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APPLICATION OF RISK BASED INSPECTION AS A PART OF LIFE MANAGEMENT OF NUCLEAR POWER PLANTS

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Risk Informed approach is a systematic effort to improve plant safety in a more efficient manner by distributing the available safety resources depending on the importance to plant safety. This approach has found immense application in various aspects associated with Nuclear Power Plants, including design, manufacturing, operation and regulation. Typical applications of Risk Informed approach are in Technical Specification, In-Service Inspection (ISI) requirements, Motor Operated Valve testing, Configuration Control etc. In order to cater to such variety of Probabilistic Safety Assessment (PSA) based Risk Informed requirements, a software package, "Risk Monitor" has been developed by the authors.

An important application of Risk informed approach that has been undertaken for Indian Pressurised Heavy Water Reactor (IPHWR) is towards Risk Informed In-Service Inspection (RI-ISI). Studies are being conducted to evolve an inspection plan that is optimised to provide effective inspections at the right location with a proper inspection frequency. Using risk informed approach, the identification of system / component for inspection resource allocation is based on the results from Level 1 PSA of a NPP. Eventhough this methodology can be employed on any of the nuclear components / systems such as mechanical systems, instrumentation, etc., as a starting point, piping has been considered for employing Risk Informed Inspection. Plant risk assessment is modelled through the analysis of Core Damage Frequency (CDF) using PSA models. Risk Informed Inspection program of piping involves the estimation of failure probability or frequency of a piping segment and estimation of

consequences of piping failures. ISI program changes could affect the failure probability values of piping and can introduce a change in CDF.

These effects can be brought out through the implementation of Risk Informed inspection strategy. Various importance measures like Fussel-Vesely, Birnbaum Importance, Inspection Importance measure etc. are employed for prioritisation of systems as well as components for In-Service Inspection. After the identification of the critical systems/ components, Failure Mode Effect Analysis (FMEA) is carried out for each piping segment. It is essential to identify the prominent failure modes and causes in order to establish the inspection items. Risk Matrix is designed with different categories, depending on the CDF values and degradation mechanisms for determining the inspection interval. Each segment is assigned the appropriate category depending on its effect on change in CDF and degradation mechanisms. Since inspection will be planned on segments based on its contribution towards risk, an optimal utilisation of inspection resource could be ensured.

Again another outcome of failure probability estimation is the assessment of residual life depending on crack growth phenomena which can be modelled using fracture mechanics methodology. Various aspects are involved like operating history, inspection results etc. which can change the failure probability values and subsequently the risk ranking.

Pilot studies have been conducted to apply Risk Informed In-Service Inspection on a typical Indian PHWR. Risk Ranking of systems has been done based on importance measures. Also Risk Matrix has been applied to rank various piping segments for inspection. As a part of this analysis, a software has been developed to carry out these studies. This paper discusses in detail the application of Risk informed In-service Inspection on a typical Indian PHWR and presents the features of the software.