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REPORT OF THE

OSART

OPERATIONAL SAFETY REVIEW TEAM

MISSION

TO THE

ARKANSAS NUCLEAR ONE

NUCLEAR POWER PLANT

UNITED STATES OF AMERICA

15 JUNE – 2 JULY 2008

DIVISION OF NUCLEAR INSTALLATION SAFETY

OPERATIONAL SAFETY REVIEW TEAM MISSION
IAEA-NSNI/OSART/08/147

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INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of the United States of America, an IAEA Operational Safety Review Team (OSART) of international experts visited Arkansas Nuclear One Power Plant from 15 June to 2 July 2008. The purpose of the mission was to review operating practices in the areas of Management organization and administration; Training and qualification; Operations; Maintenance; Technical support; Radiation protection; Operating Experience, Chemistry; and Emergency planning and preparedness. In addition, an exchange of technical experience and knowledge took place between the experts and their plant counterparts on how the common goal of excellence in operational safety could be further pursued.

The Arkansas OSART mission was the 147th in the programme, which began in 1982. The team was composed of experts from Belgium, Canada, Czech Republic, Finland, France, Germany, Hungary, Japan and UK together with the IAEA staff members and observers from Japan and Sweden. The collective nuclear power experience of the team was approximately 350 years.

The Arkansas Nuclear One (ANO) site is a member of a family of nuclear generating stations owned/operated by the company 'ENTERGY'. The site is located about 10 km West-Northwest of Russellville, Arkansas on the Dardanelle reservoir. The plant is comprised of two units. Unit 1 is a PWR manufactured by 'Babcock and Wilcox' with 886 MWe gross rated power operating since 1974. Unit 2 is a PWR manufactured by 'Combustion Engineering' with 1042 MWe gross rated power operating since 1980. Unit 1 has an associated turbine manufactured by 'Westinghouse' and is cooled by water drawn from Dardanelle reservoir. Unit 2 has an associated turbine manufactured by 'General Electric' and is cooled by means of a cooling tower. Both units have their operating license renewed for a total of 60 years. The plant work force is comprised of 761 employees and 175 permanent contractor staff.

Before visiting the plant, the team studied information provided by the IAEA and the Arkansas plant 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 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 IAEA Safety Standards and good international practices.

MAIN CONCLUSIONS

The OSART team recognizes that the managers and staff of Arkansas Nuclear One NPP following the vision of the Entergy nuclear fleet are committed to demonstrate world-class excellence in generating electricity safely, reliably and affordably. The team found good areas of performance, including the following:

- The plant staff utilizes performance indicators to effectively influence plant performance.
- The plant has a focus on behavioral improvements resulting in prompt feedback that drives continuous improvements.
- A site-wide wireless network has been installed and leveraged to enhance worker effectiveness and productivity at the plant.
- The "Plant Data Server" software developed by the plant has enabled all plant personnel to have real-time access to plant data.
- Information technology to support radiation data acquisition and field display results in improved radiological performance.

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

- The plant should review its procedure of sub-criticality monitoring to include enough detail to monitor sub-criticality properly and to take timely action.
- The plant should ensure that control of safety related keys in the Shift Manager key cabinet provides a robust barrier to maintain plant configuration.
- The plant should improve and reinforce the management of non-nuclear materials in the spent fuel storage area.
- The plant should enhance the arrangements currently in place to support timely emergency classification when radioactive releases cannot be measured by installed plant instruments.
- The plant should consider upgrading the contamination monitoring instrumentation and review its location of plant monitoring instruments in order to provide sufficient personnel contamination monitoring.

Arkansas Nuclear One NPP management expressed a determination to address the areas identified for improvement and indicated a willingness to host a follow up visit in about eighteen months.

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1.1 ORGANIZATION AND ADMINISTRATION

The ANO site is managed by a Site Vice-President. Day-to-day responsibility for Nuclear Safety is delegated to the General Manager, Plant Operations. Whilst the Site Vice-President has functional responsibility for the Director of Engineering and the Quality Assurance (QA) manager, both of these functions have a direct reporting relationship into corporate headquarters. This arrangement establishes the level of independence required for the QA Group.

Corporate and site commitment to safety is clear and highly visible as it flows through the organization. Senior Entergy Managers and plant peers frequently attend ANO in person to discuss the plant performance with its management. The plant has developed a comprehensive suite of performance indicators which is used as the basis of these discussions. The team has identified this as a good practice.

ANO management have implemented a number of initiatives designed to retain their pool of experienced and knowledgeable staff and to prepare for a potential skill shortfall in the near/medium future, notably in the Operations area. Additionally, ANO has implemented formal systems to routinely assess the behavioural performance of all personnel.

The U.S. Nuclear Regulatory Commission (NRC) has a permanent office with two resident inspector and one senior resident inspector positions at the ANO site. There are a series of scheduled and ad-hoc meetings between NRC and plant staff – the relationship is mature, cordial and professional. No ambiguity exists as to the plants ownership of safety issues.

ANO has developed and maintains a good relationship with the local community.

1.2 MANAGEMENT ACTIVITIES

The plant's managers devote a significant proportion of their time in 'walking the plant' and engaging directly with the workforce. This, together with the use of a variety of other techniques such as information screens, posters, newsletters and effective briefing ensures that management expectations and goals are effectively communicated to the workforce.

For several years the plant has consistently focussed attention on the development and implementation of its Human Performance programme. Presently, the programme has reached a level of maturity which permits an almost constant exchange of constructive feedback between Supervisors and their team members and between peers. Significantly, the detail of such feedback is recorded and frequently analysed to provide trending of possible deterioration of performance at a very early stage, which facilitates the application of early corrective action. The team has identified this as a good practice.

The plant uses a sophisticated computer based system, the 'Paperless Condition Reporting System' (PCRS) to collect and analyze significant amounts of data. In addition to information relating to systems and equipment, personnel use it as the primary method of reporting their concerns. It is also used to record issues relating to human performance. PCRS provides the plant with powerful trending capability.

1.3 MANAGEMENT OF SAFETY

The plant recognizes the central role of the Operations Department in the provision of safe nuclear operations and orientates itself accordingly. Work is scheduled in a way so as to minimize nuclear risk – a specific model ‘Equipment Out Of Service’ (EOOS) has been developed for this purpose. Significantly, a high proportion of key positions, including senior management posts are occupied by individuals who have held an Operators License. Conservative decision making is a core value within the management team.

During the mission at the plant, the OSART team has identified a number of positive features that are characteristic of the safety culture of the plant. These include:

- The plant is staffed with very motivated, engaged, well trained, knowledgeable, experienced, open minded and cooperative management and staff.

- The plant has developed and applies a strong Human Performance programme (safety minute, HP-traps and tools, 14 key tools for continuous improvement, ANO annual focus areas), which is strongly promoted by all levels of the organization including senior management.

- A comprehensive list of Performance Indicators is used as a tool to look at plant activities and to monitor the effectiveness, identify gaps and drive improvements.

- The plant has put in place a management system supported by a series of meetings where a rigorous and conservative or prudent approach is deployed when planning and performing tasks (e.g. pre-job briefing, tag out, unit reliability team, etc.). This structure provides for an efficient means of communication creating horizontal and vertical alignment throughout the organization.

- Complementary to the human performance programme and re-enforcing it, is the ‘Senior Leadership Focus’ programme which includes the ‘Leadership Effectiveness Logbook’ (LEL). Efficient tools have been set-up to re-enforce human performance, industrial safety and the plant (or fleet) ‘Four Platforms’. These platforms includes the following rules:

  - “Trust, Fairness, Honesty, Integrity”
  - “Be Deliberate and set actions under control”
  - “Follow the rules”
  - “Supervisors and Managers set and continuously reinforce high standards” and “Do what you say you are going to do”.

- It is part of the ANO staff culture to correct their behavior between co-workers without waiting to be corrected by management.

However the team when reviewing documents, when interviewing staff and when performing deep analysis of events or activities concluded that some safety culture features would benefit from improvement. Examples of these items are listed below:

- Various long standing defects remain throughout the plant. The maintenance priority system allows some delay in repairs and has not always repaired plant equipment during the first attempt (oil and water leaks, lighting, fuel leak, primary pump leak, fuel oil leak, etc.).

- The team recognizes the competitive nature of the utility business demands a focus on cost as well as safe operation of the plant. While the plant has made significant capital investments in several areas, certain policies such as overtime and time pressure on outage schedule gave an overall impression to the OSART team that the plant is "cost" driven.

- The plant has a benchmarking programme which is oriented mainly inside USA and would benefit from a broader international base.

1.4 QUALITY ASSURANCE PROGRAMME

A graded approach is applied to the management of safety (Quality Assurance - QA) activities at ANO. The grading system is detailed within corporate documents and is appropriate and is proportional to the safety significance of the activity under consideration.

The QA department routinely provides senior plant management with an assessment based on behavioural performance of staff (the 'mood' of the plant).

1.5 INDUSTRIAL SAFETY PROGRAMME

The event reporting threshold is set at a very low level to capture all low level industrial safety events and near-misses. A 'no-blame culture', together with open feedback has resulted in a very open reporting culture. Pre-job briefs stress industrial safety issues in a clear and unambiguous way. Focussed briefs/information is provided in instances when special/infrequent/particularly hazardous work is to be carried out. A example of this can be seen in the 'Human Performance Improvement Group' (HuPIG) which the OSART team has identified as a good practice in the Operations area.

DETAILED MANAGEMENT, ORGANIZATION AND ADMINISTRATION FINDINGS

1.1 ORGANIZATION AND ADMINISTRATION

1.1(a) Good Practice: The effective use of Performance Indicators to provide a foundation for driving continuous improvement

The plant staff utilizes performance indicators to effectively influence plant performance. The indicators are prevalent at all levels of the organization with lower tier indicators feeding forward to the broader scope indicators. The management team monitors the indicators and drives performance based on the goals reflected by the indicators. Goals are established which represent excellence in the industry. The monitoring of the indicators is woven into the daily plant status meetings to facilitate a high level of engagement in performance. The indicators are also used as key input elements in decisions. The administrative aspects of populating the indicators are integrated into the tasks to minimize the burden.

There are a variety of examples where the indicators have been used to improve performance. In the Radiological Protection area, dose and contamination performance has been sharply improved by broadly communicating the overall goals and then establishing short and intermediate targets for organizational focus. For example, success in meeting the annual dose goal is built upon meeting daily and weekly goals throughout the year. Dose performance is reviewed daily in management and working level meetings. Progress curves are utilized to monitor outage preparation and execution. These curves are reviewed frequently and are utilized to coordinate resources, identify problem areas and motivate the staff. The focus on goals associated with INPO index, forced loss rate, and unit capability factor have also resulted in significant improvements in these areas.

The plant's high level indicators are reviewed by the corporate office and peers from other plants on a six week basis as part of Management Review Meetings. This provides an opportunity to examine performance, challenge goals and exchange ideas for improvements. The higher tier performance indicators reviewed at this level are reflective of the lower tier indicators and performance. This structure helps establish vertical alignment of the organization giving the plant staff common goals.

The indicators are both leading and lagging meaning they are used to establish performance goals for the future and measure past performance. The leading indicators are commonly indicators that measure preparation or monitoring of activities. The lagging indicators commonly measure actual production or accomplishments.

The benefit gained from this approach is a collective focus of the staff on the correct performance elements for the plant. The performance indicators are a leadership tool, a management tool, a communication tool, an education tool and a means of motivation. The engrained nature of the use of performance indicators provides a foundation for driving continuous improvement.

1.2 MANAGEMENT ACTIVITIES

1.2(a) Good Practice: The use of a Human Performance Programme to develop a culture of continuous improvement.

