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REPORT

OF THE

OPERATIONAL SAFETY REVIEW TEAM (OSART) MISSION

TO THE

CLINTON NUCLEAR POWER STATION UNITED STATES OF AMERICA

11 – 28 AUGUST 2014

AND

FOLLOW UP MISSION

26 – 30 OCTOBER 2015

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/016/177F

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Clinton Power Station, United States of America. It includes recommendations for improvements affecting operational safety for consideration by the responsible United States authorities and identifies good practices for consideration by other nuclear power plants. Each recommendation, suggestion, and good practice is identified by a unique number to facilitate communication and tracking.

This report also includes the results of the IAEA's OSART follow-up mission which took place 15 months later. The purpose of the follow-up mission was to determine the status of all proposals for improvement, to comment on the appropriateness of the actions taken and to make judgements on the degree of progress achieved.

Any use of or reference to this report that may be made by the competent United States organizations is solely their responsibility.

FOREWORD

by the

Director General

The IAEA Operational Safety Review Team (OSART) programme assists Member States to enhance safe operation of nuclear power plants. Although good design, manufacture and construction are prerequisites, safety also depends on the ability of operating personnel and their conscientiousness in discharging their responsibilities. Through the OSART programme, the IAEA facilitates the exchange of knowledge and experience between team members who are drawn from different Member States, and plant personnel. It is intended that such advice and assistance should be used to enhance nuclear safety in all countries that operate nuclear power plants.

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover ten operational areas: management, organization and administration; training and qualification; operations; maintenance; technical support; operating experience feedback; radiation protection; chemistry; emergency planning and preparedness and severe accident management. Depending on individual needs, the OSART review can be directed to a few areas of special interest or cover the full range of review topics.

Essential features of the work of the OSART team members and their plant counterparts are the comparison of a plant's operational practices with best international practices and the joint search for ways in which operational safety can be enhanced. The IAEA Safety Standards and the expertise of the OSART team members form the bases for the evaluation. The OSART methods involve not only the examination of documents and the interviewing of staff but also reviewing the quality of performance. It is recognized that different approaches are available to an operating organization for achieving its safety objectives. Proposals for further enhancement of operational safety may reflect good practices observed at other nuclear power plants.

An important aspect of the OSART review is the identification of areas that should be improved and the formulation of corresponding proposals. In developing its view, the OSART team discusses its findings with the operating organization and considers additional comments made by plant counterparts. Implementation of any recommendations or suggestions, after consideration by the operating organization and adaptation to particular conditions, is entirely discretionary.

An OSART mission is not a regulatory inspection to determine compliance with national safety requirements nor is it a substitute for an exhaustive assessment of a plant's overall safety status, a requirement normally placed on the respective power plant or utility by the regulatory body. Each review starts with the expectation that the plant meets the safety requirements of the country concerned. An OSART mission attempts neither to evaluate the overall safety of the plant nor to rank its safety performance against that of other plants reviewed. The review represents a `snapshot in time'; at any time after the completion of the mission care must be exercised when considering the conclusions drawn since programmes at nuclear power plants are constantly evolving and being enhanced. To infer judgements that were not intended would be a misinterpretation of this report.

The report that follows presents the conclusions of the OSART review, including good practices and proposals for enhanced operational safety, for consideration by the Member State and its competent authorities.

CONTENT

INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of the USA, an IAEA Operational Safety Review Team (OSART) of international experts visited Clinton Power Station (CPS) from 11 – 28 August 2014. The purpose of the mission was to review operating practices in the areas of Management, Organization and Administration; Training & Qualification; Operations; Maintenance; Technical Support; Operating Experience; Radiation Protection; Chemistry; Emergency Planning and Preparedness; and Severe Accident Management. In addition, an exchange of technical experience and knowledge took place between the experts and their station counterparts on how the common goal of excellence in operational safety could be further pursued.

The Clinton OSART mission was the 177th in the programme, which began in 1982. The team was composed of experts from Canada, Czech Republic, Belgium, Finland, Hungary, Mexico, the Netherlands, Slovakia, Sweden, United Kingdom and the IAEA staff members. The collective nuclear power experience of the team was approximately 370 years.

Clinton Power Station is located in Harp Township, DeWitt County approximately six miles east of the city of Clinton in east-central Illinois. The site is located between the cities of Bloomington and Decatur to the north and south, respectively, and Lincoln and Champaign-Urbana to the west and east, respectively. Clinton Power Station is a single unit station with a Boiling Water Reactor (BWR) nuclear steam supply system with 624 fuel assemblies as designed and supplied by the General Electric Company and designated as a BWR6 unit. The containment system designed by Sargent & Lundy employs the drywell/pressure suppression features of the BWR-Mark III containment concept. The containment is a cylindrical, reinforced concrete, steel-lined pressure vessel with a hemispherical dome. Rated at a licensed power level of 3473 MWt, the unit is designed to operate at a gross electrical power output of 1138.5 MWe. The operating license was issued in September 1986 and commercial operation commenced in April 1987. Clinton’s current 40-year operating license expires in 2026.

Before visiting the plant, the team studied information provided by the IAEA and the Clinton Power Station to familiarize themselves with the plant's main features and operating performance, staff organization and responsibilities, and important programmes and procedures. During the mission, the team reviewed many of the plant's programmes and procedures in depth, examined indicators of the plant's safety performance, observed work in progress, and held in-depth discussions with plant personnel.

Throughout the review, the exchange of information between the OSART experts and plant personnel was very open, professional and productive. Emphasis was placed on assessing the effectiveness of operational safety rather than simply the content of programmes. The conclusions of the OSART team were based on the plant's performance compared with the IAEA Safety Standards.

The following report is produced to summarize the findings in the review scope, according to the OSART Guidelines document. The text reflects only those areas where the team considers that a Recommendation, a Suggestion, an Encouragement, a Good Practice or a Good Performance is appropriate. In all other areas of the review scope, where the review did not reveal further safety conclusions at the time of the review, no text is included. This is reflected in the report by the omission of some paragraph numbers where no text is required.

MAIN CONCLUSIONS

The OSART team concluded that the managers and the staff of Clinton Power Station are committed to improving the operational safety and reliability of their station. There is clear evidence that the station has gained benefit from the OSART process. The IAEA Safety Standards, OSART guidelines, benchmarking activities with other power stations and a comprehensive self-assessment were used during the preparation for the OSART mission.

The team found good areas of performance, including the following:

- The Exelon Nuclear Management Model (NMM), coupled with strong inter-site and corporate support allows credible cross-site comparisons to be drawn and leverages the efficient use of company resources
- A mentor programme for students in initial training programmes in all departments as well as crew training mentors for license requalification training crews.
- Cross-discipline review and ownership process regarding the control of Temporary Modifications
- Fuel failure prevention policy including a strong Foreign Material Exclusion programme.
- Tools to ensure Root Cause Analyses are completed in a timely, consistent and deliberate manner to guarantee the high quality of the investigation and report.
- Use of remote-monitoring technology, cameras and robots for radiation exposure reduction.
- The station has a Department Chemical Control Representative (DCCR) in all its departments. DCCR acts as a point of contact for the station chemical control coordinator when problems involving chemical product use, storage, labelling, or disposal arise and assists in resolving these problems.
- The station in coordination with other nuclear power plants in the Exelon fleet decided to harmonize the approaches used and to acquire standard (primary and backup) equipment for each plant of the fleet for mitigation of severe accident damage.

A number of proposals for improvements in operational safety were offered by the team. The most significant proposals include the following:

- Consistently assess and reduce, where achievable, safety hazards from storage of equipment and transient materials and consistently demarcate storage areas.
- Improve the backlog management tool and methodology so as to ensure timely completion of maintenance work orders even for lower priority work.
- Improve the efficiency and configuration control of the modification process used for phased implementation of changes, including the replacement of obsolete plant items.
- Improve the robustness of its external OE screening process and ensuring learning opportunities from international experience are not missed.
- Update the procedure for validation of the Severe Accident Guidelines (SAGs) and also complete the existing generic information by plant specific analysis of representative severe accidents as an input for the next validation of SAGs and for staff training.

Clinton management expressed a determination to address the areas identified for improvement and indicated a willingness to accept a follow up visit in about eighteen months.

CLINTON POWER STATION SELF-ASSESSMENT FOR THE FOLLOW UP MISSION

In 2014, an Operational Safety Review Team (OSART), consisting of international experts and coordinated by the International Atomic Energy Agency (IAEA), visited the Clinton Power Station (CPS) and conducted an extensive review of CPS Unit 1. The review process took place from August 11 – 28, 2014, and involved the following departments and special focus teams: Management and Administration, Training and Qualification, Operations, Maintenance, Technical Support, Operational Experience, Radiation Protection, Chemistry, Emergency Preparedness and Severe Accident Management.

In total, the OSART team identified nineteen (19) Good Practices, the highest ever awarded to a station during an OSART mission. An OSART Good Practices indicates a station has performed in an area exceptionally well and should be used as an example for benchmarking by other nuclear stations when establishing their own practices and standards of excellence. Eleven (11) Suggestions were also identified, which tied for the fewest improvements ever identified for a station during an OSART mission.

Following the OSART mission, the station performed in-depth reviews of the OSART Suggestions. These reviews analysed the adverse condition and provided a causal statement, review of the extent of condition, and an action plan for conditional remediation.

Over forty-five (45) action items were created to address the issues identified during the OSART mission. The corrective actions were formulated and given a time frame for completion with concurrence from the respective department owner and were approved by station senior management. Examples of action items to remediate the identified issues include creating a Backlog Reduction Team to reduce the number of maintenance work orders to within goal; improved communications during departmental meetings and training simulations; implementation of inventory reduction strategies and safety hazard recognition in storage areas; and improved external Operating Experience (OE) collection process.

In May 2015, during the CPS re-fueling outage, C1R15, the station successfully completed the FLEX project, which addresses the main safety challenges experienced at Fukushima, which includes the loss of cooling capabilities and loss of electrical power as a result of a severe natural event. The implementation of FLEX modifications and all provisions are required to be completed by 2016 by order of the NRC. Adoption of FLEX is a significant improvement compared to minimum plant design modifications. Clinton was the first Exelon station to complete all of the FLEX requirements.

Also in 2015, Clinton Power Station revisited its mission statement and created a new vision for the station and its future – SOAR To Excellence. This new vision encompasses the station's commitment to industrial and nuclear **S**afety, **O**perational focus, personal **A**ccountability, and equipment **R**eliability. The new vision statement has been integrated into the organization by the publication of the Clinton Station HU (Human Performance) Pocket Guide. This guide embraces an uncompromising approach to world class standards. Each employee internalizes the meaning of being a conscientious nuclear worker. The SOAR To Excellence philosophy is promoted and utilized daily in the two main Corrective Action Process groups – the Management Review Committee (MRC) and the Site Ownership

Committee (SOC). These teams work together to generate effective, long-term, corrective actions to achieve sustainability in plant configuration, risk management, safety, and equipment reliability.

The OSART team referred to the Clinton Power Station mission as one of the best in OSART's history, which spans more than 30 years and 177 previous missions. The OSART mission was highly beneficial to the Clinton Power Station. The feedback provided by the team has helped the station continue to promote a culture that emphasizes safety, is committed to implementing nuclear best practices, and upholds the highest standards of excellence.

OSART TEAM FOLLOW-UP MAIN CONCLUSIONS

An IAEA Operational Safety Review Follow-up Team visited the Clinton NPS from 26 to 30 October 2015. There is clear evidence that NPS management has gained benefit from the OSART process. Benchmarking activities with other Exelon nuclear power stations and implementation the corrective action programme, were used during the preparation for the follow up mission. The team noted that during 2015 significant safety improvements were completed under FLEX project, which addresses the main safety challenges experienced at Fukushima, including the loss of cooling capabilities and loss of electrical power as a result of a severe natural event. Clinton was the first Exelon station to complete the entire FLEX requirements well in advance of the deadline set by the regulator.

Furthermore, in 2015, Clinton Power Station revisited its mission statement and created a new vision for the station and its future – SOAR To Excellence. This new vision encompasses the station's commitment to Safety, Operational focus, Accountability, and Reliability of equipment.

The station analyzed thoroughly the OSART suggestions and developed appropriate corrective action plans. The willingness and motivation of plant management to use benchmarking, consider new ideas and continuously strive for excellence was evident and is a clear indicator of the station strong safety commitment.

The station resolved issues regarding effective communication during meetings, setting expectation on trainee's communication during simulator training and improving the maintenance backlog management and methodology.

The following provides an overview of the issues which have reached satisfactory progress of resolution but where some degree of further work is necessary.

To improve material conditions the station has implemented four long term action plans to repair: fire protection leaks; cracks in the floor coating and radwaste operation center deficiencies, and to improve housekeeping in Transformer Material Exclusion and Secured Material Zones. The station systematically assigned a dedicated owner of each CPS area with respect to housekeeping and material conditions programme. These initiatives improved the plant status from housekeeping and material conditions point of view, however, not all action plans are yet fully implemented and work still needs to be done to resolve the issue completely.

As concerns the issue related to the periodic safety reviews, the station benefited from the analyses performed recently by NRC on this subject. The station took also some limited actions to familiarize itself with the PSR process used by Bohunice NPP in Slovak Republic. The team concluded that considering the NRC actions already taken and actions taken by the

station to familiarise with PSR process used in another country, the intent of the suggestion will be met. However, referring also to the reconfirmed importance of the PSR in recently revised IAEA Safety Standards, Requirements SSR-2/2 and the welcoming by NRC on further exchange of information on this matter, as appropriate, the station is encouraged to further consider possible benefits from broadening its knowledge on the matter.

The station has initiated actions to solve on the long term the issue concerning obsolete plant items. All items which are no longer supported by the manufacturer are considered obsolete and have been identified by the station. These obsolete items are prioritised namely on the basis of their safety significance. There is a positive trend in reducing total number of obsolete items, however, the number of obsolete items ranked with high impact has not evolved significantly. The station increased also the manpower needed to resolve the issue and is striving to simplify the modification process, including by allowing use of "phased implementation changes". There is reasonable confidence that these actions should improve the situation on the longer term. However, more time is needed to see an impact on the performance.

Periodic housekeeping walkdowns are conducted to control the conformity of approved storage areas. Inventory of storage has been reduced. Safety related areas of the plant are assigned to owner departments, which are responsible for identification of equipment stored in unapproved storage areas. Fire load calculations for the approved storage areas have been mostly updated. The marking of high fire risk areas has been improved. Training has been given to raise the awareness of staff on the importance of combustible materials stored in appropriate areas. The location of some storages, however is not always marked on the ground and this may cause confusion about the expected place for storage. The station has globally reduced safety hazards from storage of equipment and transient materials. However, some further improvement is still needed in the area of seismic hazard assessment for transient materials, as well as for the marking of authorised storage places.

Since February 2015, INPO has improved the reporting process of non-domestic incidents to INPO nuclear power plants. In average, around 6 non-domestic events were reported per month up to now by INPO. The station screens these new inputs systematically since February 2015, however this screening so far has not resulted in any event been selected for detailed analyses on its applicability to the plant. In the same period about 160 events from domestic origin were analysed in details for applicability to the station. There are still no performance indicators monitoring the quality of the screening process for external OE and missed learning opportunities from external OE. Further actions are needed to integrate lessons learned from international experience feedback in station improvement programmes.

The station, together with Exelon Corporate has analyzed the issue concerning enhancement of radiation work practices to reduce the likelihood of the spread contamination. Several corrective actions were initiated and implemented, or partially implemented. CPS made strong efforts for further dose reduction and the success was demonstrated in outage C1R15. CPS started the repair of the degraded floor coatings. Deadline for full repair in the Radwaste and Control buildings and RCA is March 2016. Not all measures are fully implemented yet and some of them are long term. Plant tours confirmed improvements, however further work is needed to fully resolve the issue.

The station has updated EOP-8 "Secondary Containment Control" procedure that now addresses conditions for entry into severe accident mitigation domain triggered by spent fuel pool water level or temperature. For extension of the SAGs to cover shutdown and refuelling conditions, the station is dependent on the development of BWROG generic symptom-based

guidelines (EPGs/SAGs, Rev 4) to be used during plant shutdown conditions. This general document is expected to be approved by 2017 and the station will need within two years to implement these guidelines, as necessary. It was noted that while significant progress has been achieved with full installation of FLEX provisions, further work is needed to complete the revision process for the CPS SAGs so as to extend their scope to shutdown operational regimes.

The station has implemented several activities to update the EOPs and to enhance the validation process for EOPs/SAGs. Plant EOPs were updated in May 2015 and SAGs are expected to be revised in spring of 2016. CPS procedure 1005.12, dealing with validation of EOP/SAG support procedures, however is not yet revised and still does not explicitly address the role of the TSC staff in severe accident management. At the present moment the station is also not considering increasing the scope of the plant specific accident analyses nor software simulations to be used for verification and validation of the SAGs. Further work is needed to ensure adequate revision and validation of the SAGs.

The original OSART team in August 2014 developed eleven suggestions to further improve operational safety of the plant. As of the date of the follow-up mission, some 14 months after the OSART mission, 27 % of issues were fully resolved and a further 73 % of issues were progressing satisfactorily. There is no issue with unsatisfactory progress.

The team received full cooperation from the Clinton NPS management and staff. The team was allowed to verify all information that was considered relevant to its review. In addition, the team concluded that the managers and staff were very open and frank in their discussions on all issues. This open discussion made a huge contribution to the success of the review and the quality of the report.

The Clinton power station team who contributed to the preparation for the follow-up mission is encouraged to continue with their effort for sustaining the momentum to make continuous safety improvements.

1. MANAGEMENT ORGANISATION AND ADMINISTRATION

1.1 ORGANISATION AND ADMINISTRATION

Clinton Power Station (CPS) uses the clear and well-structured Exelon Nuclear Management Model that ensures execution of activities is consistent with the rest of the Exelon fleet. While it is rigorously implemented, it is also updated when potential gaps are proven. Strong fleet performance and experienced Corporate Functional Area Managers (CFAM) drawn from senior levels of the organization give the model credibility. In addition, there is strong support and resource sharing from the corporate office and between stations. Results are monitored using a common scorecard and a coordinated management review system. The team recognized this as a good practice.

Within the station there is a clear focus on nuclear safety and a healthy safety culture. External communications with the public are open and transparent but visitors to the Exelon web site do not see a public declaration of the operating organization's commitment to safety. The team encourages the station to address this.

1.2 MANAGEMENT ACTIVITIES

The station has a comprehensive, forward looking approach to the ageing workforce issue. This integrates risk management, business planning, advanced recruitment, optimization of individual training needs, training delivery capability and external educational facilities. In addition, the human resources function is engaged not only in the recruitment process but in identifying suitable candidates with the desirable behavioural traits sought by station departments. The team recognized this approach to knowledge transfer and retention as a good practice.

In some meetings the robustness of communications did not always result in actions being fully understood and agreed, and some action plans did not identify all the parameters needed to evaluate success. Although open questioning and challenge was present it did not always extend below the senior management level. The team made a suggestion in this area.

1.3 MANAGEMENT OF SAFETY

Nuclear oversight is well implemented at CPS. It covers all aspects of the station's operating organization including behavioural. The extensive integration of audits and assessments across the fleet is noteworthy since the plan is agreed well in advance, recognizes important station activities and the scope is consistent from station to station. The activities are conducted for all stations within a short timeframe which allows valid cross-fleet comparison. In addition, the results are published soon after completion. Station lessons are monitored using the corrective action programme and CFAMs ensure lessons are applied consistently at all stations. The team recognized this as a good practice.

In terms of safety culture the team observed behaviours of plant staff and compared these to the safety culture attributes promoted in the IAEA Safety Standards. The station staff has consistently demonstrated strong safety culture and several facts were observed by the team related to these strengths. Examples include:

- The team recognized the presence of strong leadership for safety resulting in well-defined, clearly communicated and respected management safety expectations, an effective issue identification and solving process, openness and transparency, questioning attitude and systematic searching for learning opportunities at all levels. The team has observed several management meetings where strong focus on safety was demonstrated with no exceptions.
- The team observed several examples where the right behaviours were encouraged by station and corporate senior management, including a reward scheme for noteworthy incident reports or possible ALARA improvements proposals. Senior managers encouraged station staff to understand and address the reasons behind behavioural issues rather than simply correct improper behaviour. The supportive environment for reporting issues has resulted in a high reporting rate by all CPS departments.
- The team observed strong safety culture attributes related to pre-job briefing such as detailed preparation, the use of relevant operational experience feedback with focus on safety, very good team work and looking for opportunities to avoid mistakes. Numerous examples of these high safety standards were found during pre-job briefs and reinforcement of safety behaviours during plant tours was also identified by the team.
- The team noted that CPS applies an effective policy and procedure for safety culture monitoring. The station uses INPO's 'Traits of a Healthy Nuclear Safety Culture' as the basis for assessment and improvement of fleet safety culture. Safety Culture attributes are also screened systematically in each Root Cause Analysis which is performed.

The team also identified the following areas that could be further strengthened to improve safety culture:

- The team found that the station could gain further benefit by learning more from international operating experience.
- A more proactive approach to targeting minor but long standing defects could help the station to sustain its very good performance.

Overall the safety culture at CPS was considered by the team to be fully consistent with the message played when entering the station first security-check monitors: "At Clinton Power Station safety is the way we think, work and live".

DETAILED MANAGEMENT, ORGANIZATION AND ADMINISTRATION FINDINGS

1.1 ORGANIZATION AND ADMINISTRATION

1.1(a) Good Practice: The Exelon Nuclear Management Model (NMM), coupled with strong inter-site and corporate support allows credible cross-site comparisons to be drawn and leverages the efficient use of company resources. Station personnel are widely familiar with the NMM and the expectations for its use. The model integrates all the elements of management of the Exelon nuclear fleet so that processes and activities that may affect safety are established and conducted coherently with other requirements. Implementing the model ensures that safety is not compromised by other requirements or demands and accords with IAEA SSR 2/2 Section 3: The management and organizational structure of the operating organization.

