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OSART mission highlights 1991–1992

Operational safety practices in nuclear power plants

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FOREWORD

The IAEA Operational Safety Review Team (OSART) programme provides advice and assistance to Member States in enhancing the operational safety of nuclear power plants. OSART reviews are available to all countries with nuclear power plants in operation, approaching operation or in earlier stages of construction. Most of these countries have participated in the programme, by hosting one or more OSART missions or by making experts available to participate in missions.

Careful design and high quality of construction are prerequisites for a safe nuclear power plant. However, a plant's safety depends ultimately on the ability and conscientiousness of the operating personnel and on their programmes and working methods. An OSART mission compares a facility's operational practices with proven good international practices successfully in use in other countries and by the exchange, at the working level, of experiences in promoting safety. All the plants reviewed and all the organizations that have provided experts have benefitted from the programme.

The observations of the OSART members are documented in technical notes which are then used as source material for the official OSART report submitted to the government of the host country. The official OSART reports contain recommendations for improvements and descriptions of commendable good practices. The same reports have been used to compile the present summary report which is intended for wide distribution to all organizations constructing, operating or regulating nuclear power plants.

This report continues the practice of providing summaries of the OSART missions but the format is the first of its kind. Summaries of missions in the period 1983–1990 have covered missions to operational plants, missions to plants under construction or approaching commissioning and a compilation of good practices identified in OSART missions as separate publications. The format of this report includes all such aspects in one document.

EDITORIAL NOTE

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INTRODUCTION

Many of the tasks and problems faced by those who are responsible for ensuring the safe operation of nuclear power plants are common throughout the world. The results of an OSART mission are, therefore, of interest to and possible application to many nuclear power plants and not solely to the plant in which they were originally identified. The primary objective of this report is to enable organizations that are constructing, commissioning or regulating nuclear power stations to benefit from experience gained in the course of missions conducted under the OSART programme during the period January 1991 to December 1992.

In 1982 the IAEA set up the Operational Safety Review Team (OSART) programme to assist Member States in the enhancement of safe operation of nuclear power plants. The service is available to all countries with nuclear power plants under construction, commissioning or in operation. By the end of 1993, 71 reviews had been conducted to 56 nuclear power plants in 27 countries.

OSARTs consist of senior experts in the various disciplines relevant to the mission in hand. In the course of technical discussions between reviewers and plant staff, operational safety programmes are examined in detail and their performance checked; strengths are identified and listed as *good practices or good performances* and possible solutions to weaknesses listed as *recommendations* or *suggestions*. The criteria used by the teams as they formulate their conclusions are based on the best prevailing international practices, and, therefore, may be more stringent than national requirements. OSART reviews should not be mistaken for regulatory inspections nor design reviews. Rather, OSART reviews consider the effectiveness of operational safety programmes and are more orientated management (soft) issues than to hardware. The performance or outcome of the various programmes is given particular attention.

OSART missions consist of three basic types: missions to operating power reactors (OSARTs); missions to power reactors under construction or at the pre-commissioning stage (Pre-OSARTs); and Technical Exchange missions which cover a limited range of topics or which differ in character from review missions. In addition, operational safety reviews when combined with design reviews are known as Safety Review missions. The results of 49 OSART missions completed by the end of 1990 have been summarized in OSART Results, IAEA-TECDOC-458; OSART Results II, IAEA-TECDOC-497; OSART Mission Highlights, 1988–1989, IAEA-TECDOC-570; OSART Good Practices, 1986–1989, IAEA-TECDOC-605; OSART Mission Highlights, 1989–1990, IAEA-TECDOC-681, and Pre-OSART Mission Highlights, 1988–1990, IAEA-TECDOC-763.

During the period January 1991 to December 1992, 16 review missions were conducted in 13 countries; about half of them took place in developing or eastern European countries. These missions comprised: eight OSART missions; one Pre-OSART mission; three Technical Exchange missions, two of which were to reactors in operation and one under construction; and four Safety Review missions as part of the IAEA's project on the safety of Soviet designed WWER-440 plants in eastern Europe.

This document continues the good practice of summarizing mission results but does so in a new format such that all the aspects covered previously in separate documents (OSART missions, Pre-OSART missions and Good Practices) are to be found in one volume. Attempts have been made in this report to highlight the more significant findings whilst retaining as much of the vital background information as possible. This document is in three parts: Part I is an executive summary that presents the most significant observations made during the review missions, 1991–1992; Part II presents, in chronological order, an overview of the major strengths and weaknesses identified during each review performed during the period; and Part III is a sample listing of the recently developed OSART Mission Results (OSMIR) database showing a selection of strengths (good practices and good performances) and weaknesses (recommendations or suggestions) identified in the review missions covered by this report. Each part of the report is directed towards different levels in operating and regulatory organizations: Part I to the executive management level; Part II to the middle management level and/or the plant's experts on the department level; and Part III to the specialist handling data on operational experience feedback.

Part I
EXECUTIVE SUMMARY

During the period from January 1991 to December 1992 the NPP Operational Safety Services Section of the Division of Nuclear Safety of the International Atomic Energy Agency organized and led sixteen operational safety review missions. The missions consisted of eight full-scope Operational Safety Review Team (OSART) missions, three Technical Exchange missions (that is OSART missions of limited scope), one Pre-OSART mission to a plant being commissioned and four Safety Review missions (SRMs).

A full scope OSART mission lasts three weeks and covers eight areas of review: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry; and emergency planning and preparedness. The areas that are reviewed during a Pre-OSART mission depend on the construction stage of the plant. During the one Pre-OSART mission that was carried out in the period of this report, commissioning was reviewed in addition to the normal eight OSART areas. The SRMs were carried out on the first generation of the WWER-440 plant, models 179 and 230, under the IAEA's programme on the safety of reactors built to earlier standards. Each SRM consisted of reviews of both design and operational safety issues, six in design and six in operational safety. The operational safety areas reviewed in the SRMs were: management, organization and administration; training and qualification; operations; maintenance; fire protection; and emergency planning and preparedness. In addition, technical support was reviewed at the Bohunice SRM. Only the operational safety review areas of the SRMs are presented in this report.

The more significant findings made during 1991–1992 are summarized in this section and it is hoped that operators, especially those at power plants that have not hosted an OSART mission, will examine the report with a view to determining the relevance of the findings to their own power plants. The summary section should not be interpretd as indicative of the current status of nuclear operational safety worldwide since the sample of nuclear power plants in the reporting period is small and not necessarily representative for the nuclear industry worldwide.

Management, organization and administration

The management structures of most organizations reviewed were found to be well defined and considered to be effective. However, in some cases further improvement could be made by the use of additional management tools such as performance indicators to monitor and improve plant safety and by increased presence of management staff in the plants. Generally management qualifications and experience levels were high and management staff were committed to taking the initiative in creating and maintaining nuclear safety.

Due to the past isolation of eastern European countries from the rest of the nuclear safety community, the review teams observed in some plants that the division of responsibilities between the centralized authorities and the local plant management was not clearly defined and that changes were still in progress. It was noted that the statements on quality and nuclear safety were absent from the corporate and plant policies in a few cases and more emphasis was placed on production than on nuclear safety. In order to change staff attitudes and to motivate them, giving higher priority to safety and quality was recommended.

Most plants had well structured quality assurance (QA) organizations and QA programmes were implemented adequately, but the teams found that no formal QA programmes were in place at some plants reviewed by the Safety Review missions. Improvements in QA audit activities were often recommended, such as the frequency and scope of QA audits and a follow-up system for QA corrective actions. Some plants were advised to perform periodic in-depth reviews of the status and adequacy of their QA programmes to evaluate the effectiveness of the programmes.

Good professional relationships based on mutual respect generally existed between regulatory authorities and plant management and routine and non-routine reporting to the regulatory authorities was established. Inspectors from regulatory authorities were assigned to the site to evaluate and audit plant performance and in some cases they remained on site as resident inspectors. However, at one plant a recommendation was made to evaluate the effectiveness of regulatory inspection programmes since most of the inspectors were former members of the operating organization which might influence objectivity.

In general, the industrial safety programmes were developed comprehensively in accordance with government regulations and the company policies, although the quality of programmes varied. The overall industrial safety statistics were generally satisfactory. Various recommendations and suggestions were made in areas such as housekeeping practices, the use of protective equipment and training in observation techniques. On the other hand a number of good practices were noted such as the use of a comprehensive personnel safety handbook, industrial safety training for personnel including contractors and a reward system for good industrial safety performance.

Most plants had systematic document control systems and some had introduced computer based systems. Storage conditions were generally satisfactory. Various recommendations and suggestions were made to improve document storage methods in order to prevent deterioration or loss of documents. Other proposals for improvement included the revision process for documents in order to avoid discrepancies in the documents and means of ensuring that outdated procedures are properly withdrawn from use.

The teams reviewed site access control at just a few plants. One plant was advised to perform searches of all packages being brought into the plant.

Training and qualification

In general, well defined organizations for training were found at the plants that were responsible for co-ordinating the whole training process including planning, implementing and recording training activities based on agreements with the line management. These training units were staffed by full-time and/or part-time instructors as subject matter experts from the plant technical fields. The technical qualifications of full-time instructors were generally very high; many had worked in the operating organization accumulating many years of experience. However, the review teams often made recommendations that formal instructional skills training for instructors should be established not only in initial training but also in continuing training in accordance with the concept of a systematic approach to training.

It was also recognized that at some plants it was necessary to reinforce or establish a centralized training function in the plants to enforce a common standard of quality of the training programmes for all plant staff. It was also necessary to effectively control and evaluate all on-site and off-site training activities and to maintain comprehensive training records so that a full overview of a person's training and qualification record could be achieved.

Plant specific full scope simulators were used for training at about half of the plants reviewed. Some other plants were developing simulators while for the remainder, simulator facilities were not available or the capabilities were found to be inadequate. In some plants the management groups and training centres needed to strengthen their efforts, including an interim measure until full scope simulator capability can be realized, to ensure that control room personnel were adequately trained to diagnose and manage the plant in all events. The simulators were situated at the plant or at the corporate training centre and in one case out of the country simulator facilities were used. These included functional systems and post-accident simulators particularly suited to the development of knowledge of plant and equipment, as well as full scope simulators designed to develop skills. Generally the training materials used in the programmes were of a high quality and supported trainees in obtaining the necessary knowledge and skills to perform their duties. Some plants, however, were recommended to develop training material to the good pedagogic standards with learning objectives commonly in use and to maintain training material up to date.

Initial training programmes for control room operators which include classroom, on-the-job and simulator training were generally structured in a well balanced manner. In many cases continuing training programmes were not as well stuctured as initial training and implementation of structured continuing training programmes was often recommended in order to familiarize staff with plant modifications and lessons learned from operating experiences.

Initial and continuing training programmes for field operators and other technical personnel, such as maintenance, technical support, radiation protection and chemistry personnel, were of varying quality. Generally the initial training for personnel was carried out in a satisfactory manner and adequate basic skills and knowledge were provided before personnel were assigned to their jobs. In some plants, improvements were recommended, such as increasing the amount and frequency of continuing training and developing comprehensive training programmes, especially for on-the-job training, based on systematic job and task analysis. In some cases the extensive use of mock-ups for electrical, mechanical and I&C personnel was found.

A management development programme was usually in place at the corporate and/or site locations. All new employees were provided with basic training such as radiation protection, industrial safety, fire protection, emergency and plant administration. Some plants were advised to periodically review the content of the material being taught during the general employee training.

Operations

The responsibility and authority of the staff directly controlling and operating the plants were generally clearly defined. In four plants managers and supervisors were asked to be involved to a greater extent in touring the plant to better assess plant conditions, and to meet members of staff at their places of work, thereby demonstrating interest and concern in all aspects of work. Several recommendations were made during Safety Review missions to enhance the operations department organization and shift organization to improve internal communications and team training.

At most of the plants the control room layout, panels and facilities were good and updated unit computers provided necessary information for unit operation. In contrast to the latest plant visited in the reported period, where these installations were superior, some older power plants were strongly recommended that extra care should be taken to safeguard the ergonomic and human factor issues included in their original design, which have been degraded as a consequence of repairs, maintenance and modifications. For these units, several recommendations were made to urgently review and upgrade the control room design. Some comments were also made for a few plants on the excessive number of annunciators in the alarm state in the control room and need to improve the plant alarm system. Some aspects of the labelling and colour coding were identified as requiring further improvement.

Comprehensive operating procedures and operational limits and conditions (OLCs) documents were provided for the operators at the plants reviewed by the OSARTs. Some recommendations were made to rewrite OLCs in a form that was more in keeping with internationally recognized good practices, that is in a form such as technical specifications. At some plants, special attention was required to provide symptom based emergency operating procedures that were user-oriented and in a format that was already proven by use at the other NPPs. There was also a need to ensure that up-to-date procedures reach staff in a timely manner.

The review of plant operating history indicated that the reliability of systems and effectiveness of operation was improving over recent years, which indicates managements' sensitivity to the need of safe operation. The effort to reduce human errors and reactor trips was noticeable. In some NPPs load factors were decreasing for the last two years, apparently due to longer refuelling and maintenance outages to improve plant safety. A few recommendations were made to improve the criteria for determining which events should be reported, to identify and determine the root causes and to specify how information should be fed back to the operations staff for training.

Operations personnel were attentive and responsive to plant conditions. In general, the atmosphere in the control rooms was professional and businesslike. Shift turnovers and field operators walk-throughs were observed to be performed in a professional manner. Plant material conditions and housekeeping standards were generally acceptable, but several recommendations and suggestions were made to improve lighting and equipment labelling.

