

IAEA

International Atomic Energy Agency

**REPORT
of the
OPERATIONAL SAFETY REVIEW TEAM
(OSART) to the KOZLODUY
NUCLEAR POWER PLANT
BULGARIA**

26 November to 13 December 2012

**FOLLOW UP MISSION to the
KOZLODUY NUCLEAR POWER PLANT
BULGARIA**

23 – 27 June 2014

PREAMBLE

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

This report also includes the results of the IAEA's OSART follow-up visit which took place 18 months later. The purpose of the follow-up visit was to determine the status of all proposals for improvement, to comment on the appropriateness of the actions taken and to make judgments on the degree of progress achieved.

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

FOREWORD

by the

Director General

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

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

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

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

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

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

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INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of the Bulgaria, an IAEA Operational Safety Review Team (OSART) of international experts visited Kozloduy Nuclear Power Plant from 26 November to 13 December 2012. 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; Operating experience feedback, Radiation protection; 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 Kozloduy OSART mission was the 174th in the programme, which began in 1982. The team was composed of experts from Belgium, Canada, Czech Republic, Finland, Germany, Hungary, Slovakia, Sweden, Ukraine and UK, together with the IAEA staff members and an observer from Russia. The collective nuclear power experience of the team was approximately 350 years.

The Kozloduy NPP is located in the North-West part of Bulgaria at about 3 km from the Danube River, 3.5 km to the South-East of the town of Kozloduy, and 180 km to the North of Sofia. The plant currently has two 1000 MW units (type WWER-1000/V-320) in operation. Unit 5 was first connected to the grid in 1987 and unit 6 in 1991. These two units and the site auxiliary systems needed for their operation were the scope of the OSART mission.

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

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

MAIN CONCLUSIONS

The OSART team concluded that the managers of Kozloduy NPP are committed to improving the operational safety and reliability of their plant. It was clearly demonstrated by the systematic approach of the plant in the implementation of measures aimed at achieving and maintaining the high standards of nuclear industry.

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

- combined use of ethanolamine and ammonia for secondary side chemistry control, which significantly reduces the corrosion rate in the secondary circuit;
- the plant developed procedures for using redundant sources of electrical power, these procedures and associated equipment were tested and validated during emergency exercise;
- the plant performs independent measurement of fuel assembly enrichment to verify that fuel assemblies are manufactured in compliance with design specifications;
- color coding of labels of spare parts and materials which makes a distinct identification of items requiring special attention (i.e. intended for equipment important to safety, or with limited shelf-life).

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

- the plant should justify the current method of operation of the systems for mechanical filtration of drain water and for temporary storage of liquid waste and reflect it in the operating procedures;
- the plant should develop and implement severe accident management guidelines for both open reactor conditions and the spent fuel pools;
- the plant should consider strengthening the quality of the root-cause analysis connected to human performance so that the analysis is carried out in a thorough and timely manner;
- the plant should consider reinforcing the contamination control practices in order to minimize the spread of contamination and the risk of internal contamination;
- the plant should perform dose assessment for neutron radiation and develop appropriate procedure for this assessment for everyone working in neutron fields.

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

KOZLODUY FOLLOW-UP SELF-ASSESSMENT

Kozloduy NPP management paid extremely high attention to analyze deeply the results from the OSART Mission both in terms of the overall assessment about the effectiveness of the efforts to ensure safe and reliable plant operation and in terms of the detailed findings and proposals for improvements in operational safety offered by the team.

Immediately after the end of the OSART Mission all recommendations and suggestions made were carefully reviewed and analyzed by the plant management and experts from all plant organizational structures. As a result, the specific measures were planned and included in a specially developed Programme for preparation of the OSART Follow-up Mission of 2014.

The programme measures were identified on the basis of

- recommendations and suggestions included in the OSART Mission Report;
- comments and weaknesses in performance identified during the mission but which were not basis for making recommendations and suggestions;
- review and analysis of the results described in the reports from other reviews held in Kozloduy NPP PLC.

The programme measures were grouped corresponding to the review areas and related to all Electricity Production-2 (EP-2) organizational structures connected to the organization, administration and management, personnel training and qualification, operations, fire safety, maintenance, technical support, operational experience feedback, radiation protection, chemistry and emergency planning and preparedness. The programme was extended to include also measures related to the Open Switch Yard Department, Bank Pumping Station Department and Dry Spent Fuel Storage Facility Department, Personnel and Training Centre Division, Safety and Quality Division and other mission related organizational structures of Kozloduy NPP PLC.

In the period after the mission, the programme was periodically updated and supplemented with activities resulting from the experience gained during the implementation of different programmes, additional suggestions of the plant counterparts based on their self-assessment after the mission, additional suggestion given by the other personnel, performed self-assessment in the review areas, etc.

For providing common supervision of the activities under the programme, a special Coordination Committee was established according to the order of the Executive Manager. The Committee held its meetings on a regular basis to perform management and coordination of the activities.

Aiming at a successful implementation of the programme activities, review area teams were established. The team members analyzed the status of the implementation of measures from the programme, suggested corrective measure to be added to the programme, discussed the performance of self-assessment, implemented specific tasks, etc.

A lot of efforts of the management and personnel of Kozloduy NPP were invested in areas such as:

- reassessment of the operation of the systems for mechanical filtration of drain water and temporary storage of liquid waste and introduction of changes to the operating instructions.
- development and implementation of severe accident management guidelines for both open reactor conditions and spent fuel pools.
- assessment of dose exposure for neutron radiation and development of appropriate procedure for this assessment.

A number of activities were performed also for:

- improvement of the effectiveness of the operational personnel rounds in terms of reporting the defects identified during the walk downs;
- remedy of identified deficiencies in the maintenance procedures;
- improvement of technical and operational status of electrical cables and associated components;
- implementation of performance indicators in the technical support area which allow to the management to perform supervision and self-assessment;
- further strengthening of the root cause analyses in the area of human performance;
- strengthening the practices for elimination of radioactive contamination in terms of minimization of its spreading;

- determining the location of the public information centres beyond the Urgent Protective Action Planning Zone (UPZ) and arrangement of joint press conferences;
- identifying of all targets of emergency response which will be covered during exercises and drills.

Concurrently with the performance of the activities included in the programme, many efforts were made to sustain and improve the achieved level in all other areas irrespective of the fact there is or not a specific recommendation. A special attention was paid to the improvement of the technical status of the equipment and housekeeping, as well as improvement of safety culture.

Plant management and all the plant staff considered the implementation of these activities as an important part of the continuous plant efforts for sustaining the high level of operational safety in compliance with the requirements of the IAEA international standards and the best international practices.

OSART FOLLOW-UP MAIN CONCLUSIONS

An IAEA Operational Safety Review Follow-up Team visited the Kozloduy NPP Units 5&6 from 23 to 27 June 2014. There is clear evidence that the plant management has gained significant benefit from the OSART process. The IAEA Safety Standards, benchmarking activities with other NPPs were used during the preparation and implementation of the corrective action programme.

The plant thoroughly analysed the OSART recommendations and suggestions and developed appropriate corrective action plans. These corrective actions, in some cases, cover a broader scope than was intended with the OSART recommendations and suggestions. The willingness and motivation of plant management to use benchmarking, consider new ideas and implement a comprehensive safety improvement programme was evident and is a clear indicator of the potential for further improvement of the operational safety of the Kozloduy NPP.

The plant fully resolved issues regarding the systems for mechanical filtration of drain water and temporary storage of liquid waste, identification and reporting deficiencies in the field, maintenance procedures deficiencies, performance indicators associated the goals of Technical Support Division, neutron dose assessment for all relevant staff, contamination control practices and measures to prevent spread of contamination, off-site information centres and completeness of emergency exercise programme.

The following provides an overview of the issues which have reached satisfactory progress of resolution but where some degree of further work is necessary. The plant has analysed the issue related to the condition of cables and identified the underlying causes. New quality plans were developed for activities related to cables by contractors and plant staff. A systematic field walk-down was conducted to identify all deficiencies and a program was developed for enhancement of the operating conditions of cables. At the time of the follow-up mission, about 80% of the cases have been resolved, with the remaining 20% planned to be completed by the end of next year. It has been demonstrated by the plant that there is no finding related to the newly installed cables, which indicate that the work practices on cable installation has been improved. A field walk-down has shown marked improvement in the condition of cables.

The plant has a programme to develop and implement SAMGs for unsealed reactor conditions and spent fuel pools. This includes specific thermo hydraulic analysis for a severe accident in the spent fuel pools. SAMGs have been written for unsealed reactor conditions and spent fuel

pools. To complete the SAMGs for spent fuel pools in a timely manner the plant has been written them ahead of full completion of the thermo hydraulic analysis. These SAMGs consider data currently available from the analysis with provision for further changes if required on completion of the analysis due Nov 2014. The plant now has a detailed programme showing completion of the SAMGs at the end of 2014 and implementation in May 2015 when the required training is scheduled to be completed. Following analysis of timeliness of event investigation the plant has implemented several corrective actions. Although the plant has not reached yet its desired target the timeliness of analysis has significantly improved, and continuing to improve.

The plant has implemented two main changes to improve the thoroughness of its event analyses. A quality control check is now carried out on completion of event analysis. The coding of events has been improved to adopt the WANO coding system. This improved coding has significantly increased the detection rate of human performance deficiencies. These measures are intended to monitor the thoroughness of event analyses with a view to establishing corrective actions to improve the plants performance in this area.

The original OSART team in November-December 2012 developed three recommendations and eight suggestions to further improve operational safety of the plant. As of the date of the follow-up mission, some 18 months after the OSART mission, 73% of issues were fully resolved and 27% were progressing satisfactorily. There was no issue which was considered as having made insufficient progress. These results are very good.

In addition, the plant systematically addressed all encouragements made by the OSART. This is an excellent indication of the plant's effort to use all opportunities for further improvement. The team received full cooperation from the Kozloduy NPP management and staff and was impressed with the actions taken to analyse and resolve the findings of the original mission. The team was allowed to verify all information that was considered relevant to its review. In addition, the team concluded that the managers and staff were very open and frank in their discussions on all issues. This open discussion made a huge contribution to the success of the review and the quality of the report.

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1.1. ORGANIZATION AND ADMINISTRATION

The plant has sufficient resources to accomplish the tasks assigned and there is no evidence of unacceptable backlog. Personnel are very motivated with a high degree of education. The organizational structure, responsibilities and interfaces are clearly defined and documented.

For each individual a very detailed job description is available.

Staffing needs and resource allocation are yearly assessed by all managers. The staffing plan looks 5 years ahead. There is evidence of increasing staff in certain departments at the plant in function of safety priorities.

For every supervisor or manager a deputy is assigned who meets all requirements for replacement in terms of educational level, training and experience.

There is a close cooperation between the EP-2 organization which operates Units 5 & 6 and the corporate organization. The respective responsibilities remain very clear.

The process of management of organizational changes is on a high level compared to the industry standard. It has a graded approach which is used for every organizational change, including risk assessment, independent review and approval by the Executive Director. Six months after every organizational change, a review of the effectiveness is performed by the Administrative and Control Division in close cooperation with the manager who initiated the change. The results are debriefed to the Executive Director. The number of organizational changes stays low and no adverse effects were noted.

The plant uses a well-documented system for contractor management with clear requirements, follow up and evaluations integrated in the Terms of Reference of the contract.

1.2. MANAGEMENT ACTIVITIES

Among the safety performance indicators the plant has achieved good results in the area of unplanned automatic SCRAMs, availability of the high pressure safety injection, availability of the auxiliary feedwater system and collective radiation exposure. The Unit Capability Factor was steadily improving in the period of 1999–2008 and has stabilized around 90% in the period of 2008–2012. This is well above world average of nuclear power plants and also a good result in comparison with WWER-1000 type units. These good results have been achieved due to systematic measures taken to improve the safety and equipment reliability of Units 5 and 6 and management's effort in striving to reach the high standards of the nuclear industry.

Policies, goals and objectives are integrated in a 3 year Business Plan. Every 3 months an assessment on the Business Plan is performed.

For Units 5 and 6 the Business Plan is reflected into a yearly Action Plan.

The plant uses a set of performance indicators and for all indicators that are in the yellow or red zone 3-month analyses with proposals for corrective actions are made. The complete set of indicators is analyzed on a yearly basis.

Every year a report on the status of operational safety of the plant is produced based on self-assessments by the managers. These reports are very comprehensive and are discussed at the Safety Committee of the plant and proposals are made for improvements to be taken into account in the Action Plan for the following year.

A strict follow up of agreed actions is performed, with a 2-weekly reporting to the Chief Engineer of EP-2. Overdue actions are extremely rare.

The plant takes a lot of initiatives on communication to their own staff as well as to the public.

The Intranet is very user-friendly and is intensively used to communicate goals, policies, objectives and obtained results at the plant. It also provides every employee the opportunity to raise questions to any member of the senior management. These questions and corresponding answers are visible to all staff. Staff use the Intranet to schedule private meetings with the Executive Director.

On the TV-screens attractive illustrations are displayed to pull the attention to rules of safety at work. The actual state of the plant is displayed and error reduction tools are brought to staff's attention.

Questions or remarks can also be made in an anonymous way through the use of suggestion boxes that are present in all major buildings. These remarks are entered in the Operating Experience database and screened to check if further action is required.

The effectiveness of external communication is monitored with a strong set of indicators

The team considers all these communication efforts as a good performance.

A Human Performance Programme has been installed to reduce the risk of human errors. Training has been given to all personnel and periodic retraining is performed. The programme is supported by communication campaigns and by managers performing walkdowns at the plant.

The team noticed that pre job briefing, post job debriefing and debriefing of walkdowns were performed with a content that matches the international standard. However, the way of communicating was mostly a one way communication. Coaching techniques, such as asking open questions in order to stimulate self-reflection by the staff that performed the activity, are not systematically used. The team encourages the plant to include coaching techniques in the Human Performance Programme.

1.3. MANAGEMENT OF SAFETY

Management of Kozloduy NPP is eager to implement hardware improvements in the plant to enhance safety and applies a long-term approach in doing so. This is demonstrated in the planning and implementation of major safety improvements, including the installation of new systems for severe accidents management (SAM), well before the issue of preparedness of plants for SAM came under public attention after the Fukushima accident.

In relation to the international reviews of safety of the WWER -1000 Units with the corresponding areas for possible improvement of the design, Kozloduy NPP prepared and implemented its own major Programme for Modernization of Units 5 and 6.

Hardware measures of the programme were implemented between 2002 and 2006 within the outage and refueling campaigns. In order to improve manageability of severe accidents additional systems and equipment were installed such as:

- System for Pressure Relief of the Containment
- Post-Accident Monitoring System (PAMS)
- Passive Autocatalytic Hydrogen Recombiners (PAHR) for hydrogen combustion in the containment
- Additional Diesel Generators, one at each Unit
- Safety Parameters Display System (SPDS)
- Severe accident radiation monitoring system

On the basis of a subsequent analysis performed in cooperation with two foreign nuclear utilities to examine the specifics of development and management of severe accidents and severe accidents guidelines the scope of the technical measures was extended to:

- Installation of wide-range temperature control of the reactor vessel
- Installation of additional PAHR (in progress)
- Closing the ionizing chamber channels located in the wall of the reactor vessel pit (in progress)

The team considers this consistent approach for continuous enhancement of the original design to be a good performance.

Staff is stimulated to report low level events and near misses in order to perform self-assessments on the safety management strategy. (See area OE)

The plant stimulates continuous improvement by hosting WANO missions (9 in the last 4 years) and by giving managers the opportunity to learn from international experience by attending IAEA or WANO missions (52 in the last 4 years).

The team considers this as a good performance.

During the review the team noted several work practices, situations and conditions which can be considered as an indication of safety culture at the plant.

The positive safety culture features include the following items:

- Management of the plant is very open to suggestions and remarks from the staff. Suggestion boxes exist at number of places around the plant. Any member of the staff can meet the plant Executive Director and have discussions with him.
- A self-assessment of safety culture has been performed at the plant. This assessment is based on surveys, interviews, observations, document review and discussions in focus groups. Data gathered from these activities has been used to establish a Safety Culture Enhancement Programme.
- Staff at the plant are highly motivated. Extensive programmes including opportunities to acquire higher qualification and university degree have been established.