The plant has a focus on behavioral improvements that result in prompt feedback that drives continuous improvements. The focus on behavioral improvements is evident throughout the organization including the management positions and individual contributors. Feedback is provided and accepted freely. The feedback occurs from supervisor to individual contributor, from peer to peer and from individual contributor to supervisor. The behavioral focus has become engrained in the fleet culture where emphasis is placed not only on what is done but how it is done and the behaviors exhibited. Behavioral feedback has become natural, accepted and even sought by all levels of staff and contractors.

Various tools are utilized to provide structure for the behavioral improvements. Leadership Effectiveness Logbooks are utilized as a simple means to document the coaching interaction. Goals are utilized on the number of interactions to help ensure interactions occur. The information is tabulated in a database and reviewed by the second line manager. A simplified coding system of behaviors is utilized to minimize the documentation burden. The database is used to analyze the data for trends. During refuel outages the data is compiled and analyzed daily. Behavior improvement messages are formulated based on the analysis. The message is communicated daily and represents the focus area for the next days coaching. The subsequent day's data analysis is a means of checking for penetration of the message.

The mental and physical wellbeing of the employees is monitored by observation of their behaviors. By observation of the employee, the supervisor establishes a baseline of behaviors. The supervisor observes for deviations from the established norm. The supervisor certifies monthly by signature that the observations have been made and no deviations are noted. Supervisors are trained annually on what behaviors to observe. All employees (including contractors) are covered by this programme.

The foundation for the human performance programme is based on formal procedures. The procedures describe the roles and responsibilities as well as the process elements. The procedures also describe the various behavioral traps (time pressure, shift change, etc.) and provide tools (self check, peer check, etc.) to counteract the traps.

The fundamental benefit of the focus on improving behaviors is that it results in a culture of continuous improvement. The free flow of behavioral feedback both reinforcement (positive) and correction (negative) results in continuously driving to new levels of performance. Errors are reduced and thus plant performance improved because of the feedback on human performance. Employee well being is improved because of early identifications of behavioral issues. Corrections are made before significant consequences are experienced. Additionally, the human performance programme fosters an environment which encourages the development of complementary programmes within the plant.

2. TRAINING AND QUALIFICATIONS

2.1 TRAINING POLICY AND ORGANIZATION

Training policies, procedures and processes are defined in the Nuclear Management Manual. The basic qualification requirements and main training programme elements (initial training, continuous training, training records) are well defined. A systematic approach to training is employed at the plant as a tool for assuring quality of training and training materials. As a consequence, structured task-based and/or competence based training needs analysis, learning objectives/ performance criteria definition, etc. have been systematically applied when developing existing plant training programmes. Nuclear safety topics and ALARA principles are generally integrated into the standard training programmes. Safety culture topics are included in different initial and continuous training modules. Significant nuclear industry events and operating experience are incorporated into the training material. All of these attributes were evaluated by the team to contribute to a good performance.

The site training department provides full-time support for accredited training programmes. Non-accredited training programmes such as Emergency preparedness, Supervisor Training, General Employee Training and Plant access Training are also supported. The responsibility for execution of training in these other groups lies with the respective site line manager. Line managers own their respective training programmes and are engaged in and committed to their success. The line managers identify opportunities to use training to improve performance, monitor training effectiveness, lead the various oversight committees, approve changes to training programmes, provide technical experts, and rotate employees to Training as needed. The training management team is accountable for the training programme performance and continuously seeks opportunities to use Training resources, talents and skills to improve plant and worker performance. The Training Manager is a member of the site leadership team. The OSART team recognizes this as a good performance.

2.2 TRAINING FACILITIES, EQUIPMENT AND MATERIAL

The plant should ensure that all practical fire drills and exercises are performed with the necessary sense of realism, urgency and following proper safety precautions. The team developed an issue in this area.

Diverse training facilities are provided to meet the needs of the training programme. These include appropriately equipped classrooms, self study areas, laboratories, and relevant support infrastructure. ANO also makes use of dedicated mock-ups of plant equipment which provide realistic hands on training, thus enhancing the quality of the experience for the trainees. Examples of some mock-ups are the Instrument and Control integrated control system, and the radiological monitoring system simulator. The OSART team considers the use of simulators and mock-ups to be a good practice.

The training organization is staffed with highly experienced and knowledgeable personnel. All operations instructors have been previously licensed as control room operators and most have been control room operators or shift managers. All instructors have solid experience in the disciplines they instruct. Several members of the training staff have augmented their experience with formal degrees in adult education. The OSART team recognizes this as a good practice.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2 TRAINING FACILITIES, EQUIPMENT AND MATERIAL

2.2(1) Issue: Practical training in fire drills and exercises is not always performed with the necessary sense of urgency and do not always take into account all aspects of industrial safety for trainees.

- During a fire extinguisher training session, the trainees were not wearing sufficient protective clothing.
- The in plant drill observed by the OSART team, was not performed with the proper sense of urgency, therefore reducing the learning potential of the exercise.
- The plant developed a strong programme against heat stress; however warm weather does not provide a sufficient reason for not using protective clothing during the in plant drill which could reduce the realism of the exercise.
- The time needed for the fire brigade to commence operations was 21 minutes. There are no documented performance expectations for response time.
- The fire fighters did not fully take into account the direction of the wind and stood in the downwind direction of the assumed target.

Fire Brigade exercise effectiveness could be jeopardized without taking into consideration all potential hazards.

Suggestion: The plant should consider measures to ensure all practical fire drills and exercises are performed with the necessary sense of urgency and proper safety precautions.

IAEA Basis: NS-G-2.1

8.6 Regular training (routine classroom training, fire fighting practice and fire drills) should be provided for all on-site fire brigade members. Special training should be provided for fire brigade leaders to ensure that they are competent to assess the potential safety consequences to a fire and advise control room personnel.

9.1 All plant staff and contractors' personnel temporarily assigned to the plant should receive training in plant fire safety, including their responsibilities in fire incidents, before starting work at the plant.

- The different types of fire extinguishing equipment provided and their use in extinguishing fires in the initial stage.

2.2(a) Good Practice: Comprehensive training facilities for radiation protection combined with different mockups and number of classrooms are used to enhance plant performance.

The Training department maintains numerous mock-ups of plant equipment that provide hands-on training opportunities for improving worker knowledge and human performance. The line organizations supply resources to either purchase or develop mockups when needs are identified. In many cases, subject matter experts develop the associated training materials and conduct the training under the oversight of the training organization.

For example:

– In the radiation protection training programme a simulator that mimics the plant's radiological monitoring system (RADS) is used to train technicians how to monitor dose rates and accumulated dose for individual workers involved in high risk evolutions, as well as area dose rates throughout the plant. Scenarios are developed that require the trainee to perform system operation and monitoring activities such as alarm response; use of human performance tools such as communication skills; procedure use; place-keeping, and exercise knowledge of procedure requirements. Radiation worker practical factors training walks the staff through the entire RP Radiological Controlled Area training aspects, which include RP basics such as dosimetry issue and return, dress out training for contamination controlled areas through to hazards identification of boric acid on plant items, requirements for high dose rate areas, respirator use, use of RADS, hotspots, locked high radiation areas, active leaks, contaminated tools, foreign material exclusion equipment, use of whole body monitors and small article monitors, radiological hazards of working at heights, use of respiratory equipment, scaffolding and filtered ventilation units.

– Mockups in the Instrument and Controls group include various electronics cabinetry and instrumentation, such as control drive system and integrated control system. The mockups allow trainee to gain detailed knowledge of these systems, practice human performance techniques and provide a means for performing troubleshooting plant issues without incurring potential plant risk associated with on-line troubleshooting.

The extensive use of mockup training provided to staff members serves to improve worker technical knowledge, develop skills, and reinforce expectations and desired behaviors.

2.2(b) Good Practice: Good staffing and plant knowledge improves the effectiveness of training provided to the plant.

The training organization is staffed with highly experienced and knowledgeable personnel. All operations instructors have obtained training and experience as licensed control room operators, and most have been control room supervisors or shift managers. All instructors have experience at the plant in the disciplines they instruct. Through development of training materials and implementing training, the knowledge and operating experiences of these instructors is captured for future trainees as well as current trainees.

Rotational assignments from the line organizations to the training department are made in each training area (operations, technical and maintenance), which allows high performing job incumbents to participate in training development and delivery. These opportunities allow them to enhance their knowledge of the training process while sharing their current plant experience with trainees. Training department personnel support plant activities such as refueling outages and other plant assignments which in turn keeps their technical knowledge current.

Several members of the training staff have formal degrees in education, including specific training courses in adult learning theory and learning styles for young generation learners now entering the workforce. They provide instruction to the remaining training staff in techniques that improves the effectiveness of the training provided to the plant.

The plant's Operations Department owns and works directly with Operations Training. An Assistant Operations Manager from each unit is assigned to training and is responsible for the oversight of the Operations Training Process. Currently, in operations training, there are 22 individuals in the training department who hold or have held a Senior Reactor Operator license at ANO, and an additional 4 individuals who hold a Reactor Operators license.

3. OPERATIONS

3.1 ORGANIZATION AND FUNCTIONS

The different responsibilities of all the staffing positions in the operations department are clearly described. The shift personnel are supported by a large off-shift organization, so administrative burdens in the control room are reduced.

For all infrequently performed tests and evolutions, there is a formal pre-job-brief in which management is involved and has to take part. Pagers are used to keep personnel off-site continuously informed about important issues. Everybody concerned ‘keeps the eye on the ball’.

The overtime rate is high for the operations department in comparison to international standards. The plant intends to evolve from 5 to 6 crews in the future. The team encourages the plant to strengthen the system which ensures that control room operators do not work excessive number of hours.

As a lot of effort is dedicated to optimize the duration of outages, the team advises the management to be aware of the risk of “perceived time pressure”, as the staff are very motivated to keep the milestones as foreseen.

The “job performance measure programme” consists of a yearly test, where operators have to demonstrate their knowledge, skill, and ability in the field on 5 randomly chosen areas. Different benchmarks and assessments are regularly done. All reports are stored in the “learning organization model (LO database)”. The team considers this as a good performance.

Human Performance is recognized as being a vital part of the successful and safe operation at the plant. An Operation’s team has developed the so called “Human Performance Improvement Group” (HuPIG). The programme is organized and led by workers belonging to the operations department. The team recognized this as a good practice.

3.2 OPERATIONS FACILITIES AND OPERATOR AIDS

Operations staff can use locally installed telephones, radios as well as WIFI-mobiles in the installations. Risky zones where the equipment cannot be used are clearly indicated. This is considered as a good performance.

Some labeling of equipment needs improvement so as to be more easily readable. Valves which belong to the category “Reactivity Addition Potential” are not properly tagged. The plant has established a plant labeling coordinator who will be responsible for any concerns in this area. The OSART-team encourages the plant to develop more rapid means of identifying and correcting labeling deficiencies.

While the use of operator aids is generally well managed the team noted some instances where improvements could be made. Similarly the team noted some examples where the plants high standards of material condition were not met. The team encourages the plant to reinforce management expectations in these areas.

In several locations in the plant, torque amplifying devices such as valve wrenches were available to the operations personnel to manipulate valves. Guidance on which wrench to apply to which valve is not available. Valves should be designed and maintained in a manner that they can be manipulated without requiring the use of wrenches. The use of inappropriate wrenches to manipulate a hand wheel of a valve can lead to damaging the valve and/or injury of the field operator**.** The plant management should consider limiting the use of wrenches or other torque amplifying devices to exceptional circumstances, and then only after an appropriate evaluation has been carried out. Management expectations in this area should be clearly defined. The team developed a suggestion for this purpose.

3.3. OPERATING RULES AND PROCEDURES

The operational limits and conditions (OLC) for equipment and systems are clearly defined and tracked by the shift crew. A user friendly log-keeping tool, the electronic Shift Operations Management System (eSOMS), is used and is considered as a good performance by the team.

