OSART Good Practices
ACCIDENT MANAGEMENT
Overview of the severe accident management programme

Koeberg, South Africa

Mission Date; 22 Aug.-8 Sep., 2011

Establishment of the External Event Review Team (EERT) and External Events Safety Re-assessment Project as a quick response to the Fukushima accident.

- Koeberg reacted quickly to INPO and WANO event reports in March-April 2011 and carried out required verifications and walkdowns.
- Focused self-assessment of SAMG was completed in August 2011. It defines the areas for improvement, including corrective actions and recommendations.
- Extensive review of the emergency operating procedures and SAMGs to assess the functionality of beyond design basis line-ups has been done by August 2011. Significance of the line-up reporting is in defining issues and actions concerning modifications.
- The project plan for External Events Safety Re-assessment defines a comprehensive work program to respond to internal stress tests by November 2011. Then the work of EERT will continue to the implementation of identified plant modifications in the coming years.

Mühleberg, Switzerland

Mission Date; 8-25 Oct., 2012

Development and implementation of Severe Accident Management Guidance (SAMG) for shut-down conditions.

Extending the SAMGs from full power to shut down to provide appropriate guidance for fuel damage events that might occur during plant shutdown conditions requires an understanding of severe accident behaviour that takes into account the plant conditions and physical changes in equipment configuration during shut-down conditions. SAMG for low power and shut down were finalized at the end of 2006, again prepared with support from the same external organisation. Typically, in such an accident the time until the fuel in the core or the spent fuel pool assemblies heat up is much longer than for severe accidents in full-power operation. Several specific SAMG are prepared to deal with such situations, while others from the full power SAMG are used as well.The Accident Management Program at KKM including Severe Accident Management Guidance for shut-down conditions is remarkably comprehensive.

Rajasthan, India

Mission Date; 29 Oct.-15 Nov., 2012

The station has planned and implemented backup cooling connections as a post-Fukushima action. The operation crews routinely carry out exercises to execute preventive accident management measures with these backups.

The station started planning and implementing of further preventive AM measures both for ensuring reactor core cooling and spent fuel cooling as an operating experience action after the December 2006 tsunami had partially flooded a PHWR station on the east coast of India. These actions were further accelerated after the Fukushima disaster in 2011. Hook-up hose connection points have been prepared for backup injection into steam generators, primary circuit, end shields, calandria components and spent fuel pools with portable diesel fire pumps available at the station. The suction can be taken from available water sources at the station such as the emergency makeup ponds (capacity sufficient for seven days).

Additional measures include load shedding during station blackout by switching off unnecessary loads and maintaining reserves of available water resources that are seismically qualified to 0.1g.

Training of operation personnel to carry out the implemented preventive management actions is an important element for successful execution.

Exercises with mock-ups involving shift personnel are carried out, and they include:

- exercise to provide hoses and portable pump for injecting water for cooling the planned objects through hook-up connections;
- exercise to transfer diesel oil to day tanks of the stationary fire pumps from underground storage tanks with hand barrel pumps;
- exercise to monitor crucial parameters with a portable self-powered measuring instrument during an emergency. The exercised parameters indicate the status of reactor shutdown, core cooling and containment integrity as well as spent fuel storage bay level. The exercise will be carried out during biannual shutdown of the unit.

These exercises have helped the station to identify areas for improvement to further enhance the effectiveness of preventive accident management as well as providing operation personnel real-time experience in handling beyond design basis events. The exercises are monitored by two persons from the operations management.

Rajasthan, India

Mission Date; 29 Oct.-15 Nov., 2012

There are capabilities for severe accident analysis, PSA and SAM guideline development within the company.
NPCIL has developed its own code package for severe accident analyses and the capacity to conduct in-house PSA. The in-house codes allow the analysis of complete accident scenarios from the initiating event up to performing radiological release and dose assessments. The company has expert and trained personnel to use, maintain and further develop these codes in the corporate office at Mumbai. NPCIL experts also participate in international activities organized by the IAEA for comparing severe accident analyses of PHWRs. Based on these capabilities NPCIL has worked out the SAM guideline development model and the generic SAM guidelines with support of in-house severe accident analyses. Based on these generic documents the full set of station-specific SAM guidelines will be developed. The station has a specialist to carry out station-specific PSA activities jointly with the PSA team in the corporate office. There are many benefits of capabilities within the company:

- as work is carried out within the same organisation, there is a regular interaction between the NPCIL headquarters and the station;
- personnel obtain a deep understanding of the physics behind the analyses;
- station personnel are well informed about SAM guidelines;
- transfer of knowledge and developing SAM trainer positions at the station;
- the station's review comments are analyzed by corporate office concerning their applicability to other stations.

Clinton, USA

Mission Date; 11-28 Aug., 2014

Clinton Power Station has been actively involved in the development of the Boiling Water Reactor Owners Group (BWROG) generic Severe Accident Guidelines (SAGs) shared with other BWR operators, thus contributing to the worldwide implementation of SAMGs.

Since the beginning of construction in the 1980s the Clinton Power Station has been actively involved in the voluntary US industry activity aimed at developing severe accident guidelines (SAGs). The process started with the BWROG generic SAGs developed by General Electric and a group of engineering organizations. The generic SAGs were developed using technical information from the EPRI Technical Basis Report, from published analyses and reports and from plant specific Individual Plant Examinations (IPEs). Afterwards the generic SAGs were further developed into CPS plant specific SAGs.