- Before entering any room/compartiment the plant operators mention possible risk/hazards likely to be encountered.

At the same time some other features indicate that additional efforts could result in the further improvement of safety culture:

- The plant staff are very open, motivated, knowledgeable and cooperative. However sometimes during the discussions on various issues developed by the team, they were perceived to be defensive and too persistent with their argument.
- The team observed minor deficiencies in the field which had not been noted by the plant staff. Overlooking deficiencies in the field is an indicator towards a lack of attention to details and needs to be addressed.
- A log book for reporting performance of individuals and groups is maintained in the Technical Support Department. Both good and poor performance is noted in this log, which is open to everyone hence it is not a high performance motivation tool.

1.4. QUALITY ASSURANCE PROGRAMME

The team has noticed a good Quality Assurance Programme, with QA audits on 2 Levels: one within the EP-2 organization and one independently by the Quality Division.

1.5. INDUSTRIAL SAFETY PROGRAMME

For all activities pre job briefings are performed with attention to industrial safety.

During the review the team noted several Industrial Safety risks which are not reported, eliminated or marked.

In some cases workers were observed executing activities not wearing gloves or wearing gloves not adapted to the work.

In the set of performance indicators none are used to address Contractor Industrial Safety.

Every year in the last six years period, injuries with temporary disability were recorded during performance of work.

The Industrial Safety loss time accident rate is higher than the average of the nuclear industry. The team encourages the plant to increase their efforts to reduce the remaining risks at the plant.

**DETAILED MANAGEMENT, ORGANIZATION AND ADMINISTRATION
FINDINGS**

None

2. TRAINING AND QUALIFICATIONS

2.1. TRAINING POLICY AND ORGANIZATION

The IAEA methodology on Systematic Approach to Training (SAT) is entirely implemented at the plant to ensure a high quality of training and training material. Standard training programmes are developed by the Training Center (TC), and are reviewed annually and revised if necessary. Topics on Nuclear Safety, Radiation Protection, Safety Culture as well as ALARA principles are integrated into those programmes. Individual training programmes are based on the results of individual training needs analysis by line managers in close co-operation with the TC staff using appropriate performance indicators. The programmes incorporate annually updated local and international events in nuclear industry and operating experience as well. Standard and individual training programmes are approved by and agreed with appropriate line managers.

The plant implemented a system of multiple training evaluations including assessments of the training by trainees, by line managers and by a TC task group. Additionally, the team observed a good implementation of self-assessment of trainees during the debriefing of simulator sessions. The team recognizes all this as a good performance.

2.2. TRAINING FACILITIES, EQUIPMENT AND MATERIAL

Classrooms for the training on Industrial Safety, Radiation Protection and First Aid are equipped with comprehensive mock-ups and training tools. Specialized workshops and laboratories are used for the training of electricians, I&C and maintenance personnel. The team observed that training on diagnostics, error prevention and communication between personnel of different departments is provided in mixed groups which lead to an additional improvement of human performance.

The Training Center operates specialized training tools on proper mounting and sealing of Control Rod Drive Mechanisms to the upper part of the reactor vessel, and for the maintenance of special roller bearings. The team recognized this as a good performance.

2.4. TRAINING PROGRAMMES FOR CONTROL ROOM OPERATORS AND SHIFT SUPERVISORS

The team observed highly formalized training programmes and up-to date training material for Main Control Room (MCR) operator's training. Appropriate training objectives and indicators for success are established. The team encourages the plant to improve some presentational material for the classroom training in order to reach the same high quality as other training material.

It was observed that specialized training on Human Performance is provided by both a lecturer from the TC and a specialist from the Psycho-physiological laboratory which underlines the good understanding of the importance of human factors in the nuclear field to the management of the plant.

Most Unit Shift Supervisors and Plant Shift Supervisors act as part-time simulator instructors. The team recognizes this as Good Practice.

2.9. TRAINING PROGRAMMES FOR TRAINING GROUP PERSONNEL

The Training Center may rely on more than 100 experienced part-time instructors from the plant. Appropriate individual training programmes for them are in place including specialized training on acquiring and improving instructor skills. Video records are taken from test lectures in order to analyze and evaluate instructor's performance. The involvement of part-time instructors for specialized theoretical and practical training increases the quality and adequacy of training by taking into account up to date practical aspects of the subject being taught. The team recognizes that as good performance.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.4. TRAINING PROGRAMMES FOR CONTROL ROOM OPERATORS AND SHIFT SUPERVISORS

2.4 (a) **Good Practice:** Shared duties of simulator instructors and Main Control Room (MCR) Shift Supervisors

Full Scope Simulator (FSS) instructors must be licensed shift supervisors and are required to work in the MCR of the plant for at least three months a year.

Currently, some Unit Shift Supervisors (USS) and Plant Shift Supervisors (PSS) act as part-time FSS instructors as well. Prior to this, these shift supervisors have individual training programmes including special courses to acquire pedagogical skills. According to plant's requirements it is obligatory for a USS, who is obtaining a license for a PSS, to provide FSS training to MCR operators for at least a three months period during his/her professional development. After obtaining their license, they must continue to provide simulator training for three months annually.

The novelty of this arrangement is that FSS instructors and Shift Supervisors rarely share duties in other NPPs around the world. Power plants, having the required amount of MCR operators, may take this approach into consideration.

The benefit for the instructors is that they remain familiar with the real operations and may detect additional training needs for the MCR operators at an early stage. At the same time, active Shift Supervisors acquire and improve their training and coaching skills.

3. OPERATIONS

3.1. ORGANIZATION AND FUNCTIONS

In general the operations department at Kozloduy NPP is well managed with professional and attentive staff.

Shift staffing levels are sufficient for normal and emergency conditions. The MCR staff consists of a unit shift supervisor, two senior reactor operators and two secondary side operators. Having three people with reactor operations licences in the MCR is considered as good performance by the team.

3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

System and equipment status are clearly indicated and the number of lit annunciators minimized. However, there remain some decommissioned components. There are controls and status lights for those systems without appropriate labeling. The plant is encouraged to label these decommissioned controls and indications.

After the Fukushima accident the plant has introduced power supply improvement including procedures for using all possible sources of electrical power. These procedures and equipment abilities were tested and validated during emergency exercise. The team recognized this as a good practice.

During Instrumentation and Control system refurbishment the Emergency control room has been equipped with additional controls for operation of normal non safety systems. The team recognizes this as a good practice.

3.3. OPERATING RULES AND PROCEDURES

The plant has a functional system to keep track of entries and exits of Operational Limits and Conditions. However it doesn't include details such as expiry time. The plant is encouraged to enhance the logging of such entries to include this detail.

Procedures are regularly reviewed and well maintained. However in some cases procedures from outside regulating agencies are used (e.g. The rules for safe work on electrical equipment, issued by Ministry of Energy and Energy sources). There is no current means of identifying the correct revision of that document. The plant is encouraged to develop a system for indicating to staff the correct validity of outside agency documents used as working documents.

The systems for mechanical filtration of drain water and temporary storage of liquid waste are being operated outside their design intent and the operating instructions do not reflect this. The team has a recommendation with regard to this.

3.4. CONDUCT OF OPERATIONS

Generally operators are attentive and responsive to plant conditions. There are a few cases of minor deviations from normal parameters or normal conditions where slow or no operator action is taken. Those deviations are indicated by reaching limit marks on the indicators or through status symbol color changes (from green to red) on the safety system monitor. The plant is encouraged to review these cases removing limit marks that are outdated or

unnecessary and reinforcing the response to minor deviations from normal parameters or normal conditions when appropriate.

Despite a comprehensive programme of operator rounds and joint rounds with managers not all defects are reported. The team has made a suggestion in this area.

3.5. WORK AUTHORIZATIONS

The procedure for work authorizations and implementation of modifications provides good means of communicating changes of equipment status to the shift operational personnel. For each unit there is also the position of chief technologist who provides the overview of plant status. This role is staffed by someone working normal days Monday to Friday and as such provides good continuity of the overall situational awareness of the plant state for that unit and is seen as good performance.

During execution of work the plant does not routinely lock electrical isolators in the open position to provide safety to personnel. Although this is in accordance with the state regulations it does not align with common practice elsewhere in the industry where electrical isolators are locked in the open position to provide safety to personnel. The plant is encouraged to review the practices common elsewhere in the industry and implement any improvements identified.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

The plant has a comprehensive schedule of testing and surveillances for its fire protection systems. This is coupled with a unique relationship with the state fire brigade whose fire station is located adjacent to the site and who regularly train on the site. This leads to very good relationships with the state fire brigade who provide mitigation measures when fire systems are out of service and support for such activities as hot work including its authorization. This was seen by the team as a good performance.

3.7. MANAGEMENT OF ACCIDENT CONDITIONS

The shift staff is provided with a well-structured emergency plan with clearly defined entry conditions to each category of site emergency. This plan includes good arrangements for offsite support and as such was seen by the team as a good performance.

Severe accident management guidelines are implemented for all reactor conditions except for open reactor conditions or spent fuel pool. The team has made a recommendation in this area.

DETAILED OPERATIONS FINDINGS

3.2 OPERATIONS FACILITIES AND OPERATOR AIDS

- 3.2 (a) Good Practice:** Post Fukushima plant power supply improvement – the plant developed procedures for using all possible sources of electrical power, procedures and equipment abilities were tested and validated during emergency exercise.

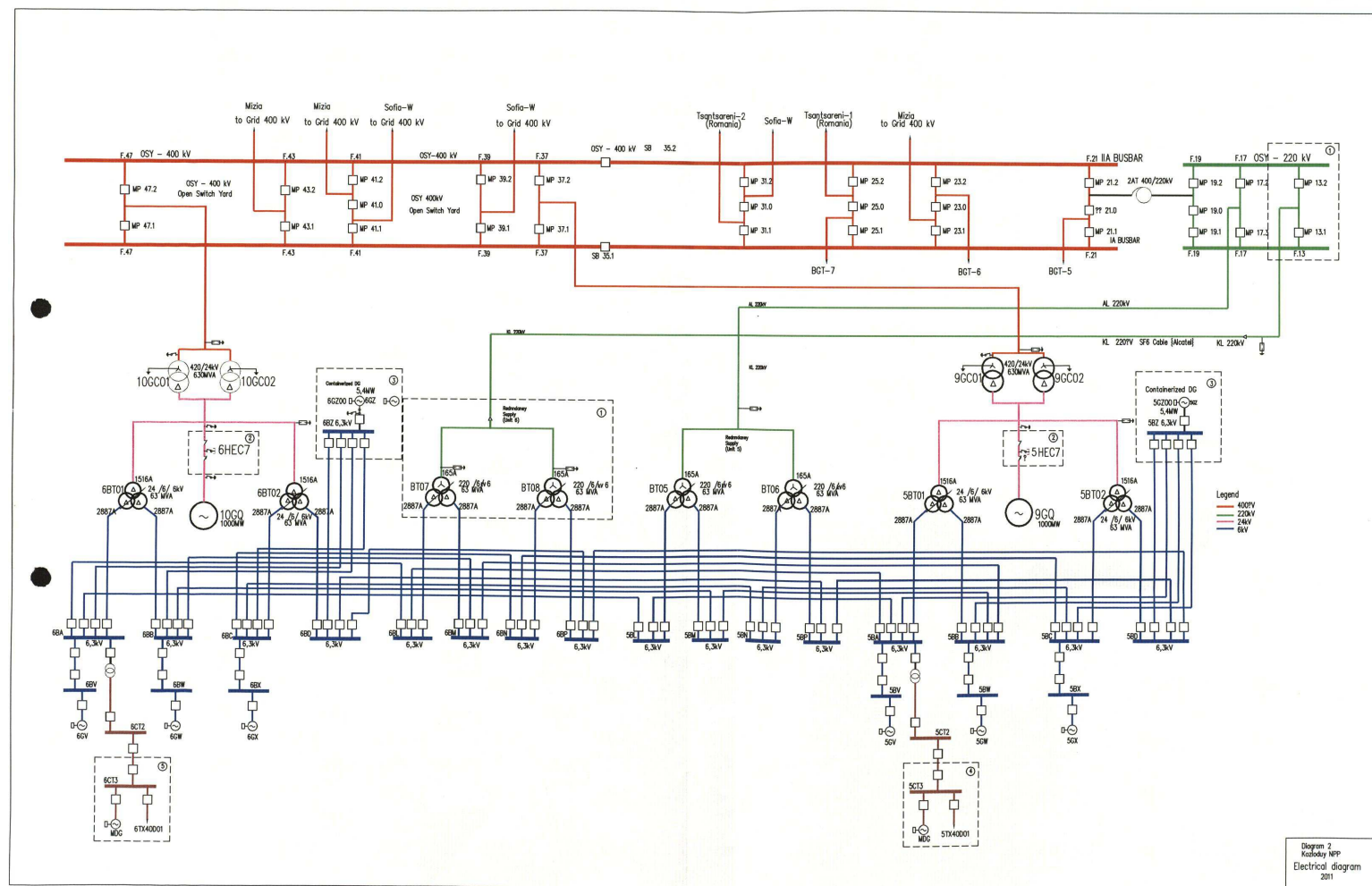
The plant significantly improved power supply availability. Consumers power supply is provided via four 6kV buses for normal operation sections (BA, BB, BC & BD, see attached diagram). This section feeds three 6kV safety buses (BV, BW, BX). The normal power supply for 6kV buses BA, BB, BC & BD is derived from the 400kV external grid. Backup supply is from the 220kV external grid. Backup lines are connected between the two units enabling back up 6kV buses BL, BM, BN & BP to be supplied from the other units supply. During the modernization in 2003/2005, 5.4 MW diesel generators (GZ) were added for each unit. Diesel generators GZ are able to be connected automatically to the normal operation section 6kV buses BA, BB, BC & BD. In case of failure any of the 6kV safety buses (BV,BW,BX) can be supplied through normal operation 6kV buses by diesel generator GZ instead of any of safety diesel generators GV,GW,GX.

Diesel generator GZ can supply the other unit via 6kV back up lines for BL, BM, BN, BP.

On 14.5.2012 a test was carried out in Kozloduy NPP to supply the load of one of the safety buses 6kV from GZ diesel generator. This proved that during the station blackout mode diesel generator GZ can take the full load of one of the three safety systems.

Besides this test on 13.5.2011 (2 months after Fukushima emergency) Kozloduy NPP carried out a test to supply all the real load of the first category DC consumers just from battery 5EA20 of the second safety system of unit 5. This was performed by an additional procedure. During the procedure performance was tested of all emergency lighting all invertors supplied by the battery, battery current, cells voltage, temperature, electrolyse consistence, hydrogen presence in the battery room and multiple opening & closing of steam dump valves. The results indicated that the battery discharge time was more than 10 hours and 18 minutes. This test allows the operation personnel to know the real discharging time of the safety system battery and to be sure that it is enough to receive supply from another source. The discharging time is a result of the modernization programme of the UPS systems and the batteries.

The addition of this power supply provides more opportunities for securing power supplies. The test performed with real load assessed the exact capability of the supply and improved the skills of the operating personal and validated emergency procedures.



3.2(b) Good Practice: Emergency Control Room improvement during Instrumentation and Control refurbishment

The Emergency control room (ECR) is intended for use in case of unavailability of the main control room (MCR) for shut down and cool down of the unit and maintaining it cool and subcritical. For this purpose, according the original design, only safety system components could be monitored and controlled from this facility.

After the modernization of the normal operation control systems and their replacements by computer based systems, a Computer Information and Control System work station was installed in the ECR. Thus, the ECR operators have access to the additional operating information on the state of the unit equipment, the radiation situation on the unit and on the site, the radiation control on the discharges through vent stacks and the environment conditions in important process compartments.

The “Soft control” function of the installed work station allows control of the normal operation systems equipment, when required. This function also allows full-fledged utilization of the available equipment in all operating modes of the unit, when the access to MCR is not possible.