The structure and purpose of the NMM and its documented structure is clear. It facilitates consistent application of company standards and procedures across a large, technically diverse fleet. When new stations enter the Exelon fleet a gap analysis is performed between the NMM and the incoming plant's arrangements. The model is updated where improvements are seen and a reasonable period of time is given for the new plant to transition to the model.

Similarly, if a gap is identified through processes such as self-assessments and INPO evaluations, peer groups consider the issue and whether the model should be updated. Proposed revisions are piloted at a small number of sites prior to introduction across the fleet if the pilot is successful. This promotes engagement of the peer groups and their associated working groups.

New hires in certain supervisory or 'singleton-expert' roles are assigned mentors from other parts of the fleet or the corporate organization. This accelerates their development and promotes use of fleet best practice.

Corporate Functional Area Managers (CFAMs) are drawn from senior levels within the organization. The knowledge, experience and authority they possess gives added credibility to the use of the NMM and encourages inter-station co-operation and use of corporate support.

Some of the notable standardizations and benefits noted by the team are:

- Operating experience: the CFAM co-ordinates the company response for all level 1 and 2 INPO Event reports (IERs), distributing the required actions to the fleet, monitoring the response and ensuring consistency.

- Training: the corporate organization has provided a centralized training centre used for much of the initial training and certain specialized training such as welding. The corporate organization has oversight of the training procedures.

- Emergency Planning and Preparedness: corporate personnel are involved in the provision of facilities, equipment and procedures for the fleet. They have deployed standard criteria for the evaluation of drills and exercises which facilitates support from site to site, fleet comparisons of performance and dissemination of lessons learned.

- Nuclear Oversight: audits and assessments are coordinated across the fleet and conducted using peers from stations, other nuclear utilities and the corporate organization. The results are used to implement fleet-wide solutions in a resource-efficient manner.

- Severe Accident Mitigation: a unified approach to, and means of mitigating, severe accidents.

Examples were also seen in other review areas such as Operations, Radiation Protection, Technical Support and Maintenance.

1.2 MANAGEMENT ACTIVITIES

1.2(a) **Good Practice**: CPS has implemented a forward looking approach to the demographic challenges facing the station by deploying a comprehensive approach to knowledge transfer and retention.

This approach includes an assessment of risk arising from the likelihood that members of staff will leave the organization, the level of knowledge that would be lost from the station and the significance of that loss to continued safe operation. The risk assessment data is used in plans for recruitment, training and budgeting.

Personnel are hired in advance of anticipated departures to give sufficient time for new hires to be trained and gain experience in areas of vulnerability. The forward looking nature of this allows the station to use college partnerships, intern programmes and targeted external recruitment to attract candidates of the required quality.

The Exelon organization recognizes the strategic value of advanced hiring in terms of approvals for “over hire” positions.

The station training organization is fully engaged with the knowledge transfer and retention process. The various training committees incorporate the advanced hiring programmes when identifying and scheduling training needs so that adequate numbers of qualified individuals are available to support station activities. Rotating experienced line personnel through the training function is beneficial in maintaining recent plant knowledge in the instructor workforce and capturing this in training materials. This also helps ensure adequate instructor resources.

Training demands are optimized by evaluating new employees soon after hiring for qualification equivalency to avoid unnecessary duplication of previous training. Training and line supervisors are engaged in approving these exemptions.

The station has partnered with the corporate human resources function to agree the behavioural traits the station is seeking as well as the qualifications and experience needs so that candidates have the right attributes to fit the station culture. This results in new hires that ‘hit the ground running’ and gives first line supervisors’ confidence in the process.

1.2(1) Issue: The station does not always use clear communications to ensure actions are fully understood and agreed during meetings.

The team observed the following regarding the identification, agreement, recording and presentation of meeting actions:

- Three-way communication was not always used when placing and accepting actions. It was therefore not always clear that the intent of the action was accurately understood and recorded.
- It is noteworthy that a corporate representative at one meeting issued an appropriate challenge on this theme and this was accepted by the meeting.
- On several occasions, action plans were presented that did not have all the information expected. For example some action plans were lists of action tracking items without action owners or due dates. This makes it more difficult to evaluate timelines to completion or engagement of action owners.
- Although there was good senior management challenge at meetings, this did not often extend to other participants.
- It was not always clear why information was being presented at meetings, an example being 'for information' or 'for approval'. On one occasion an attendee questioned why he was being asked to present to the meeting as the topic was being driven by the corporate organization and had already been authorized.

Without rigorous conduct of meetings some actions can be misunderstood which could lead to degradation of safety performance.

Suggestion: The station should consider using a more robust communication protocol in meetings to ensure actions are fully understood and agreed.

IAEA Basis

GS-R-3

5.5. The activities of and interfaces between different individuals or groups involved in a single process shall be planned, controlled and managed in a manner that ensures effective communication and the clear assignment of responsibilities.

NS-G-2.4

8.5. Appropriate arrangements should be in place to monitor the effectiveness of communications and to act promptly to eliminate identified weaknesses.

Plant Response/Action:

Clinton Power performed observations of several site and department meetings and confirmed the insight provide by the OSART team. The team found a lack of three part communication and a protocol that formally documented actions, owner and due date. The major change CPS initiated was at the end of each meeting the attendees would report out on what actions they accepted and the commitment when they would complete said action. The meeting chairperson will now assign any actions not covered during this report out. Depending on the meeting these actions will be added to the action item tracking list or formal Action tracking items in the Corrective Action Database.

Use of three part communication was found to be sporadic. It was not always used and crisply completed as appropriate. Site wide tailgates and department briefings were completed giving clear expectations on the proper use of three part communications. During meetings all participants are expected to coach and correct when three part communication is not used and should be. Clinton Power Station also issued the HU pocket guide that clearly outlines the requirement when to use three part communication and the expected performance of the use.

The end of the day Senior Leadership Team (SLT) meeting has incorporated the time to perform a self-critique of the day and meeting performance is one item discussed. This meeting also allows the team to reflect on the team core competencies.

IAEA comments:

The Clinton Power Station has performed comprehensive evaluations of different meetings conducted at the station. In addition, benchmarking with other NPSs within the Exelon fleet was performed. Appropriate actions were developed and implemented based on the internal review and benchmarking results. CPS recognized that standards outlined in procedure HU-AA-101, Human Performance Tools and Verification Practices, needed to be reinforced. In addition to this, CPS developed and implemented the "Clinton Station Human Performance (HU) Pocket Guide." This pocket guide has a strong link to the new CPS vision SOAR – Safety, Operational focus, Accountability, and Reliability of Equipment. Use of three way communication in verbal discussions is clearly described and is the expected practice.

All actions from the meetings, including responsible person and due date are added to the action item tracking list, or formal actions tracking items in the Corrective action database. The review of both list and database confirmed appropriate use of these tools.

CPS introduced an additional important activity to their management programme. Each end of the day Senior Leadership Meeting has item to perform a self-critique of the day.

The team observed some meetings during OSART FU review and it was confirmed that the new initiatives are implemented and are working properly. These meetings are very good opportunities for management and other participants to challenge one another. All participants of the meetings shall confirm their actions by the end of meeting.

Conclusion: Issue resolved

1.3 MANAGEMENT OF SAFETY

1.3(a) **Good Practice:** The implementation of Nuclear Oversight at Clinton Power Station is comprehensive and well integrated. It covers Audits (on areas with regulatory significance), Comprehensive Performance Assessments (for activities without regulatory aspects) and quality verification.

Audits are conducted by multiple teams at different sites using the same scope and plan, covering the entire Exelon nuclear fleet over a six week period.

Comprehensive Performance Assessments are similarly performed simultaneously across the whole nuclear fleet during a single 2 week period.

The periodicity of the audits and assessments is graded depending on the topic area.

Emergent issues early in the roll-out of each audit or assessment are noted for possible inclusion in the next audit in the sequence. Preparation of the resulting reports is very timely: within 3 working days after each audit or assessment.

The use of the same scope and the close timing of the audits, assessments and reports means that CPS and the rest of the Exelon nuclear fleet gains a highly consistent view of common, current issues. Findings are fed into each site's corrective action programme but also 'rolled-up' to identify common themes so that senior executives and Corporate Functional Area Managers can ensure a consistent response across the nuclear fleet. The result is that fleet-wide solutions can be created and implemented in a resource efficient manner in accordance with the Exelon Nuclear Management Model.

The way the audits and assessments are scoped, planned and executed also provides management with credible cross-fleet performance comparisons.

Additional benefit is gained from the use of specialist auditors, some from outside the company. This spreads the experience of 'aiming for excellence' more widely and promotes learning from fresh perspectives.

2. TRAINING AND QUALIFICATIONS

2.1 TRAINING POLICY

The Exelon Training and Qualification Policy is applied at the Clinton Power Station (CPS) and internal procedures ensure familiarization of all new employees with this document. A Job Familiarization Guide covers the implementation of the training and qualification (TQ) policy for specific supervisory positions at CPS. Managers and supervisors are actively involved in the training process through participation in curriculum review committees, training advisory committees, observation of training activities, kick-offs of training sessions and review and approval of training material. There are four levels of training committees (including corporate level) established. Training Performance Indicators are reviewed by line management at each training committee meeting.

There is a comprehensive set of generic Exelon procedures on the Systematic Approach to Training (SAT) methodology, which is implemented in a very rigorous manner at CPS. Training management ensures the training staff is fully knowledgeable on the SAT process and all line supervisors and managers are aware of relevant parts and their role in the training process.

A comprehensive training observation programme is in place. A detailed observation schedule for managers and supervisors is prepared to ensure all training activities and training settings are observed appropriately. A solid benchmarking and self-assessment process is in place at the plant, which also applies to the training process. Hard copies of training and authorization records are properly stored in fire-proof cabinets for a period of two years. All necessary records are scanned and entered into the Learning Management System (LMS) electronic database for easy access though the PC network.

The overall activities in this area are well conducted and the team recognized this as a good performance.

2.2 TRAINING PROGRAMMES

There is a comprehensive and well implemented Supervisory Development Programme at CPS and the team recognized this as a good practice.

A simulator training session was observed. Several error prevention tools were properly used by the crew members such as place keeping, peer checking, and self-checking. However, the communication between the crew members was not always as expected and the team suggested an improvement in this area.

The evaluation of simulator training is well structured and documented. Strict exam security rules are applied and followed at CPS. A specific performance indicator is used by CPS to indicate the success of trainees who pass through initial training for licensed operators. A low percentage result was achieved in this area in June 2005 (20 %). However, since that time the performance in this area has significantly improved with 90 – 100% results for the last five Initial Licensed Training classes. A thorough selection process, the quality of instructors and the student's mentoring programme were the most effective contributing factors in this improvement. The team recognised the mentoring programme as a good practice.

Very good performance of training instructors and other training personnel was observed at CPS. Most of the instructors demonstrated excellent lecturing skills, the lessons were very interactive, smart boards were effectively used and in-house examples were utilised. Several station staff members from line departments were interviewed during the review and they showed enthusiastic involvement in various training activities (subject matter expert, classroom and on-the-job training (OJT) instructor, task performance evaluator, etc.). The team considers this as a good performance.

2.3 TRAINING FACILITIES AND MATERIAL

CPS is well equipped with training facilities and other training material. There is a high fidelity full scope simulator and various classrooms and meeting rooms available at the on-site Training Centre. In addition, the Maintenance Learning Centre and Nuclear Support Annex facilities are equipped with a number of classrooms, computer classrooms, mock-ups and laboratories available for training purposes. There are more than 400 mock-ups available for sharing within the whole Exelon fleet for maintenance training purposes - see good practice in Maintenance area.

2.4 AUTHORIZATION

A comprehensive set of qualifications (authorizations) and training requirements are established for working positions and contractors. Qualifications of plant personnel and contractors are not valid until recorded in the electronic database – this electronic record on individual's qualification is considered as "the legal" record. There is a very easy and transparent method to verify qualifications for most of the plant personnel and supervisors in the LMS, accessible via a PC network or touch screen at the entrance to the training building. Maintenance disciplines use a daily hard copy printout of approved qualifications. CPS controls qualifications also for various positions in the emergency response organization in the same way as for other plant positions - see the good practice in the Emergency Planning and Preparedness area.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2. TRAINING PROGRAMMES

2.2(a) **Good practice:** Clinton Power Station, as part of the Exelon fleet, has a comprehensive Supervisory Development Programme (SDP). This programme provides guidance on the selection, training and development of First Line Supervisors (FLS), limited qualification of FLS candidates, and temporary supervisory upgrades for personnel selected to perform supervisory duties on a temporary basis. The programme includes guidance on the selection of continuing training topics for enhancement and development of supervisory skills and knowledge.

Initial Supervisor Training consists of several parts:

- A three week SDP course provides basic supervisory skills training and must be completed within one year of assignment to the FLS position.
- An additional week dedicated to subjects important to nuclear supervisors. Topics were selected based on corrective action programme data, performance management results, and nuclear industry operating experience. The training is presented by Exelon nuclear executives and subject matter experts.
- Each candidate is assigned a qualification book which tracks the completion of selected training topics, interviews with senior managers, and reading assignments. A Peer Coach is assigned to provide guidance and assistance in completing the qualification book.
- To verify alignment of standards and expectations, the last step of the FLS qualification is satisfactory completion of an interview at an Oral Review Board conducted by the candidate’s Department Head, the Plant Manager and Site Vice-President. Final qualification approval is granted by the Site Vice President.

Continuing development (training and non-training activities) maintains and improves the technical, administrative, supervisory, and leadership skills of the incumbent FLS and provides them with an understanding of the bases of procedures, systems and components, and integrated plant operations.

The station also conducts a Supervisor Boot Camp for all supplemental foremen, supervisors, and managers prior to each refueling outage. Topics include foreign material exclusion, temporary power, scaffolding requirements and Clinton Power Station standards. This training has improved outage performance and reduced supplemental worker error rates. The Supervisor Boot Camp training is enhanced prior to each outage to further strengthen supplemental supervisor performance.

The initial first line supervisor training programme includes nuclear industry specific training in addition to supervisory soft skills training topics.

A strong first line supervisor training programme ensures that new supervisors possess the skill sets needed to ensure high levels of personnel performance, improved efficiency, and excellent overall plant performance.

2.2(b) **Good practice:** Clinton Power Station Strong Mentor Programme

Clinton Power Station, as part of the Exelon fleet, utilizes a mentor programme for students initial training programs as well as crew training mentors for license requalification training crews. The mentors are involved with the students from the beginning of their training programme to ensure the students have all the necessary resources available for them to be successful in class.

An operations management mentor is assigned to each initial license and equipment operator training class. The mentor is the single point of contact for class conduct, management observations, and trainee performance monitoring. The mentor meets regularly with students to discuss student performance, help needed, class progress, etc.

Additionally, a shift mentor is assigned to each initial training student to supplement their on-the-job training (OJT) time. Each shift mentor meets with their respective student to ensure OJT progress is being made, answer questions about the plant, administrative processes, etc.

A training mentor is also assigned to the initial license training students. This mentor is the person who regularly works with the student to ensure they are participating in class, answer any questions, etc. The training mentor also works with the instructors to get feedback on their student on class participation, note taking, study habits, student questions, etc.

An experienced engineer is assigned as a mentor for each unique certification which new engineers are assigned to complete. The engineering mentor not only serves as an instructor to assist the new engineer with completing the certification but the mentor is also involved in evaluating student performance.

An experienced First Line Supervisor (FLS) is assigned as a mentor (Peer Coach) to assist each FLS Candidate in the qualification process and to help guide the FLS Candidate's development. The Peer Coach provides feedback to the candidate on completion of their Qualification Book on a weekly basis.

While the mentor concept is not unique to the industry, Clinton Power Station has implemented the mentor programme such that the mentors and the students feel there is a team approach to the students' success. Both the mentor and the student feel responsible for the success of the student. The training mentors are extremely involved and very intrusive in their student's performance. The line department mentors have internalized their responsibility to both the students and the station to ensure the students are well trained and qualified when they gain their qualification.

Since the implementation of this robust mentoring programme, Clinton Power Station has greatly improved their throughput in initial training programmes, with 97% of students successfully completing the last five initial operator training programmes.

2.2(1) Issue: There are weaknesses in setting the expectation on trainee's communication during simulator training sessions.

The team observed simulator training sessions of licensed control room personnel and reviewed recent event investigations and evaluation reports. The team noticed the following facts during these observations:

- In one of the sessions observed the communication between the crew members was not as expected; it was quiet, not clear enough and several quiet parallel discussions of the crew members occurred.
- As this communication was considered acceptable, it was not mentioned or corrected by the instructor during the short freeze break and debrief in the middle of the session.
- Root Cause Investigation Report, Condition Report 1570694, dated October 11, 2013 – Clearance Tagged Component Manipulated, identified a second contributing cause as multiple examples of imprecise communication between Operations and Electrical Maintenance.
- Apparent Cause Evaluation Report, Condition Report 1546871, dated August 14, 2013 – Incorrect Valve Cycled for FP Surveillance Resulting in Automatic Start of Both Diesel Driven Fire Pumps, identified several imprecise communications as a contributing cause.
- Apparent Cause Evaluation Report, Condition Report 1475865, dated February 8, 2013 – INPO identified that imprecise communications was a contributing cause.

Unclear or imprecise communication of CPS personnel can cause more significant events, which can jeopardize the station safety conditions.

Suggestion: Clinton Power Station should consider raising expectations on the quality of communication of trainees during simulator training sessions.

IAEA Basis:

SSR-2/2

4.28. Written communication shall be preferred and spoken communication shall be minimized. If spoken communication is used, attention shall be given to ensuring that spoken instructions are clearly understood.

7.7. Where the design of the plant foresees additional or local control rooms that are dedicated to the control of processes that could affect plant conditions, clear communication lines shall be developed for ensuring an adequate transfer of information to the operators in the main control room.

NS-G-2.8
4.19. Training at a plant reference, full scope simulator facility should be provided for control room operators whose actions have an immediate influence on plant behaviour. Trainees should also be confronted with infrequent and abnormal situations which have a low probability of occurrence and therefore cannot be enacted in real plant practice. Consideration should be given to training control room staff as a team to develop team skills, good communication and co-ordination habits and trust in the application of plant procedures.

NS-G-2.14

4.44. All verbal communications within the shift or between the shift crew and other groups should be clear and concise and the communication process should cover both the provision and the receipt of correct information. In all communications, the sender has the responsibility for ensuring that the information is fully understood.

Plant Response/Action:

In response to the above mentioned suggestion, the Shift Operations Supervisor (SOS) has established a detailed standard and expectations for overly quiet communications, parallel discussions in the control room, and precise communications.

Communications are an integral part of our everyday core business. The following are the expectations and standards in-accordance with procedure OP-AA-104-101, Communications, which are to be followed in the Main Control Room (MCR) and in the Simulator:

- Changes to the status of all Safety Related Systems must be announced to control room personnel. Communication of these changes should be made by use of "updates". This will ensure that all appropriate control room personnel are cognizant of the change and that any additional knowledge they may possess can be communicated at that time.

- All Operations personnel need to refrain from using slang and non-specific or imprecise communications. Direction needs to be concise, specific, and formal. All Operators should be challenging to one another when these expectations are not met.

- Speak in a volume conducive to other Operators being able to hear and understand conversations to provide feedback / input into the discussion, if necessary.

- Minimize parallel discussions / conversations when possible; do not talk over others.

The complete checklist to assist in consistency in communications is shown below:

Exelon Generation.

Communications Evaluation Checklist

ATTRIBUTE	YES	NO	N/A
Used first name in all communications			
Used Phonetic alphabet			
Used three-way communications			
Prompted for repeat backs as required			
Did not use “slang terms” or sign language			
Used proper Alpha Numeric designators			
Communicated accurately and frequently			
Used effective listening techniques to ensure understanding			
Asked questions for clarity			
Did not get distracted			
Repeated back important data			
Took notes as required			
Did not allow distractions			
Did not talk over other individual			

These supplemental standards and expectations developed by the SOS have been communicated to the operations training instructors and licensed operators through the Licensed Operator Requalification Training (LORT). The increased communication expectations were incorporated into the LORT training cycle kick-offs as a focus area for upcoming training activities. It is the expectation that the Senior Reactor Operators (SROs) coach crewmembers on-the-spot if communications are below standards. Conversely, instructors are expected to coach SROs on-the-spot if the SROs missed an opportunity to coach a crewmember. Operations and Training Management have conducted several paired observations to verify the communication standards are understood and are enforced by both instructors and operators.

Targeted observations by fleet peers resulted in improvements to the operating crew 4.0 critique process resulting in heightened sensitivity among the operating crews with respect to the importance of precise and formal communications.

Additional observations by external peers including the WANO Crew Performance Evaluation (CPE) team in June of 2015 reveal CPS Operations and Training departments have made significant improvements in these areas.

IAEA comments:

The Clinton Power Station has developed and implemented appropriate actions to resolve the communication issue. Shift communication in the MCR and during simulator training is well described in the procedure OP-AA-104-101, Communications. However, further reinforcement of this procedure was necessary. The Shift Operations Supervisor has established a detailed standards and expectations for communication, based on the above procedure.

These standards and expectations have been communicated to all shift members before shift-turnover and during the licensed operator requalification training LORT cycles 15-1 and 15-2, to make a sure that all licensed operators received this training. This is well documented and all licensed operators received credit after LORT cycles 15-1 and 15-2.

The team reviewed several Training Observation Detail reports and there were no issues regarding licensed operators communication.

The team observed simulator training session of licensed operators during OSART FU review and it was confirmed that the communication standards and expectations are followed.

