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A Study of the Ageing Effect on Onsite Power System Risk Assessment for Nuclear Power Plants

Ageing is a general process in which properties of a component gradually changes with time or use. Ageing is one of the phenomena that effects the availability of Nuclear Power plant (NPP) electrical systems. Ageing can cause the failure rate of components to increase over time as the component wears out. Operating experience has demonstrated many components failures that have occurred as a result of ageing mechanisms such as corrosion, erosion, embrittlement, fatigue, vibration and wear.

In this paper, the influence of ageing on Probabilistic Safety Assessment (PSA) results is estimated for Advanced Power Reactor (APR1400) onsite power system. Models for component ageing failure rate including surveillance test and replacement ageing control are presented for utilization. Time-dependent system unavailability due to ageing is evaluated. The average increase of system unavailability due to the ageing of system components is estimated. Components are prioritized regarding their influence on the change of system unavailability and relative increase of their unavailability due to ageing. The analysis is performed using Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE-8) software.

The obtained results show the significant increase in average system unavailability after incorporating ageing effect, and the surveillance test and replacement activities can reduce this effect. Detailed time plot over plant lifetime is obtained showing the progression of ageing impact on system unavailability. The time-dependent results show when, in a plant's lifetime, ageing effects become significant from a risk standpoint, and whether components are being replaced frequently enough. System components are ranked in accordance with their risk significance. As the components age, the contribution of some components in system unavailability increases, while it decreases for the others. The method presented is applicable for

identification and ranking of the components that should be considered in the ageing management program.

Keywords: ageing effect, onsite electrical power system, Probabilistic Safety Assessment (PSA), Nuclear Power Plants (NPPs).