During normal operation the staff do not have control rights and is it used purely as an information system during regulated inspections, switch-overs and tests performed from ECR.

In an emergency situation the control of normal operating systems is enabled by entering a special access password.

The possibility for full on line monitoring and control allows performing operations which are not included in the scope of the safety systems, transfer of boron solutions, maintaining optimum water chemistry, having part load technological process therefore avoiding repetition of thermal cycles that waste valuable equipment resource.

For those NPPs which are planning to implement a refurbishment of their instrumentation and control system it might be useful to consider including the above feature into scope of refurbishment.

3.3. OPERATING RULES AND PROCEDURES

3.3(1) Issue: The systems for mechanical filtration of drain water and temporary storage of liquid waste are being operated outside their design intent and the operating instructions do not reflect this.

The plant has increased the storage capacity for liquid radioactive waste from 3 tanks 300 m³ each by adding 4 tanks 746 m³ each. The plant has reduced drain water generation and in the period 2007–2012 the liquid waste temporarily stored at the plant was reduced by transferring significantly more liquid radioactive waste to the State Enterprise of Radioactive Waste than generated on units 5 and 6.

The plant is looking for an engineering solution to condition solid particles that have accumulated in the sedimentation tank. SiAl method applied in Dukovany NPP was analyzed by the plant, however its output cannot be directly (without further conditioning) accepted by the State Enterprise of Radioactive Waste. Incineration technology is being prepared, it may be a solution for final removal of solid particles. Until it is clarified, the plant intends to operate this system as in its present status.

Nevertheless the following was noted concerning the operating conditions of systems for mechanical filtering of drain waters (TR20) and the system of temporary storage of liquid waste (TW):

- The level of solid particles phase in the sedimentation tank 0TR20B01 is out of normal range. The relevant operating procedure does not contain an action to be taken in this situation. The problem has been known about for 10 years. The tank had in the original design a ‘monte-jus’ system to remove particles phase but it was never used because waste conditioning technology for the sludge is not available.
- The volume of tank 0TR20B01 is about 130 m³, the sludge occupies about 110 m³. This means the tank 0TR20B01 and the consecutive mechanical filters do not remove solid particles, because the solid particles are transferred from the tank further by overflow, and then back flushed from the filters to the same tank. The mass flow and the size characteristics of the solid particles not retained by the filter have not been determined.
- The plant stated that in the last two years system TR20 is operating in a kind of “equilibrium” status, but trending of available data on frequency of filter back flush was not performed.
- The total amount of sludge in common systems of unit 5 & 6 is about 150 m³. The speed of accumulation of solid particles has not been determined recently. Solid particles are transferred through the evaporation system. This could cause blocking of the level regulator of the evaporating device and hinder heat transfer in its lower part.
- After evaporation the solid particles are mixed in the evaporator bottoms with boric acid and salts and stored in the tanks 01TW50B02,03,04 designated for storage of liquid radioactive waste. An undesired phenomenon of solidification has been observed in these tanks.
- In June 2012 tanks 01TW50B02,03,04 contained 716 m³ of liquid phase and 689 m³ of solidified phase. Solid phase in January 2009 in these tanks amounted to 804 m³. These amounts are determined based on visual inspection; a more accurate

measurement with laser was performed in one tank in January 2011. A slow reduction of a solid phase that is present took place in two tanks and there was no change of the quantity of solid phase in the third. The fourth tank remains empty

- The presence of this solid phase in these tanks is not currently reflected in the operating procedures for these systems.
- Although the presence of solids is briefly mentioned in the safety analysis report there is no justification or analysis of the risks and consequences

Highly concentrated salts in solid phase may result in inhomogeneous concentration of chlorides and sulphates with a risk of corrosion for the stainless steel wall of the storage tanks for radioactive waste. This is not reflected in the operating procedures and long term sustainability for the present operating mode of TR20 system is questionable.

Recommendation: The plant should justify the current method of operation of the systems for mechanical filtration of drain water and for temporary storage of liquid waste and reflect it in the operating instructions.

IAEA Bases:

SSR-2/2

5.18. Treatment and storage of radioactive waste shall be strictly controlled in a manner consistent with the requirements for the predisposal management of radioactive waste.

NS-G-2.4

6.26. The operating organization should provide for the development of operating instructions and procedures that:

- are in accordance with design assumptions and intent; and
- provide sufficient details to allow the person assigned to perform the activity to do so without direct supervision.

6.42. The surveillance programme should ensure that items important to safety continue to perform in accordance with the original design assumptions and intent and may incorporate ... feedback from operating experience.

WS-G-6.1.

6.74. Procedures should be developed for managing and operating the storage facility... Any deviation from the approved operational procedures should be justified and its implications for safety should be determined.

NS-G-2.14

3.5. The main responsibilities of the control room operators are to operate the plant and the plant systems in accordance with the design intent and operating procedures.

NS-G-2.10

8.3. Updating of plant documentation. The PSR and associated corrective actions and/or safety improvements will invariably necessitate changes to plant documentation. Therefore, the plant operating organization should update all plant documentation including, for example, the safety analysis report, operating and maintenance procedures and training materials to reflect the outcomes of the PSR.

Plant Response/Action:

The recommendation has been analysed in details at Kozloduy NPP. A decision has been made to restore the design condition of the system for mechanical filtration of drain water.

With respect to the above decision, programmes for inspection of the individual components' condition in the system for mechanical filtration of drain water have been developed and implemented. The following corrective actions have been identified and implemented:

- The required activities have been performed and additional facilities connected with sedimentation tank 0TR20B01 put in operation. These facilities enable the transfer of sludge from 0TR20B01 to other tanks for temporary storage or to the Specialised Division Radioactive Waste-Kozloduy.
- Within a Technical Decision No. 4544, "Replacement of a measuring channel for monitoring the sludge level in 0TR20B01," a new sensor has been installed, readings checked and adjusted, and control panel alarm restored.
- Programmes have been prepared for mechanical filters inspection, and one filter was inspected as of now. Regarding this filter, the Technical Decision "Installation of isolation valves on the drain pipe of the special sewage and primary sampling valves at the intake section of mechanical filters 0TR30N01,02" has been implemented. The inspection of the second filter as well as implementation of the above Technical Decision are scheduled for the period between the outages of Units 5 and 6 in 2014.
- The monitoring of chemical indicators has been extended (transparency measurement at the intake and discharge sections). The results confirmed that the system operates in accordance with its design intent.

In response to the recommendation of the OSART Team, the Operating procedure for the drain water treatment system (RWCU-3) has been updated. The operators have been trained on the new versions of the operating procedures.

Regarding the inspection of tanks 0TW50B02, 03 and 04 intended for storage of liquid radioactive waste:

- An in-service inspection of the tanks for temporary storage of evaporation concentrate has been performed. The results indicated no problems with the base metal of the tanks.
- The "Operating procedure for the liquid radioactive waste temporary storage facility," No. 30.PAO.TW.IE.31, has been updated. The Operating Procedure includes a requirement for periodic visual inspection of the tanks for temporary storage of evaporation concentrate by a committee.
- Technical Decision No. 4526, "Installation of a pipe for flushing the line that transfers evaporation concentrate from 0TM50B01-04 to the Specialised Division

Radioactive Waste-Kozloduy and installation of safety railings on the tanks" has been implemented.

- Additional analysis has been conducted of the condition and operation of the tanks for temporary storage of evaporation concentrate as part of the "Safety Analysis Report (SAR) update to reflect the current condition of the Kozloduy NPP Units 5 and 6."
- The results of the analysis indicated that the system for temporary storage of evaporation concentrate is operated in compliance with the current regulatory and technical documents.
- The strength verification calculations proved that the design of the system complied with the design strength criteria in accordance with the current regulatory and technical documents.

The measures described above allowed the plant to ensure that the design conditions for the system operation are restored and to confirm that the system operates in accordance with its design intent.

The planned subsequent actions are aiming to modify the design in order to ensure approach to treat the accumulating sludge and sorbents. The following Terms of Reference has been prepared and included in the company Investment Programme: "Design, construction, procurement, and installation of a system for extraction and transport of sludge and sorbents from AB-3."

The subsequent utilization of the built up sludge and sorbents will be performed by the joint efforts of Kozloduy NPP and State Enterprise Radioactive Wastes (SE RAW).

IAEA comments:

The plant has carried out a number of activities on systems TR and TW to support the justification of the current operating regime and its operation in this manner:

- Detailed NDT of the in service tanks on system TW using the spare tank as a datum to determine any material degradation of the tanks caused by the current operating regime. This proved the tanks were unaffected.
- The standing high level alarm that had been present on tank 0TR20B01 has been cleared by replacing a defective level sensor restoring the alarm functionality.
- Updating of operations procedures and training of operators in these procedures.
- Other activities such as sludge sampling, clearance of line blockages, inspection of filters and provision of better monitoring equipment.

The plant Safety Analysis Report (SAR) has been updated to reflect and justify the current operating regime of systems TR and TW. This includes the current state of plant, justification for operation in this manner including postulated faults and respective action required to be taken for those faults. The updated SAR now requires the NDT performed on the tanks to be carried out periodically to prove there is no detrimental effect on the tanks from the current operating regime. The operating procedures have been updated in line with these changes to the SAR.

The plant has justified the current method of operation of these systems and reflected this in operating procedures.

Further to this the plant has:

- Included provision to reduce the solid phase burden in systems TR and TW within the plant's investment plans.
- Placed a contract with Westinghouse to re-instrument the systems associated with auxiliary building 3 which will allow better monitoring including trending of the performance of the liquid waste treatment systems and early detection of unwanted trends allowing timely intervention.

Conclusion: Issue resolved

3.4. CONDUCT OF OPERATIONS

3.4(1) Issue Despite a comprehensive programme of operator rounds and joint rounds with managers not all defects are reported.

During plant walkdowns the following unreported defects were observed:

- At the rear of the room (6AK041/2) the electrical trunking covers have missing fasteners.
- On valve 6TQ32S30 there are heavy boron deposits around the valve stem and on the valve bonnet.
- Small oil leaks
 - On both pump 5SU91D31 and associated valve SU19PO7P1.
 - From valve 6TQ33S01.
 - On the floor between Diesel generator 5GX and an associated check valve. and consequential accumulation of oil
- The drain sump within room 6QF21D03,04 contains a lot of debris which is partially and severely blocking the strainers on the pump suction lines used for draining this sump.
- The entrance door to room C214 Steam generator blowdown treatment cannot close properly as it interferes with the concrete surround at the bottom of the door. In addition the door seals are damaged. This defect appears to have existed for some time.
- Labels and handwheels are missing on impulse line valves on suction and discharge valve of pump 5SU91D61.
- No identification labels on pumps 5UX21D01, D02 and pumps 5UX31D01, D02.
- Broken label on valve 6RL42S03.
- Safety related valve 5VF11S05 position indicator is missing.
- In machinery hall, Unit 5, near 5RN53D01 part of the handrail is missing.
- In machinery hall, Unit 5, near 5RW52D11 – there is an information table placed in an inappropriate way which is head hazard.
- 5RL52D01 – there is a cracked weld between motor and pad for the position adjusting screw.
- 5RL51D01 – missing screw for motor position adjustment.
- During rounds the following defects were not noted by the field operator
 - On feed pump 6SA52 six instrument impulse line root valves were not labeled.
 - Pump 6RW52D21 had a shaft seal leak. No defect tag was present. The adjacent pump 6RW52D11 had a similar defect and a tag present.
 - The concrete ceiling above valve 6RQ62S02 was crumbling with debris falling onto an adjacent structural beam.
- In discussion with operations management the reason given for these deviations from the required standards was that operators required further training to reinforce the

standard.

Without the prompt reporting of minor defects to enable timely repair either by the accumulation of such defects or their degradation the ability of the plant to meet its designed duty may be compromised.

Suggestion: The plant should consider reinforcing the expected standards of reporting all defects to managers and staff.

IAEA Bases:

SSR-2/2

Equipment that is degraded (owing to leaks, corrosion spots, loose parts or damaged thermal insulation, for example) shall be identified, reported and corrected in a timely manner.

NS-G-2.14

4.34. Rounds should be conducted regularly by the operators to identify actual and potential equipment problems and conditions that could affect the functioning of the equipment.

4.35. They should take note of equipment that is deteriorating and of factors affecting environmental conditions, such as water and oil leaks, burned out light bulbs and changes in building temperature or the cleanness of the air. Any problems noted with equipment should be promptly communicated to the control room personnel and corrective action should be initiated.

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

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

Plant Response/Action:

After analysing the weaknesses in the rounds of operating personnel (OP) two main areas for improvement were identified and respective corrective actions were implemented:

1. Improving the skills of operating personnel in detecting and reporting inconsistencies and remarks on the condition of the equipment.
 - The routes of the rounds have been optimized (scope, duration, number per shift) to allow for higher quality rounds of the operating staff.
 - An extraordinary training of the operating personnel was carried out with regard to implementation of the administrative procedures for maintaining housekeeping and the operational condition of the equipment, premises and areas and with regard to the Quality Procedure "Maintaining housekeeping and the operational condition of the equipment in EP-2".
 - An interactive training material for improving the quality of the rounds of the operating personnel was developed. The material covers the entire process of performing rounds (preparation for the round, a review of the route, checking personal protective equipment (PPE), examples of defects, remarks and inconsistencies, respective marking at place, reporting the identified

inconsistencies, registration in the Operating Experience database (Information System for Organisation of the Operating Activity (IS OOA)).

- Training was carried out to the whole operating personnel under the newly developed interactive training material.
- A review of the effectiveness of the existing system for reporting of labelling issues was made and measures were implemented for simplification and speeding up of the corrective actions. A unified electronic form of the label for identification of defects and remarks was developed and implemented.

2. Coaching of the managing personnel in Operations division over the operating personnel during rounds. Clear definition and reinforcement of the management expectations. Review and analysis of the achieved results.

Before OSART mission, in Kozloduy NPP joint rounds are carried out by the managers together with the operating personnel of the sections in order to control the manner of performing the rounds along the established routes for the staff, identifying weaknesses (errors) in their implementation, and for training purpose as well. Additionally:

- A new checklist sheet to record the results of the joint rounds fully oriented to reflect the performance of the operators - registration of weaknesses was developed.
- Heads of sectors (HS) each month submit the results of the joint rounds with operating staff to the Chief Process Engineer - Organization of Operating Activity (CPE-OOA).
- The CPE-OOA summarises the results from the rounds and identifies corrective measures.
- Since January 2014, with the aim of performing an independent internal audit, the internal reviews system in "Operations" Division was extended. Provisions were made and the so-called "joint rounds" were put into practice – the Head of Sector makes a joint round along a routine route of another sector with the relevant filed operator.
- In the Job description of the Shift Supervisor a specific obligation is specified to periodically monitor the quality of the rounds carried out by the filed operators.
- Since April 2014, in order to optimize the process and establish it as a regular practice the Rules of the "Operation" division has changed. The management teams in "Operation" division during the monthly reporting of activities by sectors, review the results from the joint rounds with the operating staff and prepare reports, which include review and summary of deficiencies found during the conducted joint rounds. At the briefings of "Operation" division these reports from the conducted joint rounds of all sectors are reviewed and corrective measures are identified.

The plant has analysed the issue around field operators deficiencies reporting and following this analysis developed a comprehensive improvement programme.

This includes:

- Training of all operators in the standards and expectations. Following this training intervention the training is now included in the initial and continuation training of field operators.
- Refinement of rounds to shorter and less frequent rounds with the emphasis on better quality.
- Analysis of the quality of the rounds which includes corrective actions. This analysis identifies both systematic failings and individual performance issues. Allowing appropriate corrective action to be taken.
- Improvement of joint rounds including introduction of interdepartmental joint rounds. These joint rounds provide the performance data, against clearly defined criteria, used to monitor the quality of the field operator rounds.

During plant walk downs of auxiliary building, reactor buildings and turbine hall the level of unreported defects showed the intervention by the operations management has been effective.