Conclusion: Issue resolved

3. OPERATIONS

3.3 OPERATING RULES AND PROCEDURES

The station administrative procedure HU-CL-101-1001 “CPS specific procedure usage and compliance” defines Hard Card usage. Hard Cards are laminated sections of time-sensitive critical EOP and off-normal procedures pre-staged at the specific Main Control Room (MCR) panel and field equipment point of use. Laminated Hard Cards have no revision number and there is no controlled log of all valid Hard Cards. The administrative procedure does not define the tracking and controlling requirements for Hard Cards. The team encourages the station to define more precisely in this administrative procedure the methods and responsibilities of authorization and tracking for Hard Cards.

3.4 CONDUCT OF OPERATIONS

CPS operations management has improved equipment configuration control by reducing inadvertent bumping and improper operation of susceptible station equipment and incorporating configuration control defences throughout the planning and execution process. This effort included the introduction of several physical and administrative barriers and also human behaviour related improvements.

As a consequence of the introduced measures CPS achieved a significant reduction in the number of equipment configuration control events since 2006. This improved equipment configuration control is recognized by the team as a good practice.

The administrative procedure OP-AA-103-101 “Control Room access control” regulates access control to the MCR. According to this procedure, there are two administrative barriers of access control. The first one is established at the Work Control Supervisor (WCS) office where permission is required from the WCS to enter the MCR area. The second line of control is at the “at the control” area in the MCR where further permission is required by the Control Room Operator to enter the “at the control” area. This area is designated with STOP signs and has a red carpet. No physical barriers have been introduced at the entrances to the MCR. Unauthorized access to the MCR area at times could not be prevented by the existing administrative barriers.

There are approximately 600 station employees who have authorization to access to the MCR elevation through the nearest security check point from the total 700 number of site employees.

The plant has no numerical limitation on the number of people in the MCR and it is solely left to the shift supervisor, by procedure to limit the numbers.

The team encourages the station to introduce more rigorous approach to MCR access control to assure appropriate robust barriers in place to impede unnecessary access to MCR.

A Pre-Job Brief database is used to capture lessons learned and opportunities for improvement using information acquired during post-job critiques. The database contains "living" documents that are maintained and continuously updated with industry OPEX, recent related events and data from recent job performances. This PJB database was evaluated by the team as a good practice.

In general, the station is kept in a good state of cleanliness and good housekeeping is evident. The station uses Issue Reports (IRs) to convey problems to all relevant departments. These are then discussed at the multi-disciplinary Station Ownership Committee and the necessary work apportioned. Approximately 800 Equipment Operator Identified IRs were produced over the past year, also capturing very low level deficiencies, and this indicates good operator awareness and reporting. See good performance in OE area.

3.5. WORK AUTHORIZATIONS

Implementation of a clearance/ permit-to-work package was observed to be well done with very good cooperation between the Work Control Supervisor (SRO) and the Equipment Operator. Sufficient safety equipment is maintained in service or available and this is ensured by consulting Operating Technical Specifications and immediately updating the PRA (PARAGON) when the Limiting Condition for Operation is entered. The Certification meeting checklist also looks at work which is two weeks ahead to ensure that sufficient safety equipment is maintained in service. The inputs to PARAGON are made by the Work Week Manager for scheduled work and by the Control Room Supervisor for emergent activities. The use of PARAGON is considered by the team as a good performance.

There are currently six temporary modifications in place and these are continuously tracked by Operations through the shift turnover sheets. Temporary modifications are treated as a change to the design function and the internal engineering group performs walkthroughs on a monthly basis to confirm the implementation status of the temporary modifications. Operations are an inherent part of the overall approval process. The control and review of Temporary Modifications is considered by the team as a good practice.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

The fire hazard assessment is reviewed on a three-yearly basis. The review team is composed of senior fire personnel from Exelon, Corporate and site.

There is a comprehensive Fire Protection (FP) maintenance and testing programme in place which determines the required inspection, testing and maintenance of FP equipment. A FP summary is added as an attachment to the Plan of the Day on one Monday per month and all open Fire System impairments, which have been open for >5 weeks and Transient Combustible Permits which have been open for >30 days are presented.

A procedure is available to provide for fire door compensatory measures for each individual fire door which is non-functional. No non-functional fire doors were observed during team plant tours. A database of the status of fire barriers is maintained and controlled by the fire department.

The plant is split up into 123 areas and each area has an associated Prefire Plan drawn up for it. On initiation of the fire alarm, the Incident Commander or Fire Team Leader collects the relevant Plan and immediately possesses information such as hazards in the area, the location of all fire protection equipment in the area, radioactive release considerations and any special precautions that are necessary.

Three local civil fire brigades are on standby to assist CPS. If a fire is in progress, all three are mobilized and go to the site and remain there in standby mode until requested to participate or are stood-down.

The above programme was considered by the team to be a good performance.

DETAILED OPERATIONS FINDINGS

3.4. CONDUCT OF OPERATION

3.4 (a) Good Practice: Equipment Configuration Control

Operations management has improved equipment configuration control by reducing inadvertent bumping and improper operation of susceptible plant equipment and incorporating configuration control defenses throughout the planning and execution process. This effort included the introduction of several physical and administrative barriers and also human behavior related improvements.

Examples include:

- 60 cm (two-foot) wide zone areas were painted around sensitive equipment. Susceptible valves, breakers, and hand switches were also fitted with removable and permanent covers that prevent unintended manipulation. Of particular note is the use of station fabricated guards to prevent inadvertent operation of rotary handled breakers.

- Operations meetings and pre-job briefing checklists contain line items to discuss how equipment configuration control will be maintained (flagging, robust barriers, awareness of surroundings). Component misposition prevention has been included on the two-minute drill card to encourage all levels of staff to identify potential issues and implement preventive or mitigating actions. Site personnel keep the card on their security badge lanyard.
- Procedures and Work Order instructions are reviewed to ensure that component restoration steps are included for any manipulated components. Components not restored are tracked with open narrative log entries and equipment status tags to maintain equipment configuration control.

A robust Equipment Configuration Control Programme prevents the misalignment of components and placement of a device and system in a configuration other than that intended by drawings, procedures, clearances, or other similar authorizing documents.

As a consequence of the introduced measures CPS reached a significant reduction in the number of equipment configuration control events since 2006. The last event occurred over nine months ago and was a result of an inadvertent deluge of Turbine Driven Reactor Feed Pump TDRFP “B” during the performance of functional testing.

3.4(b) Good Practice: Pre-Job Brief Database

> The Pre-Job brief (PJB) database is used to capture lessons learned and opportunities for improvement using information acquired during post-job critiques. The database contains ‘living’ documents that are maintained and frequently updated with industry OPEX, recent related events and data from recent job performances. The PJB database also contains standard PJBs, tailored PJBs, Heightened Level of Awareness (HLA) briefings, checklists for Work Package Planning, sources of training for Equipment Operators and Infrequent Plant Activity (IPA) briefings for all modes of operation. The database provides a readily accessible, convenient location for all operations individuals to store lessons learned, OPEX, job performance notes and recent events. This database is seen as a significant aid in preventing events and avoiding repeat events.

3.5. WORK AUTHORIZATIONS

3.5(a) Good Practice: Temporary Modification Review and Control

The station employs a cross-discipline review and ownership process regarding the control of Temporary Modifications (TMs). The identification and control of TMs is frequently reinforced and reviewed during operator shift turnovers, requalification training and daily management meetings. This is accomplished through:

- Monthly audits of the TM log by Engineering and associated walkdowns to confirm proper implementation of current TMs and to verify that no unauthorized TMs are installed.
- The TM list and status is on a database, along with supporting analysis, and is included on the operator turnover sheets and discussed as a part of turnover for each SRO, RO and Equipment Operator.
- The temporary configuration change programme coordinator presents monthly status updates of installed TMs during the Plan of the Day meeting. This update includes the number of installed TMs, their installation date and their scheduled removal date – this provides a forum for senior leadership to challenge the removal dates.
- Operations Shift Management provides final approval of TMs prior to implementation and this ensures operations involvement in the overall review and authorization process.
- Approval of the site Vice President (VP) is necessary if a TM has to be installed for a duration greater than a refueling cycle.

The above verifies proper control of TMs and the restoration of station equipment to normal design following completion of the TM.

4. MAINTENANCE

4.1. ORGANIZATION AND FUNCTIONS

The maintenance organization is clear and well defined. Performance indicators are being used and an aspiration for continuous improvement drives the department.

The team recognized a good performance in how the station and especially the maintenance department benefits from being part of a fleet of nuclear power plants. Some of the benefits are in the areas of calibration management of maintenance and test equipment, resource allocation between stations, spare part sharing and shared funding for new innovations such as electronic work packages and 3-d software training tools for preventive maintenance work.

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

The timeframe for calibration of local instruments are set within the preventive maintenance programme. The team noted that some local instruments on safety related equipment did not function as designed. The team encourages the station to improve the maintenance of local instruments on safety related equipment.

The Maintenance Learning Centre is used for theoretical and practical training of maintenance personnel. In the aspect of understanding the requirements of working inside the station, a number of modules have been put together displaying different working environments. Some deviations are implemented for the student to recognize with the aid of recent theoretical training. The team considers this to be a good practice.

4.3. MAINTENANCE PROGRAMMES

A significant programme to reduce the maintenance backlog has been implemented by the station. However, the team observed that the number of work orders presently under execution at the station are around 1 800, most of them being classified as low level priority. The team issued a suggestion in this area.

The station has not had a single fuel failure since the startup in 1987, due to good fuel failure prevention policy including Foreign Material Exclusion FME programme. The cornerstones in the programme consists of Fuel Integrity Guidelines with conservative ramp rates, procedures from system cleanliness with criteria for system flushing and training and qualification of all maintenances personnel including contractors and supplementary work forces. The team considers this to be a good practice.

4.4. PROCEDURES, RECORDS AND HISTORIES

The content and format of maintenance procedures are clear and well defined. The process for creating work packages is substantial and contributes to high quality of the maintenance work. However, the team encourages the plant to further develop a graded approach in order to enhance the efficiency of addressing attention to all systems and equipment.

4.6. MATERIAL CONDITION

Although the overall station material condition is good, the team found examples where consistent high standards were not maintained. The team issued a suggestion in this area.

4.8. SPARES PARTS AND MATERIALS

Spare parts and materials have individual markings and their shelf life is monitored. Access to the warehouse is regulated and there are limits set for the minimum and maximum amount of each component in stock in the warehouse. There is a fleet data base (POMS) to record and prioritize the obsolete equipment. The team recognized a good performance in the proactive work of identifying equipment in a timely manner in order to maintain a low number of temporary modifications.

4.9 OUTAGE MANAGEMENT

At both fleet and station level, lessons learned are incorporated into the following outage. Actions points are being monitored over time to make sure of their completion. The plant establishes contingency plans for numerous prioritized activities prior to the outages. The contingency plans contains resources, material and procedure allocation. The team recognized this as good performance.

DETAILED MAINTENANCE FINDINGS

4.2 MAINTENANCE FACILITIES AND EQUIPMENT

4.2(a) Good Practice: Maintenance Learning Centre

The station has developed multiple scenario based mock-ups with mannequins simulating various in-plant activities to improve station personnel and outage contractor performance related to industrial, radiological, nuclear and environmental safety. Scenarios challenge employees to identify and take appropriate action when presented with faulted situations, worker behavior errors, and procedural compliance gaps.

The station reviewed contractor performance over multiple years to identify outage performance trends. From this review, the station developed seven mock-up stations with mannequins that simulate errors. The course is named Fundamentals Alley.

- The Fundamentals Alley begins with a lecture on the Generic Error Model System. It examines the three mental models that people use to make decisions (skill based, knowledge based and rule based) and the error rate associated with each model. The emphasis is to remain in rule based activity, the importance of procedure compliance and the need to stop work and involve management before getting out of process.
- Employees are then split into small groups (3 to 5 students) and each group is given a clipboard with a written description of the work activity the mannequins are performing at each of the seven stations. Students have five minutes to identify all of the errors at each station before moving to the next station.

Once all seven stations have been observed, the students return to the classroom and the instructor reviews their findings and adds additional details to support the importance of each safety topic

This training utilizes a novel and effective approach to reinforce key industrial, radiological, nuclear and environmental safety expectations for station and refueling outage contract personnel and builds confidence in new workers ability to identify safety concerns prior to performing work.

4.3. MAINTENANCE PROGRAMMES

4.3(a) Good Practice: Fuel failure prevention policy including a strong Foreign Material Exclusion programme.

A robust Foreign Material Exclusion Programme reduces the likelihood of fuel failure, thereby reducing the dose received by workers and further protecting the health and safety of the public. The station has achieved zero fuel failures throughout the life of the plant. Several items can be learned from the performance. The station has been able to achieve zero fuel failures by a strategic approach to Foreign Material Exclusion (FME). The following areas are key focus areas that are unique to the industry;

- During the original design and build of the station, extremely high standards were maintained regarding FME controls. During initial build and systems startup, the station developed a specific procedure for flushing all systems prior to putting them into service. Additionally the station has maintained that same standard that was developed from the start, each time a system is breeched. This site specific procedure establishes uniform inspection criteria for internal system component cleanliness. This prescribes a high focus on prevention of foreign material which is a cornerstone for FME.
- In the early 2000's, the industry changed the types of fuel and stated that it was acceptable to increase power ramp rates higher than ever before to shorten durations of outages. The station made a strategic decision to not follow the industry and follow a more conservative approach to fuel ramp rates. This led to a guideline document for the station called Fuel Integrity Guidelines (FIG's) for fuel ramp rates. The station continues to follow the conservative fuel ramp rates to this day, which is also unique to the industry.
- The station is also a part of a large nuclear power plant fleet and has a very strict programme for FME controls. This fleet provides all maintenance and plant personnel with very specific training on the FME programme. The station takes that one step further with their use of the maintenance learning centre to train on the fundamentals of FME. Specific qualifications are required as well for developing a project FME plan which provides a clear command and control for FME.

4.3(1) Issue: There are weaknesses in the maintenance backlog management and the methodology for ensuring timely completion of maintenance works.

A significant programme to reduce the maintenance backlog has been implemented by the station, however the team observed the following:

- The amount of work orders presently under execution at the station are around 1800, the majority of them being classified as low priority (some of these work orders are more than three years old).
- Though this is an improvement over recent years, it is still a large number compared to the station's own goal of <955.

Example of outstanding work includes:

- Pressure manometer on pre-coat pump discharge for Reactor Water Cleanup has a faulty indication (over upper range).
- Deficiency on one bank of heaters for drywell purge train "B" electric blast coil since 2011.
- Deficiency tags (>10) inside the radwaste control room.
- Local instrument (amp meter) malfunctioning at EDG div 3.
- Local instrument low level within pressure meter to start up air tank EDG div 1.
- Pipe air leak at start up tank for EDG div 1identified on issue report from 2010, although already repaired, deficiency tag remained.
- Firepump B had broken voltmeter on one of the batteries. Issue Report from 2011.
- Post treat off gas radiation monitor, 1RIXPR035, in radioactive waste building with 4 issue reports.
- Weaknesses in timely completion of maintenance work can affect the availability and operability of plant equipment and systems.

Suggestion: Consideration should be given to improving the backlog management and methodology so as to ensure timely completion of maintenance work orders, even for lower priority work.

IAEA Basis:

SSR-2/2

7.10. Administrative controls shall be established to ensure that operational premises and equipment are maintained, well lit and accessible, and that temporary storage is controlled and limited. Equipment that is degraded (owing to leaks, corrosion spots, loose parts or damaged thermal insulation, for example) shall be identified, reported and corrected in a timely manner.

GS-R-3

4.1. Senior management shall determine the amount of resources necessary and shall provide the resources to carry out the activities of the organization and to establish, implement, assess and continually improve the management system.

NS-G-2.6

5.14 A comprehensive work planning and control system applying the defense in depth principle should be implemented so that work activities can be properly authorized, scheduled and carried

out by either plant personnel or contractors, in accordance with appropriate procedures, and can be completed in a timely manner. The work planning system should maintain high availability and reliability of important plant SSCs.

Plant Response/Action:

In response to the above suggestion item, a Backlog Reduction Team was funded and implemented to work off DL/DB backlog to reduce the backlog of approximately 1800 deficient low consequence tickets to within goal of less than 955 tickets by the end of 2014. Because of the implementation of the backlog team, the backlog was reduced by the end of 2014 for all categories. Based on success of the previous backlog team, the station has put in place a team focused on Radwaste deficiencies, which are often the low priority work tickets in the system based on built in redundancy. Backlog goals have been tentatively set for 2016, which will reduce the goal for deficient low consequence from 955 to 800. Additionally, the work order backlogs for all categories are looked at least weekly at the Maintenance Director's daily staff meeting with the Maintenance Managers and with the station Senior Leadership Team (SLT) during the Plan of the Day (POD) meeting.

IAEA comments:

The station monitors the maintenance backlog on a daily, weekly, monthly and yearly basis. A new procedure is in place to check the adequacy of the resources versus the actual maintenance workload. This has allowed identifying the need for 3 more technicians in the Instrumentation Maintenance Department, which was the most concerned by the maintenance backlog. This additional manpower has been recruited and will allow keeping the effort on the backlog reduction on the longer term.

In addition, a temporary team is in place to reduce the overall maintenance backlog. This team identified that particular efforts were needed to reduce the backlog of repairs on the radwaste related systems (approximately 15-20% of the backlog), and also to a lower extent on fire protection related issues.

Currently the overall average age for all categories of open items is around 800 days. There is no target put by the station on the maximum or average age of open items and this might explain why there are still a significant number of quite old items present in the backlog. There is an opportunity to further improve by reducing the average age of open work orders and having a target on this parameter.

The station has improved the maintenance backlog management and methodology. The maintenance backlog has been significantly reduced since the OSART mission and the station will continue its efforts to maintain the backlog below its target of 955 (800 in 2016).

Conclusion: Resolved

4.6. MATERIAL CONDITION

4.6(1) Issue: In certain areas assessed by the station as low level priority, inadequate material conditions exist.

Although the overall station material condition is good, the team found examples where improvements are still needed to maintain consistent high standards, indicating a certain lack of attention to detail in the following areas:

- Water leak coming out of packing from valve stem in fire system inside RCA.
- Material issue condition to a drinking water pump in the make-up water facility without any issue report written.
- Material condition issue to a pump in the screen house.
- Malfunctioning lamps in control building cable spreading room.
- Cracks at several places in the floor coating in the radiological control area (RCA).
- Valve was covered by yellow/black striped tape such that is could not be operated.
- Inside containment, condensation on ventilation duct dripping down causing corrosion to 1VR006B and dripping near the rod drive gauge panel.
- Fibre glass insulation under the roof deteriorated at Maintenance Learning Centre.
- Label had fallen down to the ground from valve near main power transformers.
- Corrosion on valve 1E12-F037B inside the containment.
- Containment refuel floor. Clear plastic used to wrap equipment being staged in preparation for the refuel outage.
- Valve label near ITF060 broken and broken piece rammed by valve stem. Div 3 EDG.
- Acid tank leak in rad waste building.
- Caustic check valve leak in rad waste building.

Deficient material conditions, if left unattended, could lead to deterioration of the safety equipment and systems at the station, resulting in their unreliability.

Suggestion: The station should consider consistently addressing inadequate material conditions existing in certain areas assessed by the station as low level priority areas.

IAEA Basis:

SSR -2/2

7.10. Administrative controls shall be established to ensure that operational premises and equipment are maintained, well lit and accessible, and that temporary storage is controlled and limited. Equipment that is degraded (owing to leaks, corrosion spots, loose parts or damaged thermal insulation, for example) shall be identified, reported and corrected in a timely manner.

NS-G-2.6

9.18 Other items that should be subject to surveillance are those that, if they were to fail, would be likely to give rise to or contribute to unsafe conditions or accident condition.

Such items include:

- high energy piping and associated piping restraints
- structural supports (stack stay ways wires, pipe supports)

10.17. A visual examination should be made to yield information on the general condition of the part, component or surface to be examined, including such conditions as the presence of scratches, wear, cracks, corrosion or erosion on the surface, or evidence of leaking. Any visual examination that requires a clean surface or decontamination for the proper interpretation of results should be preceded by appropriate cleaning processes.

NS-G-2.14

4.36. Factors that should typically be noted by shift personnel include:

- Deterioration in material conditions of any kind, corrosion, leakage from components,
- accumulation of boric acid, excessive vibration, unfamiliar noise, inadequate labelling,
- foreign bodies and deficiencies necessitating maintenance or other action;

Plant Response/Action:

In response to this suggestion, the following action plan was implemented:

- Maintenance performed a walk down of the deficiencies identified by OSART in this IR and assured that the deficiencies were identified and scheduled.
- Identified the areas of the plant requiring improved material condition and housekeeping standards, and established plans to maintain housekeeping in each of these areas. These areas are included in the periodic housekeeping walk downs to maintain the desired standards.
- Clinton Power Station has assigned a RadWaste Operations Center (ROC) Coordinator. Part of the duties are to champion ROC system deficiencies to get them prioritized and completed in a timely fashion to maintain the system health and integrity of our operational systems. Additionally, Maintenance has taken a lead to work down the deficient item backlogs. The FIN team performs walk down and review of newly identified deficiencies and backlog items to implement repairs. This permits small repair items to be fixed quickly and larger items are properly scoped and planned to perform repairs.

Clinton has also established a housekeeping program for the site with areas being divided up by owners. The new comprehensive checklist has been developed to aid in a detailed assessment of each area to be performed monthly by the area owners. The results from the monthly walk down are entered into a dash board that ranks each area as red, white, or green and are reported out at the Plan of the Day (POD) meeting on the third Thursday of each month.