The operating procedures are clearly written, understood and supported with appropriate reference. Hand-written markings are not allowed on procedures and none were found. In case a procedure cannot be executed as expected, a deviation form gives a guideline whether the operator should stop or adapt the procedure first. The system of managing and tracking temporary changes of procedures is well implemented. The team considers this as a good performance.

3.4. CONDUCT OF OPERATIONS

Professional behavior and attitude in the main control room (MCR) were observed. The plant has clear rules which specify how communication and shift turnovers should be conducted.

A well structured shift relief sheet is used during shift turn-over. The crew remaining in the MCR takes part in the shift briefing, which is held in an adjacent room, via telephone conference.

All briefings were very well performed; however, on one occasion during the formal shift briefing, an incident involving a safety related system was not included. In order to make sure that everyone is kept on the same level of information, the Shift Managers are encouraged to brief the shift crew on all relevant and global information on events that happened in the plant, especially after an extended period off duty.

The number of annunciators being out of service in the MCR was found to be high. However most of the annunciator-related systems are out of operation or the purpose is no longer applicable. The plant is encouraged to adjust the process in order to focus on those systems, which are still operable and need to be monitored.

The team found several deficiencies in the area of the key control system. The team made a recommendation to systematically review the existing key control system in order to provide a robust barrier to maintain plant configuration. This may also contribute to raise the awareness of people who handle safety related keys.

Control room access is controlled by card reader and limited to appropriate personnel. People were observed asking for permission before entering the MCR as expected. The Shift

Manager has the authority to limit the number of people in the control room in order to prevent accumulation of personnel and excessive burden for the operators. Major disturbances from telephone calls, e.g. during shift turnovers, briefings or surveillance testing are effectively suppressed by a technical feature called “shield up”. When activated, all incoming phone calls to the MCR are answered by an answering machine, except emergency calls which are made on the official emergency number. The team has identified this feature to be a good performance.

Field operators effectively verify systems and equipment status, supported by special portable computers, which record, compare and submit important plant parameters. This is recognized to be a good practice in the area of Technical Support (TS).

Several material condition and housekeeping discrepancies were reported by the field operators, however several others were not. The plant is encouraged to maintain motivation and high expectations regarding housekeeping issues in order to minimize the amount of long standing deficiencies.

3.5 WORK AUTHORIZATIONS

The plant uses a probabilistic safety analysis based computer programme “equipment out of service” (EOOS) to assess the risk of the unavailability of certain equipment (e.g. emergency diesel) taking in account some initiating conditions (weather, etc.). This is considered as an area of good performance.

Temporary modification procedures are effectively implemented. It is expected that temporary modifications should be short in duration and few in numbers. A performance indicator has been developed to track temporary modifications which have been in place for more than 60 days. Monthly reports are generated by the engineering coordinators. The temporary modifications performance indicator is discussed at the weekly Unit Reliability Team Meetings and the Quarterly Operations Department Review to accelerate the resolution of the issue and the removal of the temporary modification from the list. This is considered as a good performance.

3.6 FIRE PREVENTION AND PROTECTION PROGRAMME

A comprehensive programme for fire prevention and protection is in place to ensure that measures for all aspects of fire safety are identified, implemented and surveyed.

Automatic fire suppression systems are installed to extinguish or control fires until such time that the manual fire suppression can be initiated by the onsite fire brigade. Water fire suppression sprinkler, spray and deluge systems are supplied from the site fire water loop. The systems are in a good shape; however the team found a few examples of corroded flanges, gaskets and bolts in some areas of the wet pipe water system. The plant is encouraged to maintain fire protection equipment to a high standard.

The onsite fire brigade responds to all fires within the protected area with offsite support provided by the London Volunteer Fire Department.

There is no clear expectation concerning the timely response to fire fighting in any procedures. The team has made a suggestion on this subject in the area of Training and Qualification.

3.7 MANAGEMENT OF ACCIDENT CONDITIONS

During the simulator evaluation training, the crew is observed by 2 plant instructors-observers and an OPS manager, while 2 instructors manipulate the simulator computer. The simulator training session is followed by a debriefing of the performance of the crew which is led by the shift manager. Going through the scenario, individual strengths and areas for improvements were collected and discussed in a very open manner. At the end of the session, each individual and the crew as a team agree on the resolution of all performance shortfalls which have been identified. This is considered as a good performance by the OSART-team.

In any situation where circumstances require the control room to be de-manned, the control room crew transfer to a prepared alternative control position. While this transfer is routinely practiced, the OSART-team encourages the plant to consider an increase in the frequency of training for this occurrence.

DETAILED OPERATIONS FINDINGS

3.1 ORGANIZATION AND FUNCTIONS

3.1(a) Good Practice: Worker ownership of improvement programme to enhance safety and performance of plant operations.

Human Performance is recognized as being a vital part of the successful and safe operation at Arkansas Nuclear One.

An Operations organization (Human Performance Improvement Group, “HuPIG”) has been formed, significantly by individuals at the worker level in the operations organization. This group, which is led by the workers and is fully supported and trusted by the management team, has developed a series of operational focused human performance tools, designed to improve the safety and performance of Operations Department. This group also reviews condition reports, operating experience and human performance improvement forms. The results are communicated to the site leadership team and to the individual crews to use as lessons learned.

Individuals in this group have influenced their peers to make their minor errors and near misses public, so that the entire department may learn from them, but also to look for good performance and ensure that these get recognized. The results and examples of Human Performance Improvement Forms and Good Catch awards are visible on the “HuPIG web page”.

The results of this group’s efforts can be for example seen in the Component Status Control Performance Indicator. In August of 2007, the human performance group was asked to help resolve the degrading performance in the area of plant status control. The group developed a recommended action plan and presented it to the management. This plan was implemented and, within a short time, the degrading trend turned into an improving trend.

3.2 OPERATIONS FACILITIES AND OPERATOR AIDS

3.2(1) Issue: Torque amplifying devices (valve wrenches) are allowed to be used to manipulate manual valves without formal approval or risk analysis.

- In several locations in the plant, torque amplifying devices such as valve wrenches were freely available to the Operations personnel to manipulate valves.

- Wrenches with different handle lengths are stored near valves with diverse hand wheel diameters. Guidance on which wrench to apply to which valve is not available.

- Procedure OP-1015.001 "Conduct of Operations", section 11, stipulates that these wrenches can not be used for Motor operating valves. In case torque limits do apply, torque measuring devices shall be used.

- Procedure OP-1015.001 "Conduct of Operations", section 12, makes clear these wrenches can not be used for manipulating air operated valves.

- Procedure OP-1015.001 "Conduct of Operations", section 13 states that for manual valve operation, wrenches can be required, and that in that case the operator should make an evaluation for the need of valve maintenance, based on criteria such as type and size of the valve, the system pressure or any physical restraint that can limit proper access to the valve hand wheel. If he considers valve maintenance is required, the operator should make a work request.

- The limitations for the use of valve wrenches on manual valves are not clear and may allow operators to apply excessive torque resulting in damage to valves. Where standards exist, the standards do not provide clear guidance on when and how valve wrenches should be used.

- Manufacturer instructions typically give the rim force and maximum recommended torque for their manual valves and caution against using wrenches or other devices on the hand wheel to increase the operating force (e.g. manufacturers Fisher, Borg Warner, Powell).

- Wrenches are very often used in the field to open or close manual valves as many valves are not easy to manipulate (estimated 30% by one Waste control operator).

- ER-ANO-2003-0122-000 provides a tooling evaluation for valve hand wheel torque wrench adapters that can be used by operations to properly apply measured torque to manually seat motor operating valves. Regarding manual valves however, there is currently nothing in ANO procedures or processes which would trigger an operator to obtain torque limits and measure the applied torque. Operation's has never used the special torque application device on manual valves.

- According to the ANO site engineering some valve failures have recently occurred that may have been caused, in part, by the improper application of additional torque.
- It is an international good practice not to have these torque amplifying devices available in place, but to ensure all valves can be manipulated without using these devices, in order to avoid damaging the valve stem, seat or discs. Proper maintenance of the valve (lubricating) can in many cases be the solution.

The inappropriate use of wrenches to manipulate a valve can lead to damaging the valve and/or injury of the field operator**.**

Suggestion: The plant management should consider limiting the use of torque amplifying devices (valve wrenches) to exceptional situations after a proper evaluation, approved by supervision.

A standard should be considered that clearly defines the expectations and contains specific guidance.

IAEA Basis:

50-SG-Q13

Condition monitoring

404. Monitoring of installed items should be carried out during the operation stage to confirm their satisfactory condition. Equipment, monitoring frequency, criteria and monitoring methods should be identified and should include, for example, those presented in Annex II. Information from condition monitoring should be fed back to those responsible for the review of the maintenance programme and used to improve performance.

NS-G-2.14

3.3 Field operators are responsible for the control of operational activities outside the control room; such activities should be carried … with relevant operating instructions and procedures.

3.6 The field operators who are assigned to control operational activities outside the control room should be made responsible for monitoring the performance and status of equipment in the field and for recognizing any deviations from normal conditions.

3.4 CONDUCT OF OPERATIONS

3.4(1) Issue: Control of safety related keys in the Shift Manager key cabinet does not provide a robust barrier to maintain plant configuration.

- Inside the Shift Manager's key cabinet no obvious distinction between safety related and non-safety related keys is made. Safety related keys are not clearly identifiable.
- The plant relies mainly on process and procedure controls to ensure the proper positioning of safety related valves and components.
- At least 5 category 'E' keys, which unlock safety related valves and components, were missing from the shift manager's key cabinet in Unit 2 and had not been logged in the shift manager's log. For both units the key list was found not to be updated.
- Only one category 'E' key is listed in an attachment to the key control procedure 1015.001, but numerous category 'E' keys are also administered in an additional key list aside from a controlled procedure.
- The plant policy does not require retention of key log records under the terms of procedure 1015.001, making event investigation more difficult.
- An inventory verification of the Shift Manager's key cabinet is performed only every 18 months.

Without a reliable control of plant safety related keys, system reliability may be reduced.

Recommendation: The plant should ensure that control of safety related keys in the Shift Manager key cabinet provides a robust barrier to maintain plant configuration.

IAEA Basis:

NS-G-2.14

5.6 Specific measures should be developed and maintained to prevent access to systems and equipment important to safety. These measures should include controlled access to certain rooms or compartments and an effective key control system or other measures to prevent an unauthorized change in position of or an unauthorized intervention affecting certain important safety valves, transmitters, breakers or other specified equipment.

50-SG-Q13:

345. There shall be a system to confirm plant configuration. Control measures, such as locking and tagging, should be documented and be used to ensure the protection of personnel and equipment during maintenance, modification and testing and to prevent inadvertent operation. The positions of valves, switches and other items important to safe operation shall be known.

4. MAINTENANCE

4.1 ORGANIZATION AND FUNCTIONS

Maintenance policies are maintained at a level which meets the requirements of current practices. They are frequently assessed by fleet peer groups, INPO, and industry best practice. There is recognition that benchmarking standards are largely US and that international review/involvement may prove beneficial/improve perspective.

The plant has developed a number of techniques to improve safety. These include the deployment of “Safety Observers” and the use of “Lanyard Cards”. The team considers this as a good practice.

4.2 MAINTENANCE FACILITIES AND EQUIPMENT

The plant has a number of well-equipped workshops that are spacious and well lit. Tools and equipment are well maintained; consumable supplies are adequate and available when needed.

However, some deviations were identified. Specifically it is not plant policy to mark all lifting equipment with a unique identification number, or to carry out routine electrical safety checks on portable electrical equipment other than visual inspections. The team encourages the plant to review its policy in this area.

4.3. MAINTENANCE PROGRAMMES

While the plant has a number of mature processes to manage maintenance programmes, the process can allow known equipment conditions or deficiencies to remain unresolved for lengthy periods. The team encourages the plant to develop a programme to ensure deficiencies are corrected in a timely manner.