In general the work planning and authorization process was well controlled by the operations personnel, but at the plants reviewed by the Safety Review missions, several aspects in the deficiency reporting, work authorization and control, and tagging were identified as requiring improvement. Moreover, the expediting of operations training and procedure revisions due to plant modifications was recommended in some plants.

It was observed that the measures needed to manage the response to severe accidents were not always well understood by plant management. Consideration was recommended for the development of procedures and guidance to control and to mitigate the consequences of severe accidents that could go beyond plant design basis. Such measures should be carefully interfaced with the existing plant emergency operating procedures (EOPs). Development of a probabilistic safety assessment (PSA) should be an essential part of the basis but not necessarily complete before the development of accident management procedures can start. One NPP was identified as having adequate guidelines and involving systems specifically added to mitigate the effects of severe accidents. At another plant the guidelines were being written and implemented, and a third plant had developed a generic PSA and its findings were under analyses; since only a few head office and plant personnel were well informed about severe accidents beyond the design basis, a more comprehensive training programme was suggested. In view of lack of accident management development in the other plants recommendations were made to enhance the EOPs, training, and improve basic instrumentation and support facilities to be used in emergency situations.

The fire fighting capabilities were found to be generally adequate. In most of the plants reviewed by the OSARTs appropriate codes, standards and procedures for system operations were taken into account in the fire protection programme. In one plant the design took into consideration the amount of combustible material permitted in each room: any modification or change in room use required approval to ensure that any impact on fuel loading or fire protection was taken into account. The fire protection programme at the plant was considered to be above average. However, in the Safety Review missions the plants were often recommended to improve their fire protection system and related installations and to enhance their routine field inspections and equipment maintenance. At all plants fire risk analyses were recommended to be carried out as soon as possible.

Maintenance

In general, the maintenance departments of the plants reviewed were adequately staffed and effectively organized to perform the functions necessary to support safe operation of the plants. The responsibilities of the maintenance organizations were clearly defined at most plants. At some plants where maintenance organizations were found to have complex structures and did not provide a clear separation from operations, it was frequently recommended that clear and direct lines of responsibility for maintenance be established throughout the departments. At a few plants a concern noted was the shortage of experienced engineers and supervisors in the maintenance organization due to the lack of an adequate analysis of workload and the high turnover rate of personnel. On the other hand, in a few cases it was found that the plant was supported by an extensive centralized organization which provided the plants with national maintenance policies and excellent maintenance support for problems or modifications.

Maintenance facilities were generally found to be well equipped and orderly. Remotely controlled tools were widely used in many plants. However, shortcomings were observed in some plants, such as the use of uncontrolled devices, lack of space to overhaul large size equipment and lack of control of contaminated instruments.

Preventive maintenance programmes were generally comprehensive and were developed for most of the safety related equipment at all the plants reviewed. The programmes were in general reviewed periodically by using manufacturers' recommendations and feedback of operating experience. At some Safety Review missions, it was noted that there were no detailed working procedures for preventive maintenance activities. It was stressed that the lack of such procedures made it impossible to ensure that equipment is maintained in a consistent and acceptable standard. State-of-the-art predictive maintenance techniques were widely used at many plants. In other plants, predictive maintenance programmes were in an early stage of development or did not exist formally. A good practice noted was the introduction of extensive on-line computerized monitoring and data analysis systems for components subjected to stress which could enhance the capability to predict fatigue damage in primary system components.

Most of the plants had administrative procedures which specified the revision, updating and evaluation of procedures. Nevertheless, it was found in some cases that maintenance procedures were not periodically reviewed and not authorized on time. The content and format of equipment history records were in general found to be good. Some plants used a computerized documentation system from which history records were easily retrievable. Recommendations and suggestions were sometimes made in such areas as improving the protection of records from hazards such as fires and providing systematic management of equipment history records stored in locations across the site.

Maintenance activities were generally found to be carried out satisfactorily and in a professional manner. Many plants had excellent work control systems which were well documented and made extensive use of computerized work management systems. Daily and weekly meetings for co-ordination between departments took place regularly. However, the review teams observed several examples where more attention should have been paid to industrial safety practices, adherence to technical procedures, foreign material exclusion programme and the cleanness control of maintenance activities both during and at the end of work.

In general, material conditions varied from average to excellent. However, at some plants, material conditions, especially for non-production-related systems, were found to be below acceptable standards and to have adversely affected on nuclear safety. At these plants, immediate steps were required to restore all degraded equipment and to develop and establish acceptable standards for maintenance work.

In-service inspection (ISI) programmes were found to be adequate and to have been based on acceptable national regulations or foreign standards. Inspections were performed in a professional manner. In general the ISI records were properly kept and the filing and retrievability of records were satisfactory.

At most of the plants reviewed, the rules and administrative procedures for purchasing and warehousing were well organized and the storage conditions of warehouses were generally good. Some plants used comprehensive computerized programmes for procurement and stores management. In some cases the review teams recommended the development of preventive maintenance programmes for specific spare parts, shelf-life control for spare parts with limited life span, segregation of safety versus non-safety related components, and segregation of stainless and carbon steel. A good practice noted at a few plants was the use of a bar code system which was an effective system for controlling inventories in the warehouse and issuing of tools.

Planning and preparation of outages and co-ordination of maintenance activities during outages were found in general to be performed satisfactorily. At about half of the plants reviewed, a specific outage management organization which consisted of representatives from departments involved was assigned before an outage. At other plants the preparation and co-ordination of an outage was performed by a normal line management organization. A current trend encouraged by the review teams was to develop a computerized outage management system for planning and scheduling of outages, to improve flexibility of schedules and to improve efficiency of co-ordination between all activities.

Technical support

The technical support organization and functions were generally clearly defined and understood. A few suggestions were made to enhance technical support staff involvement in other areas to improve staff experience and enhance the staff's ability to support the operating plant.

At all plants reviewed a surveillance programme was established and implemented. Some good practices were noticed, such as comprehensive thermal fatigue monitoring programme and an extensive computerized vibration analysis programme for all major rotating equipment to permit early detection of degradation and timely preventive action. Nevertheless, some suggestions were made that surveillance test procedures and practices be reviewed and upgraded so that they would be more comprehensive and in accordance with the IAEA technical documents. At most of the plants reviewed it was recommended that a comprehensive trend analysis programme of surveillance test results be implemented to identify adverse conditions before performance was significantly affected.

There were many different approaches to the evaluation and feedback of in-house and external events. In one plant a well developed operational feedback programme in use during commissioning of the plant was identified as a good practice. In contrast recommendations were made at other plants to enhance the programmes by better and more in-depth analysis of events, classification and storage of event records, and evaluation of human factors as a formal requirement in the analysis of events.

A plant modification programme for permanent and temporary modifications with the necessary elements existed at most of the plants visited. In a few cases suggestions were made to reduce the backlog in the approval process, to implement the required changes in design, to implement probabilistic risk assessment techniques for optimizing the programme, to incorporate timely revisions to operation procedures following plant modifications and to establish a management system to track revision, and final safety analysis report updates.

In general, reactor engineering activities ensured the safe operation of the reactor core by following the operating limits and conditions based on design, safety and nuclear fuel limits. Reactor engineering group responsibilities were adequately described in procedures. Good performances were identified in one plant where all major non-routine activities such as control rod pattern adjustments and first start up after refuelling were always carried out based on calculations derived from detailed three-dimensional core analyses that included xenon transient simulation. In genral, fuel integrity was monitored adequately by measuring fission products.

Fuel storage and handling were generally satisfactory and core management programmes were found to be comprehensive. Some suggestions were made to incorporate the inspection of the whole fuel assembly after fabrication as well as after receipt at site, into the quality assurance procedure. At most plants, tools and equipment for fuel handling were found to be in good conditions.

Radiation protection

The radiation protection organizations and programmes varied widely. At the nine plants where this topic was reviewed, seven plants were in operation and two plants in an advanced stage of construction. At all of the plants in operation, radiation protection activities were based on the national regulations and were generally found to be conducted satisfactorily and well supported by the plant management's commitment to the major radiation protection goals of reducing personnel exposures and minimizing radioactive waste.

In general radiation protection staff were found to be knowledgeable and professional, however there was a concern at a few plants that the staff should have a greater awareness of current international practices.

At plants under construction, radiation protection programmes had been prepared to support the key startup tasks such as fuel delivery and loading. However, it was recommended that management became more involved in the development of radiation protection programmes, procedures and training material.

At most of the plants, the radiation protection staff were found to be involved in the work planning process in assessing radiation protection requirements based on ALARA principles. Exposure analysis was performed in advance and necessary information for each work area, such as the expected dose rate and the appropriate protective measures were advised. Good practices, noted in some cases, were the method of pre-job reviews using in-house produced videos, excellent mock-ups for major high dose work and a surrogate photographic tour during pre-work meetings to display the exact work area. Setting administrative control levels for an annual collective dose and an individual job dose were generally carried out in line with international practices. At one plant still under construction, it was observed that the radiation protection staff were effective in affecting the design of plant and equipment to reduce radiation dose to staff who would operate and maintain it.

In general, protection of staff against internal contamination was found to be performed adequately through control of airborne and surface contamination and use of protective clothing and equipment. The extensive use of the breathing protection equipment including high quality respirators was noted at many plants. Some recommendations and suggestions were made regarding a respirator fit testing programme, a policy of taking of drinks in the controlled area and a contamination control policy at demarcation points between controlled and other areas.

Radiation protection intrumentation, equipment and facilities were mainly judged to be adequate and in some cases, excellent. They were carefully maintained and periodically calibrated at facilities in the plant or by certified firms with adequate standard sources. However, some aspects of calibration programmes and alarm setting for radiological instruments and storage condition of radioactive sources were identified as requiring further improvement.

External personnel exposure was measured officially with either film dosimetry or thermoluminescent dosimetry and at many plants good use was made of pocket electronic dosimeters with preset alarms to complement official dosimetry in reducing the risk of overexposures and to collect job related exposure data for repeat operations. Some concerns were noted mainly related to plant specific details such as film dosimeter sensitivity to low level exposures, extremity dosimetry programmes and verification methods of the personnel dosimetry system.

The separation and treatment of different types of waste were generally carried out in a satisfactory manner. All the plants reviewed were committed to the reduction of radioactive waste volumes. Several conditioning technologies were used including incineration, compaction, in-drum drying of liquid wastes, and the melting of contaminated metals at one plant. No possibility for waste volume reduction existed at one plant, although initial efforts were made by restricting packing materials from the controlled area.

The methods of liquid and gaseous effluent control and recording of results were found to be satisfactory at all the plants reviewed. Releases were kept low in general using a control level which was substantially less than the authorized limit. The environmental monitoring programmes were carried out at all the plants reviewed and were generally in accordance with accepted international practices, although it was noted at one plant that airborne monitoring was not included in the environmental monitoring programme. In some cases sampling and analyses were performed by both the plant laboratory and the regulatory laboratory. Some improvements of quality assurance programmes at laboratories, including intercomparison programmes with other plant laboratories, were advised at a few plants. In one case where the radiation monitoring system was in the process of being constructed, some improvements were proposed in the design of gaseous monitoring systems to ensure that every emission to the environment would be monitored.

Tasks and responsibilities of radiation protection staff during emergencies were normally defined as a part of emergency planning procedures. In some cases, a more detailed description of staff roles, especially in the first phases of emergencies, and more radiation protection staff on call were recommended. At most of the plants visited, well equipped vehicles for off-site measurements and protective clothing and respirators for emergencies were available both on-site and off-site, although not all plants stored sufficient amounts. At a few plants there were insufficient emergency training programmes for radiation protection staff.

Chemistry

The importance of chemistry in plant operational safety and reliability was recognized widely in all the plants visited by the OSARTs. Generally good collaboration with the operations group was in place and staff were performing their jobs in a professional manner. Duties and staffing of the chemistry organization differed from plant to plant. In a large number of cases chemistry staff were found to be engaged not only in surveillance tasks but also some operational activities such as water management. Chemistry staff at other plants were found to perform only surveillance activities. In both cases some of the plants had chemistry staff on shift. In one case it was proposed that benefit could be gained from restructuring the chemistry and radiochemistry functions.

The chemical treatment of the plants visited was generally consistent with current international standards. As a good performance it was noted that one plant had achieved 'zero-release' of radioactive material in its liquid releases. At all the plants reviewed, efforts to cope with erosion–corrosion problems and to reduce activity build-up were observed, although the scope of programmes and studies were in varying degrees. Some improvements mainly based on plant specific design features were proposed. A few plants needed improved chemistry facilities and instrumentation in order to monitor the corrosion products adequately. In the newer plants, great efforts had been made to include modern features into the plant design to minimize the erosion–corrosion problems encountered in other plants.

Chemistry surveillance programmes were established at all the plants visited, based on technical specifications, manufacturer requirements and operating experience. Generally, the quality of the chemical measurement was assured by a periodical calibration policy for laboratory equipment and on-line monitors. On-line monitoring systems were frequently used to collect data thus enabling a rapid and clear display of trends of major chemical parameters so that manual analyses were to a large extent no longer necessary. At a few plants improvements in the surveillance of some important chemical parameters were hampered by shortcomings in the available on-line instrumentation.

Raw water treatment and demineralized water systems were found to be consistent with accepted international standards at most plants in operation. Recording of chemical parameters and analytical data was generally found to be performed in a satisfactory fashion.

Computerized database systems with facilities for graphic trending were available at many plants and steps were being taken to acquire them in some other cases. All the plants reviewed issued periodical reports for information on chemistry performance and special reports were used for abnormal situations and chemistry related incidents.