Corporate procedure MA-AA-716-026, Station Housekeeping / Material Condition Program, was revised to include additional documentation and guidance for housekeeping in CPS Transformer Material Exclusion and Secured Material Zones.

The Secured Material Zone has been established to help prevent damage to transformers in normal wind conditions as well as adverse weather conditions. Parking of vehicles with materials in open or exposed storage areas is not allowed in the secured material zone. Vehicles are allowed in the secured material zone when there is a specific work activity in progress or staging of vehicles that supports scheduled work (i.e. trucks and support equipment for transformer repairs). The cognizant Supervisor is responsible to ensure these vehicles meet secured material zone requirements prior to entry.

Additionally, any materials capable of entering the exclusion/transformer zone during normal wind conditions as well as adverse weather conditions shall be secured or removed. Scaffold flooring planks and unsecured scaffold parts must be secured in a manner that will prevent it from becoming a missile hazard in the event of severe weather. Items with low wind profiles (e.g.: cones, stanchions) shall be secured or weighted to prevent movement due to wind. These items shall be removed when not in use.

The Transformer Material Exclusion Zone has been established to help prevent damage to transformers in normal wind conditions as well as adverse weather conditions. No material may be brought into or stored inside of the Transformer Material Exclusion Zone areas unless prior permission is received from the Shift Manager. If permission from Shift Manager received, then following guidelines shall apply:

- Light weight debris with closed profile (e.g. tarps, sheet metal or other building materials) shall not be stored or left unattended in Transformer Material Exclusion Zone.

- Scaffold flooring planks and unsecured scaffold parts must be secured in manner that will prevent it from becoming a missile hazard in event of severe weather.

- Heavy equipment not susceptible to overturning due to normal winds can be stored in Transformer Material Exclusion Zone. The required minimum vertical and horizontal clearance from any uncovered conductor or energized equipment (Transformer) is 8 feet, 6 inches for personnel and 10 feet for working equipment. All cables and equipment capable of entering the transformer clearance zone must be properly secured to avoid contact with energized equipment.

IAEA comments:

The station has implemented an action plan to resolve the material condition issue.

All deficiencies were identified and scheduled for repair. In addition, CPS established four long term action plans:

- Fire protection leaks repair
- Cracks in the floor coating repair
- Radwaste operation center deficiencies prioritization and repair
- Housekeeping in CPS Transformer Material Exclusion and Secured Material Zones

Another systematic activity was establishment of a housekeeping programme with a dedicated owner of each CPS area. Housekeeping walk downs are performed monthly by the area owner. Results are well recorded and discussed monthly during Plan of the Day meeting. These initiatives improved the plant status from a housekeeping and material conditions point of view. However, all mentioned action plans are not yet fully implemented and some of them are long term. Plant tours confirmed improvements in resolving this issue; however, further work is needed to fully resolve the issue.

Conclusion: Satisfactory progress to date

5. TECHNICAL SUPPORT

5.1 ORGANIZATION AND FUNCTIONS

The Exelon University is a corporate lead engineering training initiative that leverages the resources of the 10 Exelon sites, corporate offices and contract partners ‘Engineers of Choice’ (EOC) to prepare and deliver fleet-wide qualification and advanced technical training. The team recognized this as a good practice.

Exelon Engineering has developed a guide that defines leadership excellence for core business functions in Design, Plant and Programs Engineering to improve engineering leadership skills and reinforce the Technical Conscience Principles. Engineering Managers routinely engage knowledge workers at the 10%, 50%, and 90% completion milestones to ensure technical products meet high quality. The team recognized this as a good practice.

Corporate Engineering has developed tools and defined interfaces to enable Design Engineering personnel to monitor and assess the safety, quality, cost and timeliness of contracted activities. Feedback is provided to the engineering service providers (i.e. EOCs) through a standardized tool for grading performance. The team recognized this as a good performance.

Reviews are carried out every second year which consider how modifications and procedure changes within this period have affected the Updated Final Safety Analysis Report (UFSAR) and furthermore on occasions the Nuclear Regulatory Commission (NRC) will prescribe ‘back-fits’ which require station enhancements. However, the station does not perform a full scope PSR. The team issued a suggestion in this area.

The team recognized the extensive use of Probabilistic Risk Assessment (PRA) applications at the station. The PRA applications are used in accordance with the relevant national regulation. Effective planning and scheduling of work during operation, to maintain availability of safety related equipment, is managed utilizing the Paragon PRA tool. There is, however, no similar PRA tool available for managing shutdown safety. The PRA model is regularly updated to reflect plant modifications, however the team noted that one safety related modification was not captured in the last PRA revision. The team encourages the plant to increase the robustness of its PRA revision process and integrate the calculation of conditional core damage frequency in the Root Cause Analysis to assess the safety significance of events.

5.2 SURVEILLANCE PROGRAMME

The surveillance programme is well established at the station and ensures that engineered safety features and emergency equipment are in the required state of readiness and the operating systems are performing properly as well as contributing to the safe, reliable operation of the plant. However, a number of minor procedural discrepancies were observed and therefore the team encourages the station to improve its focus on procedural compliance during completion of surveillance activities.

5.3 PLANT MODIFICATION SYSTEM

The team found that modification packages for phased implementation changes, including replacement of a significant number of obsolete plant items, are not being pursued efficiently and their configuration is not controlled in the most effective manner. Therefore the team made a suggestion in this area.

Logical constraints are not always being used in the PassPort database to ensure implementation activities and commitments from evaluations, configuration changes and modifications are delivered prior to reaching “Modified” status. The team encourages the station to ensure all implementation activities are complete, prior to setting modification packages to “Modified status”, and that the appropriate status is maintained for all modifications within the PassPort database.

The team was impressed with the focus on Engineering Initiatives that improve safety margin, including: Feedwater Sulphate reduction; Main Electro-Hydraulic Control Suction Improvements; Condensate Temperature Limits; Elimination of the Potential for Drywell In-leakage; Reactor Recirculation Pump Seal Performance Improvements; and the Cable Vault Dewatering System. The team recognized this as a good performance.

The assessment of storage in plant areas has been proceduralized at the station. However, it was found that the full hazard assessments for storage of equipment and transient materials were often missing or not complied with and that areas were neither consistently demarcated nor a clear inventory of acceptable items published locally. The team issued a suggestion in this area.

DETAILED TECHNICAL SUPPORT FINDINGS

5.1 ORGANISATION AND FUNCTIONS

5.1(a) Good Practice: Exelon University Engineering Training Programme

Exelon University is a corporate-led engineering training initiative that leverages the resources of the 10 Exelon sites, corporate offices and contract partners ‘Engineers of Choice’ (EOC) to prepare and deliver fleet-wide qualification and advanced technical training. The benefits from using such an approach include:

- Provision of specialized engineering training led by subject matter experts and qualified mentors for job specific engineering training and qualification.
- Providing a key component of Exelon’s Engineering Knowledge Transfer and Retention effort.
- Enabling Exelon to retain, transfer and/or develop critical knowledge, skills and subject matter experts at a reduced cost with more timely delivery, which results in improved efficiency.
- Allowing more timely delivery of training content, efficient use of instructor resources, and reduced cost per student.
- Ensuring a curriculum selection process that follows the INPO Systematic Approach to Training process. In the fourth quarter of each year, the sites Engineering Curriculum Review Committees identify their training needs for the upcoming year.
- Developing and implementing cooperative agreements with EOC firms that allow them to participate in each other’s training.
- Allowing Exelon under EOC cooperative agreements to place less experienced engineers in EOC offices to work on Exelon projects under the instruction of experienced EOC engineers.

5.1(b) Good Practice: Exelon Engineering has developed a guide that defines leadership excellence for core business functions in Design, Plant and Programs Engineering to improve engineering leadership skills and reinforce the Technical Conscience Principles. Engineering Managers routinely engage knowledge workers at the 10%, 50%, and 90% completion milestones to ensure technical products meet the required standards. The benefits and feature of such an approach include:

- Engineering Managers have a unique role in evaluating technical human performance as compared to a field supervisor who observes the physical behaviours of the craft performing work. Exelon has implemented processes such as desktop observations and the 10%, 50%, and 90% manager reviews to assess technical human performance by knowledge workers.
- The guides identify the core business functions of the discipline, the associated key governance, and the required behaviours that define how leaders ensure excellence.
- The leadership guides were used to assess the leadership skills of engineering managers in overseeing knowledge workers in performing key engineering functions.
- The Engineering Leader Development Guides were used to develop Engineering Leader Self-Assessment Worksheets and an Oral Board Interview Guide. The Oral Board reviewed the engineering leader’s self-assessment and interviewed the leader to confirm/identify strengths and gaps to excellence.
- The Board’s assessments provided input into the 2013 mid-year performance reviews and Individual Development Plan (IDP) updates for each engineering leader.

The leadership guides and oral boards have allowed Engineering Managers to focus on closing leadership gaps and leveraging their strengths. This has benefited both the manager and their staff in becoming more effective in implementing the management model. The Engineering Managers were able to hone their leadership skills and use those skills in improving engineering products and achieving excellence in equipment reliability.

The Quality Review Team (QRT) review of engineering products and the annual Check-In Assessment of Modification Quality have found an improving trend in the quality of engineering work products – including Modifications, Technical Evaluations, System and Programme health reports, and Support/Refute Matrixes. These improvements are, in part, due to improving the leadership skills and engagement of engineering managers.

5.1(1) Issue: The station does not carry out a full scope Periodic Safety Review (PSR).

- There is evidence that the station carries out specific safety reviews as per national regulation requirements and updates its station specific documentation and Updated Final Safety Analysis Report (UFSAR) as frequently as necessary in accordance with the national regulation requirements. These safety reviews, however are generally not consistent with the full scope and periodicity of a PSR as recommended by IAEA safety standards.
- IAEA Safety Standards have established that the first PSR should be undertaken about ten years after the start of station operation, and subsequent PSR's every ten years until the end of operation. The station has not established this practice.
- IAEA Safety Standards have established that the scope of a comprehensive PSR should contain fourteen safety factors, divided into five subject areas. All individual factors are evaluated at the same time and concluded with a global assessment of plant safety, showing individual safety factor results, and agreed actions and improvements. The station does not carry out such safety reviews covering this scope at a ten year interval.

As the station does not carry out a periodic safety revaluation covering all safety factors at the same time, there is a potential for the station to fall behind improving international safety standards, and suffer unexpected consequences from cumulative effects.

Suggestion: The station should consider international benchmarking its practices for regular safety assessments to ensure station reassessments are fully meeting the objectives of the PSR.

IAEA Basis:

SSR- 2/2

Requirement 12: Systematic safety assessments of the plant, in accordance with the regulatory requirements, shall be performed by the operating organization throughout the plant's operating lifetime, with due account taken of operating experience and significant new safety related information from all relevant sources.

4.44. Safety reviews shall be carried out at regular intervals. Safety reviews shall address, in an appropriate manner, the consequences of the cumulative effects of plant ageing and plant modification, equipment requalification, operating experience, current standards, technical developments, and organizational and management issues, as well as siting aspects. Safety reviews shall be aimed at ensuring a high level of safety throughout the operating lifetime of the plant.

SSG – 25

2.4. PSR provides an effective way to obtain an overall view of actual plant safety and the quality of the safety documentation, and to determine reasonable and practical modifications to ensure safety or improve safety to an appropriate high level. To do this, the PSR needs to identify any lifetime limiting features at the plant in order to plan future modifications and to determine the timing of future reviews.

2.5. On the basis of international experience, it is reasonable to perform a PSR about ten years after the start of plant operation, and then to undertake subsequent PSRs at ten year

intervals until the end of operation. Ten years is considered to be an appropriate interval for such reviews in view of the likelihood, within this period, of the following:

- Safety until the next PSR or, where appropriate, until the end of planned operation (that is, if the nuclear power plant will cease operation before the next PSR is due);
- The extent to which the plant conforms to current national and/or international safety standards and operating practices;
- Safety improvements and timescales for their implementation;
- The extent to which the safety documentation, including the licensing basis, remains valid.

2.13. The 14 safety factors recommended in this Safety Guide are listed in the following and described in detail in Section 5:

Safety factors relating to the plant: (1) Plant design; (2) Actual condition of structures, systems and components (SSCs) important to safety; (3) Equipment qualification; (4) Ageing.

Safety factors relating to safety analysis: (5) Deterministic safety analysis; (6) Probabilistic safety assessment; (7) Hazard analysis.

Safety factors relating to performance and feedback of experience: (8) Safety performance;

(9) Use of experience from other plants and research findings.

Safety factors relating to management: (10) Organization, the management system and safety culture; (11) Procedures; (12) Human factors; (13) Emergency planning.

Safety factors relating to the environment: (14) Radiological impact on the environment.

2.17. In order to integrate the results of the reviews of individual safety factors, the operating organization should perform a global assessment of safety at the plant. The global assessment should consider all findings and proposed improvements from the safety factor reviews and interfaces between different safety factors.

Plant Response/Action:

Clinton Power Station does perform periodic reviews of the current licensing basis when changes are made and updates to the FSAR (or Updated Safety Analysis Report) are made no less frequently than 24 months. Also, since initial licensing of CPS, a major design review of the plant was conducted during the extended shutdown following refueling outage number six that lasted from September 1996 until May 1999. Another significant change to the plant operating license was associated with the extended Power Uprate that approved a 20% increase in the licensed power level. This change was implemented in April 2002. A projected design basis review will be performed in connection with License Renewal, which begins at or around the 30 year mark in 2017. Recently, it has been decided that the station's Probabilistic Risk Assessment (PRA), which is used for determining operational risk and increases in risk due to various plant configurations, including licensing basis changes, will be undergoing changes to meet current regulatory guidance and is expected to be updated by 2018. These design basis and PRA changes, are just some of the activities that have taken place or will take place while not in direct alignment with the Periodic Safety Reviews

recommended by SSG-25, should be considered under the umbrella of the recommendations of SSG-25.

It was noted that the NRC had been reviewed by the IAEA which included a suggestion under an Integrated Regulatory Review Service (IRRS) conducted in October 2010. The NRC issued SECY-11-0084 in June 2011 to address the IAEA suggestions. A Technical Letter Report (ANL-13/18) completed in December 2013 describes some of the differences in licensing processes in the U.S. compared to other countries. It is agreed that from the NRC report, that trending of aging components should be performed as part of license renewal. Due to the number of Exelon plants that have undergone license renewal and the plants that are currently going through license renewal, Clinton will be benefiting from the lessons learned from those plants. As part of the informal benchmarking completed for this suggestion, the IRRS report and the Technical Letter Report were reviewed. Also, documents were received from Enel/Slovenske Elektrane for the Bohunice plant (Slovak Republic) performed in 2007. While much of this information was difficult to understand due to the language translation differences, it could not be determined that any additional actions should be taken.

Exelon's change processes include a very detailed review of the regulatory requirements associated with plant changes. This review involves the use of the 10 CFR 50.59 change process, which consists of a licensing basis review, depending on the complexity of the change. Part of the screening process of a change includes a review of all of the licensing basis programs, such as the Quality Assurance Program, Security Plan, Emergency Plan, Fire Protection Program, ASME Codes and Standards, etc. USAR changes have assigned owners of individual sections of the USAR, so that changes are made consistently with the various standards and requirements.

Based on the reviews completed, it is recognized that licensees such as Clinton, assess the safety significance of important operating experience and important regulatory changes during the plant change process to maintain the licensing basis current, and thus the nuclear safety basis required by the Periodic Safety Reviews.

IAEA comments:

In response to the OSART suggestion the station implemented some benchmarking of limited scope with Bohunice NPP in Slovak Republic, that performed a PSR in 2007. Staff members from Clinton Station visited the Slovak plant to become familiar with the way in which the review was performed and results obtained.

In addition the station has considered the Technical Letter Report (ANL-13/18): Evaluation and Analysis of a few International Periodic Safety Review Summary Reports completed at request of NRC and issued by Argonne National Laboratory in 2013. Based on this report and the supplemental NRC staff evaluations, 371 issues were identified from the PSR reports. After screening those issues which were based on NRC regulations or guidance, the issues were categorized by 8 subject areas and prioritized into 3 categories:

- Issues addressed through NRC requirements and guidance
- Issues addressed under NRC regulatory processes
- Issues where further evaluation is needed to determine if they could be resolved under current NRC regulatory process.

The NRC continued to evaluate remaining issues in order to identify further insights and to feed these into appropriate regulatory processes. As a result of this review, the NRC identified several potential insights that should be further considered in the existing regulatory processes or for incorporation into future regulatory guidance. These insights primarily relate to external hazards and long-term aging degradation management. The NRC found that while several specific issues were identified that could be further investigated for informing regulatory efforts currently in progress(e.g. Subsequent License Renewal guidance update and Japan Lessons Learned Division rulemaking), the nature of these issues did not indicate a deficiency of the U.S. nuclear regulatory framework but rather a potential source of international operational experience. The NRC does see discussions of other countries' experiences with PSRs as a valuable resource, and welcomes these discussions during bilateral and multilateral exchange as appropriate. Documentation of the findings from the pilot study was completed with an NRC Memorandum as of 24 April, 2014.

The team concluded that considering the NRC actions already taken and actions taken by the station to familiarise with PSR process used in another country, the intent of the suggestion will be met. However, referring also to the reconfirmed importance of the PSR in recently revised IAEA Safety Standards SSR-2/2 and the welcoming by NRC on further exchange of information on this matter, as appropriate, the station could further consider possible benefits from broadening its knowledge on the matter, in particular in connection to the License Renewal process which is currently expected to start in 2017.

Conclusion: Satisfactory progress to date

5.3 PLANT MODIFICATION SYSTEM

5.3(1) Issue: Modification packages implemented over an extended time scale ("phased implementation changes"), including replacement of a significant number of obsolete plant items, are not being pursued efficiently and their configuration is not controlled in the most effective manner.

- The station carries out assessment and prioritization (scoring) of obsolescence issues. However, there are currently 2546 Equipment Items (EID) which are identified as having obsolete components, of which 226 are ranked high impact, 95 of these are reported to have evaluations or engineering changes approved for implementation. Many of these components will be common to multiple EID's.
- The modification packages being used at the station within the PassPort database do not allow for phased implementation; therefore does not allow the modification packages (EC) to be approved for multiple EID and then implemented in a phased manner for each EID (or set of EID) with relevant configuration control maintained as each phase is completed.

Obsolete plant items lead to unavailable spares which for high impact items can contribute to safety system unavailability.

Suggestion: The station should consider the improvement of efficiency and configuration control of modification packages implemented over an extended time scale, including the replacement of obsolete plant items.

IAEA Basis:

SSR-2/2

4.38. Controls on plant configuration shall ensure that changes to the plant and its safety related systems are properly identified, screened, designed, evaluated, implemented and recorded. Proper controls shall be implemented to handle changes in plant configuration that result from maintenance work, testing, repair, operational limits and conditions, and plant refurbishment, and from modifications due to ageing of components, obsolescence of technology, operating experience, technical developments and results of safety research.

4.39. A modification programme shall be established and implemented to ensure that all modifications are properly identified, specified, screened, designed, evaluated, authorized, implemented and recorded. Modification programmes shall cover structures, systems and components, operational limits and conditions, procedures, documents and the structure of the operating organization. Modifications shall be characterized on the basis of their safety significance. Modifications shall be subject to the approval of the regulatory body, in accordance with their safety significance, and in line with national arrangements.

4.40. Modification control, in compliance with the requirements set out in Ref. [4], shall ensure the proper design, safety assessment and review, control, implementation and testing of all permanent and temporary modifications. Consequences of the modification for human tasks and performance shall be systematically analysed. For all plant modifications, human and organizational factors shall be adequately considered.

4.42. The plant management shall establish a system for modification control to ensure that plans, documents and computer programs are revised in accordance with modifications.

NS-G-2.3

11.1. The following should be ensured by means of the document management system:

- That all relevant documents affected by the modification are identified and updated, and remain consistent with the plant specific design requirements, and that they accurately reflect the modified plant configuration;

- That all changes to the design over the lifetime of the plant are based on the actual status of the plant, as reflected in the current plant documentation;

- That the modified plant configuration conforms fully with the documentation and conditions of the operating license.

11.3. Documents relating to modifications, in particular to installation and testing, should be updated as soon as practicable. Responsibility should be clearly assigned for the revision of all documents, such as all drawings, including computer representations, specifications, procedures, safety reports, operational limits and conditions, descriptions of equipment and/or plant and systems, training material, including simulator aspects, vendor equipment manuals and spare parts lists.

NS-G-2.4

6.72. The operating organization should establish a procedure to ensure the proper design, review, control and implementation of all permanent and temporary modifications. This procedure should ensure that the plant's design basis is maintained, limits and conditions are observed, and applicable codes and standards are met. A record of the review shall be made available to the regulatory body. The operating organization maintains responsibility for safety implications of the modification and for obtaining the appropriate review and approval by the regulatory body if required.

Plant Response/Action:

In response to this suggestion, Clinton Power Station (CPS) took the following action:

On September 16th, 2015 the World Association of Nuclear Operators (WANO) announced CPS would retain the "Excellent" rating. This rating was achieved in part to CPS implementing the OSART recommendations. Specifically, WANO issued a "Strength" by recognizing "Site Supply Chain engagement with station activities has improved timeliness of resolving part shortages and critical parts availability." In order to achieve this strength, the Senior Manager of Design Engineering (SMDE) presented this OSART suggestion (improvement of efficiency and configuration control of modification packages implemented over an extended time scale, including the replacement of obsolete plant items) to the Station Obsolescence Steering Committee. From this discussion, it was acknowledged that although PassPort has the capability to implement a phased approach to modifications, there is no specific governance on what general information should be contained in the master Engineering Change (EC) package and what specific information should be contained in the replicate EC packages used for most equipment replacement. Without this guidance, the processing of master and replicate EC packages would be inconsistent across the fleet and that would be ineffective and inefficient. Additionally, the committee validated the priority

and resolution of high impact obsolescence items. Validation compared the Station's backlog against the backlog at other Boiling Water Reactor (BWR) stations in the fleet and identified any effective methods to reduce the backlog. CPS compared its backlog with other fleet BWRs and because methods were implemented, CPS now ranks 3rd in the fleet. Exelon uses the Proactive Obsolescence Management System (POMS) to identify and prioritize high impact obsolescence items, which is consistent with the fleet procedural direction. Currently, corporate is assisting in backlog reduction by utilizing contractors and teaming with equipment manufactures to address obsolescence.