The plant has a well-developed policy to manage the Regulatory requirements for (a) life management of the plant and (b) conditions for life extension. However, these requirements are largely focused on significant equipment and systems and the team noted that some facility related equipment was showing signs of degradation. The team encourages the plant to incorporate equipment which has a less direct influence on safety into its ageing programme.

4.5 CONDUCT OF MAINTENANCE WORK

The plant has recognized the importance of operating a robust Foreign Material Exclusion (FME) policy; consequently the plant has devoted a significant resource to improving the implementation of FME requirements in the field. The team recognizes FME as an area of good performance.

4.7 WORK CONTROL

The work control process is specified in procedure EN-WM-100. It is a mature and sophisticated process. Process control is exercised by the combined efforts of numerous groups and committees. The plant employs a suite of high quality management tools that result in an efficient process.

4.9 OUTAGE MANAGEMENT

The plant has developed a 'Control Center' concept for the management of the delivery of outages. The control center is well staffed with experienced and trained personnel (many of whom have experience as SRO's) working a 2 shift system for the duration of the outage. Additionally, managers and supervisors assume outage 'Leadership' roles for the duration of the outage to ensure compliance with the plan.

Outage planning is effective. For example, appropriate resources are devoted to this activity – the "Milestone" concept is a powerful tool which is a key component of the plant's long term planning preparation for outages. The team considered outage preparation "Milestone" implementation as a good practice.

DETAILED MAINTENANCE FINDINGS

4.1 ORGANIZATION AND FUNCTIONS

4.1(a) Good Practice: Plant committment to industrial safety for maintenance activities is clear and highly visible.

Examples of this commitment include:

– Safety Observer:

Following a plant initiative to significantly improve industrial safety performance, ANO management and the general contractor have worked together to introduce and develop the role of Safety Observer. While the responsibility for personal safety remains clearly with the worker, the safety awareness level of the crew has been augmented by the oversight that the Safety Observer brings to the work. The Safety Observer is selected by the working team, from the team, prior to performing the pre-job brief. The Safety Observer's responsibility is to ensure that the team adheres to all safety rules (such as ensuring personal protective equipment (PPE) is worn and a safety minute is performed at the work area). Additionally, the Safety Observer is a visible point of contact for questions when industrial safety concerns arise or actions need to be taken. The safety observer position is well recognized, his authority is fully accepted among his co-workers and fully supported by management.

The safety observer is identified by highly visible lanyard cards which also details the expectations of the position..

Lanyard card 1 states the following:

Side 1= “ SAFETY OBSERVER“.

Side 2= What would make the Task Safer??

- REINFORCE:
  - PPE Requirements
  - Use of “The Safety Minute“
  - Fall Protection Requirements
- Reminder of Plant Conditions
- Watch for Heat Stress Issues
- Maintain Questioning Attitude

Lanyard card 2 states the following:

– Employee Authorization to STOP Work

“As a contractor representative, you have the Authority without fear of reprimand or retaliation, to immediately stop any work activity that presents a danger to you, your co-workers, our clients, partners or the public. It is your responsibility to get involved by questioning and rectifying any situation that is identified as not in compliance with our Environmental Health and Safety policies. You are to report any conditions or activities that involve violation of established Environmental Health & Safety policies. If you don't feel the issue is addressed adequately, you have the responsibility to raise the issue higher.“

4.9 OUTAGE MANAGEMENT

4.9(a) Good Practice: The plant implementation of pre-outage preparation milestones results in more thorough disciplined planning of refueling and un-planned outages. Thorough preparation facilitates executing the outage in a controlled fashion.

The plant utilizes the milestones to ensure sufficient actions are taken to execute safe and efficient outages. The process consists of 67 milestones that provide the preparation sequence. The milestones include the provision for key performance indicators that are reviewed for current status and to identify additional help or contingencies. Key milestones include:

- Engineering modifications complete
- Regulatory body approval
- Industrial safety plans finalized
- Radiation exposure estimate finalized
- Budget approved
- Work scope freezed
- Work order planning complete
- Resources (workforce, materials) available on site
- Training complete, etc.

The fleet procedure that governs the milestone process is EN-OU-100 (Refueling Outage Preparation and Milestones).

The benefit of rigorous compliance to the milestones includes:

- Improved safety for refueling outages,
- Improved industrial safety performance,
- Improved Radiation Protection planning and execution, etc.

Additional benefits are the improvement of communication and preparation between fleet management, plant management, contractors and the plant staff. Management is fully engaged and supports the EN-OU-100 milestone process. This process forces organizational alignment.

5. TECHNICAL SUPPORT

5.2 SURVEILLANCE PROGRAMME

The plant has a comprehensive procedure which governs the surveillance testing. Data is not only taken from surveillance tests but also from other monitoring activities and collected by the designated engineer. Data was extensively trended and checked by the designated engineer and it was easily retrievable. The team recognized this as a good performance.

During the In-Service Inspection of the high pressure injection piping support in 1996, the plant identified the wear between support and piping. It was well reviewed and confirmed that there is adequate margin and decided to check it every outage. It was conducted as a visual inspection of this support. In the inspection package there were drawings of piping which showed the extent of the wear and the plant checked that the wear was not progressing by measuring it. However, the process and actual measured data was not documented; the only detail documented was that the wear had not changed since 1996. The team encourages the plant to consider developing clear process for this kind of testing.

5.3 PLANT MODIFICATION SYSTEM

The plant has a comprehensive procedure that governs every step of modification activity. The team reviewed two modification work procedures, and found some area for improvement in developing work procedures. For example, one part of the modification work instruction and one test equipment check were not written in the work procedure. The team encourages the plant to reinforce the development of the modification work procedure to be fully in line with the governing procedure.

5.4 REACTOR CORE MANAGEMENT (REACTOR ENGINEERING)

During the core loading and the start up of the plant, sub-criticality was monitored by measuring the neutron count rate with two external neutron detectors. This process was clearly written in the procedure and it was recorded in the stipulated form. However, minimum count rate was not stipulated except for the Unit 1 start up procedure and the associated action level was not always clear. The team recommended reviewing the plant procedure on sub-criticality monitoring to include enough detail to monitor the sub-criticality properly and to take timely action.

5.5 HANDLING OF FUEL AND CORE COMPONENTS

Fuel handling is governed by the plant procedure and the requirement is well written in that procedure. However, the team found several cases where fuel handling practice could be improved. The team made a suggestion that the plant considers conducting a review of its fuel handling activities with a view to updating and improving current practices.

Materials which are handled and stored in the Spent Fuel Pool (SFP) are governed by plant procedures. This procedure clearly stipulates the responsibility regarding materials and storage location. Also, log keeping is required for the stored materials. However, the team found several cases were the management of non-nuclear materials in the SFP area was not properly controlled. The team recommended improving and reinforcing the management of non-nuclear materials in the spent fuel storage area.

5.6 COMPUTER BASED SYSTEMS IMPORTANT TO SAFETY

A site-wide wireless network (WLAN) has been installed and leveraged to enhance worker effectiveness and productivity at Arkansas Nuclear One. While wireless networking in itself is not unique, the techniques and extent to which it has been leveraged at ANO is currently at a good level. The WLAN enables usage of all the benefits gained by networked global applications in areas that were previously without network connectivity; in particular, within the power block of the nuclear unit itself. The team considers this as a good practice.

Site developed software has enabled ANO to maintain consistent high availability and reliability from its plant process computer systems. One of these on-site developed systems is the Plant Data Server (PDS). The team considers this as a good practice.

DETAILED TECHNICAL SUPPORT FINDINGS

5.4 REACTOR CORE MANAGEMENT (REACTOR ENGINEERING)

5.4(1) Issue: Plant operating procedures are not detailed enough to monitor reactivity changes during core loading operation and during approaches to criticality.

- In the engineering document, minimum count rate of the source range detector in the case of "Approaching to criticality activity" (start up, not fuel loading) is stipulated based on US Regulatory Guide. US Regulatory Guide 1.68, Revision 2, requires a minimum count rate of 0.5 counts per second (cps) and a signal-to-noise ratio greater than 2 prior to commencing start up. This count rate ensures that signal is enough to monitor the criticality against back ground level. However, ANO-1 only requires a minimum count rate check (via OP-1102.008, Approach to Criticality), and the ANO-2 Reactor start up procedure (OP-2102.016) does not require either check. No justification for this omission has been provided.
- The plant does not have a minimum count rate requirement during core loading. During the core loading of 1R19 (unit 1, 19th reload), minimum count rate was 0.1 cps at the start of the reload and 0.6 at the end of the reload. The plant informed that above US Regulatory Guide requiring minimum count rate applies to core start up, and has no minimum count rate requirements for core loading. However, the plant could not show why minimum count rate requirement should not be imposed during core loading operations since core reactivity is being changed during the core load process.
- Although the plant is monitoring neutron count rate during the fuel loading with guidance for both units that directs the operator to stop and review core alterations if unexpected counts are observed, numerical criteria for determining what constitutes an unexpected change in the count rate are not described in the procedure.
- The procedure "approach to criticality" (1102.008) was reviewed. In this procedure it is written that "if unexpected count rate/power additions are observed, then immediately insert control rods to stop addition or if required, trip the reactor". Although the numerical criteria for taking timely action to address unexpected count rate increase is contained in the plant annunciator response procedure, such guidance is not written in the approach to criticality procedure. The operations manager said this will be discussed during pre-job-briefing, and operators will refer to the annunciator corrective action procedure where criteria are more precise. However, the operations manager agrees that it could be clarified in the approach to criticality procedure.
- When questioned, the reactor engineer was not aware of the event which occurred at Dampierre during fuel loading. The plant had evaluated the Dampierre event (OE INPO Document SEN 227, "Improper Fuel Reloading Results in the Incorrect Locations for 113 Fuel Assemblies") in their corrective action system in 2005. The lessons learned from this event (and other associated industry experience) have resulted in improved requirements for proper communications and shift turnover details as well as requirements for the use of spotters on the Main Refuel Bridge and Spent Fuel Machine as second person verification. However, the reactor engineer's unawareness of

this OE indicates a need to add the Dampierre event to the reactor engineering periodic refresher training.

Without properly monitoring the sub-criticality and without taking the timely action, the plant could miss the opportunity to identify the symptom of degrading sub-criticality and could miss the opportunity to take action in a timely manner.

Recommendation: The plant should review its procedures for monitoring reactivity changes during core loading operation and during approaches to criticality to include enough detail to allow for timely identification of unexpected changes to sub-criticality condition.

IAEA Basis:

NS-G-2.5

2.43. There should be strict control of core discharge, reload, shuffle or on-load refueling, and all core alterations should comply with predicted configurations. Throughout such changes, core reactivity should be monitored to prevent an inadvertent criticality and all fuel movements should be in accordance with detailed, approved procedures. Intermediate fuel patterns should be no more reactive than the most reactive configuration considered and approved in the design (some reactors using natural uranium show a reactivity increase as plutonium builds up in the fuel during its early use). There should be a method of checking that fuel movements would not be in conflict with each other, and it should be possible to track back the actual fuel movements made if necessary.

4.9 When a significant quantity of fuel is being loaded into a shut down reactor, the subcritical count rate should be monitored to prevent an unanticipated reduction in the shutdown margin or an inadvertent criticality.

5.5 HANDLING OF FUEL AND CORE COMPONENTS

5.5(1) Issue: Fuel handling activities are not always conducted in a rigorous manner.