Most of the plants visited had laboratories adequately equipped with modern and effective instruments for chemical and radiation measurements. However, major shortcoming identified in a few plants were insufficient laboratory instruments, especially for measuring low level impurities. Provision for a post-accident sampling system of the primary coolant and of the containment atmosphere was found to be an accepted international standard, although the necessity of this development was emphasized at some plants.

Quality control programmes for operational chemicals were found to be adequately performed at all plants visited, although some could be further improved. More systematic involvement of the chemical group in checking of chemicals used for maintenance work and more uncompromising control of hazardous and inflammable chemicals was often recommended. It was also recommended that a diesel fuel quality control programme should be developed at some plants.

Radiochemical measurements of environmental samples and radioactive waste were in general found to be well handled and in line with accepted international practices. One plant needed to clearly define responsibilities and interfaces between departments involved in the field of radiochemistry and environmental monitoring.

Emergency planning and preparedness

At all the plants visited an overall organizational infrastructure existed. The status of on- and off-site planning was well defined with clear identification of the duties of key personnel. Recommendations were made with regard to clearly establishing specific management instructions in the emergency organizations and subjecting the emergency plan to quality assurance control. At some plants reviewed in eastern Europe efforts to enhance the effectiveness of emergency planning and preparedness (EPP) had concentrated on directions from regulatory authorities to the NPP. Specific recommendations were made to reassess and resource the emergency preparedness work load, and to ensure that the station management were kept aware of all the changes in the off-site support structure due to the changing national situation in their countries.

The on- and off-site emergency plans were reviewed and several recommendations and suggestions were made with respect to giving more specific criteria for area evacuation and re-entry, to incorporating PSA findings in the plans and procedures and to reviewing the emergency classification criteria. The authority of shift supervisors to declare emergencies and the need for a controlled backup list for the key positions and technical staff were also emphasized in the recommendations.

Emergency procedures were generally found to provide enough detailed guidance for the rapid and effective implementation of the on-site and off-site emergency plans. Some recommendations for improvements were made to upgrade the procedures to agree with the emergency plans, and to develop procedures to assess plant conditions and safety status as well as the accident condition during the emergency.

At most plants reviewed, the on- and off-site emergency response facilities were found adequate, suitably located and habitable under emergency conditions. Some good practices were pointed out, for example the provision of a high quality radiological emergency medical centre, environmental laboratory and an excellent integrated computer system for safety parameters display and dose assessment. Commendable features found in other plants were the number of staff with different backgrounds and expertise who were devoted to emergency preparedness, a computer database of demographic survey data immediately available to the emergency controller and the provision of robots for working and visual inspection in high contaminated areas.

On the Safety Review missions, several recommendations and suggestions were made in the provision of emergency response facilities and equipment. Shelters, emergency control centres, and technical support centres were recommended to have better installations, habitability, iodine filtration, and alternate locations in some cases. Documents, dosimeters, communication systems and equipment resources in general were suggested to be improved.

Documented training programmes were provided and their importance in developing and maintaining the necessary knowledge and skills required by all persons having emergency plan duties was fully recognized at the plants visited. Some recommendations were made to have more frequent full scale exercises, to introduce formal systems to evaluate and track the recommendations from the exercises and drill analysis and to expand the scope of full scale exercises to include some important groups dealing with emergency conditions, such as medical service and off-site exposure assessment.

Examples of good practices in public relations were noted. Site officials specifically trained at a television training centre and continuous media briefing or interview strategy by utility spokespersons were considered highly effective. Nevertheless some improvements were advised to some plants which did not have a member of station staff designated to act as a link with the public and media information officers of the governments.

Commissioning

The review of commissioning activities was carried out at only one plant. The commissioning organization of the plant was found to be comprehensive, well structured and staffed by qualified personnel. Approximately one-third of commissioning engineers had been involved in the plant design and in the preparation of the commissioning programme and documentation for an early stage. The management's commitment to the clear separation of contractual and technical issues was also noted as a good practice which enhanced the quality of the commissioning programme.

The commissioning programme was found to be satisfactorily developed in line with international practices. The training programme for commissioning personnel was comprehensive and easily auditable using a computerized system.

Preparation and approval of test procedures were carried out adequately according to the generic guidelines which provided writers with consistent guidance. It was noted that consideration was made to protect equipment against possible accidents during initial energization. Conduct of tests and evaluation of test results were in general found to be satisfactory. An effective test team briefing before the commencement of a test was noted. However some abnormalities were found in the completion of test procedures and the conduct of tests. It was recommended that more emphasis should be placed to ensure that test engineers adhere to established commissioning guidelines and that the auditing process be improved.

Proposals for and approval of maintenance during commissioning was considered to be consistent with international practices. The involvement of engineering in commissioning was well established and close communication between the commissioning and engineering groups was in place. However, some weaknesses were identified in the evaluation of field changes.

The work control process during commissioning was generally of a high standard, although specifying post-maintenance retesting was recommended. The full involvement of the operation personnel in the equipment isolation process provided them with good experience for normal plant operation.

Approval of temporary modifications and notification of the new configuration of the plant were well managed according to the procedures. Some improvements in the management of temporary changes related to plant specific details were recommended.

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Part II
MISSION OVERVIEWS

GUANGDONG (CHINA)

Scope of the mission

A Technical Exchange mission to the Guangdong nuclear power station from 21 January to 1 February 1991 made a review of items essential for preparations for operations. The scope of the review was: management, organization and administration; training and qualifications; operations; maintenance; technical support; chemistry; radiation protection and emergency planning and preparedness. The mission took place shortly after a Pre-OSART mission which was carried out in November/December 1990.

Brief plant description

At the time of the Technical Exchange visit, the plant which consisted of two 930 MW(e) pressurized water reactors was in a construction phase. The commissioning of Unit 2 will follow that of Unit 1 by about 8 months.

Main conclusions

The Technical Exchange team found that an excellent start had been made by the plant in developing detailed Level 1, 2 and 3 schedules for the preparation of operation. The schedules, even though they require additional work, provide a management tool for more realistically estimating needed resources and completion dates.

A number of recommendations were made for consideration in further improving the stations preparations for operations. Among them are the need to expedite the recruitment of personnel; based on the Level 3 and 4 schedules, to perform a manpower estimate and to identify better needed resources; to reassess the operational resources need in the radiation protection and maintenance areas; to expeditiously complete the development of the administrative procedures; to expedite the development of technical procedures; to improve the Chinese staff's use of the station operating language (English); and to hold the Operations Department managers and supervisors more accountable for the performance of their branches and sections. A number of the draft schedules appear to be unrealistic in their completion times and they have yet to be integrated with each other.

Station management should seriously review the effort required to support the startup schedule and provide additional resources, where appropriate. The impact of Unit 2 startup should also be included in the schedule. The commissioning of Unit 2 will follow that of Unit 1 by about 8 months, followed by the first Unit 1 refuelling outage. These aspects should be included in the overall planning.

RINGHALS (SWEDEN)

Scope of the mission

A full-scope OSART mission was conducted to Ringhals nuclear power plant from 14 January to 1 February 1991. The review areas were: management, organization and administration; training and qualifications; operations; maintenance; technical support; chemistry; radiation protection and emergency planning and preparedness.

Brief plant discription

The Ringhals nuclear power plant consists of four units. The first unit, a boiling water reactor designed by ASEA-ATOM, began commercial operation in 1976 and has a net electrical output of 750 MW. Unit 2 is an 800 MW(e) pressurized water reactor of Westinghouse design which began commercial operation in 1975. The OSART reviewed the latest two units which are later Westinghouse pressurized water reactors of 915 MW(e) net output which began operating commercially in 1981 and 1983 respectively. The combined electrical output of the Ringhals site is 3380 MW(e).

Main conclusions

Ringhals Units 3 and 4 have good records of performance with availability factors of 85–89% for the four years prior to the OSART mission in January 1991. Cumulative doses on the site and radioactive discharges to the environment have been low.

Based on its observations, the OSART mission considers that the success of Ringhals Units 3 and 4 has been due in large measure to: a safe and redundant design; improvement by upgrading; the close attention paid to equipment maintenance; conscientious operators; surveillance testing; good housekeeping; a stable workforce which takes pride in its work; excellent use of computers to assist operators in controlling the plant; and an excellent integrated Ringhals Information System used effectively for outage planning, routine maintenance, material control, finance, personnel administration, executive information and fuel administration.

In fulfilment of its primary objective of seeking to raise nuclear safety standards, the OSART identified a number of areas where improvements should be introduced. The OSART is confident that if the recommendations and suggestions were implemented then not only would nuclear safety at Ringhals be improved but that commercial success would continue.

An early impression formed by the team concerned the apparent priorities of the company with respect to safety and quality. The highest level business statements of the company and of the plant focus on their reason for existence - generation of electricity. First mention of safety and quality is left to the next level - goals and objectives. Such a presentation creates the impression that production and commercial interests predominate. This impression was reinforced a few times during the mission. On first entering the site, one's eyes are drawn to a large display showing the output of each unit; there was an almost complete absence of displays concerning safety and quality. Secondly, emergency response training was arranged to have minimal impact on normal work to the extent that those responsible for controlling such a situation on site were not being tested with the full range of interactions and practical difficulties. These two examples show that the right message was not received. It is vitally important that neither the work force nor the general public nor visitors misunderstand the priorities. If quality and safety are put first, commercial success should be the natural outcome.

These comments also have a bearing on the second main issue which concerns the application of quality assurance principles. Ringhals has a largely decentralized structure and has chosen to place responsibilities as low in the hierarchy as can be justified. Such a principle is satisfactory and can lead to a sense of "ownership". However, lines of communication and accountabilities must be specified together with systems to check and correct performance. Confidence that tasks have been properly completed is largely based on trust and in the confidence a supervisor places in the abilities of a subordinate. This may have been very successful in the past at Ringhals NPP but this concept lacks some elements of verification common in quality assurance programmes. During the review some problems concerning interrelationships between various groups and unsatisfactory completion of activities were identified. This suggests that the implementation of the management principle is not fully effective. In general, the shortcomings were not being identified because accountabilities were not specified and activities were not being checked formally. Many of the issues raised by the OSART could be solved by the application of classical quality assurance principles.

The efforts required to implement the proposals for improvement are not large but would greatly assist the plant's drive for excellence. However, a determined effort is required by the power plant, company and regulatory body to devise action plans and monitor the progress of the work.

BOHUNICE (SLOVAKIA)

Scope of the mission

A Safety Review mission to Units 1 and 2 of the Bohunice nuclear power plant was conducted in conjunction with the OSART from 7 to 26 April 1991, with the objective of assessing both the design and operational safety of the plant. The Safety Review mission was part of the IAEA's programme on the safety of WWER-440/230 plants in eastern Europe. The twelve review areas covered in the SRM to Bohunice were: management, organization and administration; training and qualification; operations; maintenance; technical support; emergency planning, core design; systems analysis; component integrity; instrumentation, control and electric power; accident analysis; and fire protection. In the main conclusions below only the areas related to operational safety are presented.

Brief plant description

The Bohunice nuclear power plant V1, Units 1 and 2 are WWER-440 model 230 pressurized water reactors. Units 1 and 2 started commercial operation in April 1980 and in January 1981, respectively.

Main conclusions

In general some of the deficiencies of WWER-440/230 plants are well known from previous studies and missions. Some of the basic deficiencies, that are due to the lack of specific standards in the former Soviet Union at the time of design, still persist. This is especially important in the area of instrumentation and control and with respect to physical separation of safety equipment.

In the operation area, the past isolation of eastern European countries from the rest of the nuclear safety community has led to significant differences between the operating practices of WWER users and international practices.

With respect to the operation of the plant, significant emphasis should be placed on the following areas of weakness:

- Normal and emergency operating procedures are inadequate. In many cases procedures have not yet been developed and, in general, the procedures are incomplete and inadequately structured.

- Plant personnel routinely do not use the procedures that are available. Use of procedures has not been emphasized by plant management or through training.

- A number of plant practices are inadequate and do not promote safe operations, such as: many surveillance procedures for safety system testing have not been developed; surveillance testing data is not routinely recorded and evaluated; and systems and components that are isolated for maintenance are not tagged for identification in the control room and in the field.

- No quality assurance programme has been developed. Independent assessments and reviews of operations and plant quality programmes to enhance compliance with technical specifications and quality requirements are not conducted.

- Many plant operating functions are ineffectively organized. In the current organization, responsibilities are fragmented, lines of communications are long and the operating organization is not functionally structured around the two plants.

- The main control room instrumentation, process information, communications and human factor conditions are inadequate for effective plant control during transient conditions. In addition, provisions for control room habitability during accident situations have not been evaluated and made.

- The control room is inadequately staffed for transient situations and the plant staff has insufficient operating experience to support some needed programmes, for example procedure development.

- The station's accident management preparations are incomplete. The on-site emergency planning organization is not effectively structured and the facilities are inadequate. No procedures for using accident management equipment have been developed and the personnel has not been adequately trained. In addition, no systematic and graded approach to accessing and activating technical and emergency support personnel has been adequately developed.

In conclusion, the station management and the support organizations in Slovakia are taking seriously the need to upgrade the safety of Bohunice and are making significant progress in this respect, as evidenced by many modifications already completed or planned. However, due to the significance of the issues, similar attention is needed in a timely manner in the operation area, to provide a balanced approach to nuclear safety.

KOZLODUY UNITS 1–4 (BULGARIA)

Scope of the mission

A Safety Review mission to Units 1–4 of the Kozloduy nuclear power plant was conducted in conjunction with the OSART from 13–21 June 1991, with the objective of assessing both the design and operational safety of the plant. The Safety Review mission was part of the IAEA's programme on the safety of WWER-440/230 plants in eastern Europe. The eleven review areas covered in the SRM to Kozloduy were: management, organization and administration; training and qualification; operations; maintenance; fire protection; emergency planning, core design; systems analysis; component integrity; instrumentation, control and electric power; and accident analysis. In the main conclusions below only the areas related to operational safety are presented.

