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INTRODUCTION

The Fire Hazard Analysis (FHA) is mandatory requirement to ascertain the adequacy of principal of fire safety and fire protection measures provided in the plant for safe operational/emergency states of the plant and ensure nuclear safety objective using defense-in-depth philosophy so that a fire that starts in spite of prevention programme will not prevent essential plant safety functions from being performed. The term ‘hazard analysis’ does not involve any probabilistic estimation with regard to fire in current approach. The results of Fire Probabilistic Safety Assessment (FPSA) contributed to design modifications in plant to enhance the safety and thereby reduce its contribution to Core Damage Frequency but the FHA procedure is kept independent from any probabilistic input. The FHA is carried out using the engineering judgment, a new combined fire containment approach and fire influence approach with deterministic modelling framework. Qualitative assessment based on the acts, rules, standards and codes followed in design are also suggested wherever applicable. The fire hazard analysis has been completed for 5 plant of Fast Reactor Fuel Cycle facility (FRFCF) IPHWRs. The FHA has utilised also few CFD based fire influence simulation wherever required.

METHODOLOGY AND TECHNICAL BASIS

Two Level Fire Hazard Analysis methodology has been developed for 700 IPHWR/ reprocessing facility using fire containment, fire influence and a combination of fire containment and influence approach based on foreseeable combustible inventory. First level is for reasonably small rooms with lumped foreseeable combustible inventory and level two is the large rooms with distributed foreseeable combustible inventory. The combined fire containment and influence approach is used in presence of the ventilation dominated scenario. The influence approach combination is in view of additional demand of analysis to demonstrate that the presence of the opening and the ventilation does not propagate the unobstructed fire or the fire in one compartment does not result in generation of secondary fire in another compartment. The efficacy/survivality of the filters has also been included in event of enveloping fire scenario as this becomes the weakest link in the ventilation dominated scenario. The methodology included:

1. Segregation of the plant areas into identifiable ventilated/unventilated enclosures; 2. Identification of the conservative total possible combustible inventory in ventilated/unventilated enclosures for small medium size room; 3. Estimation of single source fire local heat flux based on standard fire temperatures; 4. Identification of the conservative worst possible combustible inventory in ventilated/unventilated enclosures for large and very large areas like hall corridors etc. based on the actual distribution of material; 5. Estimation of single lumped /multiple(six) fire source local heat flux based on standard fire temperatures (flux); 6. Fire duration based on complete burning of foreseeable conservative combustible inventory; 7. No oxygen starvation is assumed in the fire compartment; 8. Fire barrier rating based on localized heat flux values. The adequacy of the obtained heat flux values are cross checked with the maximum possible values of heat flux based on experimental data(from literature) and CFD modelling (literature and inhouse modelling); 9. Ensuring passive fire safety by means of adequate fire rating and safety margin; 10. Ensuring segregation of safety related power and instrumentation cables based on applicable standard so that safety functions do not get affected due to fire at a particular location; 11. Ensure redundancy of safety system, and safety related systems; 12 Ensuring adequacy of fire suppression and mitigation systems.

CONCLUSIONS

Two Level Fire Hazard Analysis methodology has been developed for 700 IPHWR/ reprocessing facility using fire containment, fire influence and a combination of fire containment and influence approach based on foreseeable combustible inventory. This framework is being extensively used not only in basic fundamental, applied fire research but also in solving the applied problems and mandatory regulatory FHA in Pressurised Heavy Water Reactor PHWRs (500 700 MWe), Prototype Fast Breeder Reactor(PFBR), Advanced Heavy Water Reactor (AHWR), Nuclear reprocessing facilities (Fast Reactor Fuel Cycle facility (FRFCF), Integrated Nuclear Recycle Facility (INRP), Research reactors.
REFERENCES