- Spent fuel bridges were parked over the fuel, although there was enough space to park over the operations floor. A fuel handling tool was hung on the Spent Fuel Pool (SFP) bridges over the spent fuel rack although there were several places to hang it outside of the fuel rack. The spent fuel bridge has been evaluated and authorized by plant design to be parked over the fuel and the tools are well below analyzed heavy load limits. However, this practice is viewed to be not in line with international good practice.
- After the fuel loading, a core inventory check was conducted. The plant procedure (OP-2502.001) requires documentation of fuel loading configuration on a specific form, for comparison to the planned configuration. However, document which is archived as inspection record was not filled in, instead a planned core map was attached. The core map does not contain orientation while orientation should be checked according to procedure. (Orientation means the position of the fuel assembly in the core with regards to its vertical axis). The plant explained that the core map from the reload report was utilized to check the core configuration and that all assemblies were oriented the same in the core every outage, so orientation was thought to be common knowledge. The configuration check was conducted verbally using three personnel. This practice has been used since 1997 without modifying the procedure.
- When the fuel is moved, the ‘from’ position and ‘to’ position is checked and independently verified for each fuel movement. Two signatures are required on the control sheet. However, four cases were found where one of the second check signatures was missing on a control sheet.
- When there was over-load or under-load hoist trip, the trip time was recorded. Unit 2 procedure OP-2502.001, Refueling Shuffle, requires the maximum or minimum load to be recorded; however, the Unit 1 procedure OP-1502.004 does not require the maximum or minimum load to be measured and recorded.
- As a prerequisite to fuel unloading, an inventory check of the SFP was conducted. After the inventory check, fuel handling training was conducted using dummy fuel. After this training, the dummy fuel was not returned to the right place and it was found during the fuel unloading. A condition report (CR) was issued, but the corrective action (CA) was „to make sure to return the dummy fuel“. The proper CA would be „not to move the fuel and the dummy after the inventory check, or to conduct a inventory check again if the fuel or the dummy are moved“.

Without rigorous attention to detail during fuel handling, there is an increased risk of damage to the fuel and losing core configuration control.

Suggestion: The plant should consider conducting a review of its fuel handling activities with a view of updating processes and improving current practices.

IAEA Basis:

NS-G-2.5

4.4 When fuel is moved from storage, it should be identified and checked against the approved refueling programme. Arrangements should be made to ensure as far as possible (for example, through an independent check by personnel not directly involved in the loading operation) that the fuel has been loaded into the specified position in the core and correctly positioned (and, in the case of light water reactors, with the specified orientation). Any sub-criticality checks to be performed during offload refueling should be specified in the refueling procedures.

4.13 For purposes of radiological protection, precautions to be taken in handling unloaded fuel, core components and materials and any disassembly operations should be specified in the procedures. There should be a clear policy to use only suitable and designated areas for storing (even temporarily) irradiated or contaminated items in order to avoid the spread of contamination or the risk of undue radiation exposure.

4.19 The following are examples of specific issues which should be taken into consideration for reactors that are refueled off-load:

…

– A final check should be carried out before vessel closure to ensure that the core has been correctly loaded (checking fuel and core component identification)

…

5.5(2) Issue: The management of non-nuclear materials in the spent fuel storage area is not properly controlled.

- According to the plant procedure, non-nuclear material stored in the SFP shall be identified in the „Miscellaneous Material Location Log". However, 7 items in the unit 1 SFP and 3 items in unit 2 SFP were logged as „unidentified" materials.
- Hanging non-nuclear materials over the spent fuel rack is not prohibited at the plant. Used filters are stored over the fuel rack in unit 2. There is no physical protection to avoid colliding with fuel handling tool.
- According to the plant procedure, impact analysis is not required. For example, there is no weight restriction to store the non-nuclear materials inside and outside of the spent fuel rack. Chemical component restriction does not exist. Interaction with the rack or the support in the case of seismic event is not considered in the procedure.
- The logbook should contain the name of the RP technician who assisted with placing items into the pool. However, there were no entries for all 131 non-nuclear materials stored in unit 1 SFP and 2 SFP.
- Among 131 non-nuclear materials which are stored in SFP of Unit 1 and 2,
  - 94 cases were found that stored date is unknown. Some of them were apparently stored recently.
  - 4 cases were found where the ID numbers of „Locked hanger" where non-nuclear materials were hooked are unknown
  - 126 cases were found that last known dose rate was unknown (It is not mandatory; however, even the dose rate of recently stored filters were not recorded.)
- Although the Reactor Engineer noticed that the non-nuclear materials logbook was not updated in a proper manner, coaching was not provided to the plant person to follow the procedure.
- At the spent fuel pit area of unit 2, „Miscellaneous Material Log Book" was informally placed on the stand of Dry Fuel Storage Handling Tool.
- After the cleaning of the spent fuel, used filters which contain an estimated value of 2000Ci were moved from cask loading pit to SFP area. Although it is under RP oversight, written procedure does not exist to control this work. Instead, for this activity the work controls are provided by Radiation Protection via Radiation Work Permit. For example, the final storage area was informed verbally at the spot. In 2R18 a Tri-Nuc water cleaning filter was dropped and recovered with no spread of contamination; however, this event may have been avoided with more strict procedural controls for this activity. A condition report was not issued in 2006 and the plant started an investigation after it was identified by the reviewer.

Without proper control of the SFP area:

- The design basis of SFP and fuel integrity might be challenged
- Fuel handling may be hindered
- Storage items may cause unnecessary contamination in the SFP.

Recommendation: The plant should improve and reinforce the management of non-nuclear materials in the spent fuel storage area.

IAEA Basis: NS-G-2.5

5.8 The handling and storage areas for irradiated fuel should be secured against unauthorized access or unauthorized removal of fuel. Core components intended to be handled or stored in areas for irradiated fuel should be managed in a specified and safe manner.

5.13 For storage under water, water conditions should be maintained in accordance with specified values of temperature, pH, redox, activity and other applicable chemical and physical characteristics so as:

- To avoid the corrosion of fuel, core components and structures in the pool by maintaining suitable pH values and other applicable chemical conditions (for example, halogen ion concentration);

- To reduce contamination and radiation levels in the pool area by limiting water evaporation and water activity;

- To facilitate fuel handling in the pool by maintaining water clarity (removal of impurities and suspended particles) and providing adequate underwater illumination;

5.14 To avoid damage to fuel stored in the storage pool, the movement of heavy objects that are not part of the lifting devices above stored fuel should be prohibited unless specifically authorized on a case by case basis. All lifting should be restricted to the minimum height necessary to complete the operation safely. The pool crane should be checked prior to the start of fuel handling to ensure correct operation.

6.1 The aspects to be considered in the handling and storage of unirradiated components should include prevention of physical damage, assurance of cleanness and prevention of radioactive contamination.

5.6 COMPUTER BASED SYSTEMS IMPORTANT TO SAFETY

5.6(a) Good Practice: Leveraging wireless technology to enhance plant operations.

A site-wide wireless network (WLAN) has been installed and leveraged to enhance worker effectiveness and productivity at Arkansas Nuclear One.

While wireless networking in itself is not unique, the techniques and extent to which it has been leveraged at ANO is currently at a good level. Also superior to the ANO WLAN implementation is the high standards of reliability and security. The WLAN enables usage of all the benefits gained by networked global applications in areas that were previously without network connectivity; in particular, within the power block of the nuclear unit itself. Once the enabling technology was placed in the hands of very innovative people in line organizations, use of it to bring new solutions to old problems flourished.

Operations, Chemistry & Engineering personnel have leveraged the wireless network in several areas to improve productivity and quality of operations. It provides personnel with real-time plant monitoring for local evolutions, wireless camera monitoring of remote plant areas, and use of a "Pocket PDS" client and other mobility tools on their wireless PDA's.

For Radiation Protection, the wireless network has been the impetus for process productivity and quality enhancement, such as direct entry and update of survey data. Wireless cameras provide quick setup for monitoring high radiation areas; the cameras enable personnel to remain in low dose areas, while monitoring activities.

Maintenance & Outage Management personnel have also leveraged this technology for productivity gains. Wireless VIPER valve actuator testers are used for MOV/AOV testing, and immediate feedback to MOV engineers. Maintenance personnel can access all current reference library material in the field. Also, I&C utilizes wireless PDS in the field to reduce resources needed for string checks.

Management personnel have adopted wireless Tablet PC's as the form factor of choice, and the site-wide wireless network enables them to be in the field while still being constantly connected to online resources and corporate applications.

Security personnel utilize the wireless network in innovative solutions to everyday use, including the Positive Identification System (PIDS) system to photo-verify individuals at access check points, use of ad-hoc local access control at security doors, and wireless pan/tilt/zoom cameras for ad-hoc security monitoring.

Training has also leveraged the wireless network to cut costs and improve the training environment. Trainees have online access to lesson plans, system training manuals, and other classroom reference material.

5.6(b) Good Practice: Plant Data Server enhances monitoring and trending capabilities.

Site developed software has enabled ANO to maintain consistent high availability and reliability from its plant process computer systems. Developing software on-site has proven very cost effective by maximizing process efficiency and minimizing reliance on and costs paid to vendors.

One of these on-site developed systems is the Plant Data Server (PDS). This computer system enables real-time access of plant data to all plant personnel, including remote access from home. PDS is used to publish data from each unit's Plant Monitoring Computer, along with other data sources, and provides information in a consistent format directly to the desktop. Integrated performance monitoring features (workspaces for customizing trends), links to other performance monitoring documents, enhanced trending tools, tools for easier transient analysis, multi-cycle archives, and a mechanism to annotate plant data events are just a few of the benefits provided by this system.

The data acquisition high level of fidelity allows early identification of very small parameter changes. PDS utilizes an in-house developed data historian that does complete archiving of all data in a high resolution mode. All historical data is available at all times, along with real time data, to facilitate diagnostics of plant problems.

The PDS client is a standard component on the Entergy Nuclear computer desktop and provides a rich set of graphical tools. These tools assist in operations, monitoring transient evolutions, plant maintenance and diagnostics, and performance monitoring. In addition to plant computer data from each unit, PDS also integrates data from the SPDS (Safety Parameter Display System) for each unit, data from the RCP Vibration Monitoring System, WinCDMS (chemistry data), and eSOMS data (operator log readings). Data from any or all of these disparate data sources can be trended together to give plant personnel a powerful data set for analysis.

A notification system is also included in PDS. This enables anyone to be notified by email or pager when any parameter reaches a specified value.

6. OPERATING EXPERIENCE FEEDBACK

6.5 ANALYSIS

The Operating Experience and Corrective Action Programme meet all relevant requirements of IAEA Safety Standards. It was noted however that ANO relies heavily on the root cause, apparent cause analysis, and management oversight processes such as the Condition Review Group, (CRG) and the Corrective Action Review Board (CARB) to ensure that adequate corrective actions are implemented in the field. The main governing documents for these processes, namely corporate level document EN-LI-119 Apparent Cause Evaluation Process, and EN-LI-118 Root Cause Analysis Process include elements of policy, process, and training manual within them. The programme is dependent upon the successful integration of the governing documents, the investigations/analysis, and management oversight.

While the process generally works, the quality and effectiveness of the corrective action programme could be improved. Due to the reliance on management oversight to ensure an adequate level of quality in the investigations, training for managers in the principles of investigations could improve the quality of the oversight role. It is the opinion of the OSART team that the governing documents are cumbersome and somewhat difficult to follow due to the multiple functions of these documents.

The team encourages the plant to augment the level of formal training provided to persons conducting root cause and apparent cause analysis as well as to those managers who sit on oversight committees such as the CRG and the CARB. The team also encourages the plant to separate the governing documents from the process and training elements of the Root Cause Evaluation, and Apparent Cause Evaluation Process documents.

6.9 ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE

The overall self-assessment strategy at ANO includes detailed departmental self-assessments performed with multidiscipline teams, corporate sponsored site level organizational assessments, and quarterly trend assessments by each major department and a quarterly roll-up of trend assessments at the site level. The team has this as a good practice related to tracking of self assessments.

DETAILED OPERATING EXPERIENCE FINDINGS

6.9 ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE

6.9(a) Good Practice: The Learning Organization Database focuses management attention which drives self assessment and continuous improvement.