Brief plant description

The Kozloduy nuclear power plant, Units 1–4 are WWER-440 MW model 230 pressurized water reactors. Units 1–4 of the plant started commercial operation in July 1974, November 1975, January 1981 and June 1982, respectively.

Main conclusions

Some of the insights and conclusions can be summarized as follows. Design weaknesses of the WWER-440/230 reactors are well known such as lack of containment, insufficient diversity and redundancy of safety injection systems and lack of segregation of safety systems. With these design weaknesses it is imperative that the highest levels of material conditions and operations and maintenance performance are sustained. When looking at such operational aspects one would expect great emphasis to be paid to such matters as operator training for normal and emergency response actions, to safety equipment that would receive the highest attention and to rooms in which safety equipment were housed that would be kept in a appropriate condition.

This is not the case at Kozloduy. The requirements placed upon successive managements have brought about a number of unsatisfactory results. With respect to operation of the plant significant emphasis should be given to the following areas of weaknesses:

- The material condition of the plant and plant equipment was unacceptable. Poor material conditions were observed in all areas including safety and safety related systems. The conditions of affected equipment was such that correct operation in accident conditions could not be guaranteed. Until such impediments to safety were removed it would be imprudent to operate any of the Units 1–4.

- The present state of Kozloduy including the poor material conditions were essentially due to a lack of safety awareness brought about by focussing attention on power producing equipment to the detriment of non-productive systems such as safety and emergency systems. This unbalanced emphasis is the antithesis of the 'culture' necessary to ensure that, as a prevailing priority, nuclear plant safety issues receive attention warranted by their significance. A new culture must take root in Bulgaria; one that moves away from a bias towards production to one which encourages people to give due consideration to safety. This safety culture must be allowed to instinctively exert a positive influence on the thoughts, decisions and actions of all persons who directly or indirectly affect nuclear safety. Such a culture cannot operate in isolation at Kozloduy nuclear power plant but must pervade all aspects of business of the Bulgarian nuclear community encompassing the Government and its organizations, the Committee on the Use of Atomic Energy for Peaceful Purposes, and the operating organization including the Committee of Energy, the power plant and supporting organizations.

- A poor attitude towards industrial safety exists at Kozloduy NPP. The unacceptable material conditions of the plant contribute to safety hazards.

- The system of plant inspections carried out by inspectors of the regulatory body, the Committee on the Use of Atomic Energy for Peaceful Purposes, has not been able to identify deficiencies and enforce corrective actions necessary. The roles of the inspectors should be reviewed and inspectors given the training and authority to carry out the tasks correctly.

- The absence of a strong centralized training function has resulted in:

    - No mechanism to ensure an appropriate standard of quality of the training programmes across the various departments.
    - The construction of the NPP training centre, which began in 1976, being far from complete.
    - The NPP not having the necessary training facilities or instructors to develop and deliver structured lectures and other needed training.
    - No assurance that each trainee will systematically receive the training required to perform adequately all the activities associated with his position.
    - Control room operators and shift supervisors not receiving simulator training before their qualification.
    - A strong emphasis on qualification and requalification examinations. However, this system is unstructured and cannot be audited and it is unlikely that a consistent standard of qualification is maintained for any position.

- The present quality of normal operating and emergency operating procedures is poor and efforts to improve these in co-operation with the World Association of Nuclear Operators (WANO) should be maintained.

- Development of new technical specifications must be completed to include, among other things, acceptance criteria for all periodic tests. Before introduction of the technical specifications all operators need to be trained in their use.

- Greater attention is needed by operators to identify and report defective equipment for corrective maintenance.

- Technical safety reviews of proposed plant modifications should be introduced.

- Maintenance standards should be raised by improving the format, content and control of maintenance procedures.

- A quality control organization and a comprehensive programme for requalification of equipment on completion of maintenance must be introduced as planned.

- A mechanism to simplify the present spare part procurement process must be developed to avoid a future shortage of spares.

- Poor housekeeping and cleanness standards result in fire hazards from oil spills being unattended and combustible materials such as rags and wood not being cleared away.

- The off-site plan is based on a very large release of radioactivity the scientific basis of which has not been established. The off-site plan should recognize smaller accidents with a limited range of hazards.

- There is an inadequate stock of direct reading dosimeters for effective control under emergency conditions.

- There is no continuous measurement of wind speed and direction.

KOZLODUY UNIT 5 (BULGARIA)

Scope of the mission

A limited scope OSART mission was conducted at Unit 5 of Kozloduy nuclear power plant from 15 July to 2 August 1991. The areas reviewed were: operations; maintenance; technical support; chemistry; and radiation protection. In the first three areas which were covered in a limited scope OSART in October 1990, the team followed up on the progress made by plant management in response to the OSART recommendations made at that time.

Brief plant discription

The construction of the Kozloduy NPS has been in three stages. Stages 1 and 2 were devoted to the construction of two pairs of 440 MW units of slightly varying design features, while the third stage was devoted to the construction of a pair of 1000 MW units. The construction of Unit 5 began in July 1980. First criticality was achieved in October 1987, with connection to the grid one month later, commercial operation began in October 1989. Unit 6 was in startup testing at about 30% power at the time of the review.

Main conclusions

In conducting the review, the team made frequent plant tours to assess the material conditions of the plant and the performance of work and held discussions in depth with the plant staff. The main conclusions of the mission can be summarized as follows.

There are a number of differences between the conditions found at Unit 5 and the conditions reported in the June 1991 Safety Review mission to Units 1–4. Unit 5 is newer, has different managers and has the benefits of newer technology and better defined programmes. The recommendations provided to Units 1–4 in the SRM were reviewed for applicability to Unit 5. Many of the generic recommendations from Units 1–4 are applicable to Units 5 and 6 and have been included in the team's recommendations.

The staff at Kozloduy Unit 5 are highly qualified and experienced. A new management team has recently been appointed and its motivation to pursue improvements is evident. The new managers are well aware of their responsibilities for nuclear safety and for the safe and reliable operation of the unit. However, supervisory and monitoring skills need to be improved and aggressively pursued at all levels of plant supervision. The plant suffers from a number of long standing problems such as a cumbersome organizational structure based on past practices, a previous lack of international exchange of operating experience and inadequate living conditions in the Kozloduy area. Many such problems were identified during the OSART mission in 1990. Greater efforts are required if the issues are to be overcome in a reasonable time.

Some aspects of the plant's programmes were found to have good levels of operational performance, such as the following: thorough investigations of in-plant operations related events; the environmental radiation monitoring programme; the installed unit radiation monitoring system; the chemistry surveillance programme; the quality control programme for material inspection; and upper management involvement in operations activities.

However, proposals were made in a number of areas to correct past shortcomings and to improve the station's approach to operational matters. A number of these basic shortcomings had been previously identified in the 1990 OSART report.

In the first category were a number of recommendations fundamental to establishing an adequate management structure and a thorough going safety culture. These included the need to clarify and better define the organizational relationship and responsibilities between the Energy Committee and the Kozloduy management; measures to increase the effectiveness of the regulatory body; the recognized need to restructure the operating organization to increase its effectiveness and eliminate fragmented and dual responsibilities; measures to improve industrial safety practices and the day-to-day supervision of work practices; improvements in the monitoring of station commitments; and cleaning the station.

The second category of recommendations addresses the following:

- The need to significantly raise the standards of maintenance practices and the quality of completed repair work;

- The need to conduct evaluations of the Belene and Temelin design review recommendations;

- The need for additional controls and safety reviews of both permanent and temporary modifications;

- The lack of adequate on-line and laboratory chemistry instrumentation;

- The need for additional radiation protection instrumentation to monitor personnel exposures more effectively;

- Improvements needed to ensure that personnel follow station radiation protection policies;

- Measures to improve the safe use of calibration sources in the radiation instrument calibration laboratory;

- The need to complete revisions to the stations Technical Specifications and operating procedures.

In addition, the station should liaise with the international nuclear community in order to prevent repetition of past mistakes.

In conclusion, the OSART review found that the operational safety conditions at Unit 5 were different from those reported by the June 1991 SRM at Units 1-4. The efforts already made at Unit 5 promise further improvements to meet international standards. Prerequisites for accomplishing this are good attitudes, which can be seen in the new management team. However, fundamental changes are required to establish a thoroughgoing "safety culture", which must affect everyone's style and habits of work. This will require a break with past practices and must be supported at every level of management and the plant staff.

NOVOVORONEZH (RUSSIAN FEDERATION)

Scope of the mission

A Safety Review mission to Units 3 and 4 of the Novovoronezh nuclear power plant, Russian Federation, was conducted from 12 to 30 August 1991, with the objective of assessing both the design and operational safety of the plant. The Safety Review mission was part of the IAEA's programme on the safety of WWER-440 plants in eastern Europe. The twelve review areas covered in the SRM to Novovoronezh were: management, organization and administration; training and qualification; operations; maintenance; fire protection; emergency planning and preparedness; core design; systems analysis; component integrity; instrumentation, control and electric power; and accident analysis. In the main conclusions below only the areas related to operational safety are presented.

Brief plant description

The Novovoronezh plant Units 3 and 4 are prototype WWER-440 units designated model 179 (pressurized water reactors) which started commercial operation in 1971 and 1972, respectively.

Main conclusions

The nuclear power plant at Novovoronezh and its staff have played an important role in the development of the WWER programme in the former USSR since all the reactors have been prototypes. Being in the forefront of any technology generates a spirit of enthusiasm and commitment so it was pleasing to see that such a healthy spirit was still present in many of those in charge of Units 3 and 4. Following the Chernobyl accident in 1986, significant changes in operational safety were introduced in the former USSR to give greater emphasis to safety with respect to production. At Novovoronezh, for example, the length of the annual outage has increased by a factor of about three to include plant modifications directed at improving safety. Also, wide ranging technological and operational documentation was introduced.

However, the Safety Review mission identified a number of significant areas where operational safety should be improved so that the plant could aspire to safety standards attained by modern power plants. The major issues identified include the following:

- A quality assurance programme, currently being developed, should be implemented as soon as possible. Managers and supervisors must be trained in the principles of quality management and take an active part in the implementation of the QA programme;

- The present analogue WWER-440 simulator, of low model sophistication, should be replaced by a simulator of modern capabilities;

- Aspects of the operator training programme relating to training materials, on-the-job training, retraining, and qualification techniques should be improved to ensure that consistent and acceptable standards of training are achieved;

- The present reliance and burden placed on operators to recall procedures from memory should be removed;

- Operating procedures for normal and emergency conditions should be improved, both in structure and format, to make them more readily usable;

- Operating procedures and operating limits and conditions should be based on a comprehensive safety analysis report;

- A consistent standard of performance of maintenance and housekeeping should be achieved. In particular generic deficiencies of cable termination that threaten the safety qualification of electrical equipment should be urgently resolved especially those affecting safety and safety related equipment;

- Good industrial safety practices should be enforced by senior plant management. Safety rules need to be communicated and enforced. Priority should be given to the removal of safety hazards;

- Radiological work protection practices should be enforced by senior plant management;

- The manner in which the storage of spare parts and materials is organized should be improved together with the implementing procedures;

- Although there have been few fires of minor consequence, the age of the plant and poor design of station buildings and components with respect to fire protection create a significant potential for a fire to take place and to threaten redundant safety equipment trains which have no physical separation. A comprehensive fire risk analysis should be carried out to determine appropriate corrective measures which should be carried out as soon as possible;

- In advance of results of a fire risk analysis, problems with existing features should be addressed. These should include:

    - inadequate design of fire doors
    - inability to correctly maintain fire doors
    - fire doors propped open
    - use of plastic floor covering in the controlled area which is a significant fire risk.

- The emergency plan, which was considerably strengthened after the Chernobyl accident, is in need of further improvements. The emergency plan designed to cater to a most severe accident is not based on an accident, has no accident classification system, does not cover non-reactor radiological accidents and does not include an 'alert' status;

- In view of the foregoing, the regulatory body should evaluate the effectiveness of its inspection programme at Novovoronezh NPP.

KOLA (RUSSIAN FEDERATION)

Scope of the mission

A Safety Review mission to Units 1 and 2 of the Kola nuclear power plant was conducted from 9 to 27 September 1991, with the objective of assessing both the design and operational safety of the plant. The Safety Review mission was part of the IAEA's programme on the safety of WWER-440/230 plants in eastern Europe. The twelve review areas covered in the SRM to Kola were: management, organization and administration; training and qualification; operations; maintenance; technical support; emergency planning; core design; systems analysis; component integrity; instrumentation, control and electric power; accident analysis; and fire protection. In the main conclusions below only the areas related to operational safety are presented.

Brief plant description

The Kola plant Units 1 and 2 are WWER-440 model 230 pressurized water reactors. Units 1 and 2 started commercial operation in December 1973 and January 1975, respectively. Units 3 and 4 are newer, of WWER-440/213 design and were not reviewed by the team.

Main conclusions

In general the deficiencies of WWER-440/230 plants are well known from previous studies and missions. Some of the basic deficiencies which are present due to the lack of specific standards in the Soviet Union at the time of design still persist. This is especially important in the area of instrumentation and control and with respect to physical separation of safety equipment.

In the operation area, the isolation of eastern block countries from the rest of the international nuclear community, in the past, has led to a significant difference between the operating practices of WWER users and international practices.