In summary, the station carries out assessment and prioritization (scoring) of obsolescence issues. In cases where replacement of this obsolete component affects multiple pieces of equipment, CPS has successfully utilized EC’s to broadly approve equipment replacements, such as in the modification associated with Love controllers. At this time, the current Exelon procedures for processing plant modifications do not allow phased implementation of modifications. Passport has the capability to allow the user to create replicate ECs from a master EC to allow modifications to be made to multiple equipment items (EIDs) without having to create a new EC for each EID. Corporate Engineering is currently working on an initiative to simplify the plant modification process, including development of new governance for phased implementation of modifications.

IAEA comments:

The station has initiated action to solve this issue on the longer term. All items which are no longer supported by the manufacturer are considered obsolete and have been identified by the station. These obsolete items are prioritised namely on the basis of their safety significance.

At the time of the OSART mission there were around 19000 obsolete items on a total of 60000 items at the station. Currently there are 17734 obsolete items and this shows a positive trend. However the number of obsolete items ranked with high impact has not evolved significantly (228 today compared to 226 at the time of the OSART mission). Some obsolescence issues have been solved, but some new ones have appeared meanwhile.

Data shows that even though new obsolete issues have been created since the visit, a number of obsolescence issues have been resolved.

The station recognised that additional manpower was needed to reduce the backlog of obsolete items, and 7 additional engineers have been recruited in the last 12 months to solve this. This additional manpower will be qualified within the next 6 to 12 months.

Exelon also recognised that its modification process was sometimes too complex and could lead to delays in implementation of changes. A committee has been created at corporate level to improve the modification process. The station is driving this corporate committee to improve and simplify the modification process. This should in turn lead to reducing the time to solve part of the issues related to obsolete components. The corporate committee has decided to use phased implementation changes in the future and this decision will be implemented within the next 6 months.

In conclusion, the station has initiated corrective actions to solve the issue. There is reasonable confidence that these actions should improve the situation on the longer term. However, more time is needed to see an impact on the performances. In particular, these

actions have not yet materialised in concrete reduction of the backlog of obsolete high impact items.

Conclusion: Satisfactory progress to date.

5.3(2) Issue: Full hazard assessments for the storage of equipment and transient materials are missing or not complied with and areas are not consistently demarcated.

- A significant amount of flexible materials was found to be stored in containment area 828 which could pose a threat to blockage of the Emergency Core Cooling System suction strainers in the suppression pool during a design basis fault in containment (high energy line break with containment spray actuation). The station's control of transient materials procedure allows storage of flexible materials in that area provided the materials are secured or maintained a minimum of 20 feet away from any openings. However, this limitation was based on an engineering judgment that was not documented in a formal engineering assessment/evaluation.
- A power cart, stored in Auxiliary Building area 707, was found to be outside the assessed storage area and close to seismically required equipment (IR 1695408).
- Scaffolding material was stored in a posted but not designated area in the Turbine Hall area 781. The storage area was overburdened.
- Heavy lifting equipment and several sea-land containers were placed on the Turbine Hall deck area 800 with no designated storage area sign.
- Trolley B.5.b (with single wheel light duty chock) was stored in Fuel Building area 755 within two metres of seismically required safety equipment.
- Storage of many wooden chairs, tables and cabinets in the Radwaste building.
- During a walkdown, it was noted that there was equipment stored which was not in compliance with CPS Procedure 1019.05. There were two drums, a toolbox and a temporary power cart staged within the procedurally required 3 ft + stored equipment height (restriction from CPS Procedure 1019.05) from panel 1PL62J, which is the seismically qualified RCIC pump room ventilation panel. There was also a Maxi-Lift stored between RHR B (1PL61JB) and RHR C (1PL61JC) pump room ventilation panels. (IR 1630607)
- A propylene cylinder was staged in a safety related building unattended and without a Transient Combustible Permit (TCP). Contractors were unaware of the requirement to have a TCP or that they needed to remain in the area of the material. (IR 1569609)
- Discarded fibreglass, rubber insulation and debris were packed into the penetration of the capped end of the Unit 2 SX lines. (IR 1551553)
- Failure to realize that a plant area in which an IT kiosk was being placed was a fire zone and the lack of questioning attitude as to what kind of impact it would have at that location by IT employees. (IR 1552603)
- A bag full of packing material but of unknown origin near the reactor services equipment in the truck bay. Lack of ownership and accountability by groups resulting in uncontrolled Transient Combustibles in a Vital Area. (IR 1527532)

Items inappropriately stored in plant areas could pose a hazard to safe operation of plant and equipment required to support nuclear safety.

Suggestion: The station should consider efficient assessment and reduction, where achievable, of safety hazards from the storage of equipment and transient materials and consistently demarcate all storage areas.

IAEA Basis:

SSR-2/2

7.10. Administrative controls shall be established to ensure that operational premises and equipment are maintained, well lit and accessible, and that temporary storage is controlled and limited. Equipment that is degraded (owing to leaks, corrosion spots, loose parts or damaged thermal insulation, for example) shall be identified, reported and corrected in a timely manner.

NS-G-2.14

6.20. Plant housekeeping should maintain good conditions for operation in all working areas. Working areas should be kept up to standard, well lit, clean of lubricants, chemicals or other leakage and free of debris; the intrusion of foreign objects should be prevented and an environment should be created in which all deviations from normal conditions are easily identifiable (such as small leaks, corrosion spots, loose parts, unauthorized temporary modifications and damaged insulation). The effects of the intrusion of foreign objects or the long term effects of environmental conditions (i.e. temperature effects or corrosion effects or other degradations in the plant that may affect the long term reliability of plant equipment or structures) should be evaluated as part of the plant housekeeping programme.

6.21. Administrative procedures should be put in place to establish and communicate clearly the roles and responsibilities for plant housekeeping in normal operating conditions, post-maintenance conditions and outage conditions. For all areas of the plant, it should be made clear who bears the responsibility for ensuring that an area is kept clean, tidy and secure. Operations personnel should periodically monitor housekeeping and material conditions15 in all areas of the plant and should initiate corrective action when problems are identified.

6.26. Management should give due consideration to any disused equipment and to the detrimental effects of such items on the behaviour of operators and the overall material condition of the plant. Plant policy should provide for the removal of all disused equipment from areas where operational equipment important to safety is located. When it is the practice at the plant to accept the retention of such equipment in work areas, the item of equipment should be clearly marked and should be covered by the plant housekeeping programme. Attention should be paid to such an item of equipment to avoid its condition affecting safety at the plant and the ability of the staff to maintain the required operational conditions.

NS-G-2.1

6.1. Administrative procedures should be established and implemented for effective control of combustible materials throughout the plant. The written procedures should establish controls for delivery, storage, handling, transport and use of combustible solids, liquids and gases. Consideration should be given to the prevention of fire related explosions within or adjacent to areas identified as important to safety. For areas identified as important to safety, the procedures should establish controls for combustible materials associated with normal plant operations and those which may be introduced in activities related to maintenance or modifications.

SSG-2

8.13. All the effects of plant changes should be considered, and the analysis should cover all possible aspects of the plant changes. In addition, it should be demonstrated that the cumulative effects of the changes are acceptable.

NS-G-2.3

2.3. No modification to a nuclear power plant, whether temporary or permanent, should affect the plant's ability to be operated safely in accordance with the assumptions and intent of the design.

NS-G-2.4

6.72. The operating organization should establish a procedure to ensure the proper design, review, control and implementation of all permanent and temporary modifications. This procedure should ensure that the plant's design basis is maintained, limits and conditions are observed, and applicable codes and standards are met. A record of the review shall be made available to the regulatory body. The operating organization maintains responsibility for safety implications of the modification and for obtaining the appropriate review and approval by the regulatory body if required.

6.73. Requests for modification should be evaluated on the basis of their impact on plant safety and reliability, plant operation and performance, personnel safety and the fulfilment of regulatory requirements. Considerations should include the need for training upgrades and associated hardware.

Plant Response/Action:

The site implemented a recurring action assigned to all departments that own storage areas (Operations, Radiation Protection, and Maintenance) to perform quarterly walkdowns of their approved storage locations for inventory reduction, safety hazard recognition, and proper marking of the location boundaries. As of the end of September 2015, three of these walkdowns have been completed. These quarterly walkdowns have:

- Identified the areas of the plant requiring improved material condition and housekeeping standards, and established plans to maintain housekeeping in each of these areas. These areas are included in the periodic housekeeping walk downs to maintain the desired standards.

- Identified the need for improved storage of miscellaneous plastic and rubber components in the Operations storage cage in the Diesel Generator building (IR 2520235).

- Performed an inventory of combustibles in the Operations storage cage in the Diesel Generator building.

- Implemented weekly walkdowns of Electrical Maintenance group storage areas to ensure housekeeping and signage is appropriate.

- Reduced the inventory in most areas owned by the Mechanical Maintenance group, including straightening up these areas.

- Fire load calculations were updated from the housekeeping walk-down reports with the exception of a single fire zone in the Control Building, CB-1f, 762 General Area.

That zone has margin to the Fire Zone Classification limit and is in progress of being updated. Currently all fire zones are within Fire Zone Classification limits.

Clinton has established a housekeeping program for the site with areas being divided up by owners. A new comprehensive checklist has been developed to aid in a detailed assessment of each area to be performed by the area owners. Standards for the approved storage areas will be maintained through these departmental walkdowns on a quarterly basis. The effectiveness of these actions will be evaluated by the issue reports created on these areas or issues identified in the housekeeping database entered through the walkdown process. Additionally, open housekeeping actions are reviewed by plant senior management at least once a month, on the third Monday of the month per the Plan of the Day standard agenda.

IAEA comments:

Periodic housekeeping walkdowns are conducted to control the conformity of approved storage areas. Inventory of storage has been reduced. Safety related areas of the plant are assigned to owner departments, which are responsible for identification of equipment and materials stored in unapproved storage areas.

Fire load calculations for the approved storage areas have been mostly updated. The marking of high fire risk areas has been improved. Training has been given to raise the awareness of staff on the importance of combustible materials being stored in appropriate areas.

The station has a process in place to assess other types of hazards associated with storage areas. For instance, for seismic hazards, items have to be placed at a minimum distance form safety related equipment, or "are to be positively restrained by appropriate means (i.e. straps, lanyards, hooks, etc.) to structural members (i.e. building column, structure steel/components), above their centre of gravity to prevent falling and damaging adjacent equipment. The station procedure is not very prescriptive as to how to adequately restrain transient materials. The relevant workforce is trained and is given latitude for choosing how to attach these transient materials (i.e. storage cabinets, movable tools, …).

The location of some storage areas is not always marked on the ground and this may cause confusion about the expected place for storage.

During walkdowns, the team found an operations work station / cabinet which was attached to a system pipe, and using a very light chain that would probably not provide adequate positive restraint during seismic events.

The station has globally reduced safety hazards from storage of equipment and transient materials. Safety hazards are better assessed, in particular for fire hazards. However, some further improvement is still needed in the area of seismic hazard assessment for transient materials, as well as for the marking of authorised storage places.

Conclusion: Satisfactory progress to date

6. OPERATING EXPERIENCE

6.2. REPORTING OF OPERATING EXPERIENCE

The station uses benchmarking against best domestic industry practices as a performance improvement tool, that when used in conjunction with other performance improvement tools such as self-assessment and the corrective action programme, ensures a systematic approach to performance improvement.

Scheduled benchmarking is a pre-planned, scheduled activity for the purpose of researching and collecting benchmarking data. It is normally conducted with a benchmarking partner either internal or external to Exelon.

Primary goals for scheduled benchmarking can be performance gap resolution or, for informal benchmarking, to capture information that should be evaluated by an Exelon organization and was received by other methods outside of the formal benchmarking process.

Tools available to perform benchmarking are:

- Telephone interviews
- Cyber benchmark (e-mail or websites)
- Industry meeting
- Workshop
- Participation on INPO peer team
- Industry site visit
- Reverse benchmarking/self-assessment

All site departments participate in the benchmarking program. The performance of the station and departments is evaluated via a biennial self-assessment of the benchmarking and self-assessment programs.

Various examples of positive results of this practice can be observed. For example Radiation Protection performed in 2012 a benchmarking of Brunswick Nuclear Station practices to prevent personnel contamination events. Five recommendations were developed from that review of which two were prioritized and implemented at Clinton Power Station. One concerned the use of special protective clothing when working in contamination areas and the second concerned the purchase and use of eyeglasses that have the capability to record video and audio which reduces the time spent and number of personnel in RCAs. Since implementing these measures, performance indicators show reduction in the number of Personnel Contamination Events.

Another example is the benchmarking of another Exelon plant performed to identify pre-outage and outage best practices in the field of Foreign Material Exclusion (FME). Four recommendations were developed from that benchmark and three were implemented. This has contributed to good performance in FME practices and no FME events have happened in the last three years. The team recognized this as a good performance.

There is a very high percentage of staff reporting the issues identified, facilitated by a no-blame culture and a generalised learning attitude. About 85% of the station staff did report at least one issue over the last 3 months, and the results of this was confirmed during team field walk downs. The team considers this a good performance.

The station requests contractors to report issues identified. However, there is no specific monitoring to ensure contractor issues are entered into the corrective action programme and the team encourages the station to monitor the reporting performances of contractors.

6.3. SCREENING OF OPERATING EXPERIENCE INFORMATION

A comprehensive external operating experience programme is in place at the station. However, the screening process of external operating experience is not robust enough and does not capture all the international learning opportunities. This part of the operating experience programme could be improved and the team made a suggestion in this area.

6.4. INVESTIGATION AND ANALYSIS

The station has a number of simple tools in place to improve the quality of root cause analyses. These are, for instance, a systematic review of safety culture attributes, a quality check list, a systematic pre-defined effectiveness review, a communication plan to convey lessons learned and the pre-job briefing conducted before starting the investigation. The team recognized this as a good practice.

Five reactor trips have occurred at the station over the last 12 months. A root cause analysis, and in one case an equipment apparent cause analysis, has been performed for each. An overarching root cause analysis has also been performed by the station to check for any commonalities. This analysis concluded that there was no common attribute.

6.7. UTILIZATION AND DISSEMINATION OF OPERATING EXPERIENCE

Operating experience is widely used at the station. It is comprehensively integrated in all activities. In particular, pre-job briefings systematically use operating experience feedback. The team observed that operating experience was used in both technical and managerial meetings, and during shift turnovers. Operating experience is also widely integrated into training. The team considers this as a good performance.

DETAILED OPERATING EXPERIENCE FINDINGS

6.3. SCREENING OF OPERATING EXPERIENCE INFORMATION

6.3(1) Issue: The screening process for external OE is not robust and does not capture all international learning opportunities.

The following facts are relevant:

- The sources of external OE which are considered at the station are listed in the attachment 1 of procedure LS-AA-115. These sources are mainly from information provided by INPO, US-NRC and vendors. These inputs screened by the station are based, in the majority, on OEF from the domestic US industry. Among the 170 inputs collected during the last 12 months by the external OE programme, 97.6% were domestic US experience inputs. The non-domestic events captured were all identified by the US-NRC. No event external to the USA, has been captured by the station sources of external OE during the last 12 months.
- Some potentially significant events from non-domestic OEF were identified by the US-NRC and not from station sources. This was confirmed by reviewing how several safety significant international events were captured. Among 6 international safety significant events reviewed (INES 1, 2 and 3 events chosen from the last 5 years), 3 have been captured by CPS sources, 2 by the US-NRC and 1 was not captured.
- During discussions in several areas, there was some evidence of lack of knowledge and consideration of latest safety related international developments and learnings, such as the results from the EU post-Fukushima "stress tests" or international radiation protection practices.
- Some CPS staff have difficulty in comprehending the usefulness of non-domestic OE, "because regulatory basis / licensing bases and/or design are different".
- The station has no performance indicator for missed learning opportunities from external OE. There is no performance indicator monitoring the quality of the screening process for external OE.
- The station has no guidance regarding the need or not to perform an "extent of condition or cause" of the event during the screening. This is therefore left to the subjective interpretation of the staff involved.
- There is a unique database (DB) for Exelon fleet Issue Reports (IRs) covering from low level events, near misses to significant events and this allows an integral view of the aspects mentioned. The results of the external OE process are also fed into this DB (PassPort). Performing searches on this DB is however, at the moment, not user friendly. It is time consuming to get the result of searches. This lack of user-friendliness can be a barrier against the widespread use of external OE at the station.

Without a robust process for external OE, some learning opportunities could be missed and some avoidable events could occur.

Suggestion: The station should consider improving the robustness of its external OE screening process and ensuring learning opportunities from international experience are not missed.

IAEA Basis:

SSR-2/2

5.27. The operating organization shall […] obtain and evaluate information on relevant operating experience at other nuclear installations to draw lessons for its own operations. […] Relevant lessons from other industries shall also be taken into consideration, as necessary.

4.34. Where practicable, suitable objective performance indicators shall be developed and used to enable senior managers to detect and to react to shortcomings and deterioration in the management of safety.

NS-G-2.11

3.5. At a nuclear installation, two sources of information are available: internal operational experience and external operational experience. Internal operational experience is experience from events that occur at the plant itself. External operational experience is experience from outside the plant, either from within the same State or from another State, from nuclear installations that utilize similar technologies or from those that utilize different technologies.

10.12. Reports in the system for the feedback of operational experience should be stored in such a manner that the information they contain can be easily sorted and retrieved […]. The information should be organized to facilitate frequently needed searches for, for example:

- Events at similar units;
- Systems or components that failed or that were affected;
- Identification of the causes of events;
- Identification of lessons learned;
- Identification of trends or patterns;
- Events with similar consequences for personnel or for the environment;
- Identification of failure types or human factor issues;
- Identification of recovery actions and corrective actions.

6.8. Since trending is performed to identify a deviation from an expected value or level, a method of recognizing deviations is necessary. Generally, a comparison should be made between the frequency with which a parameter occurs over time and a threshold value that should encompass the expected values. Any deviation beyond the threshold value should be considered for further analysis.

Appendix II

II.8 The *safety assessment* should be focused on the safety consequences and implications of the event. The primary aim of this review is to ascertain why the event occurred and whether it would have been more severe under reasonable and credible alternative conditions, such as at different power levels or in different operating modes. The safety significance of the event should be indicated.

Plant Response/Action:

Clinton worked with INPO to improve the robustness of the external OE screening process for Clinton as well as for the Exelon fleet and for the US nuclear industry. INPO developed a process that includes significant and noteworthy international events from the WANO Significant and Noteworthy Events report that is published on the INPO webpage on a monthly basis. The WANO events are loaded to the INPO Consolidated Event System (ICES) which makes them easily retrievable by US licensees.

As part of the enhanced INPO process, the international events from the WANO Significant and Noteworthy Events report are included in the INPO Nuclear Network Daily Download. The INPO process change began in February 2015.

Exelon uses the INPO Daily Download to create the Exelon fleet Daily Industry Events Report (DIER) that is screened at Clinton by the Management Review Committee (MRC) daily. International events that are found by the MRC to be potentially applicable to Clinton are included in an issue report for detailed evaluation for lessons learning.

IAEA comments:

Since February 2015, INPO has improved the reporting process of non-domestic incidents to INPO nuclear power plants. The selection of these WANO international events is independent from any similarity of design. In average, around 6 non-domestic events were reported per month up to now by INPO.

The station screens these new inputs systematically for applicability since February 2015, on a monthly basis, through its normal external operating experience screening process. Since February 2015, around 50 international events have been reported to the station through this channel. The screening of these around 50 reports did not lead to any requests for additional in-depth analysis (no Issue Report generated) at the station. In the same period (February to September 2015), around 160 Issue Reports were issued for US events by the station to analyse more deeply the applicability and the need for possible corrective actions. This shows that the station still does not put enough emphasis on learning from international operating experience feedback.

Periodic self assessments are conducted to evaluate the quality of operating experience reviews, however, there are still no performance indicators monitoring the quality of the screening process for external OE or missed learning opportunities from external OE.

The station plans to improve the user friendliness of searches in the operating experience database in 2016. Hyperion tools will be replaced by Oracle based tools.

The team concluded that, considering the actions taken by INPO and the station, the intent of the suggestion will be met. However, further actions are needed to integrate relevant lessons learned from international operating experience into station improvement programmes.

Conclusion: Satisfactory progress to date

6.4. INVESTIGATION AND ANALYSIS

6.4(a) Good practice: Tools have been put into place to ensure root cause analyses are completed in a timely, consistent and deliberate manner to guarantee high quality of event investigations.

Tools have been put into place to ensure root cause analyses are completed in a consistent and deliberate manner to guarantee high quality of the investigation and report. Positive improvements in the quality of the products are evident.

These tools are:

- A pre-job briefing is held during the first meeting of the investigation team.
- A review of safety culture attributes associated to the event is performed as part of the root cause analysis. For each attribute identified, corrective actions are defined.
- For each corrective actions preventing recurrence, mentioned in the root cause analysis report, an effectiveness review is pre-defined in the report. This effectiveness review is defined using concrete and specific criteria to measure the effectiveness of the action.
- A communication plan is developed to convey lessons learned from the event to the station staff.
- A quality checklist is completed and attached to each root cause analysis report. This consists of checks that the content and quality attributes are met such as the safety culture assessment was performed to address all the safety culture components; making sure that previous OE has been screened to find possible similar events and that corrective actions address the causes. These checks are comprehensive and are systematically used to achieve the desired quality before submitting report for approval.