There is continuous support from the BWROG, resulting in adequate updates of the documents, whenever justified. Considering operating experience (e.g. Fukushima accident), the safety philosophy change or the significant number of partial changes are drivers for development of a new version of the guidelines. The process is coordinated by the BWROG Emergency Procedures Committee. All US BWRs including Clinton NPP are represented on the Committee. The Committee meets 4-times a year; continuous support to all BWRs is provided. Contacts with the corresponding group for PWRs were also established. Generic guidelines developed by the BWROG (all US BWRs utilize the generic guidelines) are afterwards transformed into plant specific guidelines. Clinton Power Station is actively involved in this systematic process by contributing to this coordinated activity and reflecting agreed approaches into plant specific procedures and guidelines.

Development of generic strategies and guidelines became an important sample (pilot) which was later, with some derivations, followed by many NPPs worldwide. To some extent, the lessons learned and experience gained from the development and use of SAGs in the USA was also reflected in the development of the relevant IAEA Safety Guide (NS-G-2.15).

Taishan, China

Mission Date; 8-26 Jan, 2017

The plant has a comprehensive accident management programme that complements it's design features.

Despite significant improvement in generation III design, the plant has established additional layers of defence within the SAM arrangements. This demonstrates a conservative safety culture in the transition towards plant operations.

The design features have been complemented with the equipment and measurements that have been widely qualified to severe accident conditions. Their availability is ensured by introducing them into the Operational Limits and Conditions and the periodic testing programme.

The severe accident management programme development is supported by the set of severe accident analyses and design phase PSA level 2. The SAM guidelines have been developed and implemented and the technical supporting tools and software to be used have been implemented. The accessibility analysis has been provided for the local actions.

The SAM programme has been complemented with Post-Fukushima actions, and particularly with the mobile equipment for power and pumping supply during an emergency.

For information, the design features for severe accident mitigation include the

- dedicated primary system depressurization,
- containment hydrogen management,
- ex-vessel molten core stabilization system, and –prevention of containment over-pressurization.

Penly, France

Mission Date; 4 - 21 Sep., 2023

An accident mitigation strategy has been developed for the re-injection of highly contaminated water from the Nuclear Auxiliary Building back into the Containment Building to reduce off-site contamination. The system has been designed, installed and has procedures for its implementation.

The aim of this strategy is to limit the contamination of the Nuclear Auxiliary Building which both improves the accessibility of the building and reduces off-site leakage from the building. This is done by re-injecting the contaminated effluents back into the Containment Building.

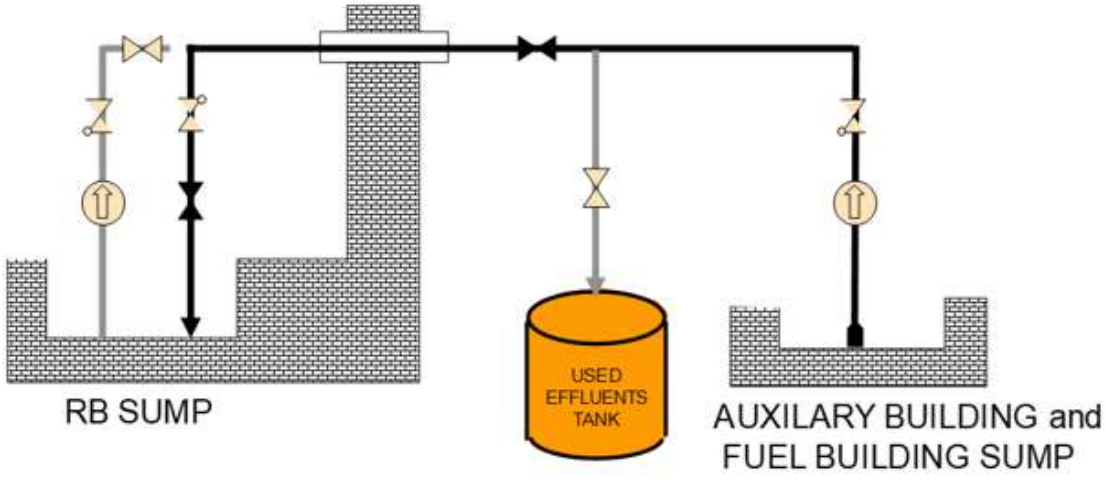
The Containment Spray and Safety Injection pumps are located outside of the Containment Building. Thus, during the Containment Spray or Safety Injection recirculation phase of an accident, contaminated water passes through the Nuclear Auxiliary Building.

The Containment Spray and Safety Injection systems are not designed to operate in a severe accident with very hot primary fluid, heavily loaded with debris and heavily contaminated. Under the effect of this loading, it is likely that leaks will occur at the pump packings or joints sensitive to irradiation.

Thus, leaks may occur and contaminated water build-up in the sumps of the Nuclear Auxiliary Building. These effluents are collected and can be re-injected into the Containment Building.

Upon detection of a threshold exceedance on the radiation sensors associated with the Nuclear Auxiliary Building, Operations re-inject the effluents from the entire nuclear island back into the Containment Building either in the accident phase and/or in the post-accident phase.

The documented procedure is simple to apply and can be performed entirely from the Main Control Room, preventing unnecessary exposure to fission products.



Benefits

1. Re-injecting highly contaminated water behind the 3rd Fission Product Barrier where it belongs.
2. Improving accessibility to the Nuclear Auxiliary Building, parts of which may need to be entered to perform recovering actions.
3. Reducing off-site contamination since the Nuclear Auxiliary Building is not designed to retain significant severe accident by-products.