With respect to the operation of the plant, significant emphasis should be placed on the following areas of weakness:

- The control rooms are inadequately staffed to safely operate and manage the plant in transient and accident conditions. Considering the poor control room design and inadequate instrumentation, this conditions should be corrected without delay.

- Significant efforts need to be made to improve the material conditions and housekeeping in the plant. In particular, the maintenance standards and the material condition of the balance of plant and the service water system are clearly inadequate.

- Normal and emergency operating procedures are inadequate. In many cases procedures have not yet been developed and, in general, the procedures are incomplete and inadequately structured.

- Plant personnel routinely do not use procedures even when procedures are available. Use of procedures has not been emphasized by plant management or through training.

- Management accepts and does not correct non-conforming conditions. All levels of plant management need to enforce the expected standards of performance. Standards must be raised and supported by all levels of the staff and work force.

- A quality assurance programme has not been developed. Independent assessments and reviews of operations and plant quality programmes are not conducted to enhance compliance with technical specifications and quality requirements.

- Many plant operating functions are ineffectively organized. In the current organization, responsibilities are fragmented, lines of communications are long and the operating organization is not functionally structured.

- The main control room instrumentation, process information, communications and human factor conditions are inadequate for effective plant control room, habitability during accident situations have not been evaluated and provided.

In conclusion, the station management and the support organizations of the Russian Federation are taking the need to upgrade the safety of Kola seriously and are making progress in this respect. However, many decisions on the scope of the planned upgrades are left to be made. Greater co-ordination by the ministries involved, is necessary and overall direction and guidance by the Russian regulatory body is needed.

DUKOVANY (CZECH REPUBLIC)

Scope of the mission

Subsequent to the OSART mission of September 1989 to the Dukovany nuclear power plant and the follow-up visit of November 1990, the IAEA agreed to perform a detailed review of the maintenance programme of the plant on completion of the restructuring of the relevant plant organizations. This review was conducted as a Technical Exchange mission from 14 to 25 October 1991 to Units 3 and 4 by two experts from the IAEA.

Brief plant description

The Dukovany plant is a four-unit WWER-440/213 plant of Soviet design. Each unit has a thermal output of 1375 MW or an electrical output of 440 MW. Unit 1 began commercial operation in 1985, Unit 2 in 1986, Unit 3 in 1987 and Unit 4 in 1988. The reactors are representative of the improved WWER-440/model 213.

Main conclusions

The maintenance organization at nuclear power plant has moved away from the previous matrix type organization, following a far reaching reorganization which was started at the plant at the beginning of 1990. The maintenance and operating responsibilities have been separated. The matrix type organization was split as of 1 January 1991. Mechanical maintenance, part of electrical maintenance, planning and scheduling functions and outage management are now under the responsibility of the Deputy Director for Maintenance. The remaining Electrical Maintenance Group (including switchboards, busbars, circuit breakers and batteries) and the Instrumentation and Control Group (I&C) are still under the responsibility of the Deputy Director for Operation. All maintenance sections will merge in July 1992.

At the time of the visit, the re-organization was not yet complete. In particular, the maintenance organization was still provisional and was planned to be finalized by July 1992. At that time, the responsibility for part of the Electrical Maintenance Group, as well as the Instrumentation and Control Group, both still under the responsibility of the Deputy Director for Operation, will be transferred to the Deputy Director for Maintenance.

The overall impressions of maintenance were favourable. The plant had made major efforts to develop a modern approach to maintenance and the maintenance policy compares well with those of western units. In order to reach the western level, some efforts have to be made in areas such as procedures management, spare parts management and enhancement of root cause analysis for equipment failures.

Root cause analyses on equipment malfunctions should be performed by a specialized group of experienced engineers, independent of the daily routine or daily problems.

The material condition of the plant is good and the maintenance facilities are large and adequate to support activities during outages. All maintenance activities are supported by procedures, but these procedures are not reviewed on a periodic basis. The whole procedures management system must be improved. Equipment history is kept up to date and complete. It is suggested that the equipment history be computerized for easier access.

The preventive maintenance programme is comprehensive and effectively supports nuclear safety. Some efforts should be made to develop a comprehensive predictive maintenance programme in order to optimize the preventive maintenance programme and the cost-effectiveness of maintenance activities. As far as outage management is concerned, although the refuelling outage schedules are prepared by hand, the preparation and the conduct of the outages are well co-ordinated and supervised. It is suggested that a critical path analysis method be used for the scheduling and follow-up of the refuelling outages.

The in-service inspection programme is comprehensive, well controlled, well documented and performed in a very professional manner. It compares favourably with international practices. Finally, spare parts procurement and reception did not draw any particular remark. However, in the warehouses, safety related spare parts are not clearly segregated and each part is not identified separately.

KOEBERG (SOUTH AFRICA)

Scope of the mission

A full-scope OSART mission was conducted of Units 1 and 2 at the Koeberg nuclear power station from 4 to 22 November 1991. The areas reviewed were: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry; emergency planning and preparedness.

Brief plant description

The Koeberg NPS consists of two pressurized water reactor units typical of the 920 MW(e) French CP-1 type PWR with seawater cooling. Construction began in 1976 and the units began commercial operation in 1984 and 1985 respectively.

Main conclusions

Koeberg NPS is the only nuclear power station in the large South African utility, Eskom. The power station has the benefit of support from corporate headquarters, particularly in technical areas. The power station generally meets its production targets. It is not required to operate at full output but is capable of high load factors.

The power station management sets clear goals and generates good programmes to support nuclear and conventional safety. Good examples are to be found in all areas but particular mention can be made of health physics training, chemistry and emergency planning. However, the implementation of some programmes is not as successful as it could be. In many cases greater management participation is required to ensure that the shortcomings are properly identified and appropriate solutions applied. Management should find more time to tour and to be seen about the power station in meeting people and in observing and inspecting material conditions and work in progress. Shortcomings in procedures, untidy work areas, plant defects not attended to and lapses in industrial safety, housekeeping and cleanness must be tackled promptly and in a manner that drives home each manager's total commitment to quality and safety.

Over the years the development of the quality assurance programme has led to a profusion of documents, to the extent that control of periodic reviews and timely reissuing of procedures has been lost. As a result, power station personnel have become accustomed to working with procedures that have passed their scheduled review date; this is eroding the safety culture that has been built up through comprehensive training programmes and can lead to the undermining of an individual's confidence in the power station's drive for quality. Management should monitor power station activities more closely and should not be satisfied solely by the adoption of action plans. Effectiveness of implementation should be the test.

Line management is committed to the training of personnel and there are a number of highly qualified instructors who have previously worked at the power station. The management of training at Koeberg NPS is decentralized and the Koeberg Training Committee, with representatives from line organizations, provides a measure of co-ordination in compensation. However, this committee should increase its effectiveness in carrying out the Koeberg NPS training policy. In general the training programmes contain all the necessary elements to ensure that staff are suitably qualified for their tasks; but in conducting training, the control of training materials should be improved; in maintenance, rigorous adherence to implementation schedules is crucial to ensure that the results of the training programmes result in improved employee and station performance.

The organization of the Operating Department was found to be well structured but the power station suffers a high rate of staff turnover. This results in there being a large number of trainees: there are about 15 vacant positions in operations and 30 in maintenance. If the reasons for the high turnover were evaluated to determine root causes it might be possible to take remedial actions. Industrial safety was seen to be given a high priority but nuclear safety less so. Greater priority should be given to nuclear safety. The operations associated with a witnessed shutdown and startup of a unit were generally satisfactory but it was of particular concern that the permanent existence of a 'red' high flux alarm did not cause the operators to take immediate and appropriate action. The disregard of such an important alarm showed the need to re-emphasize the importance of nuclear safety and thereby improve the safety culture.

The maintenance personnel at Koeberg NPS are dedicated to giving their best. The overall performance of the Maintenance Department is acceptable. With staff located all over the site, communication is made difficult between the various functions and other departments. The written maintenance programmes support nuclear safety and clearly define the requirements. A state of the art predictive maintenance programme is being developed. There are, however, many administrative procedures which tend to overlap and can lead to confusion. The computerized work control system (PERMAC) has the potential to provide a wide range of useful services but insufficient attention has been paid to the maintenance and updating of the database to ensure that the output can be relied upon absolutely. The maintenance facilities were generally satisfactory, especially the In-service Inspection Hall which contained special equipment for outage maintenance. The material condition of the plant and equipment was generally acceptable but lapses in cleanness and housekeeping controls were evident.

Technical support is provided through well structured organizations in the Technical Support and Production Support Departments. Further support is also provided from Eskom's corporate office and by vendors through their site representatives. Altogether these provide suitable resources. The Koeberg NPS Occurrence Management Programme satisfactorily ensures that a wide range of events are reported and analysed. The programme includes training for investigators but human factors are not fully taken into account in the analysis. Experience from other power plants is reviewed both at corporate headquarters and at the station. The existence of parallel routes of receiving and reviewing external experience results in unnecessary duplication and competition for resources. Plant modifications are effectively managed but an analysis of the root cause giving rise to the need for a modification would greatly improve the engineering and approval stages. Satisfactory programmes exist that cover surveillance testing, reactor engineering and fuel handling but in all cases some minor improvements should be incorporated to increase effectiveness.

The majority of the staff at Koeberg NPS and health physics staff in particular have not had the opportunity to visit other nuclear power plants and to compare Koeberg NPS's programmes with others. Now that the political scene is changing, Technical Exchange visits by power station staff should be used to good effect. Control of external radiation doses is satisfactory and the ALARA (as low as reasonably achievable) programme is well thought out. The system of ALARA job guides has been identified as a good practice worthy of bringing to the attention of all other NPPs. The dosimetry system as a whole is good but there is a need to carry out an external intercomparison test to give confidence that it measures up to systems in the rest of the world. The power station was generally clean in radiological terms but there was a need to improve some aspects of contamination control and access procedures. Koeberg NPS has moved part way to adopting Système International (SI) units for radiation protection. It is strongly recommended that the use of a mixture of units in procedures, instruments and limits is ended as soon as possible before confusion leads to an incident. The annual authorized discharge quantities are lower than actual discharges from many other NPPs. The radioactive waste (radwaste) programme was good with many innovations. The decontamination workshop is among the best seen by the OSART members.

The Chemistry staff were seen to be highly motivated, and firmly committed to performing an effective and pre-emptive chemistry control (EPCC), but care should be taken to ensure successful implementation of EPCC by excellent collaboration with other groups, especially operations. Sampling devices are well designed and sample collection is carried out carefully. The lack of a post-accident sampling system should be remedied. Laboratories gave evidence of good housekeeping although some were not spacious. Analytical and other test results were properly recorded and reported. The present state of the working procedures was unsatisfactory. The fundamental hierarchy of procedures should be reviewed and corrective action taken. The storage of spare chemicals and instruments was unacceptable; the new chemistry building provides the opportunity to rectify the shortcoming and to introduce an effective shelf-life management programme.

Nuclear emergency planning is carried out by dedicated competent staff appointed for that purpose. The emergency planning and preparedness programme is of a high standard as regards both on-site and off-site aspects. This includes both facilities and personnel. Among a number of recommendations made, the most significant related to the role of the power station's Emergency Controller, among whose duties is responsibility for deciding and ordering public protection measures as a result of a radioactive release. This responsibility placed upon the Emergency Controller was unique in the team's experience. It was recommended that responsibility for public protection measures be passed to civil authorities and that appropriate training be given, where necessary. Demographic data for the area within a 16 km radius were available on a personal computer. This provides the Emergency Controller with important information on, for example, population, schools and seasonal visitors, on which advice for public protection measures can be based. The meteorological programme was also impressive with three full time meteorologists who have access to excellent equipment supported by computers.

The sum total of the OSART team's proposals is not onerous and is well within the capabilities of Eskom's and Koeberg NPS's managements. Successful implementation, however, requires the commitment of management to seek solutions, devise action plans and after that to monitor progress and effectiveness at regular intervals. It is in this way that excellence can be aspired to.

GRAFENRHEINFELD (GERMANY)

Scope of the mission

A full-scope OSART mission was conducted of the Grafenrheinfeld nuclear power station (KKW) from 25 November to 13 December 1991, as the fourth OSART mission to Germany. The areas reviewed were: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry; emergency planning and preparedness.

Brief plant description

The Grafenrheinfeld NPP is a single unit pressurized water reactor (PWR) with a net electrical output of 1235 MW(e). The plant achieved criticality in December 1981 and began commercial operation in June 1982.

Main conclusions

Grafenrheinfeld (KKG) is a well designed and well managed nuclear power plant. The operating history of KKG over the past ten years is impressive: high availability (averaging 85% for the past five years), no reactor trips (scrams) for the past three years, and short annual refuelling outages averaging 35 days. The very successful operating and safety record is due to several factors, including:

- responsible plant management by Bayernwerk and KKG,
- the very clean and well maintained plant,
- a high commitment to safety by both staff and management,
- good federal and state regulatory processes,
- high quality operating procedures,
- highly motivated and well qualified operating and support staff,
- a good system for monitoring and controlling radiological conditions and environmental releases,
- a willingness to learn from the operating experience of other nuclear power plants and plants in other countries.

In line with one of the principle objectives of the OSART mission, the OSART team also made proposals for further improvement of Grafenrheinfeld's operational practices. These proposals can be summarized as follows:

- In order to improve the management of the various information and data systems in the plant, computer capability should be increased.

- Only a limited number of emergency preparedness exercises have been conducted since the plant went into operation in 1982. More frequent exercises of the emergency response teams were recommended in order to determine the effectiveness of the emergency plan and to develop and maintain the skills of the personnel involved.