Conclusion: Issue resolved

3.7. MANAGEMENT OF ACCIDENT CONDITIONS

3.7(1) Issue: Severe accident management guidelines (SAMGs) do not exist for open reactor conditions or spent fuel pools.

SAMGs for at power conditions and some shutdown conditions exist and plant has already developed and implemented emergency operating procedures for the spent fuel pools.

The need to develop additional procedures for both spent fuel pool operation and open reactor conditions is recognized by the plant management and a programme of work is in progress. Terms of reference for analysis of accidents in the spent fuel pools have been developed and a study will take place in 2013. This can then be used as the basis for severe accident management guidelines.

For open reactor conditions the plant is currently training staff on new symptom based procedures that contain reference to actions required for beyond design basis accidents. These procedures will be in place in early 2013.

- During interviews it was explained that Severe Accident Management Guidelines do not exist for open reactor conditions or the operation of the spent fuel pools.

Without the severe accident management guidelines for all conditions there may not be effective defence in depth to control the release of radioactive material to the environment in the event of a severe accident.

Recommendation: The plant should develop and implement severe accident management guidelines for both open reactor conditions and the spent fuel pools.

IAEA Bases:

SSR-2/2

5.9. Arrangements for accident management shall provide the operating staff with appropriate systems and technical support in relation to beyond design basis accidents. These arrangements ... shall address the actions necessary following beyond design basis accidents, including severe accidents.

NS-G-2-15

2.16. Severe accidents may also occur when the plant is in the shutdown state.

In the severe accident management guidance, consideration should be given to any specific challenges posed by shutdown plant configurations and large scale maintenance, such as an open containment equipment hatch.

The potential damage of spent fuel both in the reactor vessel and in the spent fuel pool or in storage should also be considered in the accident management guidance. As large scale maintenance is frequently carried out during planned shutdown states, the first concern of accident management guidance should be the safety of the workforce.

NS-G-2-15

2.17. Severe accident management should cover all modes of plant operation.

Plant Response/Action:

Kozloduy NPP has planned and develops SAMGs covering the scope of depressurized reactor condition and SFP.

Activities are conducted in accordance with specially developed "Programme for implementation and maintenance of Severe Accident Management Guidelines (SAMG) for shutdown reactor and SFP for Units 5 and 6 of Kozloduy NPP."

The scope of the programme includes the processes of development, review, verification, validation, operator's training and commissioning of a set of SAMGs for shutdown reactor and SFP, covering the following plant states:

- cold and depressurized reactor;
- fuel refuelling;

Currently, 5 Guidelines for shutdown reactor and SFP have been developed (see the below list). The entry conditions from the SB EOPs for shutdown reactor and SFP to the SAMGs for shutdown reactor and SFP have been established based on the measuring channels installed at Kozloduy NPP capable to resist severe accident conditions, as well as on the basis of the so far implemented design modifications enabling supply of coolant to the reactor and SFP during the above modes of operation. Examples of such design modifications at Units 5 and 6 are the following: Supply of buses CT-3 from mobile DGs, switching the power supply of the hydraulic accumulators' valves from Second to First Category.

List of the developed SAMGs for shutdown reactor and SFP:

- 1) SAMG – UWRP “Severe Accident Management Guidelines for the Underwater Refuelling Pool (UWRP) at shutdown unit.
- 2) SAMG – 0.0 “Severe Accident Management Guidelines in case of SBO at shutdown unit”
- 3) SAMG - DR “Severe Accident Management Guidelines for depressurized reactor”
- 4) SAMG – SFP “Severe Accident Management Guidelines for the Spent Fuel Pool (SFP)”
- 5) SAMG – C “Severe Accident Management Guidelines for the Containment at shutdown unit”

For analytic justification of the set of SAMGs for shutdown reactor and SFP, the deterministic analyses of Units 5 and 6 Level 2 PSA have been used. All the modes of operation of the Unit have been analysed in the Level 2 PSA including the phenomena concerning the SFP, behaviour of systems and Unit as a whole; operators actions; progress of the individual severe accident scenarios, release categories, uncertainty and sensitivity of the results. Additional conservative thermohydraulic analyses are contracted: "Analysis of the phenomena during a severe accident in the SFPs of Kozloduy NPP Units 5 and 6". Within them the processes of severe fuel damage in the SFP and related phenomena and physical conditions in the containment during the following plant operating modes were analysed: cold and depressurized reactor and refuelling which includes the depressurized reactor state.

Based on these analyses, the technical background documents of the SAMGs for shutdown reactor and SFP will be developed. They cover the conditions and criteria for transition from SB EOPs to SAMGs for shutdown reactor and SFP, critical timing for the performance of the

basic and alternative protective operators' actions, and requirements for performance of the planned protective or consequence mitigation actions.

The progress in the implementation of the "Programme for implementation and maintenance of Severe Accident Management Guidelines (SAMG) for shutdown reactor and SFP for Units 5 and 6 of Kozloduy NPP is reported to BNRA as part of the control of the implementation of the National Action Plan of Bulgaria related the European Stress Tests.

IAEA comments:

The plant has a programme to develop and implement SAMGs for unsealed reactor conditions and spent fuel pools. This includes specific thermo hydraulic analysis for a severe accident in the spent fuel pools at unit 5 and 6. Some of the original timescales for this programme have proved optimistic due to the originality of these guidelines.

Although behind the original programme dates SAMGs have been written for unsealed reactor conditions and spent fuel pools. To complete the SAMGs for spent fuel pools in a timely manner the plant has been written them ahead of full completion of the thermo hydraulic analysis. These SAMGs consider data currently available from the analysis with provision for further changes if required on completion of the analysis due Nov 2014.

The plant now has a detailed programme showing completion of the SAMGs at the end of 2014 and implementation in May 2015 when the required training is scheduled to be completed. This is also in line with the National Action Plan of Bulgaria related to the European stress test.

Conclusion: Satisfactory progress to date.

4. MAINTENANCE

4.1. ORGANIZATION AND FUNCTIONS

The plant applies a broader definition to the “rework”: number of work orders for one equipment in the reporting period (3 months). In many cases different maintenance activities were performed on the same equipment in the given period, but they were not a repetition of work due to performance deficiencies. Thus the indicator on the amount of rework is relatively high. Also the “Rework” performance indicator limit value - set initially in 2010 - has been exceeded. The team encourages the plant to adjust the limit value of the “Rework” performance indicator to a correct representative level, and to continue tracking reworks and determining their causes.

The limit value for the performance indicator regarding the ratio of corrective maintenance to all maintenance work is presently 30%. The plant is encouraged to set a target value and deviation tolerances for this performance indicator based on optimization methods.

Before work site turn-over, operations personnel always instruct maintenance personnel on work site safety precautions. Preparation of maintenance work sites is inspected jointly by operations and maintenance personnel before opening the work order. The team encourages the plant to stimulate questioning communication between field operators and maintenance crews (e.g. at safety precaution briefing, work site turn-overs, and prompt identification of deficiencies in the plant).

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

There is no administrative control of the items in the RCA workshop tool-room. The team encourages the plant to provide a system for recording the stocks and the needs in the hot workshop in order to avoid unavailability of tools and instruments necessary for urgent repairs of structures, systems and components during the outage.

Unapproved list of measurement instruments was used in the warehouse zone no. 6. Using such unapproved documents is inappropriate for the control of measuring and test equipment to trace their calibration and accuracy. The team encourages the plant to improve this situation.

4.3. MAINTENANCE PROGRAMMES

The Shock Pulse Measurements Method (SPM) is applied at the plant for early assessment of the condition of rolling bearings on pumps and Heating-Ventilation-Air Conditioning fans; for identification of similar defects and for prolonging the bearing operation time. 80% of bearing deficiency indications can be solved by simply adding the necessary amount of lubricant. Since the introduction of SPM at the plant no rolling bearings have broken on the equipment covered by SPM.

Predictive maintenance activities using SPM assist the optimization of maintenance planning.

SPM contributed in reducing the number of delayed works to zero on ventilation systems in and outside the containment, pumps on the safety systems, and all the pumps in the turbine hall in 2011 and 2012.

The team recognized this as a good performance.

4.4. PROCEDURES, RECORDS AND HISTORIES

The content and format of maintenance procedures in some cases do not provide appropriate guidance for the correct conduct and supervision of maintenance works. The team made a suggestion in this respect.

4.5. CONDUCT OF MAINTENANCE WORK

Minor weaknesses in maintenance worker practices prevent personnel from good performance (e.g. not all tools and spares taken to the work site from the beginning of the work, not using the most appropriate bolting tools, excessive cleaning with chemicals, procedure not always properly used on a routine basis, work area delimitation minor inconsistencies). The team encourages the plant to improve maintenance worker practices.

4.6. MATERIAL CONDITIONS

The material condition of some electric cables and associated components is inadequate. The team made a suggestion in this regard.

4.8. SPARES PARTS AND MATERIALS

The team encourages the plant to pay more attention to keep the packaging of all stored spare parts and materials intact until their final destination in the plant. This applies especially to spare parts for safety related equipment (e.g. graphite seals, electronic connector cables).

The plant uses color coding of labels of spare parts and materials depending on their safety significance. The team recognized this system as a good practice.

DETAILED MAINTENANCE FINDINGS

4.4. PROCEDURES, RECORDS AND HISTORIES

4.4(1) Issue: The content and format of maintenance procedures in some cases do not provide appropriate guidance for the correct conduct and supervision of maintenance works.

Maintenance management has recognized some procedure deficiencies, e.g. general format maintenance cards do not take into account sufficiently the technical specifics and the safety significance of the equipment. Maintenance management undertook corrective action which resulted in 100 new procedures and 150 new revisions of the procedures in the last two years.

However the team noted the following deficiencies:

- In the maintenance procedures for periodical technical servicing the following deficiencies were present:
 - A basic step was missing from the technical servicing task list of fire-water pump.
 - The task list for the periodical technical servicing of the condensate pump motor contained some steps which were not applicable to the job. The reason is that the same format is used for similar type-group of equipment.
 - The procedure for periodical technical servicing of chemical pump did not contain controls (e.g. specifying the tool) to avoid over tightening of the flexible coupling fasteners.
- Workers and their supervisors omitted to note some deficiencies during technical servicing of Heating-Ventilation-Air Conditioning system fans (e.g. rusty bearing, missing bolts, bolts left in the fan, cracked drive-belts, rust and damage at the flexible connection to fan outlet duct), and during technical servicing of steam generator blow-down cooling pump (excessive greasing of pump bearings, not reassembling the pump axis protective grid).

Excessive paperwork due to unnecessary signatures during work performance involved interruptions and diverted the attention from the real scope of the work, and also lengthened work.

Most maintenance and technical servicing task-list forms (maintenance cards) require writing down the performer and/or supervisor name and signature at each step, which takes up most of the space on the task-list form, leaving not enough space to write down the deficiencies encountered during work.

- A reminder list containing the basic questions which have to be always asked and answered at maintenance pre-job-briefings (PJB) is not available to assist efficient preparation for conduct of maintenance work, although the main points to be addressed during maintenance PJB are given in procedure No.40.
- Maintenance procedure deficiencies were the root cause of occurrences which lead to a turbine trip and reactor protection system actuation event in March 2010. The technical servicing program of the protection relay cabinet did not include enough inspection details. A reporting document with acceptance criteria of the turbine dump valve electrical actuation mechanism was missing from the procedure.

Maintenance procedure deficiencies can lead to inadequate maintenance practices which may result in system, structure and component unreliability or defects.

Suggestion: The plant should consider correcting maintenance procedure deficiencies.

IAEA Bases:

SSR-2/2

8.3. The operating organization shall develop procedures for all maintenance ... These procedures shall be prepared, reviewed, modified when required.

NS-G-2.6

4.23. Procedures and work related documents should specify preconditions and provide clear instructions for the work to be done, and should be used to ensure that work is performed in accordance with the strategy, policies and programmes of the plant.

The procedures and work related documents should be technically accurate, properly validated, verified and authorized, and they should be periodically reviewed. Human factors and the ALARA principle (to keep radiation doses as low as reasonably achievable) should be considered in the preparation of work instructions.

5.8. The information contained in the procedure should be presented step by step in a logical order. All references and interfaces with other relevant procedures should be carefully reviewed and verified. The level of detail should be such that the individual carrying out the work can follow the procedure without further guidance or supervision.

5.9. The content and format of a typical procedure should be in accordance with the provisions established for quality assurance. The content should therefore typically include the following:

(f) Special precautions: any special safety procedures such as special measures for radiation protection, the securing or removal of loose items, and any necessary control of materials (for example, incompatible lubricants or chemicals) and environmental conditions.

(g) Special tools and equipment: a listing of all special tools, rigging and equipment necessary to carry out the work.

(h) References: a list of applicable sections of reference documents that may need to be consulted, such as documents containing baseline data, test and calibration charts, drawings, printouts, instruction books, manuals, applicable codes and standards, photographs and descriptions of mock-ups.

(i) Instruction text: a step by step listing of work details which identifies any changes in radiological or other conditions as work progresses. At selected steps, craftpersons may be required to sign their names or their initials to indicate satisfactory completion of the preceding step or steps, either on the procedure or on an attached checklist.

(j) Inspection witness points: selected points in the work sequence at which an inspection for quality control purposes or another type of inspection by a competent person, as required by the regulatory body, is to be made. Work may not proceed past this point until the inspection has been performed and documented.

(k) Return to service: the actions and checks necessary for returning the equipment or system to an operational condition after the person responsible has certified that the task is completed.

Where appropriate, independent checking and acceptance criteria should be specified. These criteria should include correct reinstatement and correct compliance with procedures as well as confirmation of system operability (for example, confirmation of valve line-up).

Plant Response/Action:

An analysis was done to identify reasons for deficiencies in the area of maintenance procedure. The important causes were identified, such as procedures prepared with outdated formats and requirements, lack of quality control of procedures, inadequate user friendliness of the procedures, inappropriate combining of documents, lack of possibilities for feedback, untimely incorporation of new practices, and changes not incorporated as a result of equipment modification or replacement.

A document has been prepared and endorsed with the title Schedule for Preparing the Working Documents Required to Regulate Maintenance Activities of the Maintenance Division in 2013-2014. In accordance with this Schedule all steps regarding introducing of changes and/or issuance of new working documents regulating the maintenance activity at the Maintenance Division were completed.

The activities for optimising the form and contents of the maintenance job sheets for technical servicing and maintenance of equipment and facilities have been completed. The necessary amendments have been made to the Quality Procedure Development of Procedures for Technical Servicing and Maintenance Activities. These amendments concern the new requirements to the format and contents of maintenance job sheets. The new revision of the document has become effective as of 04.04.2013.

Changes have been made to the technical servicing and maintenance instructions (maintenance job sheets), in the section(s) that refer to use of torque wrenches, in conformity with the Schedule for Preparing the Working Documents Required to Regulate Maintenance Activities of the Maintenance Division in 2013 and 2014.

The technical servicing and maintenance instructions (maintenance cards) have been revised and modified as necessary in the section(s) that refer to foreign materials exclusion (FME) from equipment open for technical servicing and maintenance, in conformity with the “Schedule for Preparing the Working Documents Required to Regulate Maintenance Activities of the Maintenance Division in 2013 and 2014”.

IAEA comments:

The plant has analysed the issue related to the maintenance procedures carefully, and identified the important causes for the issues. A strategy was developed to review and revise as necessary for all the maintenance procedures. All procedures are required to be reviewed and revised at least every three years. Currently, there are 431 procedures in place, with only 18 of them to be revised according to the new requirements. A time schedule for maintenance document update is established annually. At the time of the review there were only seven procedures overdue in the maintenance area for review and revision.

The changes to procedures have been communicated to the plant staff and contractor personnel by various means, such as pre-job brief, training, self-study of procedures, and field observations by maintenance supervisors and managers.

A dedicated person was assigned to coordinate and report on the maintenance procedure activities, and the control of the maintenance procedure contents has been improved.

Continuous monitoring has been adopted with the observation of supervisors and managers with emphasis on procedures compliance and procedure filling-in etc.