The team observed that following the implementation of these tools, the quality of root cause analyses was significantly improved.

7. RADIATION PROTECTION

7.2. RADIATION WORK CONTROL

In general, good radiation protection practices are established, however the team observed gaps in data collection, environmental monitoring and housekeeping. The team developed a suggestion in this area.

It was observed that during the outage of 2013, 43 permits were given to extend the maximum dose from 20 mSv to 30 mSv, and 22 permits from 20 mSv to 25 mSv. A spot-check showed that some of those extensions were not used. Therefore the team encourages the station to re-evaluate and modify its relevant policy as necessary.

7.3. CONTROL OF OCCUPATIONAL EXPOSURE

In 2013 the plant managed to reduce the annual collective radiation exposure (CRE) by 0.75 Sv. The total of routine dose and outage dose in this year was 1.28 Sv. This was achieved by source term reduction, improvement measures in shielding, technological measures and staff behaviours.

The station has 90 cameras positioned throughout the station that are used by Operations, Engineering and Maintenance personnel in the conduct of tours and troubleshooting. The station uses this technology extensively to monitor areas in which high dose rates exist, reducing the dose to station personnel. Also two robots with cameras and dosimeters are utilized. The team considers the use of cameras and robots to be a good practice.

A decision has been made to change CPS from biennial to annual outages. In the first year, a maintenance and refuelling outage will be done and the next year the outage will be restricted to refuelling. This pattern will be continuously repeated. Although it is not expected that dose limits will be exceeded, calculations show that this switch will lead to a CRE increase of approximately 0.3 Sv every two years, if extra dose saving measures are not realised. Therefore, the team encourages the plant to further increase their efforts for dose reduction.

7.5. RADIOACTIVE WASTE MANAGEMENT

The station effectively operates a liquid radwaste treatment installation. The primary goal for processing radioactive wastewater is to produce high quality water for use as process fluid while achieving zero discharge from the station by utilizing waste segregation and adequate, timely sampling and processing. The team considers the liquid radwaste treatment installation to be a good practice.

7.6. RADIATION PROTECTION SUPPORT DURING EMERGENCIES.

It was observed that a decontamination facility in the technical support centre located outside of the protected area was built, but needs additional maintenance prior to use. Contaminated people coming from outside the plant should go either in the plant for decontamination, or, if decontamination in the station is impossible because of an accident, they need to be transported to another Exelon plant or a relocation centre, where they will be monitored and decontaminated.

The team encourages the station to reconsider the use of the decontamination facility at the entrance of the technical support centre.

There are dosimeters at 55 locations in the vicinity of the plant and these are used for routine reporting and are read quarterly. The dosimeters are read by vendors and the results are reported to the ODCM Program Manager, which then reports any abnormalities to the Radiation Protection Manager. In case of emergency these dosimeters are read out “on demand”. This procedure takes eight hours. The radiation protection department has direct read out equipment at its disposal. However, the direct read out is less precise and less accurate than achieved at the vendor. Therefore the team encourages the station to incorporate the direct read out next to the vendor read out in the emergency procedures and the drills and exercises.

DETAILED RADIATION PROTECTION FINDINGS

7.2 RADIATION WORK CONTROL

7.2(1) Issue: Some radiation control practices may not provide sufficient protection against the spread of radioactive contamination and not provide adequate environmental monitoring.

In general, good radiation control practices are well established, however the team observed the following:

- Environmental monitoring and dose assessment:
  - The Illinois Emergency Management Agency (IEMA) radiation monitors around and in the vicinity of the station only measure gamma-dose rates and the station doesn't use the results routinely during normal operation.
  - During the exercises / drills use of the station "off-site dosimeters" is not practiced.
  - There are four deficiency stickers on the Eberline radiation monitoring system – post treatment off-gas monitoring system – in the Radwaste building.
- Housekeeping
  - Several gloves were lying around in the RCA while there are plenty bins in place.
  - Poor housekeeping of the radiation protection instruments facility.
  - Radioactive sources were locked in cabinets but there was poor housekeeping in the cabinets.
  - Several areas of damaged floor coatings were evident in the Radwaste and Control buildings and in the RCA.
  - Protective clothing is not worn in the radiation controlled areas, but only in contamination controlled areas.

Without adequate monitoring, practice during emergency planning drills and exercises use of off-site dosimeters and isolated housekeeping practice gaps, the likelihood of undetected contamination spread could increase.

Suggestion: The plant should consider improving its radiation control practices to reduce the likelihood of the spread of contamination and provide for adequate environmental monitoring.

IAEA Basis:

RS-G-1.8

5.65. The specific objectives of emergency radiation monitoring in the environment are:

(a) To provide accurate and timely data on the level and degree of hazards resulting from a radiation emergency, in particular on the levels of radiation and environmental contamination with radionuclides;

NS-G-2.7

3.3 The operating organization shall designate as a controlled area any area in which specific protective measures or safety provisions are or could be required for:

(a) controlling normal exposures or preventing the spread of contamination during normal working conditions; and (b) preventing or limiting the extent of potential exposures.

3.48. Protective clothing should be worn in controlled areas to prevent the contamination of skin and personal clothing and the spread of contamination from controlled areas. Gloves of various types and materials should be made available for use to prevent the contamination of hands in work involving contaminated equipment. Disposable or washable boots made of rubber or plastic should be used in the event of leaks onto the floor.

Plant Response/Action:

In response to this suggestion, a work request was generated for the degraded floor coatings. The actual repair will be via the normal work control process and cycle plan per the Exelon Work Management Model.

The noted gloves in the OSART inspection were removed and lockers were installed for controlling gloves inside the radiological controlled Area vice leaving them leaving around.

The deficiency stickers on the post treatment off gas monitoring system were verified repaired for all issues other than adjusting flow rate for monitors with mass flow kits.

The RPM peer group was engaged in the suggestion to utilize the IEMA monitors during normal operation; however, no action was taken to incorporate into the Exelon Management Model.

Additionally, anti-contamination clothing is utilized in contamination control areas but not in radiologically controlled areas due to the majority of radiologically controlled areas being maintained clean. This was also discussed with Exelon Corporate peers and no action to incorporate into the Exelon Management Model was taken.

The ability to direct read environmental DLRs were verified, and a recurring action was created to verify that ability on a periodic basis. This will be presented to the Corporate RPM peer group to evaluate for inclusion into the Exelon Management Model.

The RP Calibration Facility was reorganized alleviating the housekeeping concern for source storage.

IAEA comments:

The station, together with Exelon Corporate has analyzed the issue of radiation work practices to reduce the likelihood of the spread contamination. Several corrective actions were initiated and implemented, or partially implemented.

CPS made strong efforts for further dose reduction and achieved very good results, e.g. collective dose during outage C1R13 was 2.06 Sv, outage C1R14 was 1.05 Sv and this year's outage, C1R15, was only 0.77 Sv.

CPS started the repair of the degraded floor coatings. Deadline for full repair in the Radwaste and Control buildings and RCA is March 2016.

Lockers were installed for controlling gloves inside the RCA.

The Off Gas monitor in the Radwaste building was repaired.

The housekeeping of the RP Calibration Facility was improved and all radioactive sources are stored properly.

CPS analyzed use of IEMA monitors and concluded that they have more accurate area monitors and stack monitors to give them radiation situation very quickly and precisely, however they are using IEMA monitors during drills and exercises. In addition CPS purchased two dosimeters readers (STAR) and station can now read dosimeters without vendor involvement.

Not all measures are fully implemented yet and some of them are long term. Plant tours confirmed improvements in resolving this issue; however, work is still needed to fully resolve the issue.

Conclusion: Satisfactory progress today

7.3. CONTROL OF OCCUPATIONAL EXPOSURE

7.3 (a) Good practice: Use of remote-monitoring technology for radiation exposure reduction.

In 2013, CPS reduced the annual collective radiation exposure (CRE) by about 0.75 Sv (75 Rem) lower than the CRE during any year with an outage since 2000.

CPS have effectively reduced personnel exposure through implementation of an aggregate approach that uses technology and innovative dose reduction methods. This includes the use of remote-monitoring technology to monitor areas in which high dose rates exists, reducing the dose that station personnel would normally receive to perform tours and troubleshooting.

There are 90 cameras positioned throughout the station that are used by Operations, Engineering and Maintenance personnel in the conduct of tours and troubleshooting.

The station uses a remote operated robot to investigate leaks including steam, water and vacuum leaks in high radiation areas. This has effectively reduced the man-hours that personnel would have to be in the high radiation area doing this investigation.

The station utilizes technology to communicate and guide station workers in high radiation areas, to move them to lower dose rate areas or coach on body positioning to optimize ALARA practices.

Additionally, the station uses a reward programme that encourages station personnel and contractors to provide suggestions on ways to reduce collective radiation exposure. From these types of inputs, ideas have evolved such as removing the peripheral fuel bundles from the core during a refuelling outage to reduce the dose rates in the bio-shield closest to the reactor. This was estimated to reduce dose in the last outage by 77 mSv (7.7 Rem).

Through a combination of both the use of advanced technology and strong engagement of the work force, the station has reduced historically high exposure to be the best in the US fleet for on-line dose in BWR’s and among the top five for the world.

The dose savings due to remote-monitoring are predicted to amount to 60 mSv (6 Rem) per year.

7.5. RADIOACTIVE WASTE MANAGEMENT AND DISCHARGES

7.5 (a) Good practice: Zero radioactive liquid waste release.

The station effectively operates a Liquid Radwaste Treatment Installation to prevent the need to discharge.

- The station has a “zero discharge” policy and has not performed a radioactive liquid discharge since 1992.

- The station maintains a rigorous process of tracking seasonal changes in station water inventory. This process predicts changes in station inputs due to environmental conditions such as humidity/temperature and necessary water movement from refuel activities, ensuring there is adequate storage space to receive and process water without the need to discharge.

The primary concern for processing radioactive wastewater is to produce a high quality of water for use as process water while achieving zero discharge from the station by utilizing waste segregation and adequate, timely sampling and processing.

The Liquid Radwaste Treatment Installation is fed by three wastewater streams:

- The Floor Drain Waste Water System is the primary source of contaminants. These contaminants range from organic material and cleaning solutions to high levels of crud, sediment, and resin.

- The Chemical or Equipment Drain Waste System contains liquids from numerous chemical drains and sumps. Liquids in this system will vary extensively in chemistry parameters and may contain organic compounds, detergents, volatile solutions, and resin.

- Laundry Waste system inputs can contain low levels of detergents from drains in the Turbine Building and Service Building.

Front end sampling is used in some cases to determine the best method of processing; in other cases specific tanks are processed without front end sampling, such as equipment drain tanks.

8. CHEMISTRY

8.4 CHEMISTRY CONTROL IN PLANT SYSTEMS

To minimize intergranular stress corrosion cracking (IGSCC) in critical components and to lower the activity levels, the station has been using standard noble metal chemistry and zinc injections into the feedwater. In 2014 the station started to apply on-line noble metal chemistry and installed electrochemical potential measurements to follow the effectiveness of noble metal injections. By using the new approach, less hydrogen is needed in the water to mitigate IGSCC. This will contribute to reduced radiation fields in the main steam lines. The team recognizes these improvements as a good performance.

The station has a closed cooling water corrosion control programme. The programme consists not only of following the prevailing water chemistry conditions and visual inspections of components but also having material samples exposed to operational water chemistry conditions in different systems. These samples are removed and examined periodically and the results given to system health engineers for ageing management evaluations. The team considers this as a good performance.

8.6 CHEMISTRY SURVEILLANCE

Four times a year the station undertakes intra-laboratory and inter-laboratory tests to identify analytical interference and improper calibration, analytical technique and instrument operation. The inter-laboratory programme consists of active and in-active samples. All qualified technicians take part in these campaigns and chemistry managers follow the individual performance to evaluate if re-qualification training is needed. The team considers these quarterly tests as a good performance.

The station has a post-accident sampling system to obtain samples from the reactor coolant, suppression pool and containment atmosphere. However, the laboratory does not have a specific detector to analyze undiluted, highly radioactive samples and therefore they have to be sent to off-site laboratories. This causes delays in obtaining the results and also introduces unnecessary doses to personnel transferring the samples. In addition, the detectors used in the station laboratory are cooled continuously with liquid nitrogen, which needs to be supplied to the station on a regular basis. The team encourages the station to re-evaluate and modify, as appropriate, its procedures to analyse highly radioactive samples during accident and post-accident situations.

8.9 QUALITY CONTROL OF CHEMICAL AND OTHER SUBSTANCES

The station has a department chemical control representative (DCCR) in all its departments. The DCCR acts as a point of contact for the station chemical control coordinator when problems involving chemical product use, storage, labelling, or disposal arise and assists in resolving these problems. The DCCR is also required to take corrective actions when gaps are identified in chemical control requirements, to coordinate the monthly chemical control locker inspections and also assist personnel in the department with the purchasing process for chemical products.

This procedure ensures that unlabeled chemicals are rarely found at site. The team recognizes this as a good practice.

8.9 QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

8.9(a) Good practice: The station has a department chemical control representative (DCCR) in all its departments. DCCR acts as a point of contact for the station chemical control coordinator when problems involving chemical product use, storage, labelling, or disposal arise and assists in resolving these problems. DCCR is also required to take corrective actions when gaps are identified in meeting chemical control requirements. DCCR coordinates the monthly chemical control locker inspections and assists personnel in the department with the purchasing process for chemical products. In addition, the following factors contribute to the successful chemical control programme at the station:

- Each storage area has a designated person whose responsibility is to assure that the handling, labelling and storing of chemicals is done in a proper manner. Ownership creates responsibility.
- The station chemical control coordinator does quarterly walk-downs together with the department chemical control representative to inspect storage areas for unauthorized or improper use of chemicals.
- The station has strictly followed the policy in labelling all the chemicals at the site (5 different types of labels).
- If chemicals have to be transferred to smaller containers, the secondary containers are available in various storage locations. These secondary containers are pre-labelled but also plant specific labels must be attached to the containers.

The benefit of this approach, as compared to the arrangement whereby the chemistry department is the only responsible organization for chemical control, is as follows:

- The responsibility for the chemical control and labelling is distributed throughout the departments using the chemicals.
- Departments have their own contact point to help personnel on a day-to-day basis regarding questions on handling, storing and labelling the chemicals.
- The station chemical control coordinator has a clear contact point in the other departments.

9. EMERGENCY PLANNING AND PREPAREDNESS

9.1 EMERGENCY PROGRAMME

CPS Emergency Programme (EP) consists of the Standardized Radiological Emergency Plan for all Exelon stations, standard procedures for most of activities for the preparedness and response, and a CPS specific annex to the standard plan. Responsibilities for CPS, Exelon corporate offices and external organizations are clearly defined for specific responses of potential nuclear and radiological emergencies. Participating external organizations include authorities from the county where the station is located, the State of Illinois agencies and federal agencies. There is good cooperation of on-site and off-site organizations with respect to emergency planning and preparedness. External agencies are notified for the lowest class of emergency, and provided with updates for any change in the classification of emergency. This standard approach to emergency preparedness and response is recognized by the team as a good practice.

9.4 EMERGENCY PROCEDURES

The team noted that the station uses the value of 500 mSv (50 Rem) as a standard for the administration of KI (potassium iodide) tablets to Emergency Response Organization (ERO) members. This value is in agreement with national regulations, but deviates from IAEA GS-R-2 “Preparedness and Response for a Nuclear or Radiological Emergency” that uses the value of 100 mGy (approximately 10 Rem) for this purpose. The team encourages the station to consider applying a more conservative threshold for its ERO staff.

9.6 EMERGENCY EQUIPMENT AND RESOURCES

The station demonstrates good readiness for emergency plan facilities, equipment and materials. Verification of the availability is assigned to different groups at the station and in the corporate office. Prioritization management process ensures that all equipment related to emergency response receives timely and appropriate attention in case of unavailability. Some cabinets and kits were observed to be well organized and labelled, with name and pictures of the interior, facilitating easy identification of the proper equipment and materials. However, this is not consistently applied to all cabinets and storage areas related to emergency response. The team encourages the station to extend this good labelling and housekeeping practice to all cabinets and areas as practical.

CPS has 150 KI tablets available on site and 3,000 in Cantera Corporate office; the value for the site is low compared with usual practices in plants worldwide. In light of Fukushima lessons learned, the team encourages the station to reevaluate the adequacy of the quantity of KI tablets held on site.

9.7 TRAINING, DRILLS AND EXERCISES

Responsibilities for training and qualification of the Emergency Response Organization (ERO) are clearly assigned in the emergency plan. All members of the ERO are required to complete initial training and qualification when they are assigned emergency response activities, and receive periodic requalification. Both initial qualification and requalification include performance-based activities such as participation in drills and exercises. Training material is standardized, ensuring homogenous knowledge and skills among fleet stations and corporate responders, and allowing better understanding and support in case of emergencies.

The station has identified all critical tasks for emergency response and developed a detailed check list with evaluation criteria for them; this ensures that these tasks are included in drills and exercises as required by regulations and procedures.

The station uses, on a regular basis, qualified personnel from other stations and corporate offices to act as controllers/evaluators in drills and exercises.

The team recognizes the training and drills programme as a good performance.

DETAILED EMERGENCY PLANNING AND PREPAREDNESS FINDINGS

9.1 EMERGENCY PROGRAMME

9.1(a) Good Practice: Fleet-wide standardized process for emergency preparedness and response with strong involvement from Corporate offices, qualified personnel and high availability of facilities, equipment and materials.

Some of the components are:

- Exelon has developed a standard Emergency Plan and procedures that allow support from corporate offices and other Exelon stations in drills/exercises control and evaluation, review of procedures, and verification of off-site facilities and equipment.
- The review of procedures and the plan takes advantage of having a team of EP managers that ensures that intended changes are appropriate.
- Corporate offices are responsible for the relationship with external agencies, allowing the station EP group to concentrate in onsite activities. This relationship allows better understanding and participation of external organizations in the station emergency plan.
- Common set of performance indicators allows the comparison among fleet EP programmes fostering healthy competition and driving the effort for improvement. Corporate offices have a good tool to assess the performance of the EP process in all fleet stations.
- A standardized training programme has been developed using a detailed job task analysis for each Emergency Response Organization position, including performance-based activities. Most of the training material is common to the fleet helping to ensure better use of resources.
- Having standardized processes facilitates corporate offices to operate common facilities such as the Emergency Operations Facility (EOF) and the Joint Information Center (JIC) and the purchase and storage of supplies such as KI tablets.
- Standard criteria for the evaluation of drills and exercises allow support from other stations and corporate offices, comparisons in performance and dissemination of lessons learned from drills/exercises. More than 300 criteria allow detailed tracking and monitoring of performance.

Most of the performance indicators are challenging and are 100% or in the high 90s, for example: equipment availability, staffing and qualification of personnel, and drills participation.

Having a common process for all the stations in the fleet improves not only the level of preparedness but also, on the level of response, and allows better support from corporate offices and other stations in the fleet.

14. SEVERE ACCIDENT MANAGEMENT

14.1 OVERVIEW OF SEVERE ACCIDENT MANAGEMENT

Clinton Power Station (CPS) joined the US industry initiative in the early nineties to address the need for severe accident management (SAM) by incorporating severe accident guidelines (SAGs) into the system of plant procedures. The revised procedures were implemented by 1998.

The CPS SAGs are based on the Boiling Water Reactor Owners Group (BWROG) generic SAGs, developed by General Electric and a group of other 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). The development of generic strategies and guidelines became an important pilot project which was later on, with some derivations, followed by many nuclear power plants (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). The OSART team considers CPS involvement in this effort of development of generic SAGs and sharing them with the international community as a good practice.

The overall system of generic BWROG SAGs as well as CPS procedures associated with actions related to accident management includes:

1) Two SAG Flowcharts/SAG Support Procedures (SAG-1 Primary Containment Flooding and SAG-2 Reactor Pressure Vessel (RPV), Containment and Radioactivity Release Control).
2) Seven EOP Flowcharts/EOP Support Procedures (EOP-1 RPV Control, EOP-1A ATWS RPV Control, EOP-2 RPV Flooding, EOP-3 Emergency RPV depressurization (Blowdown), EOP-6 Primary Containment Control, EOP-8 Secondary Containment Control, EOP-9 Radioactivity Release Control).
3) Off-Normal Response Procedures.
4) Annunciator Response Procedure actions.
5) Abnormal Operating section actions located in the System Operating Procedures.
6) Integrated Plant Operating Procedures.
7) Normal/Infrequent Operating section actions located in the System Operating Procedures.

Off-normal Operating Procedures include Extensive Damage Mitigation Procedures, which are used in parallel with other procedures (EOPs, SAGs) under conditions of station infrastructure damage due to explosion, fire or natural/destructive phenomena. Items 1) and 2) in the list above are high level procedures/guidelines providing instructions and guidance to the personnel for prevention and mitigation of severe accidents.

Typical characteristics of the BWROG EOPs/SAGs include:

- The EOPs/SAGs do not use any probability threshold for selecting the accident scenarios covered by the procedures but their intent is to address any mechanistically possible situation.
- EOPs/SAGs are based on directly measurable parameters (symptoms), i.e. they are symptom based.
- In addition to directly measurable parameters, there are two symptoms (core damage is occurring; core debris breached the RPV) which are assessed using a combination of several measurable parameters (pressures, levels, radiation levels).
- There may be event specific procedures covering earthquakes, tornados, station black-out or fires, but they must not contradict the symptom based EOPs/SAGs.
- The guidelines and procedures are in a user friendly format with flowcharts, supplemented by supporting procedures.
- Computational aids or variables and curves (simple diagrams used for assessment of the plant conditions) are embedded into the EOPs/SAGs.
- There is a clear transition from the preventive to the mitigative domain (from EOPs to SAGs); once the EOPs are exited, they are not re-entered.
- The SAGs may only be excited when adequate core cooling is assured, and the plant is being maintained in a stable condition. This decision to exit is made by the person with command authority.
- The majority of actions are performed from the control room, but there are several local (field) actions included in the guidelines e.g. containment venting.