The overall self-assessment strategy at ANO includes detailed departmental self-assessments performed with multidiscipline teams, corporate sponsored site level organizational assessments, quarterly trend assessments by each major department, and a quarterly roll-up of trend assessments at the site level. Findings from these self-assessments are input into a designated section of the Paperless Condition Reporting System (PCRS), known as the Learning Organization Database (LO). Controls on actions within the LO data base parallel those of the Corrective Action Programme (CAP), with escalating approval requirements for extensions on corrective actions. Separating the condition reports related to self assessment actions into the LO data base improves the use and tracking of self-assessment condition reports, and provides a tool to facilitate direct detailed oversight of completed and pending actions by the Self Assessment Review Board chaired by the Site Vice President.

7. RADIATION PROTECTION

7.1 ORGANIZATION AND FUNCTIONS

All members of the Radiation Protection (RP) group (including contractor RP technicians) have a rigorous training programme covering all aspects of radiological protection. Persons who are required to work in the Radiation Controlled Area (RCA) take Radiation Worker training. The plant has developed this Radiation Worker training which takes the individual through a practical interactive tour of various scenarios associated with radiological hazards expected on the plant. A good practice has been identified in this area under Training and Qualification.

7.2 RADIATION WORK CONTROL

The planning of work within RCA's follows a robust and well structured work management process. Each task is assigned a Radiation Work Permit which identifies the limitations, precautions, instructions and requirements to maintain all aspects of radiological exposure are ALARA. Areas of radiological and contamination hazard have barriers and signage to indicate such and access restrictions and precautions are implemented for high radiation areas. The plant has a programme for contamination area reduction within the radiation controlled area of the plant. This is a proactive approach to source term management. However, already in 2008, there have been a number of events relating to areas of contamination being found in clean areas of the plant and there have been a few personnel contamination events. The current locations of plant contamination monitoring instrumentation and the detection limitations of some of these contamination monitoring instruments do not optimize personnel contamination monitoring. The team has made a suggestion in this area.

7.3 CONTROL OF OCCUPATIONAL EXPOSURE

The team has found that the plant has developed various ways to reduce occupational exposure in an effort to achieve their five year dose reduction goal. The implementation of the ALARA principle is well established and publicized in many plant goals and performance indicators. Much effort is put into the ALARA planning process, both at power and for future outages, with the detailed preparation of plans, equipment and briefing notes. Practical aspects of the ALARA principle were observed in many areas, as an example, radiological controls for scaffolding which has a requirement for a radiological survey to identify any potential radiological hazard at heights. The scaffold is then tagged to confirm acceptability prior to access. Of particular note are the developments and improvements made in the source term reduction techniques such as customized shielding, most of which is uniquely designed and fabricated for hotspot locations. A risk basis analysis of the shielding product considers any chemical compatibility, the contamination decontamination aspects, impacts of temperature and the weight loading of the product while also attempting to reduce or eradicate the lead content. The team considers this as a good performance.

A system known as Radiation Acquisition and Display System (RADS) has been developed by the plant to allow workers to obtain radiological information prior to entering radiation fields. This system displays live radiation and airborne radioactivity levels throughout the plant from over eighty monitoring devices, (up to one hundred and forty during the outage), which transmit information every four seconds from the field in which they are located. The system provides alarms to alert the plant staff if radiation or airborne conditions are changing. The plant also uses an electronic message board known as MDRD (Marquee Dose Rate Display) to communicate and display radiation dose rate information and instructions to workers local to the areas. The MDRD system measures the radiation dose rates in the area and displays the dose rate information on a large marquee sign, which can be visible from at least 30m. The system can be programmed to change color to indicate the potential hazard associated with the dose rates, going from green (low) through yellow to red. Each change in color is reflected in a new written instruction that is displayed on the marquee sign to instruct nearby workers. The team considers this to be a good practice.

All radioactive leaks are identified and contained in drip catchers with hoses connected to active floor drains. A sign is posted locally identifying the leak before information is transferred to an electronic log. The log identifies the location of the leak, the date of discovery and a scheduled date for repair. However, some leaks are long standing defects and some have long term scheduled maintenance dates, and one drip catch was found to be leaking. The plant is also currently operating with known fuel failures. The team encourages the plant to maintain a focused review on all aspects of leak management in order to minimize the potential release of radioactive contaminants to plant and personnel.

7.5 RADIOACTIVE WASTE MANAGEMENT AND DISCHARGES

The plant has a system for the identification and storage of radioactive waste. All waste is segregated then stored in approved containers which are identified, labeled, moved and stored in a designated location, in the Radioactive Waste Building, dependant upon the activity of the contents and the date of shipping for further processing or disposal. Plant observations identified that the storage area is clean, well designated and well managed. However observations identified that a drum containing slightly radioactive oil was stored unlabeled in an unauthorized area. A Condition Report was raised to highlight this issue. The team encourages the plant to review its process for the identification, storage, and movement of radioactive waste.

DETAILED RADIATION PROTECTION FINDINGS

7.2 WORKPLACE MONITORING PROGRAMME

7.2(1) Issue: The contamination monitoring instrumentation, used at the plant, does not provide sufficient personnel contamination monitoring due to detection limitations and the location of the plant monitoring instruments.

- The installed whole body monitors at the RCA exit do not provide entire body monitoring due to geometric detection limitations.
- During the first quarter of this year;
  - Three personnel contamination events have been recorded in Auxiliary Building due to contamination where it was impossible to determine the cause.
  - There have been six events which have identified contamination found in clean areas.
  - Currently the plant field contamination monitoring equipment (frisker) is not provided immediately adjacent to the locality of the plant contamination areas but, in most cases, several tens of feet away.
- Recent surveys have identified the presence of alpha contamination in contamination controlled areas – the current field monitoring instrument (friskers) used is not effective in measuring low levels of alpha contamination.

Due to the detection limitations and locations of the contamination instrumentation there is a potential for the release of contamination to personnel and other plant areas.

Suggestion: The plant should consider upgrading the contamination monitoring instrumentation and review its location of plant monitoring instruments in order to provide sufficient personnel contamination monitoring.

IAEA Basis:

NS-G-2.7

Sec 3.12 “Equipment is required to be provided, as appropriate, for the monitoring of persons at exits from controlled areas in order to ensure that the contamination levels on their clothing and body surfaces are below a specified level”.

Sec 3.24 “The main objectives of radiological monitoring and surveying are: to provide information about the radiological conditions at the plant and in specific areas before and during a task; to ensure that the zone designation remains valid; and to determine whether the levels of radiation or contamination are suitable for continued work in the zone”.

Sec 3.28 “The operating organization should ensure that equipment necessary for the RPP is provided, including various instruments for measuring radiation and for sampling and analysis. The quantities and types of equipment provided should be adequate for anticipated needs in normal operations and emergencies, and account should be taken of radiological conditions prevailing and suspected or expected to prevail in the local area”.

7.3 CONTROL OF OCCUPATIONAL EXPOSURE

7.3(a) Good Practice: Information technology to support radiation data acquisition and field display results in improved radiological performance.

A software system called the Radiation Data System (RADS) provides the ability to monitor radiation and airborne radioactivity levels throughout the plant and also outside areas. This system has been developed by the plant to allow workers to obtain radiological information prior to entering radiation fields and provides a method for radiological surveys to be documented and retrieved. Over 80 monitoring devices are used to provide dose rate information every 4 seconds from the field where they are located. During the outage period the number of devices is increased to over 140. The system provides alarms to alert the plant staff if radiation or airborne conditions are changing. Trending of dose rate data allows for accurate evaluations of dose reduction strategies.

Display computer monitors are located at the radiation controlled area boundary and throughout the plant for the workers to access. All hard wired computers also have access so any permanent plant staff can review radiological data before leaving the office. The data displayed provides live time information from the detectors located on plant and also imported data from recent radiological surveys completed by radiation protection technicians. Other information includes details of hotspot and any lead shielding.

The RADS system also allows a worker exposure to be monitored in the field by telemetry of information back to a central station. If conditions change in the field an alarm will occur locally with the worker and at the central monitoring station or also locally to any wireless laptop computers. The system can be used during outage, non-outage and emergency conditions. Telemetry data can be used up to 0.65 miles from the plant during emergency situations.

A RADS simulator has also been developed that provides scenario training to the radiation protection technicians. The process provides instruction for the response to alarms or any changing conditions in a control environment by providing radiological data in a real life setting. The required training scenario can be selected for a multitude of situations such as under vessel repair to diving in contaminated water. The system also has a scenario for emergency planning exercises to provide data that would be seen under emergency conditions. The simulator can also be used as a process to validate procedures against any of the scenario situations.

The plant also uses an electronic message board to communicate radiation dose rate information and instructions to workers. The system called MDRD measures the radiation dose rates in the area and displays the dose rate information on a large marquee sign, which can be visible from at least 30m. If the dose rates increase in the area then the display changes colors and will also provide additional instructions to the workers in the field. The dose rate information can be displayed locally at the sign and by telemetry at other monitoring stations across the site. When conditions are normal the sign displays the information in green. When the dose rates increase to a preset limit the sign color changes to yellow and if a higher limit is reached the color changes to red. Each change in condition is reflected in a new written instruction that is displayed on the marquee sign to instruct nearby workers.

The plant has implemented the use of the marquee sign, particularly in areas where dose rates are subject to change. An example of such an activity would be radiography where it is used to enhance radiological controls. A MDRD sign is placed close to the radiography source and will provide an indication that the source is in a shielded position. Once the source is out of the shield the sign color changes to red, providing additional warning instruction to workers. In another example of source term reduction and trending, the detector can be placed directly on a radiation hotspot and the trend displayed on the MDRD at a safe distance.

8. CHEMISTRY

8.1 ORGANIZATION AND FUNCTIONS

The team identified as a good performance the number of indicators for trending the most important parameters which are reported at a high management level, showing the importance given to them. Should an indicator reach a high value, justification or explanation would be given by the Fleet Chemistry Manager during the regular meeting.

The team identified as a good performance the existence of Chemistry Daily Status Reports. This helps to avoid miscommunication and helps to keep the Operations and Chemistry departments properly informed on all issues and corrective actions and their resolution. This is also a good support document for the daily management meeting (Operational Focus Meeting).

Items that are noted on the status report include necessary changes to condensate polishing plant configuration (which ones are in service) and changeout (e.g. resin replacement), chemistry equipment that is out-of-service that may affect plant reliability, and chemistry parameters that are out-of-specification or exhibiting an adverse trend. Trend charts are incorporated into the status report to better explain the history of a specific problem and show the progress in the resolution.

The relation between the Fleet Chemistry Manager (FCM) and the Chemistry Superintendent is efficient in both directions. For several reasons including the recent assignment, the FCM has never attended the International Water Conferences, one of the places where chemists from all over the world may exchange their best views, improvements, results, events and concerns. Considering the increased role of standardization, in order to take full benefit of such an organization, the team encourages Entergy to attend the future conferences which occur every other year (e.g. NPC'08 in September 2008 in Berlin, Canada 2010).

8.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

The team identified as a good performance the "Outage Impact Team" including at least Chemistry, Operations, Engineering, RP and Outage group, which is actively preparing all important steps for a successful outage. Among other benefits, the interaction between the various members of the team is efficient in minimizing overall occupational exposures.

The plant properly performs boron analyses of the reactor coolant system (RCS) with grab samples. However, the team encourages the plant to consider using recent advanced on-line monitors for measuring boron and hydrogen which are important chemistry parameters for the safe plant operation. Although on-line boron and hydrogen-monitors are not required by the EPRI guidelines, most plants in other countries have boron meter based on neutron absorption from B-10. The ANO boron meters from the primary coolant were abandoned in the past due to inaccuracy.