The maintenance department has also developed a set of performance indicators to directly or indirectly monitor the effectiveness of maintenance procedures, such as the percentage of outage work with maintenance documents (including maintenance procedures) ready and repeat work on the same equipment three months after outage. However, the new performance indicators were introduced this year and the trends of the performance indicators cannot be shown at the moment.

Conclusion: Issue resolved

4.6. MATERIAL CONDITIONS

4.6(1) Issue: Material condition of some electric cables and associated components is not in line with plant expectations.

The plant has identified deficiencies of electric cables. As corrective actions, the plant has prepared technical specifications for a repair program to be performed on a contract basis. In addition, the plant maintenance personnel have repaired more than 200 deficiencies on cables in 2012.

However the team noted the following deficiencies on cables and associated electric components:

- defective crane cable repaired by unapproved method – crane UQ21E03 in room XB116;
- electric cables in contact with hot pipe – e.g. cable tray runs through the heat insulation of pipeline at 6TG13W01- suction of 6TG13D01;
- cables without support – e.g. in room 5A121;
- cable tray heat insulation panels missing or damaged – e.g. power cables in cable tray in front of 5A123/1, cable racks in corridor 5A121;
- cable tray covers not fastened, not closed – e.g. in room 5A123/5A121;
- cables not routed on cable tray – e.g. above 6UT30S21, above 6UT30S13, in room 6A107;
- cables outside the trays – e.g. next to the alcove of 5VF30/60; in front the alcove of 6VF30/60, near the wall;
- cut cable ends not isolated – e.g. in corridor 5A3506, damaged end pieces on casing pipes (cable route) to UB63N01,02;
- cable terminations not isolated and not marked – near cabinet 5VQ13XK01;
- cable through wall penetrations unsealed – e.g. 6TL27S115;
- damaged cable of electrical tool in the warehouse – warehouse 201, storage area №7, Enerpac №23 workstation;
- electrical cable of motor of SG blow-down cooling pumps not sealed in the metal pipe-duct with sharp edges. - e.g. 2RY30D01-D;
- electrical connection boxes with unsealed penetrations – e.g. 5UL29D01, junction box at 6VF27S05;
- missing cableglands – e.g. 5VF40S02, 5TK21M02;
- several cracked or missing plastic caps of small diameter cable ducts in the water chemistry plant.

Without correcting the deficiencies of electric cables, the good working order of systems, structures and components is jeopardized and electric shock hazard is present in the plant.

Suggestion: The plant should consider improving the material condition of the electric cables and associated components.

IAEA Bases:

SSR-2/2

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

NS-G-2.6

2.1 The maintenance programme for a nuclear power plant should cover all preventive and remedial measures, both administrative and technical, that are necessary to detect and mitigate degradation of a functioning SSC or to restore to an acceptable level the performance of design functions of a failed SSC. The purpose of maintenance activity is also to enhance the reliability of equipment. The range of maintenance activities includes servicing, overhaul, repair and replacement of parts, and often, as appropriate, testing, calibration and inspection.

2.7. The operating organization should monitor the performance or condition of SSCs against the goals it has set so as to provide reasonable assurance that the SSCs are capable of performing their intended functions. Such goals should be commensurate with safety and, where practicable, industry-wide operating experience should be taken into account. When the performance or condition of an SSC does not meet the established goals, appropriate corrective action should be taken.

INSAG 12

3.3.9. Operational excellence, 116. Principle: Operational excellence is achieved in present and future nuclear power plant operations by: augmenting safety culture and defence in depth; improving human performance; maintaining excellent material condition and equipment performance.

Plant Response/Action:

The plant has studied the reasons for the unsatisfactory material conditions of cables carefully and the important reasons were identified, such as inadequate control of activities involving cables, insufficient attention to cables during walk-down, and use of unapproved practices for cables installation etc. Corrective actions were taken to prevent new findings related to cables.

The following activities related to improving the electric cables' material condition were implemented:

- Room walkdowns have been undertaken to record the remarks on electric cables conditions and pictures have been taken. The identified remarks have been recorded in a specially developed data base;
- On the basis of this data base, a programme (containing long term and short-term actions) has been developed and given effect to as of 05.04.2013 under the title of Programme for Improving the Material Condition of Electric Cables at EP-2;
- Short-term activities for enhancing the electric cables material condition and operability at EP-2 within this Programme have been completed;
- Long-term activities implementation has been arranged;

- The progress on implementing of the Programme is reported every 2 (two) weeks and the program implementation continues.

IAEA comments:

The plant has analysed the issue related to the condition of cables and identified the underlying causes. New quality plans were developed for activities related to cables by contractors and plant staff. Control points have been selected for cable related activities to make sure that cables are managed in an appropriate manner.

A systematic field walk-down was conducted, which identified about 3500 findings on cables. A three-year program was developed for enhancement of the operating conditions of cables. At the time of the follow-up mission, about 80% of the cases have been resolved, with the remaining 20% planned to be completed by the end of next year. The program will be updated on an annual basis.

The new expectation on identification of conditions for cables has been communicated to plant staff by training and check-list was developed to facilities the identification of conditions for cables.

It has been demonstrated by the plant that there is no finding related to the newly installed cable, which indicate that the work practices on cable installation has been improved.

The maintenance department is reporting to the plant management on the progress of cable condition corrections on a two-week interval basis.

A field walk-down has shown marked improvement in the condition of cables, and only one cable penetration was found not sealed.

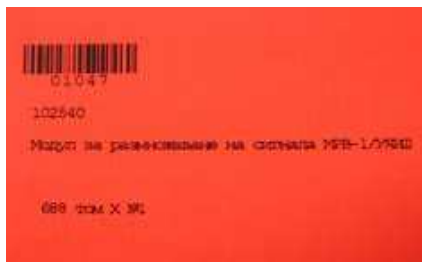
Conclusion: Satisfactory progress to date

4.8. SPARE PARTS AND MATERIALS

4.8(a) Good practice: Color coding of labels of spare parts and materials

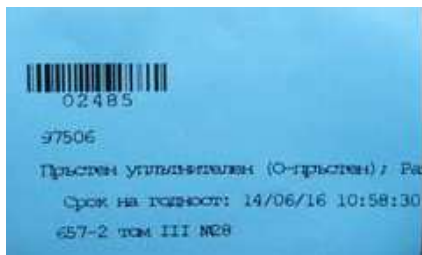
The barcode labels of items inventoried in the central warehouse and in the shop warehouses at the plant have different color depending on their safety significance. The color coding makes a clear distinction between the spare parts and materials requiring special attention (i.e. spare parts and materials intended for systems, structures and components (SSC) important to safety, or with limited shelf-life) and the items not important to safety, or without special requirements.

The colored barcode labels used at the plant are:



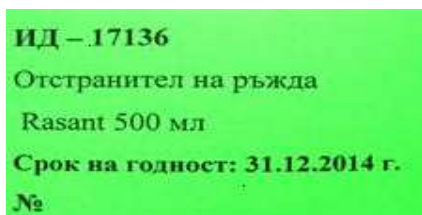
RED:

- spare parts for SSC important to safety;
- chemical products for primary circuit equipment, safety systems equipment and safety-related normal operation systems, which comply with the norms for halogens and sulphur content (oils, greases, solvents, reagents, etc.)



BLUE:

spare parts and chemical products with limited shelf-life e.g.: rubber items - O-rings, belts, seals, graphite gaskets; packings; chemical products - greases, degreasers, rust converters, glues, etc.



GREEN:

chemical products which do not comply with the norms for halogens and sulphur content for use on the primary circuit equipment, but are within the norm for use on the secondary circuit equipment.

white colour

all the other spare parts

Shelf-life information provided by the manufacturer for limited shelf-life items is recorded in the warehouse management system.

The shelf-life information is visualized on the blue label which is placed on those spare parts and materials when they are inventoried. Bulk materials are consequently labeled when distributed for use. For example greases purchased in large containers are distributed to maintainers in tins which are labeled similarly.

This warehouse management system decreases the risk of using inappropriate spare parts and materials on equipment important to safety, and also draws attention to spare parts and materials with limited shelf-life.

The use of color coded labels can be easily applied with insignificant expenses.

5. TECHNICAL SUPPORT

5.1. ORGANIZATION AND FUNCTIONS

The Technical Support (TS) department is well organized and has highly qualified staff. Self-assessment is carried out at individual level. However there is no complete set of performance indicators for all the TS department responsibilities, which would allow appropriate monitoring by management and self-assessment by sections and groups. The team has made a suggestion in this area.

5.2. SURVEILLANCE PROGRAMME

The diesel generators are tested every month and the duration of the test is not less than 30 min, and each third month the duration of the test is not less than 1 h. Once a year there are full scale no-load operation tests and tests with different loads, including 100% operation. The duration is not less than 30 min after full parameter stabilization. The total duration of this test is about 12 hours.

International experience shows that endurance tests can provide plants with additional information regarding the reliability of the EDG. After Fukushima, it is recognized that this type of information is important. The team encourages the plant to consider long term endurance tests of the diesel generators of an appropriate time interval.

5.3. PLANT MODIFICATION SYSTEM

The process is well established and responsibilities are defined. When a technical decision is made, in the beginning of the process, all the department heads that are going to be influenced by the plant modification, state which documents have to be updated. This lowers the risk of some documents not being updated in time with inadequate quality. The team considered this to be a good performance.

The plant have large investment programs ahead, life time extension, power uprate, stress test implementing measures etc. The plant modification process has an essential part in this and it is important that its efficiency is secured. The team encourages the plant to implement performance indicators to the plant modification process.

5.4. REACTOR CORE MANAGEMENT (REACTOR ENGINEERING)

The plant has developed an independent enrichment verification control for fresh fuel at the site. The team identified this as a good practice.

DETAILED TECHNICAL SUPPORT FINDINGS

5.1 ORGANIZATION AND FUNCTIONS

5.1(1) Issue: Goals for the Technical Support (TS) department are not associated with performance indicators which would allow monitoring by management and self-assessment by sections and groups.

The TS department sets goals annually but they are not measurable and only few of the performance indicators are associated to these goals.

- The goals at corporate level are broken down by the TS management. However there are no specific performance indicators associated with all responsibilities within TS.
- The management in TS does not periodically review the progress of their goals because they are not measurable. One example of a goal that is not measureable is: “All documents should be updated”.
- There are no performance indicators corresponding to the plant modification process.
- Three interviews with different staff persons in the TS confirm that self-assessment at section and group level is not mandatory.
- There are no performance indicators at section and group level.

Corporate goals set up expectations from the management to the employees. If managers do not clarify corporate goals by breaking them down in a comprehensible way to sections and group level they won't be understood and focus might be lost of safety related areas that need improvement.

Suggestion: The Technical Support department should consider implementing performance indicators associated to their goals, allowing monitoring by management and self-assessment.

IAEA Bases:

GS-R-3

6.2. Senior management and management at all other levels in the organization shall carry out self-assessment to evaluate the performance of work.

NS-G-2.4

3.20. “The plant management should develop goals and objectives that support and complement established corporate goals. The plant goals and objectives should be commensurate with the expectations of the management of the operating organization, and should include key performance areas of the plan and areas recognized as needing improvement. Suitable goals and objectives should be established at the departmental level to support the goals of the plant management. Departmental goals and objectives should be

coordinated among the department to ensure that they are consistent and mutually supportive and reflect management's priorities."

3.21. "Where it is reasonable, the goals and objectives of all management levels should be measurable and stated in terms that allow measurement of progress and clear determination of achievement. They should be challenging, realistic and focused on specific improvements in performance, and should be limited in number to prevent dilution of efforts in key areas. They should be communicated, understood and supported within the organizational structure responsible for their accomplishment."

3.22. "Management, at the appropriate level, should periodically review progress towards the accomplishment of goals and objectives. Formal reviews of progress should be conducted and results should be communicated periodically to the personnel of the operating organization."

GS-G-3.5

6.3. Managers normally perform oversight reviews and assess the performance of activities through their day-to-day line management activities. Other, more structured mechanisms include:

(a) Line management monitoring:

To achieve these objectives, line managers and supervisors:

—Should examine trends in performance indicators;

6.6. The input to self-assessment by senior management should include information on:

(a) Safety related results and trends and performance indicators;

Plant Response/Action:

In order to perform self-assessment of the activities in the Division and the status of the planned and actually completed tasks, specific measurable performance indicators were developed and implemented related to the activities within the TS Division.

"Methodology for calculation and reporting of self-assessment indicators of the TS Division" was developed and approved.

A new revision of "Procedure on TS Division activities analysis", which stipulates the process of reporting and analysis of those indicators was issued.

The calculations results are entered into an "Indicator reporting and analysis form" Appendix 1 to the Methodology and are attached to these analyses.

In case of unsatisfactory status or a status requiring improvement, an analysis of the causes, leading to such results is performed. After discussions with staff, the suggestions for corrective measures are developed and the activities to address the identified problems with particular processes and activities, as well as to prevent further problems, are undertaken.

IAEA comments:

Following the OSART mission appropriate action was performed as regards to the development and utilization of Technical Support Division performance indicators.

The plant established a set of six specific performance indicators associated with Technical Support Division goals and main activities, including plant modifications. The performance indicators are measurable and regularly compared with target values. They are used for diagnosing weaknesses and identifying corrective actions for the effectiveness of Technical Support Division. The process is described in the “Methodology for calculation and reporting of self-assessment indicators of the TS Division”, published in September 2013. The operating feedback after about nine months was utilized and the methodology was modified in May 2014.

Development and usage of performance indicators has resulted in an effective monitoring and self-assessment of Technical Support Division main activities, and performance improvements.

Conclusion: Issue resolved

5.4 REACTOR CORE FUEL MANAGEMENT

5.4(a) **Good practice:** Independent testing of fresh fuel enrichment

Since 2009, 100% of the deliveries of fresh nuclear fuel undergo a gamma-spectrometric control of the ^{235}U enrichment at the plant.

The measurement is performed in Fresh Fuel Storage Facility, for each assembly, immediately after completing the standard incoming inspection. The aim of this additional control is to compare the declared enrichment according to the passport with the actually measured one, which guarantees that the fuel was adequately designed and manufactured in compliance with the design specifications.

The sensitivity of the method allows distinguishing the enrichment of the fuel that is used at the plant with sufficient reliability. Practically, this inspection is the final stage where a difference between the declared and actual enrichment could be detected, before the assembly is placed in the core.

Preventing the insertion of a fuel assembly with the wrong enrichment, i.e. avoiding the possibility of loading a fresh assembly with 4.3% enrichment instead of a fresh assembly with a 3,98% or 3,53% enrichment helps avoid unintentional criticality and flux shape problems and greatly enhances safety.

Although the quality and assurance (Q/A) system for many NPP guarantees that fresh fuel from the manufacturers is within specified requirements with the respect of enrichment levels, the investment cost for this equipment is low and it provides an additional barrier for not inserting fuel with wrong enrichment into the core.

A wrong enrichment level of the fuel is usually detected during start up tests and the fuel has then to be removed. In this case this can be avoided before the refueling starts during the outage which also saves time.

6. OPERATING EXPERIENCE FEEDBACK

6.2. REPORTING OF OPERATING EXPERIENCE

In 2012 there has been more than 15 000 Low Level Events, Near Misses and other remarks identified in a special “Remark” system, also described as Condition reports. The plant has put into place a system to locate adverse trends and identify corrective actions. The team recognizes this as a good performance.

6.3. SOURCES OF OPERATING EXPERIENCE

There is a strong emphasis to the WWER plants as a source of operating experience information. Direct information exchanges with other nuclear power plants are working well with the new request system. In 2012 the plant has requested information 12 times through WANO Moscow Centre and it has received good quality response to its requests. The team recognizes this as a good performance.

6.4. SCREENING OF OPERATING EXPERIENCE INFORMATION

The team noticed a well operated three phase screening system, where after initial screening the information is further screened by a permanent Commission where all plant activities are well represented. The third level is the Operating Experience Council which is a consultative body to the production director. The team recognizes this as a good performance.

