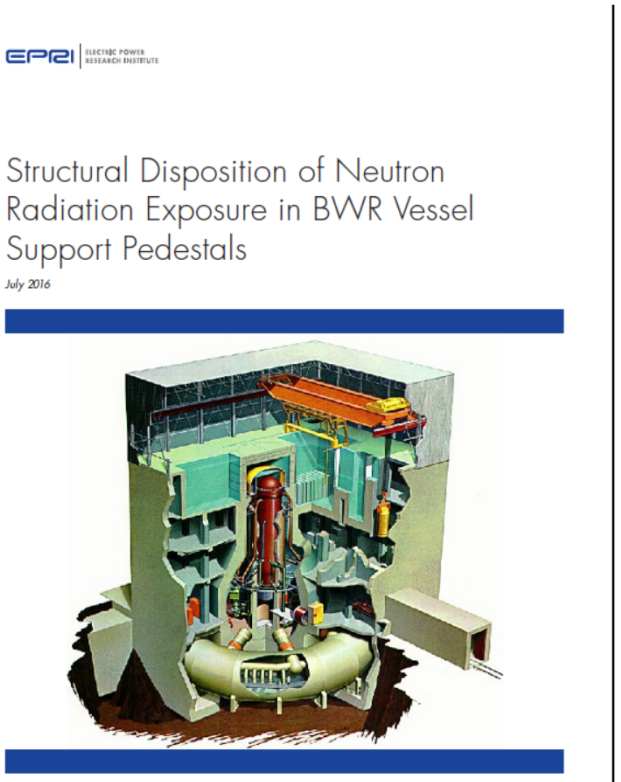
BWR Vessel Support Irradiation

EPRI Report 3002008128 (published June 30, 2016 as a "free" public report): Contains an analysis of structural effects of accumulated neutron fluence in concrete reactor vessel support pedestals in the US fleet of BWRs. The results indicate that plant specific analyses should not be required.

Conclusions of the report:

- The threshold neutron fluence to cause concrete swelling and changes to the mechanical properties was determined to be 1 x 10^{19} neutrons/cm^2 (E > 0.1 MeV). This value is consistent with the threshold reported in the NRC Draft Standard Review Plan for SLR.

- The maximum neutron fluence for 80 years of operation of the US fleet of BWRs was determined to be ~ 1 x 10^{19} neutrons/cm^2 (E > 0.1 MeV) at the beltline region in the biological shield concrete (see EPRI Report 3002002676 – has been transmitted to the NRC).



BWR Vessel Support Irradiation

EPRI Report 3002008128

- The bounding fluence at the reactor vessel support pedestal surface was conservatively estimated by correcting the beltline biological shield fluence using a distance correction applied using dimensions of a typical BWR.

- The maximum neutron fluence for 80 years of operation of the US fleet of BWRs was determined to be ~ 1.8 x 10^{18} neutrons/cm^2 (E > 0.1 MeV) at the reactor vessel support pedestal surface. Note that this value is approximately an order of magnitude lower than the threshold for damage as defined in the NRC Draft Standard Review Plan for SLR.

- The results of the bounding approach should be applicable to the entire fleet of US BWRs. The analysis indicates that microstructural damage to the vessel support pedestals resulting in changing mechanical properties is highly unlikely. As such, site-specific analyses should not be required.

Note: An analysis of radiation effects on structural margin in PWR biological shielding is being published in Q3, 2016 (EPRI Report 3002007347).

Together…Shaping the Future of Electricity