- The staff turnover at Grafenrheinfeld has been very low and as a result the staff are experienced and well qualified to perform their tasks. However, it was observed that a systematic approach to in-plant training of non-licensed personnel was lacking. Improvements were recommended in the training area in order to remedy this shortcoming.

- Plant modifications have been few in number. However, the plant modification control programme could be improved by better documentation and traceability of internal safety assessments.

- Grafenrheinfeld has had a very small number of reportable and non-reportable events. Follow-ups to these events could be improved by a more systematic root cause and human factors analysis programme.

The recommendations and suggestions were few in number and were made to enhance the operation of a plant which already has instilled a strong safety culture.

BLAYAIS (FRANCE)

Scope of the mission

A limited scope OSART mission was conducted to Units 1–4 of the Blayais nuclear power plant, France, from 13 to 31 January 1992. The areas of review were: training and qualification, maintenance, at both the corporate and plant level and chemistry.

Brief plant description

The Blayais NPP was built by Framatome and has four 910 MW(e) pressurized water reactors. The units achieved criticality and commercial operation as follows: Unit 1 in 1981; Unit 2 in 1983; Unit 3 and 4 in 1983. The four units are of the CP-1 standardized series of EDF 900 MW(e) reactors.

Main conclusions

Blayais NPP is a well designed and well managed nuclear power plant. The team identified a number of commendable features in the programmes of the utility and the power plant, for example:

- A high commitment to safety by both staff and management;
- Knowledgeable and dedicated staff;
- High quality procedures;
- An excellent corporate and plant chemistry programme;
- Excellent outage planning and optimization of resources;
- A commitment to high quality training and provision of training resources.

In line with one of the principle objectives of the OSART review, the team also identified a number of weaknesses for management's consideration for improvement:

- The experience feedback process is centralized at the corporate offices to monitor and analyse equipment related faults. However, with this extensive centralization significant backlogs have developed in the processing of fault reports and the completion of analyses of these events. Also, performance indicators are not used to monitor the programme.

- A set of maintenance performance indicators has not been developed at the corporate office or the station which would form a basis to measure and compare maintenance performance at the station or between stations.

- A systematic follow-up programme has not been developed to ensure the correction of maintenance related quality assurance deficiencies. In addition, quantitative performance indicators to monitor the effectiveness and trends of the station quality assurance programme are not used. A number of deficiencies were noted in the implementation of the station's quality programme during the team's review.

- The general material condition and cleanness of the station was adequate with some notable exceptions. A surprisingly large number of steam and water leaks in the turbine hall of Units 3 and 4 were evident and higher standards of cleanliness should be strived for.

- A calibration programme for local gauges and instruments has not been established even though some of them are used for surveillance on systems important to safety. A number of inoperable and out of calibration gauges were found during the review.

- A systematic approach has not been used to determine the content of the various on-the-job training (shadow training) programmes (with the exception of control room operators). The programmes are not well structured or controlled to ensure consistency in implementation or content.

In conclusion, a high commitment to safety is evident in the Blayais NPP staff but past accomplishments in EDF should not be allowed to lead to complacency, and a critical attitude towards safety issues should remain an important element in the management of the station and regulatory oversight. Implementation of the OSART recommendations and suggestions will contribute to the continued safe operation of the plant.

FESSENHEIM (FRANCE)

Scope of the mission

A full-scope OSART mission was conducted of Units 1 and 2 at the Fessenheim nuclear power station from 9 to 27 September 1992. The areas reviewed were: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry; emergency planning and preparedness.

Brief plant description

Fessenheim NPP has two 880 MW(e) pressurized water reactors. The units achieved criticality and commercial operation as follows: Unit 1 in March 1977 and December 1977; Unit 2 in June 1977 and March 1978. The two units are the first of the CP-O pre-series of EDF 900 MW(e) reactors.

Main conclusions

The Fessenheim NPP is a well designed and well managed nuclear power plant. The team identified a number of commendable features in the programmes of the utility and the power plant, for example:

- Effective outage management and integration of maintenance and operations during outages;
- Knowledgeable and dedicated staff;
- High quality procedures for normal and emergency conditions;
- Good plant design and facilities with account taken of human needs;
- Effective work control processes and use of quality plans for maintenance;
- Sound strategic plans which are implemented through effective utilization of management contracts.

In line with one of the principle objectives of the OSART mission, the team also identified a number of weaknesses for management's consideration for further improvement:

- Management presence and monitoring in the plant should be increased to set higher standards of performance such as in the areas of material condition and housekeeping;

- A systematic process should be established to ensure the timely completion of action items and commitments;

- Greater attention should be given to the control and review of plant configuration changes such as temporary plant and procedure modifications;

- Wider use of objective internal evaluations through quality assurance should be used to evaluate and improve the implementation of various plant programmes;

- Increased emphasis is needed in the operator training programme on refresher training and on comprehensive skill and knowledge evaluations prior to authorization and for re-authorization;

- Improvements should be made in the analysis of events and in control of the operating experience programme, including in the definition of responsibilities, in the consistency and thoroughness of event analysis and in ensuring the timely completion of all recommended actions;

- A more questioning attitude should be instilled in areas of plant operation, such as in relation to the review process for important normal operating procedures, the use of uncalibrated local gauges for safety system surveillances, and the need of more frequent surveys for potential contamination outside of the controlled zone.

In conclusion, a commitment to safety is evident in the Fessenheim NPP staff but past accomplishments by EDF should not be allowed to lead to complacency, and a critical attitude towards safety issues should remain an important element in the management of the station and regulatory oversight. Implementation of the OSART recommendations and suggestions will contribute to the continued safe operation of the plant.

FUKUSHIMA (JAPAN)

Scope of the mission

A full-scope OSART mission was conducted of Units 3 and 4 at the Fukushima nuclear power station from 23 March to 10 April 1992. The areas reviewed were: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry; emergency planning and preparedness.

Brief plant description

The nuclear power station of Fukushima Daini comprises four 1100 MW(e) boiling water reactors of domestic production based on the General Electric BWR 5 design. Construction began on Units 3 and 4 on the Fukushima Daini site in December 1980 and the units were brought into commercial operation in June 1985 and August 1987.

Main conclusions

The experts of the OSART mission all came from western countries and so had to make adjustments in their evaluation of plant practices. Although the team members sought to understand how Japanese culture affected the various plant programmes and personal attitudes they were not able to take this fully into account in their judgements. Their comparisons of operational safety were largely made against western practices. The plant, utility and regulatory body are requested to consider whether any of the team's proposals require adaptation because of national differences.

In reviewing Units 3 and 4 the team was greatly impressed by the commitment of the staff to the achievement of high levels of safety in the operation and maintenance of the plant. This commitment is seen in the generous financial and human resources provided by the Tokyo Electric Power Company to ensure that the goal of safe operation is achieved. Priority is given to the prevention of accidents and the plant management are firmly committed to safe operation. The safety performance of the plant is impressive and is the result of a successful policy of thorough maintenance, inspection and testing of all important systems during the extended outages.

The dedication of the staff to the care of the plant is immediately seen in the immaculate appearance of the plant, and its excellent material condition. The success of the maintenance, inspection and testing policy is seen in the total absence of alarms in the main control room, that tests on safety related equipment have not revealed unacceptable performance in six years and no fuel has suffered any leakage of radioactive material in the life of the power plant. In addition, the power plant, in its care of the environment, achieves its self-imposed policy of zero release of radioactive material in its liquid releases.

The OSART members noted that the utility has a policy of taking all possible measures in the design, operation and maintenance of its nuclear power plants to prevent accidents occurring. This is a most commendable policy since it addresses the origin of problems which otherwise might need human intervention to mitigate the consequences. The outcome of the wholehearted implementation of this policy has been to create an almost flawless operating regime albeit at the cost of extended outages. People have grown used to long periods of stable operation with minimal disturbances to the point that it may be difficult for them to consider that the plant could malfunction. As the team sees it, people have become conditioned to accept stable operation as the norm and might find it difficult to accept that more attention should be given to preparing for abnormal events and emergencies.

In view of these comments and in fulfilment of one of the principal objectives of the OSART programme the OSART members made a number of proposals for the consideration of the managements of TEPCO and Fukushima Daini. The largest number of recommendations and suggestions addresses the question of preparedness for the unexpected such as: operator refresher training; improved emergency operating procedures; and planning and preparedness for emergencies. Other topics include conduct of quality assurance audits by the power plant of plant activities; improvement in control of procedures and storage of documents. These and other issues are discussed in the summaries given below for each of the eight review areas that follow.

However, to put all these recommendations into practice, the comments need to be taken in context. TEPCO and its staff are clearly demonstrating their commitment to safe operation of Units 3 and 4 at Fukushima Daini nuclear power station but past accomplishments are no guarantee of a safe future. This requires all staff to continue to be vigilant and open to consider and to implement measures to enhance nuclear safety. Having seen the determination of the company to operate the reactors safely, it is to be expected that the proposals made will be addressed satisfactorily and implemented with appropriate priority.

ANGRA (BRAZIL)

Scope of the mission

A Technical Exchange visit took place at the Unit 1 of Angra nuclear power plant from 4 to 15 May 1992. Two OSART missions to the plant had been conducted in 1985 and 1989. The Technical Exchange mission reviewed a number of topics from the OSART programme, chosen to cover those aspects of the Angra 1 programme that had undergone the greatest change since 1989.

Brief plant description

Angra is the first Brazilian nuclear power plant and was conceived as a three unit plant. At the time of the mission, Unit 2 was under construction and was partially completed, Unit 1 began operation in 1984. The plant is a two-loop Westinghouse unit with a gross electrical output of 657 MW(e).

General conclusions

The recommendations of the Technical Exchange review do not superseded those of the 1989 OSART mission but are in addition. Outstanding actions from the recommendations and suggestions of the 1989 OSART mission should be progressed to completion.

In the three years since the last OSART mission to Angra, Furnas and the nuclear power plant have carried out a number of improvements. These were apparent to those team members of the Technical Exchange mission who had been team members for the earlier mission. The improvements included: organizational changes supported by administrative procedures showing the distribution of responsibilities within the Thermonuclear Production General Co-ordination; substantially improved training with line managers clearly responsible for ensuring that their staff are adequately trained and qualified for their duties; improved housekeeping and material conditions; a good work control, planning and authorization process; a satisfactory surveillance test programme; chemistry procedures which are comprehensive in their coverage; and an integrated computer system, available during the response to an emergency, that provides on-line monitoring of plant parameters combined with a superior radiation protection model.

Particularly noticeable was a change in attitudes of some staff, especially in their motivation. This is creditable because changes in attitude may take many years to come to fruition. This change was seen in the desire of some staff to meet safety and quality requirements and in their motivation of seeking improvements. A sense of pride in their work and in their power plant was evident.

The purpose of the mission was not primarily to identify what the power plant does well but also, in co-operation with the staff, to identify areas where there was scope for further improvement in the interests of nuclear safety. In this spirit a number of recommendations and suggestions have been made to stimulate a fresh approach to some of the programmes of the plant. Proposals for improvement include: managers should periodically review the effectiveness of the quality assurance programme; managers and supervisors should find time to observe activities in the field; the programme to improve equipment labelling should be expedited; steps should be taken to eliminate delays in reviewing and implementing plant modifications; issues in chemistry not fully resolved from the 1989 OSART mission should be completed, such as staffing and the installation of an improved secondary sampling system; and in emergency planning there is a need to develop drills and exercises that fully test the co-ordination of the Control Room, Technical Support Centre, Operational Support Centre, Access Control and the regulatory body, CNEN. These and other proposals are detailed in the official Report to the Government of Brazil.

GRAND GULF (USA)

Scope of the mission

A full-scope OSART mission was conducted of the Grand Gulf Nuclear Station from 3 to 21 August 1992. The areas reviewed were: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry; emergency planning and preparedness.

Brief plant description

The Grand Gulf Nuclear Station is a single unit 1250 MW(e) (net) boiling water reactor based on the General Electric Mark 6 design. The unit was brought into commercial operation in July 1985.

Main conclusions

In reviewing the Grand Gulf Nuclear Station, the OSART team was greatly impressed by the commitment of management and staff to the achievement of high levels of safety in the operation and maintenance of the plant. Entergy is a well managed utility, which actively supports Grand Gulf in its objectives of achieving excellent regulatory, operating and cost performance. Entergy provides Grand Gulf with clear policy direction, adequate personnel resources, and substantial operating and capital improvement budgets. Grand Gulf has received consistent high ratings during evaluations from both the Institute of Nuclear Power Operations (INPO) and the United States Nuclear Regulatory Commission (USNRC). The OSART confirmed these evaluations.

The OSART identified many positive initiatives which contributed to an environment of continuous improvement. These initiatives were supported by the corporate quality improvement programme. Corporate and plant management are highly visible and actively involved in direct daily contacts with plant staff, where they address topical issues or reinforce objectives and goals. Many of the indicators of a strong safety culture were noted to be present. Grand Gulf has dedicated management and supervisory staff and well trained and highly motivated operating and maintenance personnel. Technical support at both the corporate and plant level is good. The plant utilizes many inovative techniques to improve plant performance from the standpoint of both nuclear safety and cost effectiveness.