6.5. ANALYSIS

At the plant root cause analysis is not always performed in a thorough and timely manner to prevent the recurrence of events connected to human performance. The OSART team made a suggestion in this area.

DETAILED OPERATING EXPERIENCE FINDINGS

6.5 ANALYSIS

6.5 (1) Issue: Root cause analysis is not always performed in a thorough and timely manner to prevent the recurrence of events connected to human performance.

The plant carries out the root cause analysis of category 1 and 2 events (significant events) using the basic ASSET methodology with enhancements. Although the plant event analysis teams are aware of this enhanced methodology and have established procedures and practices for its use, the team observed the following with regard to analysis of category 1 and 2 events:

- On 3 January 2012, the bearing temperature of the primary coolant make up pump in Unit 6 started increasing at a high rate. Noise from the pump was heard by a field operator. The pump was stopped and a metallic spring (foreign material) was found while carrying out maintenance on the pump. This spring had originated from the seal of the associated booster pump, when maintenance replaced this seal two years back. The team observed that the event root cause analysis didn't address the possibility of a similar Foreign Material Exclusion (FME) problem in the other five identical pumps in Units 5 and 6.
- In the above event, the operator took 33 minutes to stop the pump although there was a sharp rise in oil temperature (however still within the operational limits) and noise from the pump. The root cause analysis did not comment on the activities of the operators.
- In 2011, human performance was the cause of nine events (out of 53 occurrences). Seven of those occurred because of the inadequate use of error reduction tools. Due to limited coding field, the plant analysis didn't go beyond to identify the specific prevention tool (like self-check), which was responsible for this event. Industry data indicates that failure to self-check is one of the main root causes of human performance issues. The team was informed that the plant is planning to use WANO coding from 2013.
- In an event of July 2010, cracks in the casing of the Unit 5 emergency diesel generator fuel nozzles were discovered. Missing instructions from the manufacturer, which led to the lack of a replacement program for this component, were identified as the contributing factor. The root cause analysis was stopped at this contributing factor and did not identify the root cause. The plant confirmed that in the root-cause analysis report, the contributing factor was actually meant to be the root cause.
- In 2011, human performance was identified as a root cause for 16% of category 1 and 2 events (significant events). This is much below the industry average, which is typically 50-55%.
- In the primary coolant make up pump event of January 2012, deficiencies in the equipment manufacturer's instructions were found to be the root cause. In the event of the turbine TG10 trip and consequent reactor scram in October 2012, the equipment manufacturer's instructions were found to be a contributing factor. Nevertheless, the root-cause analysis of the October 2012 event does not make any reference to the earlier event involving a similar cause. Identifying the extent of a root cause would be

useful because equipment related problems are major contributors to events at the plant.

- The plant has stated that in addition to the ASSET methodology, they are also using Event and Causal Factor charting. However this methodology was last used at the plant more than three years ago, during the investigation of event 6SC10D01 Inadvertent Shutdown in April 2009.
- Management at the plant has established an expectation of completing the root cause of Category 1 and 2 events in 30 days. It was observed that in 2011, around 1-5 category 2 events monthly were not meeting this time frame.

Without precisely identifying the root causes of events involving human performance, prevention of recurrence of events cannot be ensured.

Suggestion: The plant should consider strengthening the quality of the root-cause analysis connected to human performance so that the analysis is carried out in a thorough and timely manner.

IAEA Bases:

SSR-2/2

5.28, in part, “Events with significant implications for safety shall be investigated to identify their direct and root causes, including causes relating to equipment design, operation and maintenance, or to human and organizational factors.”

NS-G-2.11

4.3, in part, “The level of the investigation carried out should be commensurate with the consequences of an event and the frequency of recurring events. Significant factors that would influence the magnitude of an investigation may include the following:

-Whether a similar occurrence has taken place earlier at the same installation”

4.10, in part, “Either one technique or a combination of techniques should be used in event analysis to ensure that the relevant causes and contributing factors are identified, which aids in developing effective corrective action.”

Plant Response/Action:

A requirement was put in place to ensure an independent quality control on event analyses by introducing a check list. Modifications were introduced in the procedures for reporting and analysis of operating event.

A procedure on regular revision of independent control results and consequent activities was developed with regard to the procedures above mentioned.

Until incorporation of the Operating Experience module into the Information System for Organisation of the Operating Activity, a code nomenclature based on the codes used for events in WANO reports was put in place. For each finalized 1st or 2nd category event analysis all applicable codes are determined, while trends are used in the analysis of consequent events of this category. This is arranged by introducing a requirement in the procedure for reporting and analysis of operating events.

IAEA comments:

The suggestion in this area was about:

1. The timeliness of event investigation
2. The thoroughness of event investigation

Following analysis of timeliness of event investigation the plant has implemented the following corrective actions.

- The staffing of the operating experience department has now an additional root cause analysis expert. This allows more investigations to take place in parallel and prevents category 1 (reportable/safety significant) events adversely affecting the timescales of category 2 events (non-reportable/not safety significant).
- The timescales for category 2 event investigation has been increased from 30 days to 45 days. This is in line with IAEA –TECDOC-1581 (actual recommendation is less than 60 days). This decision was made to preserve the quality of the investigation while allowing the completion target to be met.
- The weekly progress meeting between the Chief Engineer and operating experience now includes tracking progress of investigations as well as corrective actions.

From the plants performance indicators of category 2 event reports completed in the stipulated timescales an improving trend can be seen. The largest percentage change is associated with the implementation of progress review rather than the relaxation of the completion timescale. (For category 1 events a report is required by the regulator within the stipulated 30 day timescales). Although the timeliness of analysis has significantly improved, and continuing to improve the plant has not reached its desired target.

Following the OSART suggestion the plant has implemented two main changes to improve the thoroughness of its event analyses

1. A quality control check is now carried out on completion of event analysis. The data from this check is correlated and used to produce a performance indicator. This performance indicator is not yet part of the plant indicators as insufficient data has been gathered, it will be adopted in 2015 when sensible targets can be set.
2. The coding of events has been improved to adopt the WANO coding system. Adopting this system aligns the plant coding of internal events with their main source of external operational experience feedback which comes from WANO. This improved coding has significantly increased the detection rate of human performance deficiencies.

These measures are intended to monitor the thoroughness of event analyses with a view to establishing corrective actions to improve the plants performance in this area. Due to the relative infancy of these measures improvements will not be realised until corrective actions are implemented based on this monitoring. This situation is also reflected in the plants performance indicator on repeat events. This shows an improvement in the short term but due to frequency of events needs to be analysed over much longer timescale to show sustained improvement in this area driven by more thorough event analysis.

Further to this the plant has plans to adopt a WANO good practice from Paks NPP to review repeat events using their Safety Through Organisational Learning (SOL) methodology, an in-depth means of analysing selected events. This will identify any weaknesses in the original event analysis which will result in corrective actions to improve event analysis.

Conclusion: Satisfactory progress to date.

7. RADIATION PROTECTION

7.2. RADIATION WORK CONTROL

Radiation protection program is well implemented at the plant. The workplace monitoring program is comprehensive and before the work adequate instructions are provided to the workers. Areas in the radiation controlled area, workshops, tool storages, etc. are kept very clean and the access to them is well controlled. However personal contamination events at the exit from the radiation controlled area (RCA) are not always reported and analyzed. An observation of the handling with the radioactive waste also indicates inappropriate practices. The team suggested that the plant should consider reinforcing the contamination practices in order to minimize the spread of contamination and the risk of internal contamination.

7.3. CONTROL OF OCCUPATIONAL EXPOSURE

The personal exposures at the plant are well below the plant control limits for a long time. The ALARA principle is implemented and workers understand the requirements.

Adequate dosimeters are provided to the workers, however neutron dosimeters are not provided for all persons working in neutron fields. The team recommended that the plant should perform dose assessment for neutron radiation and develop appropriate procedure for this assessment.

A procedure on how to record personal exposures on extremities is not available at the plant. The team encourages the plant to develop such a procedure.

7.6. RADIATION PROTECTION SUPPORT DURING EMERGENCIES

Procedures for the radiation support during emergencies describe well the roles and responsibilities of the radiation protection staff. The redundancy of radiation instrumentation is visible especially in the field of the electronic personal dosimeters, since a large number of them are available at several places in the plant.

The Automated Aerological Probing System, designed to measure the atmospheric parameters in vertical profile in case of emergencies, was identified as a good practice by the team.

The team noted as a good practice the monthly training on response to unanticipated situations performed for each radiation protection shift. The basic goal of the frequent monthly trainings is to improve the preparedness of all shifts to adequately react and undertake the same actions in case of specified emergency situations.

DETAILED RADIATION PROTECTION FINDINGS

7.2. RADIATION WORK CONTROL

7.2(1) Issue: Contamination control practices at the plant are not always effectively reinforced.

- Personal contamination events at the exit from the RCA are not always reported and analysed.
 - A random check on one of the three monitors that measure the surface contamination of the workers dressed in the working overalls showed 161 contamination events out of all 2546 measurements done in previous 16 days. A half of them was beta and a half spurious alpha contaminations.
 - The similar check on the monitor, where workers are undressed, indicated 234 contamination events out of 2000 measurements done in previous 16 days. The random check of 10 selected results gave information that 9 of them were caused by spurious alpha and one by beta contamination.
- Personal contamination- events at the portal monitors at the exit from the RCA are not included in the list of performance indicators.
- One event of personal surface contamination was found on the main gate monitor this year.
- The installed hands and shoes contamination monitor in the “Refreshment room” B606 does not measure the other important parts of worker’s body like a face or overall and the monitor is also not equipped with a physical barrier to prevent workers from bypassing the monitor without measurement. The team was informed that the plant has decided to replace the existing monitor by an appropriate type.
- Workers were observed at radioactive waste collecting point, room M124/2, handling bags containing radioactive waste.
 - Three of the bags had tears in several places creating the potential for internal contamination. The workers were not equipped with respiratory protection.
 - When the work was finished, the surface contamination measurement of the yellow foil used to cover the floor was not performed properly. Instead of the contamination instrument the dose rate instrument was used.

Contamination control contributes to prevent spreading of contamination to the clean areas in the RCA and also helps to minimize the risk of internal contamination.

Suggestion: The plant should consider reinforcing the contamination control practices in order to minimize the spread of contamination and the risk of internal contamination.

IAEA Bases:

GSR Part 3

3.90. Registrants and licensees:

(d) Shall establish measures ...to control the spread of contamination;

NS-G-2.7

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 and contamination are suitable for continued work in the zone.

3.50. In areas where airborne contamination or loose surface contamination is present or may be produced during work, use of respiratory protective equipment may be necessary and should be considered. The protective equipment should meet the specifications in the RWP and any administrative procedures should be complied with.

NS-G-2.4

5.20. To monitor safety performance in an effective and objective way, wherever possible and meaningful, the relevant measurable safety performance indicators should be used. These indicators should enable senior corporate managers to discern and react to shortcomings and early deterioration in the performance of safety management within the train of other business performance indicators.

NS-G-2.7

2.27. The exceeding of an investigation level should prompt a review of its circumstances to determine the causes. Appropriate lessons for future operations should be derived and any necessary additional measures should be taken to improve the current arrangements for protection.

RS-G-1.1

5.70. Investigation levels have an important role to play in monitoring programmes. ... Investigation levels can be set in terms of virtually any measurable quantity related to the individual or the working environment. They should be defined by management in their RPP, their purpose being to facilitate the control of operations and exposures. If they are exceeded, a review should be initiated to address the protection and safety arrangements and the reasons for the value being exceeded. Such reviews may lead to the introduction of additional protection and safety measures.

Plant Response/Action:

The suggestion to reinforce the practices to control radioactive contamination in Kozloduy NPP was discussed, analyzed and applied in the practice of the plant as follows:

Analysing the causes for the issue the following reasons for its existence were identified:

1. Rare cases when internal contamination of personnel was registered led to an underestimation of the risk of spreading radioactive contamination.
2. Insufficient requirements in the RP procedures for the implementation of certain activities bearing risk of radioactive contamination
3. Gaps in the training of personnel on the risks of the spread of radioactive contamination.
4. Labelling in the controlled area showing the requirements for control of radioactive contamination needs improvement

The procedures to control radioactive contamination in other nuclear power plants were examined to define suitable approaches to solve the issue. Also the measures to solve similar problems listed in the OSMIR database were studied.

As a result the following measures were taken to solve the issues:

- Briefings of workers of Kozloduy NPP and external organizations working in the controlled area on the risks of the spread of radioactive contamination and measures for its non-proliferation;
- Training to operating personnel in charge of radiation control in the controlled area;
- Modifications of the document defining activities of the operating personnel, in charge of radiation control in the controlled area relating to strengthening the control of radioactive contamination at the exit of the controlled area and analysis of cases of contamination were implemented;
- The labelling indicating the location of the monitors for control of contamination of arms-legs and the need for measuring with gamma monitors in the controlled area was improved;
- Management and radiation protection responsible engineering personnel, requirements for periodic walk downs in the controlled area were reinforced;
- Sound and light signalling is now displayed on the Main Radiation Monitoring Room at a “Contamination” monitors for control of surface contamination, RTM-860TS type at the exit of the controlled area;
- Since April 2013, the relative number of contamination, registered at the exit of the controlled area is introduced as a performance indicator to assess the effectiveness of radiation protection;
- Analyses of the new performance indicator are conducted periodically by a special council, which is headed by the Safety division manager. Measures are identified to improve the control of radioactive contamination;
- KNPP analysed the effectiveness of sanitary barriers used for non-proliferation of radioactive contamination and identified measures for their improvement;
- KNPP analysed the need for a system to identify workers who pass through the monitors for control of radioactive contamination at the exit of the controlled area and planned its implementation;

Up to date, outside the period of the outage, the registered contaminations at the monitors at the exit of the controlled area are about 0.4 % of the number of visitors of the controlled area within a month. During the outage period, the registered contaminations are about 1%.

Under implementation are the following measures:

- Delivery of a monitor for compulsory measurement of surface contamination of the body in the room for refreshments in the controlled area (Б626);
- Replacement of monitors for surface contamination of personnel after the bathrooms with a new type of gamma and beta detectors and upgrading of existing monitors in front of the bathrooms. KNPP will develop a system for identification of persons and work station will be positioned on the Main

Radiation Monitoring Room for monitoring and control of registered contaminations.

IAEA comments:

The plant has analysed the issue related to the contamination practices in-depth and identified the important causes and root cause for the issue. In addition benchmarking in other plants was performed. This led to a comprehensive set of corrective actions based on a systematic approach to address the issue. A long term strategy was developed to resolve the issue and improve the radiation protection practices.

Implemented measures can be summarized as follow:

- Additional training of radiation protection staff
- Additional training for the plant staff and contractors before the outage
- Improvements of radiation work permit (RWP)
- Improvements of the pre-job briefings, including risk of surface contamination and internal exposure
- Strengthening the contamination monitoring programme
- Analysis of the radionuclides distribution in the RCA
- Strengthening the programme for contamination survey in the RCA rooms
- Purchasing and installing additional monitoring devices and surface scanning device
- Revised monitoring procedure during radwaste handling
- Increased frequency of RP engineering and management staff walk downs in the RCA
- Better labelling and use of gamma contamination monitor at the RCA exit
- Introduction of three additional performance indicators related to contamination events
- Analysis of the recorded contamination events and appropriate corrective actions
- Decreasing of the alarm levels set-points at the RCA exit contamination monitors
- Improvement of sanitary barriers

The plant has a programme to implement additional measures, by purchasing additional contamination monitors for contamination control at the RCA exit. However these measures are beyond the intent of the OSART suggestion, but will increase quality of radiation control.

The plant demonstrated good improvements in relative number of contamination events, using the new indicators and the plant tour confirmed effective implementation of corrective measures.

Conclusion: Issue resolved

7.3. CONTROL OF OCCUPATIONAL EXPOSURE

7.3(1) Issue: Neutron dose assessment is not performed for everyone working in neutron fields and procedures for dose assessment from neutrons are not available at the plant.