The primary coolant limits in OP-1000.106 "Primary Chemistry Monitoring Program" are mainly based on EPRI guidelines which are more restrictive than Technical Specifications limits. The Chemical Volume Control System (CVCS) has limits based on Technical Specifications. The CVCS chloride limit in ANO document is 110 ppb (75% of Tech. Spec. for RCS). The RCS EPRI limit is 50 ppb Cl. Consequently, the CVCS which is designed to purify RCS (among other purposes) will not be able to match the RCS limit if it only complies with the limit of 110 ppb. The team encourages the plant to establish more consistency between various limits for related systems for each parameter.

The team identified as a good performance the absence of regeneration of secondary system ion exchange resins (condensate polishers of U-1 and steam generator blowdown of U-2). In addition to eliminating the risk of impurities ingress, the absence of regeneration decreases the quantity of liquid wastes, without significantly altering the duration for resin replacement; the cation resin operates saturated with the amine.

Without accurate pH values and overall secondary water chemistry treatment control, there is a risk of an increased concentration of iron corrosion product transport to the Steam Generator with the associated long term risk of tubing degradation. There is also a long term risk of increased erosion-corrosion (Flow Accelerated Corrosion). Although the plant specification is not in disagreement with EPRI Guidelines, the team suggested to accurately verify that all the contributing parameters to the secondary water treatment are properly specified and monitored with consistency between the various parameters.

The team encourages the plant to include in each specification of chemistry programme the expected or normal values in addition to the limit values which are much broader and required according to various sources. Moreover, the team encourages the plant to ensure consistency between all these various input limits. In OP-1000.106 “Primary Chemistry Monitoring Program”, the typical chloride value is < 5 ppb while the specified value is < 50 ppb for the reactor coolant system and < 110 ppb for the Chemical and Control Volume system which should have a lower limit than the primary coolant that it is purifying. The procedure 1052.027, “Auxiliary Systems Water Chemistry Monitoring” includes a limit range of 3-100 ppm for the tolytriazole, the copper corrosion inhibitor, without giving a target value. No relation has been established between the copper content and the tolytriazole concentration to settle such a target range. The same lack of precision applies to other parameters in other systems.

8.3 CHEMICAL SURVEILLANCE PROGRAMME

The team identified as a good performance the overall control of analytical programme and its accurate detection of potentially out of specification values. The programme for chemical analysis is automatically generated. The results of values are introduced into the Chemistry Data Management System in such a way that it is easy to recognize if any value is missing and if any value is out of the specification limit. In addition, the specialist in charge of the area gets a pager alert.

8.6 QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

The procedure applied to procure chemicals does not guarantee that all received batches of chemicals will meet the fleet specifications. The risk is to acquire a product that would contain impurities above the specified limits and induce a risk of corrosion or radioactivation once used in a safety related system. The team suggested to modify the procedure to ensure all received batches of chemicals will meet the fleet specifications, by including a first step to check if the product specifications comply with the Fleet specifications. Moreover, this process should be at the fleet level to get the benefit of fleet standardization.

DETAILED CHEMISTRY FINDINGS

8.2 CHEMISTRY CONTROL IN PLANT SYSTEMS

8.2(1) Issue: The plant does not accurately verify all contributing parameters to the secondary water treatment to ensure that they are properly specified and monitored for consistency between various parameters.

Although the plant specification is not in disagreement with EPRI Guidelines, there are uncertainties in the secondary water control to accurately verify that all the contributors (mainly pH) are properly considered.

- On Unit 1, there is an ongoing difference (at least from April to June 2008) for the secondary water pH ranging from 0.2 – 0.4 pH units between the measured value and the calculated value. On the contrary, the calculated conductivity matches the meter value according to ammonia, hydrazine and morpholine measured concentrations.
- The laboratory pH value gives a similar value to the online pH value with the same discrepancy of at least 0.2 units from the theoretical value for U-1. However, the inline pH meter is only quarterly monitored with buffers and all the other calibrations and crosschecking only exist in adjusting the on-line monitor to the grab sampled laboratory pH-meter. This checking with the grab sample does not provide any confirmation of the actual pH value which remains inaccurate.
- The cation conductivity value may suggest that the organic acid concentrations are likely in the order of historical values (early 00's) of about 15 ppb acetate and formate, but the absence of organic acid analysis during the last years does not help at clarifying whether the pH value is slightly in error or if there is some presence of anions affecting the pH and the cation conductivity.
- Ethanolamine (ETA) is listed as a control parameter in the plant specification, but without specific values (in practical adjusted in the band of 3-7 ppm) and the specification only states "to be consistent with pH". Since pH is inaccurate, due to improper calibration or to the presence of another chemical compound, it is not reliable to refer to it for the amine control parameter, as indicated in the specification. If pH measurement is not feasible, an acceptable alternative to specifying that the amine has to be consistent with the pH would be to specify the consistency between amine and specific conductivity, provided that the amine range is also specified.

Without accurate pH values and overall secondary water chemistry treatment control, there is a risk of an increased concentration of iron corrosion product transport to the Steam Generator with the associated long term risk of tubing degradation. There is also a long term risk of increased erosion-corrosion (Flow Accelerated Corrosion).

Suggestion: Consideration should be given to accurately verify that all the contributing parameters to the secondary water treatment are properly specified and monitored for consistency between various parameters.

IAEA Basis:

50-SG-Q13

401. Management should ensure that chemistry and radiochemistry work provides optimum protection for plant systems and materials. The requirements for chemistry and radiochemistry work should include:

– Evaluating chemistry data to identify control problems and analytical errors, and to correct them.

DS388

Para. 4.6 "the control parameters are the most important chemical parameters to monitor the chemistry regime treatment and the presence of deleterious impurities";

Para. 6.12 "Online chemistry monitoring and data acquisition systems should accurately measure and record data for key parameters";

Para. 6.15 "Use of technological data comparisons from different sampling points or use of comparison of different parameters measurements from the sampling point for evaluation of measured data reality**".**

8.6 QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

8.6(1) Issue: The process being used to procure chemicals does not guarantee that all received batches of chemicals will meet the fleet specifications.

– There is a fleet procedure “Chemical Control Program” EN-EV-112 Rev. 4 issued 03/27/08 which contains the specifications for chemicals to be used by each plant for purchase of chemicals. Based on this procedure, each plant may add a new chemical to be purchased. However, the process is mainly based on analysis to verify the compliance of the analysis results with the fleet specifications.

– For the example given (Neolube 1260), the total sulfur specification of the manufacturer was <630 ppm total sulfur while the fleet specification was < 500 ppm. This chemical has been approved to be purchased based on the fact that the actual analysis was within the specifications. Future batches of this product should not be used since it may contain sulfur content above the fleet procedure requirement. This chemical was already approved but has not been used in any plant system yet.

– The fleet procedure (EN-EV-112 Rev. 4) is inadequate to ensure all the purchases of batch chemicals comply with the fleet specifications.

Any deviation from the specifications may induce a corrosion risk for chloride or sulfur while the presence of other activable elements may induce higher dose rates. The risk is to acquire a product from a batch which will not be analytically checked and that would contain impurities above the specified limits and inducing a risk of corrosion or radioactivation once used in a safety related system. Consequently, the logical order would be starting to see if the product specifications are in agreement with the fleet specifications.

Suggestion: Consideration should be given to modify the process being used for purchase of chemicals to ensure all received batches of chemicals will meet the fleet specifications.

IAEA Basis:

50-SG-Q13

401. Management should ensure that chemistry and radiochemistry work provides optimum protection for plant systems and materials. The requirements for chemistry and radiochemistry work should include:

– Ensuring the proper handling, storage, use and disposal of bulk chemicals, spent resins, laboratory chemicals, corrosive agents and cleaning agents.

DS388

Paragraph 9.2 …the use of chemicals and materials at the plant, including those brought by contractors, should be controlled according to clearly established procedures.

9. EMERGENCY PLANNING AND PREPAREDNESS

9.1 EMERGENCY PROGRAMME

The on-site emergency planning and preparedness activity of ANO is coordinated by a 4-member organization headed by the emergency preparedness manager. The most important roles in off-site emergency response are assigned to the home and neighbor counties and to the State of Arkansas. The cooperation of on-site and off-site organizations concerning emergency planning and preparedness is continuous and efficient, which is recognized by the team as an area of good performance.

9.3 EMERGENCY PLANS AND ORGANIZATION

In accordance with best international practice, integrated emergency management exists at ANO which takes into account the different kind of hazards. The Emergency Plan and its procedures cover the planning and preparation consideration the radiological hazards for both operation of units and dry fuel storage. However, not all of the design and operational features of the dry interim spent fuel storage facility have been considered. The OSART team suggests that the plant should consider further development of emergency planning for the dry interim spent fuel storage facility.

9.4 EMERGENCY PROCEDURES

In addition to the Emergency Plan, 27 implementation procedures are established. These procedures are properly developed, maintained and reviewed. The plant maintains all procedures and documents necessary for use by Emergency Response Organization (ERO) personnel on the Entergy Web. Designated computers in each primary and alternate emergency facility receive daily downloads with copies of all procedures and documents required for sustained ERO operations. As a result, if failures of the intranet occur, all required documents can be retrieved and used from local computer hard drives with no loss of information. This Print Document Disaster Recovery System was identified as a good practice by the OSART team.

The plant is generally prepared for identification and classification of emergency situations; however the procedure used for emergency classification does not guarantee the timely classification of all credible emergencies. The OSART team recommends that plant enhance the arrangements currently in place to support timely emergency classification when radioactive releases can not be measured by installed plant instruments.

The plant is responsible for the sufficient protection of all individuals who are on the site in case of emergency. The plant applies multiple procedures for protection of emergency workers and non-essential workers; however the team found weaknesses concerning the emergency intervention levels, dose control and emergency preparedness of personal protective measures. The OSART team recommends that the plant update the emergency preparedness arrangement for taking practicable measures to provide protection for all individuals who are on the site in case of emergency.

9.5 EMERGENCY RESPONSE FACILITIES

The medical preparedness for handling, decontamination and treating emergency causalities is acknowledged as a good performance. Based on the letter of agreement, Saint Mary's Medical Center responds and assists with respect to medical treatment of injured persons. The Center has sufficient plan, equipment, instruments and substances (decontamination tents, contamination monitors etc.) as well as qualified personnel for adequate medical treatment.

9.6 EMERGENCY EQUIPMENT AND RESOURCES

The plant has four facilities where the ERO can be operated. A software program (WebEOC) is used for reducing manual upkeep of status boards and data between the emergency facilities and can be used as primary tool for making offsite notifications to key officials during emergency events. It can also be used for a repository to share information with the media and for all public inquiry. The OSART team acknowledges this system as a good performance.

9.7 TRAINING, DRILLS AND EXERCISES

The training organization of the plant includes one emergency preparedness instructor who provides overall coordination of emergency preparedness training. The plant conducts four full scale multi-facility integrated drills/exercises per year to allow each Emergency Response Organization (ERO) Team to have the ability to participate in one drill, and control/evaluate in another drill. The plant has developed and uses a rigorous system for developing, performing and evaluating emergency drills/exercises. The drills are prepared based on a desk guide. The drill scenario is always supported by control room scenario and ANO developed simulation software (RADs simulator) for supporting the radiation protection aspects of drills. The drills/exercises are evaluated by utility evaluators, offsite agencies and peer evaluators from the fleet and other non-Entergy Plants. Lessons learned from the drills are captured in the site condition reporting system and tracked to resolution as necessary. The OSART team considers the procedures for preparation, implementation, and evaluation for emergency drills/exercises as an area of good performance.

DETAILED EMERGENCY PLANNING AND PREPAREDNESS FINDINGS

9.3 EMERGENCY PLANS AND ORGANIZATION

9.3(1) Issue: The emergency planning process does not consider all of possible accident scenarios specific to the dry interim spent fuel storage facility.