In view of these comments and in fulfillment of one of the principal objectives of the OSART programme, the OSART members made a number of proposals for the consideration of the management of Entergy and Grand Gulf. Although Grand Gulf has had high annual capacity factors throughout its operating lifetime, it has also had a high number of forced outages due to reactor trips. Many of the trips were caused by instrumentation faults. It was recognized that a 'scram reduction task force' was addressing this issue but increased priority and improved management direction was recommended. The high levels of radiation exposure during outages were also of concern. Additional efforts to reduce sources of radiation exposure and contamination were recommended. Grand Gulf is very adequately staffed, but it was noted that technical support personnel were working excessive amounts of overtime during outages. A suggestion was made to re-evaluate and redistribute work loads. Suggestions were also made to improve and/or streamline some of the work approval processes. Due to the design of the plant and in particular the poor quality of the service water, control of some of the plant chemistry parameters is an ongoing challenge. Additional suggestions were made to improve performance in this area by obtaining technical advice from BWRs in other countries around the world.

The preceeding comments must be taken in context. Entergy, Grand Gulf and its staff are clearly demonstrating their commitment to safe operation. Past accomplishments are not a guarantee of a safe future. This requires all staff to continue to be diligent and open to consider and implement measures to enhance nuclear safety. Having seen the determination of the management of Entergy and Grand Gulf to operate the plant safely, it is to be expected that the proposals will be addressed satisfactorily and implemented with appropriate priority.

SIZEWELL 'B' (UNITED KINGDOM)

Scope of the mission

A Pre-OSART mission was carried out at the Sizewell 'B' Power Station from 26 October to 13 November 1992. The station was entering the commissioning phase. The operating organization's preparations for operation were reviewed in the areas of: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry; emergency planning and preparedness, together with arrangements for conducting commissioning.

Brief plant description

The Sizewell 'B' Power Station is a single unit UK-standard pressurized water reactor power station design based on the Westinghouse standardized nuclear unit power plant system (SNUPPS) design with a net output of 1188 MW(e). The station is owned by Nuclear Electric plc (NE). It is being constructed by the NE PWR Project Group and will be operated by the NE Sizewell 'B' Station staff. Construction began in July 1987 and commercial operation is scheduled for May 1994.

Main conclusions

Although extensive experience in the operations of nuclear power plants has existed for a long time, Sizewell 'B' is the first pressurized water reactor scheduled for operation in the UK. Considerable foresight and initiative have been demonstrated in obtaining the benefit of international experience in the development and implementation of the UK programmes for construction, commissioning and operation. These preparations included the early selection of an initial Sizewell 'B' staff of managers that for the most part had extensive experience in other nuclear plant designs. These managers were then assigned on a temporary basis to visit PWR power plants in various countries to train and exchange technical information in their respective areas of expertise. Their subsequent assignment to key station positions enabled them to use international experience in the design and in all aspects of station preparations for commissioning and operation. A number of these managers have been involved with the project for several years and are important members of the strong management team at Sizewell.

The review team was impressed with the station organization, the highly motivated and professional staff, the emphasis on team building, the development of high standards within a strong quality culture and by the staff's understanding of and commitment to both nuclear and industrial safety. There was also a strong commitment to training as reflected by the use of post and training profiles to identify training requirements for each staff member, established schedules for training completion and the provision of good instructors and training facilities.

The team also noted that a number of programmes are being implemented to enhance station operation, including computer applications to collect and manage plant information; the use of probabilistic safety analysis techniques in the development of the design, technical specifications and surveillance programmes; the systematic approach to industrial safety; a maintenance strategy for each system; a strong system engineering programme and the planned provision of excellent facilities to support station operation.

In fulfillment of one of the principle objectives of the OSART programme the team made proposals for consideration by Sizewell 'B' management that would enhance existing programmes and make existing good performance more effective. For example, the team proposed that the significant amount of work remaining should be scheduled in more detail and resources committed in advance to ensure that the commissioning schedule can be supported. It also suggested that quality control monitoring activities should continue to be upgraded to selectively verify and improve the applications of existing management policies and procedures. There were a few areas where the precision in conducting commissioning activities and in completing related documents should be further strengthened to remove ambiguity and potential for error. It was also noted that the generally strong training programmes should be extended in a few areas.

These comments need to be taken in context. Nuclear Electric and Sizewell 'B' are clearly demonstrating a strong commitment to nuclear safety. The staff exhibits a very positive attitude towards further improvement and a motivation to be the best in all aspects of plant operation. However, continuing assurance of safety will require the staff to remain vigilant and to consider and implement suggestions aimed at enhancing nuclear safety. In view of the Sizewell 'B' commitment to safety and determination to be the best, it is expected that the proposals that have been made will be addressed satisfactorily and implemented with appropriate priority.

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Part III
OSART MISSION RESULTS DATABASE

III.1. DESCRIPTION OF THE OSMIR DATABASE

All the results collected in OSART missions are incorporated in the OSMIR (OSART Mission Results) database. Currently sixteen missions corresponding to 1991 and 1992 have been included. The size of OSMIR is nearly 2.7 Mb and the file containing the results "MISSREST" is 1.5 Mb with 1602 records.

The results are classified as follows (see Section III.1.1):

R	Recommendations
S	Suggestions
G	Good Practices
P	Good Performances.

Results are contained in Review Areas and Topics (see Section III.1.2), which permit the retrieval of selected results in accordance with a pre-defined criteria. A result is therefore identified by the following keys:

Mission No.	X (See Appendix A)
Review Area	3 (Operations)
Topic	8 (Fire Protection Programme)
Type of Result	(R, S, G, P)

OSMIR is composed of several databases, the most important concerning search keys is "MISSIONS". In this database all technical and administrative references described below are contained:

Technical	Administrative
Plant (name)	Mission No.
Reactor type/size	Country
Plant status	Mission dates/year
Mission type	Report reference
Commercial operation	

The file MISSREST contain all the results in memo fields. The system used to support OSMIR is Dbase IV 1.5/2.0. Copies of OSMIR are supplied in one diskette (compressed using Windows 3.1 software).

IIII.1.1. Definitions

The OSART missions compare observed plant performance with successful and cost-effective safety practices found at other nuclear power plants worldwide. This comparison may result in a recommendation, suggestion, good practice or good performance in accordance with the following definitions:

Recommendation

A recommendation is advice on how improvements in operational safety can be made in that activity or programme that has been evaluated. It is based on 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.

Good Practice

A good practice is an indication of an outstanding performance, programme, activity or equipment markedly superior to that observed elsewhere, not just the fulfillment of current requirements or expectations. It should be superior enough to be brought to the attention of other nuclear power plants as a model of the general drive for excellence.

Good Performance

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 station. It might not be necessary to recommend its adoption by other nuclear power plants, because of financial considerations, differences in design and other reasons.

III.1.2. Database review areas and topics key

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1.01 Corporate Organization and Management
1.02 Plant Organization and Management
1.03 Quality Assurance Programme
1.04 Regulatory and Other Statutory Requirements
1.05 Industrial Safety Programme
1.06 Document and Records Management
1.07 Site Access Control (Optional)

2. TRAINING AND QUALIFICATION

2.01 Organization and Functions
2.02 Training Facilities, Equipment and Material
2.03 Control Room Operators and Shift Supervisors
2.04 Field Operators
2.05 Maintenance Personnel
2.06 Technical Support Personnel
2.07 Radiation Protection Personnel
2.08 Chemistry Personnel
2.09 Management Personnel
2.10 General Employee Training

3. OPERATIONS

3.01 Organization and Functions
3.02 Operations Facilities and Operator Aids
3.03 Operating Rules and Procedures
3.04 Operating History
3.05 Conduct of Operations
3.06 Work Authorizations
3.07 Accident Management
3.08 Fire Protection Programme

4. MAINTENANCE

4.01 Organization and Functions
4.02 Maintenance Facilities and Equipment
4.03 Maintenance Programmes
4.04 Procedures, Records and Histories
4.05 Conduct and Control of Maintenance Work
4.06 Material Conditions
4.07 In-service Inspection
4.08 Stores and Warehouses
4.09 Outage Management

5. TECHNICAL SUPPORT

5.01 Organization and Functions
5.02 Surveillance Programme

5.03 Operational Experience Feedback System
5.04 Plant Modification System
5.05 Reactor Engineering
5.06 Fuel Handling
5.07 Safety Related Computer Applications

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9.04 Preparation and Approval of Test Procedures
9.05 Control of Test and Measuring Equipment
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9.07 Maintenance During Commissioning
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9.10 Interface with Engineering
9.11 Initial Fuel Loading
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9.13 Work Control and Equipment Isolation during Commissioning
9.14 Control of Temporary Modifications

III. 2. SAMPLE OF THE OSMIR DATABASE

This section is a sample listing of the OSMIR database. A selection of strengths (good practices or good performances) and weaknesses (recommendations or suggestions) identified in the review missions covered by this report is presented in the normal listing order of nine review areas.

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1.01 Corporate Organization and Management

Recommendation: The exchange of information between the operators of WWER-440 model 179/230 reactors has decreased and different approaches in such matters as safety analyses, preparation of technical specifications, operator training, modifications to improve reactor safety, etc. are being taken. An owner's group of operators of WWER-440 model 179/230 reactors should be established in order that common approaches can be taken in such matters as safety analyses, preparation of technical specifications, operator training, and safety related modifications.

Good Practice: The integrated Strategic Management Initiative resulted in the development of a company strategic plan. This plan established concrete objectives and medium term (three year) initiatives for all levels of the company. The management system derived from this process is based on a negotiated management contract between successive tiers of responsibility. These contracts constitute the short term management plan, detailing the annual commitments of a given tier of the hierarchy having decision making authority, relative to the tier above. The commitments are clearly stated and are easily measured. Progress is monitored by performance indicators established at the time the contract is negotiated. Periodic monitoring of the contract is performed such that corrective actions may be taken if deviations from the desired objectives are forecast. At the end of the contract period, a report is submitted that analyses any differences between desired and actual results.

1.02 Plant Organization and Management

Good Practice: The regular practice of the Production Manager publishing monthly information bulletins for all staff members relative to the achievement of objectives is commendable.

Recommendation: The plant has a policy by which employees can be fined for commiting operating errors, causing unsafe acts, etc. Such a policy could result in mistakes or errors being concealed rather than being reported and prevent constructive corrective actions from being taken to avoid recurrence. The management of the plant should re-evaluate its present policy relating to fines for commiting errors. There should be a policy of incentives based on safe performance and not production levels. Discipline, if necessary, should not encourage the concealment of errors.

1.03 Quality Assurance Programme

Recommendation: The major part of the QA programme effort is directed towards the writing of checklists for normal operating procedures and emergency operating procedures. Although procedures and checklists are an important part of any QA programme, they are not a substitute for good management and supervision of activities in the plant. Managers and supervisors must be trained in the principles of quality management and be convinced to take an active part in the implementation of the QA programme. There is very good information relating to the establishment of a quality assurance programme in the IAEA NUSS Safety Series No. 50 (refer to Safety Series No. 50-SG-QA5, Quality Assurance During Operation of Nuclear Power Plants).

Good Practice: The training that is provided to develop quality awareness is very comprehensive and innovative. The instruction is given by an expert in quality from the Safety Department, together with an instructor from the department the trainees come from. This approach is an effective way of making the quality concepts applicable to each work group. Participation of the Department Head, to open and close the training, reinforces management's commitment to quality within the department.

1.04 Regulatory and Other Statutory Requirements

Recommendation: Judging by the material conditions of the plant and safety concerns and hazards noted, the effectiveness of the in-plant evaluations by the local inspectors is somewhat in doubt. The regulatory agency should evaluate the effectiveness of the local inspectors or obtain an independent evaluation of their effectiveness. Such independent evaluation could be arranged by the IAEA, Division of Nuclear Safety.

Good Practice: The development of an outage risk assesment document and computer programme enable rapid reviews of proposed activities to ensure that optimum selections of sequences of work activities were made to maximize nuclear safety. Examples of such review results were: when to lower the level of the suppression pool and the impact of using a freeze plug.

1.05 Industrial Safety Programme

Recommendation: The fire fighting system in the diesel generator room uses carbon dioxide and the system has to be manually activated from the air lock, with no indication that somebody else might be in the room. A system indicating clearly the presence of personnel in the diesel generator room should be put in place in order to avoid any activation of the carbon dioxide fire fighting system with people present.

Good Practice: The personnel Safety Handbook and the safety training given to personnel are very comprehensive and indicative of management's sensitivity towards providing a safe work place. Each job performed by a contractor is preceded by the signing of a pre-job summary agreement. This agreement covers job type, location, industrial safety considerations and expectations. It is signed by the site representative of the relevant department and the contractor's representative.

1.06 Document and Records Management

Recommendation: The present system has prescribed a hierarchy and relational structure that has led to a plethora of procedures. The large numbers have overwhelmed the resources of the station with respect to production, approval, distribution, review, updating and storage. Numerous instances were found by the OSART of procedures that had not been reviewed by the required date. To have staff use documents that are so clearly "out-of-date" is to erode the culture of quality and safety. Management intervention is required to ensure that procedure reviews are carried out in accordance with quality management requirements. A structured programme to overcome the significant number of procedures overdue for review should be implemented. This should start with safety related maintenance and operating working procedures which should be reviewed urgently.

1.07 Site Access Control (Optional)

Suggestion: The security system could be improved by the installation of magnetic card controlled access gates or turnstiles. Consideration should be given to replacing the existing personnel access control system with a magnetic card access control system when the existing equipment is no longer serviceable. Not only would this be an improvement in security, but such a system could be used for personnel accounting during emergencies.

2. TRAINING AND QUALIFICATION

2.01 Organization and Functions

Recommendation: There is no programme in place to periodically observe instructors as they teach to assess their effectiveness as instructors. Currently, Training Department management relies on feedback from students to assess the effectiveness of the instructors. Training Department management should ensure that instructors are periodically observed and coached on identified weaknesses. The instructor observations should be reviewed annually to identify common weaknesses. These should be used systematically to develop instructor continuing training topics.