The personal exposures at the plant are well below the limits for a long time. Based on the historical data the plant had decided to provide neutron dosimeters only to selected workers and the neutron exposures of the rest of the workers not wearing neutron dosimeters have been assumed as negligible. However, the previous assessment could not be valid for unanticipated works or when the radiation condition changes.

- Neutron dosimeters were not provided for all persons working in neutron fields.
- The assessment of the exposure of every individual not wearing neutron dosimeters is not performed.
- The procedure how to assess the personal exposure from neutron radiation of those individuals not wearing neutron dosimeters and how to record it is not available.

When the personal dose assessment of all kinds of radiation is not performed, the personal exposure can not be stated accurately to ensure the person does not exceed the dose limits.

Recommendation: The plant should perform dose assessment for neutron radiation and develop appropriate procedure for this assessment.

IAEA Bases:

GSR Part 3

3.100. For any worker who is normally employed in a controlled area, or who occasionally works in a controlled area and may receive significant occupational exposure, individual monitoring shall be undertaken where appropriate, adequate and feasible. In cases where individual monitoring is inappropriate, inadequate or not feasible, the occupational exposure of the worker shall be assessed on the basis of the results of monitoring of the workplace and on information on the locations and durations of exposure of the worker.

RS-G-1.3

8.6. ... However, because the different types of high LET radiation have different quality factors, it is advisable when monitoring in terms of $H_p(10)$ to record neutron doses separately. It should be remembered that photon, neutron and beta doses are to be combined to determine the total personal dose equivalent.

8.7. If a dose assessment is not available for a period when a radiation worker was (or should have been) monitored — which may happen when a dosimeter has been damaged or lost, or recorded a dose that, on investigation, is declared invalid — the record keeping system should allow the introduction of doses estimated or assessed by an authorized person. These dose estimates should be marked in such a way that they can be distinguished from official dose measurements made by the approved monitoring service.

Plant Response/Action:

The recommendation to assess occupational exposure to neutron radiation and to develop a relevant procedure for this evaluation by Kozloduy NPP was discussed, analysed and applied in the practice of the plant as follows:

After the analysis, the following reasons were identified for its existence:

1. Low levels of radiation fields that are maintained in the plant have led to an underestimation of the risk of exposure to neutrons.
2. Low values recorded during almost ten years of control of the neutron exposure of a part of the personnel working in neutron fields have led to underestimation of the risk of neutron exposure for the remaining personnel.

To solve the issue the procedures to control neutron exposure in other plants were examined. The following measures were identified and implemented:

- Analysis of sources of neutrons in Kozloduy NPP was made with a report on the assessment of individual dose of neutrons of Kozloduy NPP personnel from 2005;
- Procedure for the assessment of individual radiation exposure to neutrons was developed on the basis of an assessment of the working environment parameters;
- The number of passive dosimeters for individual control of neutron dose exposure was increased. In 2012 the number of individual passive dosimeters in the controlled area of Units 5 and 6 was 36 and since July 2013 it was increased to 106;
- In addition since the end of March 2014, 100 individual electronic neutron dosimeters were put into operation;
- At the point of distribution of individual dosimeters there is a list of all activities in the controlled area, requiring either wearing of a personal neutron dosimeter or an assessment of the individual dose exposure to neutrons following the procedure.

As a result of the measures implemented, , reliable monitoring of individual exposure dose to neutrons has been provided to any person currently working in an environment with neutron radiation on the territory of Kozloduy NPP.

IAEA comments:

Following the OSART mission analysis was performed with regard to the neutron dose assessment recommendation. In addition benchmarking in other plants was performed in order to implement appropriate corrective actions.

The plant has been performing detailed analysis of sources of neutrons including assessment of individual neutron dose of plant personnel since 2005.

The plant also developed a procedure for the assessment of individual neutron radiation exposure based on assessment of the working environment parameters. This procedure was issued in July 2013. In 2013, the plant performed 37 assessments of neutron exposure and no neutron exposure above registration level was identified. As of June 2014, 5 assessments were performed with the same results.

The number of plant passive dosimeters for individual control of neutron dose exposure was increased from 65 in 2012 to 150 dosimeters at the beginning of 2014.

The plant introduced 100 individual electronic neutron dosimeters in March 2014. These dosimeters are used for daily control of the neutron exposure.

The procedure for the assessment of individual neutron radiation exposure was revised in May 2014. This procedure is comprehensive and also includes the use of electronic neutron dosimeters and a list of all places and activities in the RCA requiring monitoring of the individual neutron exposure.

In 2013, there were only 3 cases when workers received exposure from neutron radiation, however values were very low 0.3, 0.29 and 1.37 mSv respectively.

The plant tour confirmed appropriate use of neutron dosimeters.

As a result of all implemented measures, reliable monitoring and assessment for neutron radiation is provided for everyone working in neutron fields and this is to ensure that the workers will not exceed the dose limits.

Conclusion: Issue resolved

7.6. RADIATION PROTECTION SUPPORT DURING EMERGENCIES

7.6(a) **Good Practice:** Automated Aerological Probing System

Automated Aerological Probing System (AAPS) is designed to measure the atmospheric parameters in vertical profile in case of emergencies. The measurement is achieved by the instruments (GPS, temperature, pressure) attached to the balloon that is released to the atmosphere in case of necessity. The following meteorological parameters are determined:

- mixing layer height;
- main atmospheric transfer direction and speed;

The two values - mixing layer height and main transfer speed and direction are extremely important for all model scales (from the ones of NPP area to those of transboundary contamination). They are used to determine the spreading of radionuclides in the atmosphere, their settling and ground concentrations, depositions, and radiation exposure. Where such data is unavailable, some averaged values are used for the respective geographic region or some calculation from semi-empirical formula based on data from ground parameters. With this data the prediction of atmospheric dispersion is improved.

Data for the above parameters are used in the model for evaluation and forecast of the radionuclide spreading within the 30 km area in case of accident.

The plant exercises the Automated Aerological Probing System launching the balloon once every three months.

7.6(b) Good Practice: Monthly training on response to unanticipated situations performed for each radiation protection shift.

The Emergency Training in the Operational Radiation and Dosimetry Monitoring section for the operating personnel is performed on a monthly basis.

The scenarios are developed in advance and described in the site Instruction on the Implementation of Emergency Training and are renewed for each calendar year.

The goals of the repeated training are as follows:

- Registration of the occurred change in the situation, reporting and localizing the emergency, as well as non-admission of spread to other equipment or premises;
- Training of the staff for actions in case of emergency situations;
- Improve all shifts to adequately react and undertake the same actions on identifying the event source term;
- In case of the occurrence of such event, the actions of the staff are expected to be quick, accurate, correct, so that they would contribute to the clarification of the situation;
- During the emergency the whole staff is expected to react in a strictly defined succession of actions. These actions shall also contribute to the decreasing of the dose exposure for the workers who participate in the emergency liquidation;
- Initiation of open discussions to help resolve a given problem.

8. CHEMISTRY

8.2 CHEMISTRY CONTROL IN PLANT SYSTEMS

The Plant Chemistry performance indicators for the primary and secondary circuits are more strict, than those normally used in international chemistry and radiochemistry practice. These challenging performance indicators were initiated by the Plant Management. The team identifies this as a good performance.

8.3 CHEMICAL SURVEILLANCE PROGRAMME

The water chemistry programme for the primary circuit combines both chemistry and radiochemistry on-line and off-line monitoring systems, which is a good tool in terms of ALARA and chemistry performance. This system is supported by special software named ANTIOXI for evaluation and prediction of mass transport and activated corrosion products buildup in different parts of the primary circuit. Based on the results from the ANTIOXI software the plant is able to reduce the duration of works to be performed during outage and occupational dose rate. The detailed action plan developed on the basis of chemistry and radiochemistry procedures, on-line and off-line chemistry and radiochemistry monitoring systems ensures prompt and adequate response of the operation personnel to chemical parameters variations. The team identified this as a good performance.

The team identified as a good practice the combined secondary chemistry (AMETA) program. This program combines the benefits of ETA and high ammonia regimes to significantly reduce corrosion-erosion processes and provides uniform pH in mono and biphasic streams.

DETAILED CHEMISTRY FINDINGS

8.3 CHEMICAL SURVEILLANCE PROGRAMME

8.3(a) Good Practice: Combined use of use of ethanolamine (ETA) and ammonia (NH_3) for secondary side chemistry control, called AMETA, significantly reduces the corrosion rate in the secondary circuit.

The team identifies as a good practice the combined secondary chemistry (AMETA) program. This program combines the benefits of ETA and high ammonia regimes to significantly reduce corrosion-erosion processes and provides uniform pH in mono and biphasic streams.

As a result of AMETA chemistry implementation mass transport of corrosion products to the steam generators is reduced up to the trace concentrations and the buildup of corrosion products on the heat exchanging surfaces is significantly reduced.

The actual amount of corrosion products inside the steam generators is so low that it is not representative for the instrumentation methods of analyses. The cleanliness of heat exchanging surfaces of the steam generators is confirmed by filming and photos.

The SG inventory pH value is increased to more alkaline area. As a result from this change, the corrosion products convert from hematite to magnetite form. Therefore the corrosion products are easily removed from steam generator inventory. No sludge accumulation is observed on the bottom part of steam generators and low rows of tubes. The new chemistry regime also provides increase of pH values in SG header crevices.

The number of SG plugged tubes is as low as 84 (15 at Unit 6 and 69 at Unit 5) since the units were commissioned.

The scope of maintenance works to be performed during outage of the secondary side equipment is significantly reduced. (maintenance of pipes, turbine blades, equipment in contact with biphasic media, etc.).

AMETA is a good method for equipment layup during shutdown, outages and startup. In the very first day of operation the concentration of corrosion products in SG feedwater already corresponds with the values specified for the fifth day of plant operation.

In AMETA conditions all chemicals are injected in automatic mode in strict proportion between ammonia and ethanolamine.

No hide-out return phenomena is observed during the plant shutdown.

9. EMERGENCY PLANNING AND PREPAREDNESS

9.1. EMERGENCY PROGRAMME

As part of its emergency planning programme, the plant personnel have a frequent and active relationship with their off-site counterparts before an emergency. They have weekly coordination meetings with the fire service, the police service and the municipal authorities. The operating organization informs the local government when it declares a nuclear emergency, even at the alert level. The team considers the way the plant and the off-site authorities conduct their interactions is a good performance.

9.2. RESPONSE FUNCTIONS

As part of the arrangements for the monitoring and management of the contamination of evacuees from the site, the plant supplies personnel and equipment to the several check points that act as Reception Centres for evacuees. At these check points, the non-essential personnel evacuated from the plant and the evacuees from the population are checked for contamination. If they are contaminated, they shower in tents and are given new clothes, before going to shelters for evacuees. It is noteworthy that the plant and the off-site authorities have exercised these arrangements with several hundred persons from the plant. These exercises took place in the spring and summer, but never in winter. The team encourages the plant to exercise these arrangements in winter since it may lead to important findings on the way to perform these operations in cold weather.

9.4. EMERGENCY PROCEDURES

The plant has put in place a process to control, review and periodically update the emergency procedures. The changes in emergency procedures are implemented quickly in the electronic version and as a consequence, the team did not observe procedures containing hand made changes. The team considers this a good performance.

In general, the plant updates the procedures that contain phone lists at least annually or as required. Nevertheless, an emergency procedure for the medical team contained a phone list that had not been updated since 2009. The team encourages the plant to put in place a process to ensure that all procedures that contain phone lists are updated more frequently.

9.5. EMERGENCY RESPONSE FACILITIES

The plant has located its emergency operation centre in an extremely well protected and shielded bunker. The plant also has a shelter located under the main administration building that can accommodate 800 persons. The team considers these arrangements a good performance.

The plant has acquired redundant and diverse communication systems for its internal communications and for communications with the off-site authorities. For each communication function, there are several backup systems available. This improves the likelihood that at least one of the communication systems will function during an emergency. The team considers these arrangements a good performance.

The plant has located throughout the site some 160 personnel gathering points to be used during an emergency. These gathering points are well identified and adequately located. Each

gathering point is equipped with a cabinet containing full face respirators, filter cartridges and iodide tablets in sufficient quantities for all personnel.

The team suggested that the plant should consider arrangements for holding joint press conferences at a public information centre located outside the UPZ.

9.6. EMERGENCY EQUIPMENT AND RESOURCES

The plant has identified the need to transmit information concerning the status of units 5-6 and the consequences for the public and the environment to several off-site organizations. The plant has developed an Emergency Response Centre Information System (ERCIS) to automatically acquire the necessary information, fill-in pre-arranged forms, and fax, print or email the forms with the touch of a button. The team considers this a good practice.

The plant has maintained real, credible arrangements for the protection of all on-site personnel during a nuclear emergency. These arrangements include the means of protecting from exposure by inhalation of fission products all on-site personnel and the prompt evacuation of all non-essential personnel. This is a good performance.

9.7. TRAINING, DRILLS AND EXERCISES

The managers from the plant participate in every exercise, and they actively support the emergency preparedness training program. The fire fighters and rescue teams responding at the plant receive advance training at a national facility located in the town of Montana. This facility includes rooms that simulate the conditions that may exist during an accident at the plant: radiation environment, high noise level, presence of steam or noxious gases, and total darkness. The team considers these training, drills, and exercises arrangements a good performance.

The team suggested that plant should consider creating a list of response functions that are appropriate for the on-site emergency response organization. It should consider using this list to create an exercise program that will cover all response objectives over a period of several years.

DETAILED EMERGENCY PLANNING AND PREPAREDNESS FINDINGS

9.5 EMERGENCY RESPONSE FACILITIES

9.5(1) Issue: The public information centre is located inside the urgent protective action planning zone (UPZ) and the existing arrangements do not include provisions for press conferences where the plant and the off-site authorities jointly address the press.

Although the plant and the off-site authorities each have good plans to hold frequent press conferences, and the coordination arrangements between the plant and the off-site authorities are good, the following observations were made:

- The plant has a public information centre located on-site, another one in Kozloduy, about 7 km from the plant and well within the UPZ (30 km).
- The plant plans to build a new backup Emergency Operation Centre (EOC) that will be well sheltered, underground, and will also be located about 7 km from the plant. A new public information centre will be located above the backup EOC.
- Currently, it is not the practice of the plant and the off-site authorities to hold joint press conferences in the same location. In past exercises, press conferences were held in separate, but nearby locations.

The current location of the emergency information centre may render it unusable under accident conditions and this may delay communication with the media. Public information given from different locations may lead to confusing and inconsistent information about the risks of exposure and the appropriate actions to be taken. This confusion may lead to unsafe actions on the part of the public and loss of confidence in the official's recommendations.

Suggestion: The plant should consider determining the locations of public information centres outside UPZ and put in place arrangements for holding press conferences jointly with the off-site authorities at this centre.

IAEA Bases:

GS-R-2

4.83. Arrangements shall be made for: providing useful, timely, truthful, consistent and appropriate information to the public in the event of a nuclear or radiological emergency; responding to incorrect information and rumours; and responding to requests for information from the public and from the news and information media.

GS-G-2.1

Appendix VIII, Table 15. Public Information Center; Function: Coordination of all information released to the news media concerning the emergency by the facility, local governments and national governments. Staffed by representatives of all these organizations. Characteristics: Located in the vicinity of the site of the emergency with space and infrastructure to support use by the news media and for conducting media briefings. For facilities in threat categories I, it is a pre-designated facility outside the UPZ.

4.36. These arrangements should ... coordinate the provision of information to the public by national officials, local officials and the operator. This could include the establishment, as soon as possible, of a public information center, as described in Appendix VIII, to serve as the single source of information.

6.12. Joint press briefings should be given periodically (at a joint public information center) with participation by the operator and local and national officials.

Appendix VIII, para VIII.2. Each emergency facility or location should be ... usable under accident conditions.

Plant Response/Action:

The new revision of Kozloduy NPP PLC Emergency Plan in item “Notification of public and mass media”, identifies the locations of the off-site information centres (OSIC) outside of the UPZ (30-km zone), and the arrangements associated with conduct of joint press conferences of the plant management and off-site authorities with mass media.