The reactor pressure vessel water level is a key parameter (symptom) for decision making. Other symptoms include containment and pressure suppression pool water level, RPV and containment pressure, hydrogen concentration and radiation level in different containment zones, containment, drywell and suppression pool temperature, RPV bottom head metal temperature and RPV coolant injection rate.

In the past, the development and updating of the SAGs generally in the USA was typically performed with minor plant modifications. The scope of the hardware modifications was driven by the cost benefit analysis usually resulting in limited modifications. Hardware modifications are still usually performed only when specifically required by the NRC. Nevertheless, at present, there is an ongoing process of acquiring some additional equipment as a part of the so called FLEX project (specified in NEI 12-06 document Diverse and Flexible Coping Strategies (FLEX) Implementation Guide) aimed at responding to prolonged loss of AC power and beyond design basis hazards. FLEX modifications required by the NRC include implementation of mobile/transportable diesel generators, portable pumps for refilling the reactor vessel and spent fuel pool and improved monitoring in the spent fuel pool. According to the NRC order, all provisions including installation of equipment shall be completed by 2016. Adoption of FLEX is a significant change as compared with the earlier typical US approach with minimum plant hardware modifications.

14.2 ANALYTICAL SUPPORT FOR SEVERE ACCIDENT MANAGEMENT

In discussion with members of the Emergency Procedures Committee of the BWROG, it was clarified that performing accident analysis is done at the industry (BWROG) level and not at the plant level. Differences between reactors are reflected by adopting sufficient margins in interpretation of the results. A large set of analyses for different reactor designs is summarized in the EPRI Technical Basis Report and in the BWR Owners' Group Technical Support Guidelines, BWR Owners' Group Emergency Procedure and Severe Accident Guidelines.

Information contained in generic documents, in particular in the EPRI Technical Basis Report, provides comprehensive and valuable information about the nature of severe accident phenomena, uncertainties in predictions, an overview of available preventive and mitigative strategies and the positive and negative effects of the different strategies. Nevertheless, it is questionable as to what extent the generic data can be considered as a reliable source of the plant specific information, especially for determination of time windows for performing accident management actions, for confirmation of the feasibility and effectiveness of the actions, for determination of environmental parameters needed for the assessment of operability of equipment and for the assessment of habitability of control places under severe accident conditions. It would be therefore beneficial to have plant specific analyses, demonstrating the effects of differences in design on the plant responses to the accidents. It is particularly true in case of CPS due to the fact that the CPS is the only station with a Mark III containment in the whole Exelon fleet and it would be therefore appropriate to assess differences in accident progression as compared to the other Exelon units. Results of plant specific analysis will also provide a valuable and unique source of information for validation of SAGs.

During the OSART mission, the selected results of deterministic accident analysis performed in 2011 by the MAAP 4.0.5 computer code as input for the development of the PSA Level 2 were discussed. It can be stated that even though these plant specific results were not aimed exactly for development of EOPs and SAGs, they in combination with generic SAGs provide valuable information on progression of the accidents. These results can be used as a starting point for more comprehensive analytical support for future updating and validation of the SAGs. Such results can also be used more extensively in combination with other means (such as a multifunctional simulator) for staff training. Broader use of the PSA is advised for the area of SAM e.g. for selection of scenarios for validation, training or drills.

The OSART team made a suggestion (14.5(1)) one component of which is focused on updating of the verification and validation procedure and development of the plant specific analysis in support of SAM.

14.3 DEVELOPMENT OF PROCEDURES AND GUIDELINES

All plant specific documents from the technical bases through the guidelines up to the procedures have been developed for CPS by an external company KLR Services, Inc. who was selected as a sole source provider based on their recognized qualification. Final verification and validation of the EOPs-SAMGs was performed by the CPS. At the plant level, the organizational unit responsible for relevant activities is the Operational Support Department (with around 10 employees). There is a EOPs/SAGs coordinator responsible for coordination with other departments, as needed.

In general, the process of development of EOPs/SAMGs provides for reflecting the existing plant configuration in the accident management. There is a procedure CPS 1005.09 last revised in 2011 "Emergency Operating Procedure (EOP) and Severe Accident Guideline (SAG) Program" which specifies requirements for the preparation, approval and maintenance of EOPs and SAGs. The procedure adequately describes the whole system of procedures, responsibilities of plant staff for execution of the EOPs and SAGs, distribution of the documents, physical locations, hierarchy, usage of the procedures, entry and exit conditions, etc. There is a "writer guide", which establishes the rules for unified clear writing of both EOPs and SAGs.

The process of development of plant specific SAGs includes several plant specific documents as follows:

- "Clinton Power Station Severe Accident Guidelines Derivation Document" (SAG-DD). The document identifies the source of each step of Clinton SAGs and provides a record of design decisions implemented during the conversion of plant specific technical guidelines (PSTG-SAGs) into flowcharts.
- "Clinton Power Station Severe Accident Guidelines Technical Bases" (SAG-TB). The document is derived from the corresponding document for the whole BWROG and provides guidance in diagnosing and responding to a severe accident at CPS. It discusses entry and exit conditions of SAGs as well as all individual actions contained in the SAG-1 and SAG-2.
- "Clinton Power Station Plant Specific Technical Guidelines"-SAG, SAG-PSTG. The document describes in more detail individual actions contained in the SAGs.
- EOP/Off-Normal Performance Aid Matrix, CPS 1005.09: provides a method for controlled development and distribution of EOP/Off-Normal performance aids.
- SAMG Team – Technical Support Guidelines (TSG), CPS 4750.01: provides guidance to supplement flowcharts to assist in the response and decision making during SAMG execution.
- Seven EOPs - from 3 of these EOPs there is an entry point to the SAGs (EOP-1, EOP-1A, EOP-2).
- Two SAGs, SAG-1 and SAG-2.
- Operating procedures for performing actions associated with the use of individual components and systems.

All parameters used in execution of SAGs are included in the Safety Parameter Display System (SPDS) which should be available both in the control room as well as in the TSC. Certain inconsistencies in the availability of parameters in the control room and the TSC were

revealed during the mission and the team encourages CPS to eliminate these in the future updating of the SAGs.

Plant specific computational aids (variables and curves) embedded into the EOPs/SAGs flowcharts include:

- RPV saturation temperature.
- Minimum usable level measurements depending on containment temperatures.
- Minimum debris retention injection rate; it is not completely clear as to what extent the scope of the core degradation is taken into account.
- Pressure suppression pressure based on suppression pool level.
- Containment spray initiation limit.
- Hydrogen deflagration limit.
- Primary containment pressure limit (initiation for containment venting).

Such variables and curves represent valuable means for fast decision making under conditions of high stress.

No major dedicated equipment has been installed in CPS in the past for severe accident mitigation, except hydrogen igniters. Igniters require the availability of AC power for their operation. In response to the Fukushima accident, the NRC requires enhancing the reliability of the power supply to the igniters. The team encourages CPS to evaluate the benefits from replacement of igniters by passive autocatalytic recombiners (PARs) which do not need a power supply. The PARs are the usual means adopted in many plants, for example European and Canadian NPPs, and they could be more reliable and a cost effective solution.

New equipment envisages within the FLEX project will be installed so that it will not be affected by severe accident conditions. Most of the projects associated with installation of FLEX equipment and other provisions are in the last stage of the design (about 90 % completed) and constructions/installations are ongoing. Completion of the FLEX project in CPS is scheduled for March 2015. All newly purchased equipment should either be adequately robust to survive external hazards, or stored in adequately resistant places. During operation, the equipment will be subject to the preventive maintenance programme with the established rules for testing. At present, non-conventional use of some equipment (hoses, cables) is partially tested during the exercises and drills.

It is important that both existing as well as newly installed equipment will be covered by future validation of EOPs/SAGs in order to ensure that design parameters of the equipment provides for its survivability under accident conditions. There are several local (field) actions included in the EOPs/SAGs. Examples of field actions are containment venting, turning off equipment endangered by submergence in containment and turning off selected breakers. Venting to the environment is made through the ventilation system which connects containment and the diesel generator (DG) building. The venting point is located on the connecting line, physically placed on the roof of the DG building. Releases from the venting pipe go directly to the atmosphere and there is no filter along the venting pathway. Future SAGs validation should consider accessibility of local control places under high radiation levels such as those used during venting and the interrelation between containment venting and off site emergency arrangements, as reflected in suggestion 14.5(1) made by the OSART team.

At present, the accidents taking place in the spent fuel pool (SFP) and accidents occurring during shutdown operating regimes are only partially covered by the EOPs/SAGs. There are plans to integrate such accidents into the whole system of procedures and into flowcharts by May 2015. The issue of accident management in connection with the SFP and shutdown operating regimes is recognized by the plant and the CPS is in the process of integrating the existing provisions into a comprehensive SAM program. The team made a suggestion in this area.

Present SAGs and emergency plans do not explicitly address potential long term implications or concerns resulting from implementing the severe accident mitigations strategies, such as large volumes of contaminated water or contamination of large areas in the vicinity of the station. The CPS, preferably at the higher (BWROG) level, could include this kind of strategic considerations into plans for future updating of the guidelines.

14.4 PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

The function, roles and responsibilities of all members of the emergency response organization (ERO) are defined in the Exelon Standardized Radiological Emergency Plan. The Plan addresses all aspects of the ERO, including responsibilities, overall external support system (including federal support), emergency classification, notification, communication, emergency facilities and equipment, accident assessment, response, radiation exposure control, medical and health support, recovery planning, drills, exercises, training, etc. In the annexes of the Plan, radiological emergency plans for individual stations are included.

Overall authority and responsibility for execution of all emergency response has the emergency director in command and control. At the moment of accident this role has the shift emergency director (shift manager) working in the control room. Later on, this role is transferred to the station emergency director in the Technical Support Centre (TSC) and further on to the corporate emergency director in the emergency operations facility. Responsibility should be transferred to a higher level as soon as possible, provided availability of adequate staffing level, staff briefing of the status and plans and completed turnover from one level to another. Emergency director in command and control shall execute so called non-delegable responsibilities, i.e. event classification, recommendations of protective actions for the general public, notification of off-site authorities and authorization of emergency exposure above 50 mSv (5 rem).

The TSC at CPS is well equipped both with hardware provisions as well as appropriate software for assessment of the severity of the emergency and for supporting adequate decisions. Full occupancy of the TSC represents about 25 highly qualified staff, mostly managers, who receive specialized training depending on their role in the ERO. The suggestion made by the OSART team on updating of the validation procedure includes more attention to be paid to both control room and TSC staff in the validation (and in the SAGs).

All documents supporting development of EOPs/SAMGs as well as all procedures are available in the TSC both in electronic as well as in a hard copy form. All TSC staff are working in the same room in case of an emergency. Each member has their own "user aids" providing additional advice on performing their duties. The TSC is well equipped with computers, large screens, overhead projectors, white boards, etc.

There are multiple communication means, including pagers, radio communication, plant wired lines, wireless phones, satellite phone and public telephone lines. The TSC provides communications to the control room, to the operations support centre, to the corporate emergency operations facility, to the NRC and to the state and local emergency operations centres. Based on the measured radiation situation inside the plant and the identified release pathway and information about weather conditions, the evaluators working in the TSC are able to predict the radiological consequences in term of doses.

External support to the station in case of an accident is well organized. The OSART team noted as a good practice that CPS in coordination with other nuclear power plants in the Exelon fleet decided to harmonize the approaches and equipment for each plant of the fleet for mitigation of severe accident damage, so that the equipment available and experience acquired in one plant can be utilized by another plant. The CPS is also involved in the establishment of the regional response centres equipped with additional equipment available for all NPPs in the country, thus providing a cost effective means for NPP responses to emergencies.

The on-site emergency response is coordinated with off-site assistance (ambulance, medical, hospital, firemen and police services). The overall coordination of ERO includes the station emergency response level, the corporate emergency response level and the federal assistance level. Coordination includes security actions including communications, which are under responsibility of the security coordinator, who reports to the TSC (Emergency Director). The coordination addresses also the ingress/egress in case of emergency, considering both electronic as well as the manual personnel accounting method. There is a number of written agreements with the external support organizations signed both at the CPS level (medical services, fire protection, relocation centres, weather forecast, legal services) as well at corporate Exelon level (11 agreements signed e.g. with DOE Radiation Emergency Assistance Center, INPO, meteorological support, environmental monitoring, etc.).

14.5 VERIFICATION AND VALIDATION OF PROCEDURES AND GUIDELINES

The whole process of verification and validation is described in the plant procedure CPS 1005.12 “EOP/SAG Support Procedure Verification and Validation Program” which was developed in 1991 and updated in 2001 and 2004. The procedure contains a number of forms and checklists developed for commenting, for recording results of verification and validation and for resolution of comments. The table-top method, walk through method or simulator method (only for EOPs) are used as tools for the validation.

Comprehensive verification and validation of EOPs/SAGs as well as associated drills were performed in 1998. Several modifications of EOPs/SAGs since then did not include such significant changes which would require new validation. It is however, clear that ongoing changes in plant configurations and procedures will require new validation of EOPs/SAGs.

The team made a suggestion in this area so that the validation procedure will better reflect the complexity of severe accidents, the current level of knowledge and new requirements in the area of accident management and the role of all participants involved in the execution of SAM actions, in particular staffing of the TSC and its interface with the control room.

14.6 TRAINING NEEDS AND TRAINING PERFORMANCE

There is a well established system of emergency response training, exercises and drills standardized for the whole Exelon fleet, covering both on-site and off-site actions within the emergency plans, including staffing of the control room and the TSC. The CPS procedure on ERO training and qualification specifies, for each position, the required skills and qualifications as well as subject of the training. ERO training is performed annually and it includes exercises and drills once in every 24 months. Training includes initial training, requalification and continuing training. Special requirements are specified for SAM training. Training on the SAGs is done every year, one year focused on SAG-1, next year on SAG-2. Training is completed by an exam; the criteria for successful completion of training are given in the procedure. Training on the use of available mobile sources is ongoing and will be covered more comprehensively after complete installation of FLEX in 2015.

For execution of EOPs and SAGs, staff of the control room and the TSC is trained most comprehensively. Involvement of all other resources is ensured through the station emergency director on command and control. Training and drills include natural and man-initiated external hazards which are considered as one of initiators for transition into a severe accident. Training, exercises and drills in accordance with established procedures are followed by evaluation, participants’ critique, production of evaluation reports and ensuring feedback in order to improve the process.

Full scope simulator (replica simulator) is a powerful tool for training in the area of EOPs including transition for EOPs to SAGs. Until now, only the table-top method using well developed lectures associated with other reference materials was available for training.

However, there is a 2013 initiative of the whole Exelon fleet including CPS with the objective to enhance training in the area of SAM by using simulation tools. These tools include a multifunctional table top simulator (called SAMG Portable Trainer) which is based on MAAP 5 computer code and provides interactive access to all models with graphical depiction of all phenomena. The simulator also offers predictions of consequences up to the off-site dose projections. Dresden and Oyster Creek power stations have agreed to be the two

pilot sites for this initiative. The simulator can be used in the future also for verification and validation of the plant SAGs. By acquiring such a multifunctional simulator, CPS will obtain a powerful and cost effective tool for training as well as for validation of the SAGs.

14.7 SEVERE ACCIDENT MANAGEMENT UPDATING AND REVISIONS

There is a systematic process in place aimed at updating of EOPs and SAGs when new information becomes available. BWROG plays a key role in the whole process. Until 1995, the BWROG generic guidelines (Rev0 through Rev4) covered only EOPs. In 1996, based on the NEI 91-04 report first guidelines combining EOPs and SAGs (EPG/SAG Rev 0) were issued. EPG/SAG Rev 1 and EPG/SAG Rev2 were issued in 1997 and 2001, respectively. Current plant specific EOPs/SAMGs for Clinton NPP are based on EPG/SAG Rev 2. EPG/SAG Rev 3 has been issued in 2013, reflecting different lessons learned from the Fukushima accident as well as security threats. Rev 4 envisages for 2017 should reflect implementation of FLEX provisions and include an integrated response to accidents at shutdown regimes and in the spent fuel pool, as well as all possible new NRC requirements resulting from the outcome of ongoing rulemaking. Considering operating experience (e.g. Fukushima accident), a safety philosophy change or a significant number of partial changes are drivers for development of a new version of the guidelines. The main source of accumulating operating experience is through the BWROG, which includes not only all US BWRs, but also BWR reactors in Japan, Spain, Mexico and Switzerland. There is also some operating experience obtained from WANO, but indirectly, through INPO. Use of generic procedures as a basis for development and implementation of plant specific procedures significantly facilitates updating the procedures and contributes to the quality of final product.

The process coordinated by the BWROG Emergency Procedures Committee is systematic and is considered by the OSART team as a contribution to a good practice 14.1(a) of sharing generic severe accident guidelines worldwide.

DETAILED SEVERE ACCIDENT MANAGEMENT FINDINGS

14.1 OVERVIEW OF SEVERE ACCIDENT MANAGEMENT

14.1(a) Good practice: 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).

14.3 DEVELOPMENT OF PROCEDURES AND GUIDELINES

14.3(1) Issue: The Severe Accident Management Guidelines do not cover accidents occurring at shutdown operating regimes or accidents in the spent fuel pool under conditions of prolonged station blackout, loss of ultimate heat sink and plant surroundings damaged by external hazards.

The team observed the following:

- Conditions for entry into the severe accident mitigation domain consider only plant states for the reactor at power operation.
- Clinton Power Station is developing severe accident guidelines (SAGs) applicable for shutdown operating regimes and accidents in the spent fuel pool but these will be integrated into the overall system of SAGs in about 2 years.
- Existing off-normal procedures for management of accidents in the spent fuel pool and accidents taking place during shutdown operating regimes are not yet integrated in the overall system of SAGs.
- The possible consequences of prolonged station blackout including complete loss of all AC and DC power sources are not comprehensively addressed in the SAGs.
- Clinton power station has not yet completed the process of implementation of equipment and other FLEX provisions and integration of EOPs, EDMGs and SAGs in order to reflect lessons learned from Fukushima Dai-ichi accident.

Following a possible severe accident, the absence of comprehensive SAGs can leave the plant staff under a complex plant situation and high stress conditions without appropriate guidance, possibly leading to inadequate responses and severe consequences for the surrounding area.

Suggestion: The plant should consider updating the SAGs with the objective of extending their scope to shutdown operational regimes and the occurrence of an accident in the spent fuel pool under conditions of prolonged station blackout, loss of ultimate heat sink and plant surroundings damaged by external hazards.

IAEA Basis:

NS-G-2.15

2.11. For any change in the plant configuration or if new results from research on physical phenomena become available, the implications for accident management guidance should be checked and, if necessary, a revision of the accident management guidance should be made.

2.12. In view of the uncertainties involved in severe accidents, severe accident management guidance should be developed for all physically identifiable challenge mechanisms for which the development of severe accident management guidance is feasible; severe accident management guidance should be developed irrespective of predicted frequencies of occurrence of the challenge.

2.16. Severe accidents may also occur when the plant is in the shutdown state. In the severe accident management guidance, consideration should be given to any specific challenges

posed by shutdown plant configurations and large scale maintenance, such as an open containment equipment hatch. The potential damage of spent fuel both in the reactor vessel and in the spent fuel pool or in storage should also be considered in the accident management guidance.

2.17. Severe accident management should cover all modes of plant operation and also appropriately selected external events, such as fires, floods, seismic events and extreme weather conditions (e.g. high winds, extremely high or low temperatures, droughts) that could damage large parts of the plant. In the severe accident management guidance, consideration should be given to specific challenges posed by external events, such as loss of the power supply, loss of the control room or switchgear room and reduced access to systems and components.

2.18. External events can also influence the availability of resources for severe accident management …. Such possible influences should be taken into account in the development of the accident management guidance.

3.111. For any change in plant configuration, the effect on EOPs and SAMGs as well as on organizational aspects of accident management should be checked. A revision of the documents should be made if it is found that there is an effect on these procedures and guidelines.

Plant Response/Action:

Current content of EOPs and SAGs in use at Clinton were developed in accordance with NEI 91-04, Rev. 1: Severe Accident Issue Closure Guidelines, and EOP/SAG Rev 2. Although the EOPs and SAGs are applicable in all modes of operation, the EOPS and SAGs do not specifically address severe accidents that can occur at other than rated condition.

The Industry has recognized, as written, EPG/SAG Rev 3 provides no specific guidance on hot or cold shutdown conditions. NEI 14-01 and the NRC rule making activities associated with on site and off site emergency preparedness are expected to be published in the third Quarter of 2016 and will require EOP/SAG scope to include events initiated from cold shutdown or refuel conditions. The BWROG is developing a project plan that is expected to satisfy the NTTF Recommendation 8 rulemaking requirement(s) for shutdown guidance.

Clinton power station has completed the process of implementation of equipment and other FLEX provisions and integration of EOPs, EDMGs and SAGs in order to reflect lessons learned from Fukushima Dai-ichi accident. The process of revising the SAGs is currently in progress. CPS has draft copies of the SAGs to make comments on at this time. The guidelines have overall goals that protect the reactor, containment, and spent fuel. These guidelines are symptom-based and are not specifically dependent on the initial plant conditions and are expected to bound response to a Beyond Design Basis event initiated from power operation. The EOPs Rev. 3, implemented in conjunction with the FLEX rule prior to the end of C1R15 (May 2015), provide separate EOP entry conditions and mitigation actions related to Spent Fuel Pool level and temperature and are independent of plant operating state.