The emergency classification process used for potential emergency situations of dry spent fuel storage is not specific. The classification includes emergency situations related to in-core fuel assembly head removed, refueling canal, the spent fuel pool and the cask loading pit, etc. The emergency action level given in dose rate is derived from the direct radiation of a single uncovered spent fuel assembly. The assumptions upon which this action level is based are not valid for the dry interim spent fuel storage facility since the storage cask safety analyses assumes releases from the casks and precludes that spent fuel is uncovered.

The dose projection model (RDACS method) which is used for emergency classification and dose projection is not adapted for potential fuel storage facility incidents. The isotopic composition, magnitude, and pathway of releases of potential fuel storage facility incidents were not considered in the RDACS method.

The VSC-24 type storage cask safety analyses report among others analyzed the accidental pressurization event as a design basis event which could occur during a typical cask lifetime. This accident scenario can result in significant releases on-site and to the environment. The licensing basis document excluded this scenario; as this scenario is outside the design basis of the plant, however the conservatism should be required during emergency planning.

Gaps in emergency planning can cause delays in emergency response.

Suggestion: The plant should consider further development of emergency planning for dry interim spent fuel storage facility.

IAEA basis:

GS-R-2

3.14. In designing a threat category I, II or III facility "[a] comprehensive safety analysis is carried out to identify all sources of exposure and to evaluate radiation doses that could be received by workers at the [facility] and the public, as well as potential effects on the environment… The safety analysis examines… event sequences that may lead to [an emergency]. On the basis of this analysis… requirements for emergency [preparedness and] response can be established." (Ref. [11], para. 2.7.)

EPR-METHOD 2003

2.2.5 …This threat assessment for facilities can be based on the results of generic accident studies [12, 13] as summarized in Tables III and IV. This is generally sufficient for the emergency planning process. If a detailed analysis is to be performed, it should consider a range of potential emergencies and not be limited to "design basis" accidents.

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329. ….some of these events can also be considered as severe accidents, which are beyond the design basis. While the probability of such accidents occurring is extremely low, the operating organization should consider events such as these during the preparation of operating procedures and contingency plans…..

9.4 EMERGENCY PROCEDURES

9.4(1) Issue: The procedure describing the methods for emergency classification does not sufficiently guarantee the timely classification of such emergency scenarios when radioactive releases can not be measured by installed plant instruments.

The emergency classification procedure is sufficient in general, however:

- Emergency Action Levels are based on parameters requiring time consuming calculations [e.g. total effective dose equivalent (TEDE) and committed dose equivalent (CDE)] instead of using directly measurable parameters (e.g. dose rate and airborne activity). In cases of releases that bypass installed plant monitoring instruments, the 15 minutes requirement to classify the emergency could not be met.

- The plant has no telemetric monitoring network positioned around its perimeter. This international standard, if met, could support timely emergency classification and hence earlier determination of protective recommendations for the general population.

- In the case of releases which might by-pass the installed monitoring instruments, the plant relies on monitoring teams to measure the magnitude of dose rate and contamination, which are then used in the calculation of TEDE and CDE. These values are used for emergency classification.

Untimely classifications of events could result in unnecessary delays in required notifications and activation of the Emergency Response Organizations.

Recommendation: The plant should enhance the arrangements currently in place to support timely emergency classification when radioactive releases can not be measured by installed plant instruments.

IAEA basis:

GS-R-2

4.70 **…** These arrangements shall include access to instruments displaying or measuring those parameters that can readily be measured or observed in the event of a nuclear or radiological emergency and which form the basis for the EALs (see para. 4.20) used to classify emergencies. For these arrangements the expected response of the instrumentation or systems at the facility under abnormal conditions shall be taken into account.

IAEA Glossary, p. 56: Emergency Action Level: A specific predetermined, observable criterion used to detect, recognize and determine the emergency class.

GS-G-2.1

Appendix VI. Table 12.

Identifying, notifying and activating (the objective is timed from the time at which conditions indicating that emergency conditions exist are detected)

Classify the emergency (declaration of emergency)	<15 min	<15 min	<15 min

9.4(2) Issue: The emergency preparedness arrangements for taking practicable measures to provide protection for individuals who are on the site including emergency workers do not always meet international standards.

- Based on the letter of agreement London Fire Department (first responder) provides personnel and equipment as required to assist extinguishing fires located at ANO site. This includes both inside and outside the protected area. The fire-fighters are equipped with pen dosimeters which can not be easily read during fire fighting activities. The provision of self-reading alarm dosimeters when the fire-fighters arrive at the plant protected area is inadequate because their duty may cause exposure prior to arrival at site.

- The turnback dose (emergency guidance level) prescribed for the fire-fighters of London Fire Department is unreasonably low 500 micro Sv (50 mRem) and could hinder fire fighting in the controlled area or in the exclusion area during emergency situations.

- The general intervention level used for iodine prophylaxis for emergency workers does not meet international standards. There is no operational intervention level for iodine prophylaxis of emergency workers in readily measurable units.

- Wearing of a dosimeter is not required for the staff of Technical Support Centre (TSC) and Emergency Operational Facility (EOF) during emergency until the radiation became measurable in TSC/EOF. The plant does not provide electronic personal dosimeter for all of emergency workers; however the plant has a sufficient number of electronic personal dosimeter available.

- The TSC is not equipped with an atmospheric isolation function or an emergency air handling system, consequently the staff of TSC must immediately evacuate if the total effective dose equivalent (TEDE) exceeds 4 mSv/hr (400 mRem/h). TEDE can not be readily measured, as required by international standards.

- The evacuation procedure gives the operational intervention level for TSC/OSC evacuation in total effective dose equivalent (TEDE) unit; however the operational intervention levels for other evacuations (e.g. EOF, general plant area) are given in readily measurable units.

- The exit doors are marked in the turbine halls and radiation controlled area of Unit 1 and Unit 2, but there are no safe, clearly and durably marked escape routes to indicate the direction towards the exit doors. There are several positions inside the buildings from where the exit signs can not be seen. In case of electrical blackout or fire which results in smoke inside the building it may be difficult for some workers to quickly find the exit.

- The ANO Emergency Plan protective action guides do not express general intervention levels for protective actions in terms of avertable dose, and hence do not meet IAEA standards.

- In case of emergency situations, the plant policy is the early evacuation of non-essential workers; however certain conditions may preclude or delay plant evacuation. The plant is not adequately prepared for iodine prophylaxis of non-essential workers if the evacuation is precluded or delayed.

Inadequate protective measures can result in less than adequate justification and optimization of radiation exposure to workers.

Recommendation: The plant should update the emergency preparedness arrangements for taking all practicable measures, so as to meet international standards for providing protection for all individuals who are on site.

IAEA basis:

GS-R-2

4.51**.** … shall be provided with a sufficient number of safe escape routes, clearly and durably marked, with reliable emergency lighting, ventilation and other building services essential to the safe use of these routes. …

4.62 Arrangements shall be made for taking all practicable measures to provide protection for emergency workers for the range of anticipated hazardous conditions (see para. 4.61) in which they may have to perform response functions on or off the site.

Schedule III–3. The generic optimized intervention value for iodine prophylaxis is 100 mGy of avertable committed absorbed dose to the thyroid due to radioiodine. [See Addendum to Annex III.]

EPR-METHOD Appendix 16**.** Radiation Protection Equipment For On-Site Emergency Workers

(5) Dosimeters: each worker should wear thermoluminescent dosimeters in order to provide a record of the accumulated dose after the emergency. Each person on the team should carry a self-reading (e.g. electronic) dosimeter (up to 250 mSv).

GS-G-2.1

4.15**.** …. adapt urgent protective actions to protect workers and the public, including the application of operational intervention levels (OILs) with arrangements to revise the OILs as appropriate to take into account the conditions prevailing during the emergency."

Operational intervention level (OIL**).** A calculated level, measured by instruments or determined by laboratory analysis, that corresponds to an intervention level or action level. OILs are typically expressed in terms of dose rates or of activity of radioactive material released, time integrated air concentrations, …

Appendix V.19. To be most effective, stable iodine prophylaxis should be provided before or shortly after an intake of radioiodine (i.e. before or shortly after a radioactive release). …

BSS 115 Schedule V.

V-l. Intervention levels are expressed in terms of avertable dose, i.e. a protective action is indicated if the dose that can be averted is greater than the corresponding intervention level. …

EPR-METHOD Appendix 3: Emergency Worker Guidance Levels (Table)

9.4(a) Good Practice: The Emergency Planning Procedure/Print Document Disaster Recovery System enhances the plant's emergency preparedness.

The plant maintains all procedures and documents necessary for use by Emergency Response Organization (ERO) personnel on the Entergy Web. Should this system be lost for any reason, emergency planning has a disaster recovery system established that ensures access to these documents is retrievable by all ERO personnel. Designated computers, in each primary and alternate emergency facility, receive a daily download from document control. The most current revision of all procedures and drawings required for sustained ERO operations is loaded to the hard drive of these computers. If a failure of the intranet occurs, all required documents can be retrieved and used from local computer hard drives with no loss of information experienced while responding to an emergency event. This process reduces work burden and cost on document control by allowing electronic update of procedures and prints in ERO facilities without having to maintain hard copy backup. It also reduces the need to audit prints and procedures for current revisions which saves even more time.

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 fulfillment 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.*

LIST OF IAEA REFERENCES (BASIS)

Safety Standards

- **SF-1**; Fundamental Safety Principles (Safety Fundamentals)
- **Safety Series No.115**; International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources
- **Safety Series No.117**; Operation of Spent Fuel Storage Facilities
- **NS-R-1**; Safety of Nuclear Power Plants: Design Requirements
- **NS-R-2**; Safety of Nuclear Power Plants: Operation (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-2-10**; Periodic Safety Review of 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-2.14**, Conduct of Operations at Nuclear Power Plants (Safety Guide)
- **GS-R-1**; Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety (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)
- **GS-G-2.1**; Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)
- **GS-G-3.1**; Application of the Management System for Facilities and Activities (Safety Guide)
- **50-SG-Q**; Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations (Code and Safety Guides Q8-Q14)
- **RS-G-1.1**; Occupational Radiation Protection (Safety Guide)
- **RS-G-1.2**; Assessment of Occupational Exposure Due to Intakes of Radionuclides (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)
- **WS-G-6.1**; Storage of Radioactive Waste (Safety Guide)
- **DS388;** Chemistry Control in the Operation of Nuclear Power Plants (Draft 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

- **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

▪ ***TECDOC, IAEA Services Series etc.***

- **IAEA Safety Glossary** Terminology used in nuclear safety and radiation protection 2007 Edition
- **Services series No.10**; PROSPER Guidelines
- **Services series No.12**; OSART Guidelines
- **TECDOC-489**; Safety Aspects of Water Chemistry in Light Water Reactors
- **TECDOC-744**; OSART Guidelines 1994 Edition (Refer only chapter 10-15 for Pre-OSART, if appricable.)
- **TECDOC-1141**; Operational Safety Performance Indicators for Nuclear Power Plants
- **TECDOC-1321**; Self-assessment of safety culture in nuclear installations
- **TECDOC-1329**; Safety culture in nuclear installations - Guidance for use in the enhancement of safety culture
- **TECDOC 1446** OSART mission highlights 2001-2003
- **TECDOC-1458**; Effective corrective actions to enhance operational safety of nuclear installations
- **TECDOC-1477**; Trending of low level events and near misses to enhance safety performance in nuclear power plants
- **TECDOC-955**; Generic Assessment Procedures for Determining Protective Actions during a Reactor Accident
- **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

- **ILO-OSH 2001E**; **International labour office** – Guidelines on occupational safety and health management systems
- **ILO International labour office – Code of practice**; Safety and health in construction
- **ILO International labour office – Code of practice**; Safety in the use of chemicals at work

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