The off-site information centre (OSIC), located at the House of Culture at the town of Kozloduy functions up to Site Area Emergency class. When the emergency evolves into General Emergency, the Emergency Action Manager orders the OSIC staff to move to the Check and Reception Centre according to the instructions of the National Headquarters (NH). Kozloduy NPP deploys an Off-site Information Centre at this Check and Reception Centre where they work jointly with the national and regional structures. The locations for deployment of this Centre are in the following settlements: for Sector I - in the villages of Kovatchitsa and Mokresh; for Sector II - in the villages of Madan and Lehchevo; for Sector III - in the village of Borovan and in the town of Byala Slatina; and for Sector IV - in the town of Knezha and the village of Ostrov.

This change is included into the Off-site Emergency Plan of Kozloduy NPP PLC.

IAEA comments:

With the suggestion of OSART mission in 2012, the plant has made efforts to establish eight sites for mobile off-site information centres outside the UPZ area for conducting joint press conference in case of general emergency. These eight sites for mobile off-site information centres are located at different locations to ensure diversity.

The emergency plan of the plant was revised to incorporate the off-site information centres, and specifies the arrangement for conduct of joint press conference of plant management and off-site authorities with the media and public.

Trainings and meetings have been used to inform the public relation specialists of the plant, the municipalities of Kozloduy and relevant personnel from the nearby towns of the changes made to the joint information centres and drills were conducted in September 2013 to prepare and send sample information messages.

A field visit of one mobile off-site information centre at one site was conducted, the mobile off-site information centre were found to be well equipped with the necessary equipment for joint press conference and independent mobile diesel generator was available to supply power in case of power black-out. There are four sets of mobile off-site information centres available for deployment. The deployment of the mobile off-site information centres are tested on an annual basis and it can be made functional within about two hours.

Conclusion: Issue resolved

9.6 EMERGENCY EQUIPMENT AND RESOURCES

9.6(a) Good practice: Emergency Response Centre Information System (ERCIS)

The plant has identified the need to transmit information concerning the status of units 5-6 and the consequences for the public and the environment to several off-site organizations. There are several pre-arranged forms used for this purpose.

The plant has developed an Emergency Response Centre Information System (ERCIS) to automatically acquire the necessary information and fill-in the forms. The forms can then be faxed, printed or emailed with the touch of a button.

The ERCIS is used by emergency team on duty at the ERC during drills or emergencies to prepare messages to state institutions. The ERCIS is tailored to the work of each person on duty at the Emergency Response Centre. Each work station is authorized to acquire specific information from a server and transmit it to the off-site authorities. Every form sent to the off-site authorities is logged and time-stamped automatically.

Информационна система за ЦУА v.3.0.6
Системни функции: Информация Въвеждане Помощ

Информация

- Обстановка
- Информационни бланки
- Прогнози
- АИС

Въвеждане

- Въвеждане
- Персонал
- Технологични бланки
- Радиационен мониторинг
- Метеорологичен мониторинг
- Работни бланки
- Съобщения
 - Начално
 - Актуализиращо
 - Финално

Телефон за потвърждение	(02) 940 68 88 0887 277 434	(02) 960 10 262 (02) 862 60 73	(02) 926 32 94	(092) 692296 0886 404 108	096 315 112 0886 404 113
Изпратено	☒	☒	☒	☒	☒

ПЪРВОНАЧАЛНО СЪОБЩЕНИЕ
за авария в АЕЦ "Козлодуй"

Дата и час на събитието: [дд.мм.гггг] [чч:мм:сс]	Дата и час на изготвяне на бланката [дд.мм.гггг] [чч:мм:сс]	Време след началото: [дд] [чч:мм:сс]
30.11.2012 13:30:45	30.11.2012 14:01:18	Дни: 0 Часове: 00:30:33

Класификация на аварийното състояние

☒ Тревога ☐ Локална авария ☐ Местна авария ☐ Обща авария

	Бл. 1	Бл. 2	Бл. 3	Бл. 4	Бл. 5	Бл. 6	ХОГ	Други
Аварирало съоръжение	☐	☐	☒	☒	☐	☒	☒	ОРУ, БПС, ЦПС-3,4 ЦПС-1
Засегнати съоръжения	☐	☐	☒	☒	☐	☒	☒	СБК-1,2; СБК-3; ИЛК, В.Т.

Радиоактивни изхвърляния

☒ Все още няма ☐ Продължават ☐ Прекратени

Възможност за бъдещи изхвърляния

☐ Да ☐ Не ☒ Неизяснена

Препоръчителни мерки за населението (при възможност)

	Да / Не	Направление / Сектори
Укриване	☐ НЕ	
Подна профилактика	☐ НЕ	
Евакуация	☐ НЕ	

Описание на събитието и развитието на ситуацията:

Блокове 5 и 6 се изключват с АЗ от енергосистемата на страната вследствие земетресение. Загуба на външно ел.хранване. ДПС 5и 6 работят нормално. Активиран Ав.план по критерий 4.3-земетресение. Има пострадали и разрушения на адм.сгради и съоръжения.

Дата, Час на предаване на съобщението:	Должено от:
30.11.2012 14:01:18	ГР1
	Длъжност: Ръководител на аварийните работи
	Име, Фамилия: АЛЕКСАНДЪР ХРИСТОВ НИКОЛОВ

Въведи Отказ Изчисти Затвори Печат Данни от сценарий

Т 30.11.2012 13:30:45 Тренировка АЛЕКСАНДЪР ХРИСТОВ НИКОЛОВ Ръководител на аварийни работи - ГР1 00:09:39

The server has access to the following information:

- meteorological data from three weather stations;
- radiation monitoring data from the industrial (on-site) gamma monitors;
- radiation monitoring data from the ring of detectors surrounding the plant in the EPZ;

- radiation monitoring data from the fixed network in the UPZ;
- nuclear units 5 and 6 process parameters;
- safety parameters display system (SPDS);
- post accident monitoring system (PAMS);
- spent fuel storage facility (SFSF) parameters.

ERCIS has three modes of operation:

1. Monitoring mode during normal operation to get access to real data from the site, the weather stations and the radiation monitors.
2. Scenario mode during exercises to get simulated data. In this case, the simulated data is prepared using EPA-Dose, JRODOS and main control room simulator.
3. Emergency mode to obtain real data regarding the emergency and transmit forms to the off-site authorities.

The benefits of this system are that it improves the accuracy and timeliness of the information transmitted to the off-site authorities. It also simplifies the management of the information and allows the Emergency Action Manager to track the information that was sent. Finally, it allows the same system to be used during drills or exercises, improving the training of emergency team.

9.7 TRAINING, DRILLS AND EXERCISES

9.7(1) Issue: The on-site organization has no comprehensive list of response functions that could be used to review the completeness of the exercise program.

Although the plant has frequent exercises and a good evaluation program for these exercises, the following observations were made:

- The plant has no separate list of response functions for the review of the exercise program; EPR-METHOD (2003) provides an example of a list of response functions for the on-site organization.
- The plant doesn't have a procedure to check if they exercise or test all response objectives of the on-site emergency organization over a period of several years.

Without a master list of response functions, the plant may not test all elements of the emergency plan regularly. The evaluation process may not be systematic if not tied to the objectives initially selected. Without systematic tests of each element of the emergency plan and systematic evaluation of every objective, gaps in training may lead to a loss of effectiveness of the response organization.

Suggestion: The plant should consider creating a list of response functions that are appropriate for the on-site emergency response organization. It should consider using this list to create an exercise program that will cover all response objectives over a period of several years.

IAEA Bases:

GS-R-2

5.36. The performance of exercises at facilities in threat category I, II or III shall be evaluated against established response objectives that demonstrate that identification, notification, activation, and other initial response actions can be performed in time to achieve the practical goals of emergency response.

GS-G-2.1, para 1.6.

This Safety Guide does not provide detailed guidance on all the arrangements or operational criteria necessary to respond effectively to a nuclear or radiological emergency. The IAEA has published more detailed information on developing and maintaining an effective emergency response capability. EPR-METHOD (2003) provides an overview of this information.

EPR-METHOD (2003), Section 4.0.

Describe the arrangements used to perform the preparedness functions listed, which are needed to develop and maintain the capability to respond to an emergency. Identify which organizational component (section, group, team or position) within the response organization will be responsible for all or part of the performance of these functions.

Section 4.2, para. B6.3

Conduct drill and exercise programmes for specified functions required to be performed for emergency response and all organizational interfaces and the national level programmes at suitable intervals.

EPR-Exercise-2005

2.7. An exercise programme should be prepared by each organization and coordinated with other organizations. The exercise programme and training programme should be coordinated and form a coherent structure. An exercise programme typically includes a detailed one-year plan and a more general long-term plan. ... all response objectives identified for each organization in the emergency plan should be covered over the period stipulated in the long-term plan. ... a statement about the aim and objectives of the one-year plan.

EPR-Exercise-2005

4.1. The most recent guidance for emergency response objectives is EPR-Method. Exercise objectives are defined as a subset of response objectives that will be tested during the exercise. For practical reasons, a single exercise does not test ALL response objectives. Therefore, it is necessary to choose which response objectives will be tested. Over an exercise cycle, the aim would be to test all response objectives.

Plant Response/Action:

Specific table in the Annex “Procedure for emergency drill and exercise objective setting” to the new revision of the Kozloduy NPP PLC Emergency Plan systematizes all objectives that can be covered during drills and exercises at Kozloduy NPP PLC in the course of 5 years, and the organizations responsible for their implementations.

This change is included into the Off-site Emergency Plan of Kozloduy NPP PLC.

IAEA comments:

Based on the suggestion of OSART team in 2012, the plant has revised the list of response functions of its emergency plan. The revision of response functions was based on the internationally recognized practices EPR-Method (2003) with addition of plant specific response functions, and all these response functions are scheduled to be tested within a timeframe of five years.

An internal directive was issued to communicate the changes to the plant personnel, and training and briefing was provided to emergency response personnel as well. Relevant emergency personnel are also required to study the revised procedure by themselves, and a visit to the Main Control Room (MCR) confirmed that this process is effective.

The scheduled response functions in 2013 were tested during the general emergency exercise 2013. In 2014, a full scope national exercise with the participation of IAEA will be conducted with the evolution up to severe accident. In 2015, an exercise on terrorist attack is scheduled. In 2016, an exercise on recovery after emergency is planned. In 2017, another full scope exercise with the new Emergency Response Centre will be conducted with the scenario of reactor shut-down state.

Conclusion: Issue resolved

**SUMMARY OF STATUS OF RECOMMENDATION AND SUGGESTIONS OF THE
OSART FOLLOW-UP MISSION TO KOZLODUY NPP**

	RESOLVED	SATISFACTORY PROGRESS	INSUFFICIENT PROGRESS	WITH- DRAWN	TOTAL
Operations					
R 3.3(1)	R				
R 3.7(1)		SP			
S 3.4(1)	R				
Maintenance					
S 4.4(1)	R				
S 4.6(1)		SP			
Technical Support					
S 5.1(1)	R				
Operating Experience					
S 6.5(1)		SP			
Radiation Protection					
R 7.3(1)	R				
S 7.2(1)	R				
Emergency Planning and Preparedness					
S 9.5(1)	R				
S 9.7(1)	R				
TOTAL R (%)	66.6%	33.3%			
TOTAL S (%)	75%	25%			
TOTAL	73%	27%			

DEFINITIONS

DEFINITIONS – OSART MISSION

Recommendation

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

Suggestion

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

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

Good practice

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

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

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

Note: An item may not meet all the criteria of a ‘good practice’, but still be worthy to take note of. In this case it may be referred as a ‘good performance’, and may be documented in the text of the report. A good performance is a superior objective that has been achieved or a good technique or programme that contributes directly or indirectly to operational safety and sustained good performance, that works well at the plant. However, it might not be necessary to recommend its adoption by other nuclear power plants, because of financial considerations, differences in design or other reasons.

DEFINITIONS - FOLLOW-UP MISSION

Issue resolved - Recommendation

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

Satisfactory progress to date - Recommendation

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

Insufficient progress to date - Recommendation

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

Withdrawn - Recommendation

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

Issue resolved - Suggestion

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

Satisfactory progress to date - Suggestion

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

Insufficient progress to date - Suggestion

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

Withdrawn - Suggestion

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

LIST OF IAEA REFERENCES (BASIS)

Safety Standards

- **SF-1**; Fundamental Safety Principles (Safety Fundamentals)
- **GSR Part 3**; Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition
- **SSR-2/1**; Safety of Nuclear Power Plants: Design (Specific Safety Requirements)
- **SSR-2/2**; Safety of Nuclear Power Plants: Operation and Commissioning (Specific Safety Requirements)
- **NS-G-1.1**; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)
- **NS-G-2.1**; Fire Safety in the Operation of Nuclear Power Plants (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-2.12**; Ageing Management for Nuclear Power Plants (Safety Guide)
- **NS-G-2.13**; Evaluation of Seismic Safety for Existing Nuclear Installations (Safety Guide)

- **NS-G-2.14;** Conduct of Operations at Nuclear Power Plants (Safety Guide)
- **NS-G-2.15;** Severe Accident Management Programmes for Nuclear Power Plants Safety Guide (Safety Guide)
- **SSG-13;** Chemistry Programme for Water Cooled Nuclear Power Plants (Specific Safety Guide)
- **GSR;** Part 1 Governmental, Legal and Regulatory Framework for Safety (General Safety Requirements)
- **GS-R-2;** Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)
- **GS-R-3;** The Management System for Facilities and Activities (Safety Requirements)
- **GSR Part 4;** Safety Assessment for Facilities and Activities (General Safety Requirements 2009)
- **GS-G-4.1;** Format and Content of the Safety Analysis report for Nuclear Power Plants (Safety Guide 2004)
- **SSG-2;** Deterministic Safety Analysis for Nuclear Power Plants (Specific Safety Guide 2009)
- **SSG-3;** Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **SSG-4;** Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **GS-R Part 5;** Predisposal Management of Radioactive Waste (General Safety Requirements)
- **GS-G-2.1;** Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)
- **GSG-2;** Criteria for Use in Preparedness and Response for a Nuclear and Radiological Emergency
- **GS-G-3.1;** Application of the Management System for Facilities and Activities (Safety Guide)
- **GS-G-3.5;** The Management System for Nuclear Installations (Safety Guide)
- **RS-G-1.1;** Occupational Radiation Protection (Safety Guide)
- **RS-G-1.2;** Assessment of Occupational Exposure Due to Intakes of 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)
 - **SSR-5**; Disposal of Radioactive Waste (Specific Safety Requirements)
 - **GSG-1** Classification of Radioactive Waste (Safety Guide 2009)
 - **WS-G-6.1**; Storage of Radioactive Waste (Safety Guide)
 - **WS-G-2.5**; Predisposal Management of Low and Intermediate Level Radioactive Waste (Safety Guide)
- ***INSAG, Safety Report Series***
- INSAG-4**; Safety Culture
- INSAG-10**; Defence in Depth in Nuclear Safety
- INSAG-12**; Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 Rev.1
- INSAG-13**; Management of Operational Safety in Nuclear Power Plants
- INSAG-14**; Safe Management of the Operating Lifetimes of Nuclear Power Plants
- INSAG-15**; Key Practical Issues In Strengthening Safety Culture
- INSAG-16**; Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety
- INSAG-17**; Independence in Regulatory Decision Making
- INSAG-18**; Managing Change in the Nuclear Industry: The Effects on Safety
- INSAG-19**; Maintaining the Design Integrity of Nuclear Installations Throughout Their Operating Life
- INSAG-20**; Stakeholder Involvement in Nuclear Issues
- INSAG-23**; Improving the International System for Operating Experience Feedback
- INSAG-25**; A Framework for an Integrated Risk Informed Decision Making Process
- Safety Report Series No.11**; Developing Safety Culture in Nuclear Activities Practical Suggestions to Assist Progress
- Safety Report Series No.21**; Optimization of Radiation Protection in the Control of Occupational Exposure

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

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

▪ ***Other IAEA Publications***

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

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

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

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