Actions are in place to continue to support the BWROG Emergency Preparedness Committee in development of generic symptom-based guidelines (EPGs/SAGs) to be used during plant shutdown conditions. This includes implementing EPG/SAG, Rev 4, guidelines that extends the scope of the EOPs/SAGs to shutdown operational regimes and the occurrence of an

accident in the Spent Fuel Pool under conditions of prolonged station blackout, loss of ultimate heat sink, and plant surroundings damaged by external hazards.

IAEA comments:

The team recognises that resolving this issue needs long term measures. After the OSART mission, the station completed the implementation of all equipment and provisions foreseen under the FLEX project, which addresses the main safety challenges experienced at Fukushima, including the loss of cooling capabilities and loss of electrical power as a result of a severe natural event. The station prepared and validated Clinton FLEX strategy documents associated with NRC Order EA-12-049, however the process for revising as necessary the SAG to take into consideration FLEX provisions is not yet completed (e.g. revision of SAG-1 and SAG-2). The station has plan in place to complete this revision by spring of 2016. The revised EOP-8 "Secondary Containment Control" procedure now addresses conditions for entry into severe accidents mitigation domain triggered by spent fuel pool water level or temperature, regardless of plant mode.

Concerning the SAG that covers shutdown and refuelling conditions, the station is awaiting the development of BWROG generic symptom-based guidelines (EPGs/SAGs, Rev 4) to be used during plant shutdown conditions. This general document is expected to be approved by 2017 and the station will be requested within two years to implement these guidelines as necessary to extend the scope of CPS EOPs/SAGs to shutdown operational regimes.

For the time being, CPS does not foresee replacement of igniters by passive autocatalytic recombiners (PARs), which do not need a power supply.

During the OSART FU mission, the station presented the revised EOP-8 "Secondary Containment Control" and FLEX strategy documents. It was noted that while significant progress was achieved with full installation of FLEX provisions, further work is needed to complete the revision process for the SAG so as to extend their scope to shutdown operational regimes. The full integration of EOPs, EDMGs and SAGs is also not yet completed.

Conclusion: Satisfactory progress to date

14.4 PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

14.4(a) Good practice: The approach taken to severe accident damage mitigation is based on the uniform response of the Clinton Power Station and the whole Exelon fleet of nuclear power plants.

CPS in coordination with other nuclear power plants in the Exelon fleet decided to harmonize the approaches used and to acquire standard (primary and backup) equipment for each plant of the fleet for mitigation of severe accident damage. Each site having unified mitigating equipment, some of which is portable including unified connections points of cables and hoses, will allow transferring and utilizing the equipment at another site if needed. The approach taken would also facilitate sharing experiences and resources in training and maintenance.

In addition, the Clinton Power station is involved in the establishment of regional response centres equipped with additional equipment available for all NPPs in the country, thus providing a cost effective means for NPP responses to emergencies. The National SAFER Response Center is in an advanced stage of implementation.

Due to compatibility of the means which allows sharing them with other nuclear power plants in the Exelon fleet and with the regional centre, the CPS will be better positioned to effectively deal with severe accidents by more powerful means and for a prolonged period of time. In this way also public trust and confidence is further strengthened.

14.5 VERIFICATION AND VALIDATION OF PROCEDURES AND GUIDELINES

14.5(1) Issue: The current verification and validation procedure and available plant specific data do not adequately address the validation of the severe accident guidelines.

The team observed and noted the following:

- Comprehensive validation of EOPs/SAGs was performed in 1998 and the station has not yet completed the process of updating them to take into account current level of knowledge and plant changes.
- With the scope of review performed, verification and validation documentation needs to be updated to include current expectations regarding the scope and level of detail of plant specific severe accident analysis.
- Procedure CPS 1005.12, dealing with verification and validation of EOPs/SAGs and developed in 1991, focuses on EOPs and does not explicitly consider severe accidents.
- Procedure CPS 1005.12 is not yet updated to include lessons learned from the Fukushima Dai-ichi accident.
- While both control room and TSC staff are actively involved in the execution of the SAGs and their performance is verified in drills, validation of SAGs according the CPS 1005.12 does not explicitly address the role of the TSC staff.
- There are a number of scenarios analyzed by the MAAP 4 computer code in support of PSA Level 2, but they do not cover all information needed for confirmation of the feasibility/effectiveness of the SAGs.
- Without plant specific accident analysis full validation of the SAGs is difficult; for example it can be difficult to verify if “the plant response agrees with the procedure intent” or “the-procedure steps can be performed in the designated time intervals”.
- Although the verification and validation procedure considers assessment of the environmental conditions in working places for performing staff actions, such assessment can hardly be assessed without availability of plant specific predictions of accident progression.
- Some of the actions from the SAGs to be performed locally (containment venting, turning off equipment endangered by submerging in containment, turning off breakers) may be difficult under high radiation level.
- Plant data available in the TSC are not fully consistent with the SAGs (reactor pressure vessel metal temperature is not available in the TSC); either the parameter needs to be made available or the procedure modified by using another appropriate parameter.

Limited consideration of the role of the TSC and complexity of severe accidents in the procedure for validation of the SAGs and limited plant specific results of severe accident analysis would not provide sufficient basis for the adequate next validation of the SAGs as an important precondition for performing SAGs in a timely and safe manner.

Suggestion: The plant should consider updating the procedure for validation of the SAGs and also completing the existing generic information by plant specific analysis of representative severe accidents as an input for the next validation of SAGs and for staff training.

IAEA Basis:

GS-G-4.1

3.143. Detailed analysis of some severe accident sequences should be performed, including, for example, hydrogen fire, steam explosion and molten fuel–coolant interaction. The results of the most relevant severe accident analyses used in the development of the accident management programmes and emergency preparedness planning for the plant should be specified….

NS-G-2.15

2.38. Appropriate levels of training should be provided to members of the emergency response organization; training should be commensurate with their responsibilities in the preventive and mitigatory domains.

3.8. Additional important elements that should be considered in the development of an accident management programme include:

(5) Verification and validation of procedures and guidelines;

(6) Education and training, drills and exercises;

(7) Supporting analysis for the development of the accident management programme;

…

3.26. Insights into the plant damage states in the evolution of the accident should be obtained wherever possible. They are helpful, as they can help to select strategies, because some strategies can be effective in one plant damage state, but may be ineffective or even detrimental in another. In addition, such insights are relevant for the estimation of the source term and, if available, should be used for this purpose.

3.33. The procedures and guidelines should contain the following elements:

…

—The time window within which the actions are to be applied (if relevant);

—The possible duration of actions;

…

3.45. Procedures and guidelines should be based on directly measurable plant parameters. Where measurements are not available, parameters should be estimated by means of simple computations and/or precalculated graphs….

3.53. In the development of procedures and guidelines, account should be taken of the habitability of the control room and the accessibility of other relevant areas, such as the technical support centre or areas for local actions. It should be investigated whether expected dose rates and environmental conditions inside the control room and in other relevant areas may give rise to a need for restrictions for personnel. It should be determined what the impact of such situations will be on the execution of the accident management programme; the need for replacement of staff for reasons of dose should also be considered.

3.57. Adequate background material should be prepared in parallel with the development and writing of individual guidelines. The background material should fulfil the following roles:

—It should be a self-contained source of reference for:

…
- Results of supporting analysis;

…

3.96. The accessibility and habitability of the physical locations of the teams of evaluators and implementers as well as of the emergency director under severe accident conditions should be checked and maintained. The possible loss of AC power should be considered in providing for communication between the control room and the technical support centre.

3.100. All procedures and guidelines should be validated. Validation should be carried out to confirm that the actions specified in the procedures and guidelines can be followed by trained staff to manage emergency events.

3.113. International research on severe accident phenomena should be followed actively and new insights should be processed accordingly in the accident management programme.

3.115. Analysis of a potential beyond design basis accident or severe accident sequence typically has one of the following objectives: (1) formulation of the technical basis for development of strategies, procedures or guidance; (2) demonstration of the acceptability of design solutions to support the selected strategies, procedures and guidelines in accordance with the established criteria; or (3) determination of the reference source terms for emergency plans….

3.117. In the first step of the analysis of a potential beyond design basis accident or severe accident sequence, a set of sequences should be analysed that would, without credit for operator intervention in the beyond design basis accident or severe accident domain, lead to core damage and subsequent potential challenges to fission product barriers…

3.122. In the second step of the analysis of a potential beyond design basis accident or severe accident sequence, the effectiveness of proposed strategies and their potential negative consequences should be investigated. The analysis performed at this step should also support development of the actual procedures and guidelines, since proper set points to initiate, throttle or terminate actions need to be determined. The potential availability and functionality of equipment and instrumentation, as well as the habitability of workplaces under the prevailing accident conditions, should be investigated.

3.123. In the third step of the analysis of a potential beyond design basis accident or severe accident sequence, once the procedures and guidelines have been developed, they should be verified and validated. Validation requires the development of suitable scenarios. Analysis is necessary to determine the evolution of the accident and the various phenomena to which the operators and technical support centre may need to respond.

3.129. Analysis should be performed to investigate the effectiveness of the accident management guidance and, where feasible, the associated reduction of risks at the plant. Analysis should also be used to demonstrate that dominant scenarios are mitigated.

Plant Response/Action:

The EOP/SAG V&V process was enhanced to incorporate many of the recommendations provided above. These include specifically addressing V&V of the SAGs and conduct of SAG validation in conjunction with the TSC personnel. The V&V process includes validation that field actions can be performed within assumed timelines based on expected environmental conditions, including radiation levels. As discussed in OSART Good Practices, CPS has been actively involved in the development of the Boiling Water Reactor Owner’s Group (BWROG) generic SAGs. Through this forum, CPS has incorporated latest industry estimates of accident progression and plant response to specified actions. The V&V process has been updated to require timely incorporation of latest industry recommendations, including lessons learned from the Fukushima Dai-ichi accident. These industry recommendations are supplemented by plant specific analyses where necessary.

Plant EOPs were updated in the Spring of 2015 to reflect EPG/SAG Revision 3 guidelines. These were validated following the revisions to the V&V process discussed above.

In addition, FLEX guidelines were also incorporated in response to NRC Orders promulgated as a result of the Fukushima Dai-ichi accident. These FLEX guidelines were validated via walkthroughs consistent with the industry guidelines developed through the Nuclear Energy Institute (NEI) and endorsed by the NRC.

Revisions to the SAGs are scheduled to be implemented prior to startup from the upcoming refuelling outage in the Spring of 2016. These changes will be validated in conjunction with TSC personnel as described above.

IAEA comments:

The team recognises that resolving this issue needs long term measures. In the period after the OSART mission, the station has implemented several activities to update the EOPs and to enhance the validation process for EOPs/SAGs. Plant EOPs were updated in May 2015 to reflect EPG/SAG Revision 3 guidelines and SAGs are expected to be revised in spring of 2016. The EOPs were revised in accordance with CPS 1005.09 which was revised in February 2015 to require participation of TSC staff in validation of SAGs. However, CPS 1005.12, dealing with validation of EOP/SAG support procedures is not yet revised and still does not explicitly address the role of the TSC staff in severe accident management. The station should update CPS 1005.12 prior to the validation of the SAGs next version.

FLEX guidelines were also implemented. These FLEX guidelines were validated via walkthroughs consistent with the industry guidelines developed by the Nuclear Energy Institute (NEI) and endorsed by the NRC.

During the OSART FU mission, it was noted that the validation of FLEX was performed by a limited number of station staff. Actually 10 out of 16 procedures were validated by only one and the same person. The process for selection of the number of staff and composition of validation teams is not well specified. The station is encouraged to clarify this process before validation of the new SAGs.

During the OSART FU mission, the revised documents were found easily available in the MCR and TSC.

The station performed analyses on the impact of the missing parameter in TSC (reactor pressure vessel metal temperature) on the effective implementation of SAG and concluded that no further actions are needed, since the diagnostic process where this parameter is used can be performed conservatively even without such data. At the present moment the station is also not considering increasing the scope of the plant specific accident analyses nor software simulation to be used for V&V of the SAGs.

Conclusion: Satisfactory progress to date

DEFINITIONS

DEFINITIONS – OSART MISSION

Recommendation

A recommendation is advice on what improvements in operational safety should be made in that activity or programme that has been evaluated. It is based on IAEA Safety Standards or proven, good international practices and addresses the root causes rather than the symptoms of the identified concern. It very often illustrates a proven method of striving for excellence, which reaches beyond minimum requirements. Recommendations are specific, realistic and designed to result in tangible improvements. Absence of recommendations can be interpreted as performance corresponding with proven international practices.

Suggestion

A suggestion is either an additional proposal in conjunction with a recommendation or may stand on its own following a discussion of the pertinent background. It may indirectly contribute to improvements in operational safety but is primarily intended to make a good performance more effective, to indicate useful expansions to existing programmes and to point out possible superior alternatives to ongoing work. In general, it is designed to stimulate the plant management and supporting staff to continue to consider ways and means for enhancing performance.

Note: if an item is not well based enough to meet the criteria of a 'suggestion', but the expert or the team feels that mentioning it is still desirable, the given topic may be described in the text of the report using the phrase 'encouragement' (e.g. The team encouraged the plant to…).

Good practice

A good practice is an outstanding and proven performance, programme, activity or equipment in use that contributes directly or indirectly to operational safety and sustained good performance. A good practice is markedly superior to that observed elsewhere, not just the fulfilment of current requirements or expectations. It should be superior enough and have broad application to be brought to the attention of other nuclear power plants and be worthy of their consideration in the general drive for excellence. A good practice has the following characteristics:

- novel;
- has a proven benefit;
- replicable (it can be used at other plants);
- does not contradict an issue.

The attributes of a given 'good practice' (e.g. whether it is well implemented, or cost effective, or creative, or it has good results) should be explicitly stated in the description of the 'good practice'.

Note: An item may not meet all the criteria of a 'good practice', but still be worthy to take note of. In this case it may be referred as a 'good performance', and may be documented in the text of the report. A good performance is a superior objective that has been achieved or a

good technique or programme that contributes directly or indirectly to operational safety and sustained good performance, that works well at the plant. However, it might not be necessary to recommend its adoption by other nuclear power plants, because of financial considerations, differences in design or other reasons.

DEFINITIONS - FOLLOW-UP MISSION

Issue resolved - Recommendation

All necessary actions have been taken to deal with the root causes of the issue rather than to just eliminate the examples identified by the team. Management review has been carried out to ensure that actions taken have eliminated the issue. Actions have also been taken to check that it does not recur. Alternatively, the issue is no longer valid due to, for example, changes in the plant organization.

Satisfactory progress to date - Recommendation

Actions have been taken, including root cause determination, which lead to a high level of confidence that the issue will be resolved in a reasonable time frame. These actions might include budget commitments, staffing, document preparation, increased or modified training, equipment purchase etc. This category implies that the recommendation could not reasonably have been resolved prior to the follow up visit, either due to its complexity or the need for long term actions to resolve it. This category also includes recommendations which have been resolved using temporary or informal methods, or when their resolution has only recently taken place and its effectiveness has not been fully assessed.

Insufficient progress to date - Recommendation

Actions taken or planned do not lead to the conclusion that the issue will be resolved in a reasonable time frame. This category includes recommendations on which no action has been taken, unless this recommendation has been withdrawn.

Withdrawn - Recommendation

The recommendation is not appropriate due, for example, to poor or incorrect definition of the original finding or its having minimal impact on safety.

Issue resolved - Suggestion

Consideration of the suggestion has been sufficiently thorough. Action plans for improvement have been fully implemented or the plant has rejected the suggestion for reasons acceptable to the follow-up team.

Satisfactory progress to date - Suggestion

Consideration of the suggestion has been sufficiently thorough. Action plans for improvement have been developed but not yet fully implemented.

Insufficient progress to date - Suggestion

Consideration of the suggestion has not been sufficiently thorough. Additional consideration of the suggestion or the strengthening of improvement plans is necessary, as described in the IAEA comment.

Withdrawn - Suggestion

The suggestion is not appropriate due, for example, to poor or incorrect definition of the original suggestion or its having minimal impact on safety.

LIST OF IAEA REFERENCES (BASIS)

Safety Standards

- **SF-1**; Fundamental Safety Principles (Safety Fundamentals)
- **GSR Part 3;** Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition
- **SSR-2/1**; Safety of Nuclear Power Plants: Design (Specific Safety Requirements)
- **SSR-2/2**; Safety of Nuclear Power Plants: Operation and Commissioning (Specific Safety Requirements)
- **NS-G-1.1**; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)
- **NS-G-2.1**; Fire Safety in the Operation of Nuclear Power Plans (Safety Guide)
- **NS-G-2.2**; Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants (Safety Guide)
- **NS-G-2.3**; Modifications to Nuclear Power Plants (Safety Guide)
- **NS-G-2.4**; The Operating Organization for Nuclear Power Plants (Safety Guide)
- **NS-G-2.5**; Core Management and Fuel Handling for Nuclear Power Plants (Safety Guide)
- **NS-G-2.6**; Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants (Safety Guide)
- **NS-G-2.7**; Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants (Safety Guide)
- **NS-G-2.8**; Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (Safety Guide)
- **NS-G-2.9**; Commissioning for Nuclear Power Plants (Safety Guide)
- **NS-G-2.11**; A System for the Feedback of Experience from Events in Nuclear Installations (Safety Guide**)**
- **NS-G-2.12**; Ageing Management for Nuclear Power Plants (Safety Guide)
- **NS-G-2.13**; Evaluation of Seismic Safety for Existing Nuclear Installations (Safety Guide)
- **NS-G-2.14;** Conduct of Operations at Nuclear Power Plants (Safety Guide)
- **NS-G-2.15**; Severe Accident Management Programmes for Nuclear Power Plants Safety Guide (Safety Guide)

- **SSG-13**; Chemistry Programme for Water Cooled Nuclear Power Plants (Specific Safety Guide)
- **SSG-25**; Periodic Safety Review for Nuclear Power Plants (Specific Safety Guide)
- **GSR Part 1** Governmental, Legal and Regulatory Framework for Safety (General Safety Requirements)
- **GS-R-2**; Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)
- **GS-R-3**; The Management System for Facilities and Activities (Safety Requirements)
- **GSR Part 4**; Safety Assessment for Facilities and Activities (General Safety Requirements 2009)
- **GS-G-4.1**; Format and Content of the Safety Analysis report for Nuclear Power Plants (Safety Guide 2004)
- **SSG-2**; Deterministic Safety Analysis for Nuclear Power Plants (Specific Safety Guide 2009)
- **SSG-3**; Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **SSG-4**; Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **GSR Part 5**; Predisposal Management of Radioactive Waste (General Safety Requirements)
- **GS-G-2.1**; Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)
- **GSG-2**; Criteria for Use in Preparedness and Response for a Nuclear and Radiological Emergency
- **GS-G-3.1**; Application of the Management System for Facilities and Activities (Safety Guide)
- **GS-G-3.5**; The Management System for Nuclear Installations (Safety Guide)
- **RS-G-1.1**; Occupational Radiation Protection (Safety Guide)
- **RS-G-1.2**; Assessment of Occupational Exposure Due to Intakes of Radio-nuclides (Safety Guide)
- **RS-G-1.3**; Assessment of Occupational Exposure Due to External Sources of Radiation (Safety Guide)
- **RS-G-1.8**; Environmental and Source Monitoring for Purpose of Radiation Protection (Safety Guide)

- **SSR-5;** Disposal of Radioactive Waste (Specific Safety Requirements)
- **GSG-1** Classification of Radioactive Waste (Safety Guide 2009)
- **WS-G-6.1**; Storage of Radioactive Waste (Safety Guide)
- **WS-G-2.5**; Predisposal Management of Low and Intermediate Level Radioactive Waste (Safety Guide)

▪ ***INSAG, Safety Report Series***

INSAG-4; Safety Culture

INSAG-10; Defence in Depth in Nuclear Safety

INSAG-12; Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 Rev.1

INSAG-13; Management of Operational Safety in Nuclear Power Plants

INSAG-14; Safe Management of the Operating Lifetimes of Nuclear Power Plants

INSAG-15; Key Practical Issues In Strengthening Safety Culture

INSAG-16; Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety

INSAG-17; Independence in Regulatory Decision Making

INSAG-18; Managing Change in the Nuclear Industry: The Effects on Safety

INSAG-19; Maintaining the Design Integrity of Nuclear Installations Throughout Their Operating Life

INSAG-20; Stakeholder Involvement in Nuclear Issues

INSAG-23; Improving the International System for Operating Experience Feedback

INSAG-25; A Framework for an Integrated Risk Informed Decision Making Process

Safety Report Series No.11; Developing Safety Culture in Nuclear Activities Practical Suggestions to Assist Progress

Safety Report Series No.21; Optimization of Radiation Protection in the Control of Occupational Exposure

Safety Report Series No.48; Development and Review of Plant Specific Emergency Operating Procedures

Safety Report Series No. 57; Safe Long Term Operation of Nuclear Power Plants

- ***Other IAEA Publications***

    - **IAEA Safety Glossary** Terminology used in nuclear safety and radiation protection 2007 Edition
    - **Services series No.12**; OSART Guidelines
    - **EPR-EXERCISE-2005**; Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, (Updating IAEA-TECDOC-953)
    - **EPR-METHOD-2003**; Method for developing arrangements for response to a nuclear or radiological emergency, (Updating IAEA-TECDOC-953)
    - **EPR-ENATOM-2002**; Emergency Notification and Assistance Technical Operations Manual

- ***International Labour Office publications on industrial safety***

    - **ILO-OSH 2001;** Guidelines on occupational safety and health management systems (ILO guideline)
    - Safety and health in construction (ILO code of practice)

Safety in the use of chemicals at work (ILO code of practice)

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