Good Practice: The local and national programmes to improve the educational levels of personnel (50% of high school diploma and 2 years by the year 2000), given the necessary time and economic resources (training and qualification bonus), will increase motivation, improve qualifications and lead to safer plant operation. Additionally, the existing high number of training hours given to plant personnel during the last year constitutes action to improve the technical level of personnel.

2.02 Training Facilities, Equipment and Material

Recommendation: The plant Training Department is not equipped with dedicated training equipment or laboratories for plant maintenance personnel. The lack of dedicated maintenance training facilities makes hands-on maintenance training very difficult to administer. Dedicated maintenance training facilities and equipment should be developed. These facilities should be capable of conducting training on basic maintenance activities, such as pump motor shaft alignment and use of calibration and testing equipment. It should also be capable of more advanced and specialized maintenance activities such as main coolant pump seal repairs and high-voltage electrical circuit breaker repairs.

Good Practice: The provision of high quality interactive computer aided instruction (CAI) equipment using compact disc read only memory (CD ROM) technology for use by operators on a scheduled or voluntary basis considerably enhances the learning process of the operators in the area of plant familiarization and also provides the operator with a readily accessible means of learning about plant parameters.

2.03 Control Room Operators and Shift Supervisors

Recommendation: A structured examination system should be developed for all NPP qualification and requalification examinations. The pass/fail criteria for qualification and requalification examinations should be defined clearly and validated for each job position.

For each position, a structured process should be developed for assessing whether the candidate possesses all the skills required before qualification. This is particularly important for control room operators and shift supervisors.

Good Practice: The team skills development course is conducted before the crews begin to train on the full-scope simulator, thus aiding the achievement of the objectives of the simulator courses. This course addresses communications, leadership and stress management. It enhances training by promoting team performance.

2.04 Field Operators

Recommendation: Continuing training for the Field Operators who come off-shift for the 24 day continuing training cycle is basically the same as that given to the control room operators with the exception of the subject matter and depth of coverage. Implement a formalized continuing training programme for station field operators, based on a systematic approach to training. This should be done by providing an appropriate number of instructors within the Training Department to develop and coordinate the continuing training programmes.

2.05 Maintenance Personnel

Recommendation: At present annual training consists of special maintenance skills, industrial safety training, and management training. The total time used for training purposes varies between three and seven percent of the annual working time. Continuing training programmes for the maintenance personnel should be developed in a more systematic manner to include plant modifications, procedure changes, radiation protection, industrial safety, outage and operating experience from the plant and other power plants and other topical technical matters.

Good Practice: Trainees receive a self-evaluation package prior to attending a training course. This is to verify that prerequisites are met and improves the effectiveness of follow-up training.

2.06 Technical Support Personnel

Recommendation: There is no formal programme in place to orient the technical staff to the plant process systems, design bases, and basic operating characteristics. A course should be developed to provide the technical support staff with plant specific orientation to the plant systems, principles of operation, design bases and basic operating characteristics. The technical staff should also be trained in details of nuclear power plant safety concepts. A continuing training programme should be developed to keep the staff aware of new international developments in nuclear power plant safety, the outcomes of large conferences, industry experiences and lessons learned.

2.07 Radiation Protection Personnel

Recommendation: A systematic approach to training process is not applied in training radiation protection personnel. Integrate the missing elements of a performance based systematic approach to training process into all station training programmes. The highest priorities should be a task analysis and standardized writen lesson plans assuring all important tasks are consistently covered in sufficient detail.

Good Practice: Radiation protection personnel are provided the highest level of fire-fighting training to ensure that there are qualified fireman on the site who are experienced in radiological protection practices.

2.08 Chemistry Personnel

Recommendation: The existing training courses are in various styles and not consistent with respect to quality and completeness of learning objectives and content. Although a chemistry training procedures has been revised recently, it is not complete with regard to all aspects of a training control system. It is important to establish a thorough and detailed control system with specific expectations for course products because a number of those chemistry personnel who will be developing training courses do not have training development experience. Additional detailed guidance on designing, developing, implementing and evaluating the chemistry training programme should be established prior to designing the new courses. This will ensure a more consistent product from the various course developers and implementers. Exchange of information should be accomplished with other training groups at the plant to learn from processes already in use.

2.09 Management Personnel

Recommendation: The station plans to increase the provision of management training, but is hampered by lack of suitable courses in the country. Currently there is no programme for management and supervisory training at the station. The station should develop a plan to provide an appropriate level of supervisory and management training to all grades of staff. The programme should be implemented as training becomes available through on-site or off-site training courses.

2.10 General Employee Training

Recommendation: Exercises and drills should be organized as an opportunity to put into practice the lessons that have been learned during a structured training session. The feedback of performance from the exercises and drills should then be fed back into the training sessions. An analysis should be carried out of the training required to gain the knowledge and skills necessary for personnel to perform well in emergency response conditions. Training programmes should be developed and the training should then be carried out in a timely manner in advance of the exercise and drill programme. After the exercises and drills have been completed, the lessons learned from the exercises and drills should be incorporated into the training programmes.

Good Practice: A qualification booklet is issued to all utility radiation workers and contractors (vendor and specialist). This booklet contains an initial and requalification training record. Assurance that the training has been set to common accepted standards throughout the country ensures that minimal orientation is necessary as utility staff and contractors move from site to site.

3. OPERATIONS

3.01 Organization and Functions

Recommendation: The operations manager visit the respective control rooms each day in order to be updated on current unit status. However, minimum time was spent by production management in conducting plant tours. Consideration should be given to greater involvement of management in plant tours. Increased involvement by management would enable them to better assess plant conditions and give them an opportunity to meet members of staff at their work place so indicating management's interest and concern in all aspects of the life at the plant.

Good Practice: The Shift Engineer, the Assistant Engineer, and the Reactor Operator are required to have a university degree, giving each shift more capability to understand and cope with accident conditions.

3.02 Operations Facilities and Operator Aids

Recommendation: The original control panel design presented a uniformity of display which enabled the operator to scan information and locate particular parameter displays with speed and reliability. The fitting of replacement instruments with different designs has significantly confused the display presentation, a problem which is further aggravated by a noticeable lack of segregation and demarkation between panels or plant items. The control panels should be provided with visible demarkation of systems, major plant items and/or functions. Where a new design of instrument is to be fitted the existing features of symetry should be maintained.

Good Practice: A magnetic board in the control room readily displays the status of all safety relevant systems. Redundant systems and components are also displayed so that the operator can determine which systems are out of service. A plant data sheet (copy of the magnetic board) must be filled out by the shift supervisor at the end of each shift.

3.03 Operating Rules and Procedures

Good Practice: The plant has implemented emergency operating procedures which go beyond the emergency response guidelines recommended by the Vendor Owners' Group. These beyond emergency response guideline procedures in conjunction with the added safety systems provide additional assurance for maintaining containment integrity in beyond design basis accidents. These procedures are considered to be a good practice in planning for severe accident mitigation.

Recommendation: An operator aid should be developed and used in the unit control rooms to visually display existing limiting conditions of operation, fallback times, and plant status, as well as supporting details such as departments and individuals responsible for return of the equipment to service.

3.04 Operating History

Recommendation: For other events not involving loss or reduction of power generation capability, the decision whether to conduct event reviews is made by the Chief Engineer or the Operations Division Manager. Although the criteria for making this decision are not formalized to ensure consistency, these managers indicated that they would require a review and a report for all events that involve safety-related systems or failures of safety-related equipment, serious operator errors, and maintenance problems involving poor quality work on safety-related systems or equipment. The criteria for determining which events are significant enough to receive senior operations and station management review should be defined and formalized so that all events with potential nuclear safety significance are consistently reported and reviewed and the lessons learned are shared with shift personnel in all units. Similarly, the criteria for determining which events are to be reviewed by the Technical Support Division should be defined and formalized.

3.05 Conduct of Operations

Recommendation: Although operators are expected to check locked valves during rounds, a periodic, systematic check of these valves is not made, e.g. prior to startup of the unit following refueling outages, to ensure that each valve is properly locked in the required position. Many of these valves in the plant were observed to be locked in a way that does not prevent inadvertent operation. The consolidated list of valves to be locked into position during plant operation should be used periodically as a checklist, to ensure that each of these valves is properly locked into the required position - as a minimum, before startup following each refueling outage. Consideration hould be given to also checking the proper position and locking of these valves, using these lists, periodically during operation, e.g. quarterly or at least semiannually, to provide added assurance that the position of the valves has not been inadvertently changed.

Good Practice: On the basis of experience at the Three Mile Island NPP some safety related valves are locked out with special keys. When the valves are not in the safe position (for normal operation), the keys are locked on the valves. It is easy to see in the shift supervisor's office whether a key is missing. These keys are not interchangeable and for each safety train there are keys in different colours in a display case.

3.06 Work Authorizations

Recommendation: Although the monthly work schedules are coordinated with the schedule for switching and preventive maintenance of plant equipment, they are not coordinated with the surveillance testing schedule. The schedule for corrective maintenance work should be either consolidated with or at least coordinated with the surveillance testing schedule, to preclude the need to repeat surveillance tests following corrective maintenance.

3.07 Accident Management

Recommendation: The arrangement and display of essential safety parameters does not highlight their importance or provide a focus for the attention of the operator. The instrumentation displaying essential safety parameters should be relocated into single group and positioned at a prominent place on the reactor control panel. Until such modifications have been carried out the existing instrumentation should be highlighted by colour coding the instrument alarms or by colour coding the background panel around the instrument.

3.08 Fire Protection Programme

Recommendation: Many fire barriers are absent in the controlled areas of the reactor halls and in the cable run areas. Many empty cable penetrations and pipe penetrations are also no sealed. The absence of such fire barriers, many since the startup of the plant, invalidates any fire risk analysis carried out. A fire hazard analysis should be carried out to determine the threat of fire spreading from one reactor unit to the other. If necessary, protective measures should be taken.

4. MAINTENANCE

4.01 Organization and Functions

Recommendation: Maintenance programmes and activities are essentially organized around equipment important to nuclear safety or energy production. All other equipment, such as service equipment and non-nuclear auxiliary equipment, are frequently not maintained to an adequate level. As a result, the material condition of this equipment was poor. An example is the Service Water System, that was built according to the lowest category and safety class defined in the construction codes, although it should have been considered a safety related system. For this reason it was poorly maintained and the material condition of the system was observed to be very poor. Following international practice, balance of plant equipment should be maintained to the same standards as equipment important to nuclear safety or plant availability. For example, the Service Water System should be maintained as a safety related system. All maintenance and modifications should be performed according to requirements for class 2 safety related equipment.

Good Practice: The plant maintenance policy represents a rational approach to equipment maintenance by categorizing the different equipment and adapting the maintenance activities to the importance of the selected equipment to nuclear safety and plant availability. This policy tends to reduce unnecessary maintenance and will increase plant safety.

4.02 Maintenance Facilities and Equipment

Recommendation: Some components not identified by design documentation were being machined in the workshops. It is recommended that better control be established relative to machining activities. No machining should be performed without clearly defined material and design specifications.

Good Practice: The utilization of an acoustic/thermal/visual robot to sense temperature, sound and vibration and to send these with TV pictures to the control room is considered to be a good practice.

4.03 Maintenance Programmes

Recommendation: It was found that urgent repair work on a safety related component carried out outside normal working hours did not have any work instruction, even on the computerized work control system work order form sheet, and did not have any QC approval. Management should take action to enforce the requirement for urgent corrective maintenance work on safety related components. These requirements state that a work instruction should be written and QC approval be requested before work can be done.

Good Practice: The Maintenance Strategy Report for each system describes the reasons for the maintenance programme and the actual programme for all components of the system. It is reviewed and updated annually and includes an assessment of the quality of the programme.

4.04 Procedures, Records and Histories

Recommendation: Detailed working procedures are not available for preventive maintenance activities. The lack of such procedures makes it impossible to ensure that imilar equipment is maintained to the same standard and also prevents previous results from being taken into account in improving the effectiveness of the preventive maintenance programme. Detailed working procedures for the preventive maintenance of components should be developed so that results of earlier preventive maintenance can be used to improve the preventive maintenance programme. This should ensure that similar equipment is maintained to a consistent standard.

4.05 Conduct and Control of Maintenance Work

Recommendation: In the controlled area of the plant the post-maintenance testing of an electrical motor was observed. Two instruments that were past their calibration control date were seen, one of which was in use. On another instrument the calibration control sticker was missing. The calibration control of electrical test instruments kept in the controlled area should be improved. Instruments that are beyond their calibration period, or are missing calibration stickers, should be removed from the workshops.

Good Practice: The kick-off meeting before start of work is an excellent way to discuss and inform all the involved personnel about important matters for the performance of work.

4.06 Material Conditions

Recommendation: The large number of deficiencies in the material condition of plant equipment reflects long-term lack of application of sufficiently high standards of maintenance quality and workmanship and raises serious concern as to the ability of this equipment to perform as designed in an emergency. In addition, accumulations of dirt, dust, and a variety of debris in many areas of the plant reflect long-term lack of needed attention to housekeeping and cleanness. Accumulations of oil on frequently used walkways and stairways in many areas of the plant also reflects insufficient emphasis on ensuring safe working conditions in all areas of the plant and insufficient operator feeling of responsibility for their working conditions. Standards for acceptable material condition of plant equipment should be established. At least the shift operating personnel should be trained to ensure understanding of these standards and why they are important. In addition, shift operating personnel should be trained in observation techniques for identifying deficiencies.

4.07 In-service Inspection

Good Practice: The snubber testing in the mechanical services workshop allows extensive testing of snubbers to be carried out. State-of-the-art equipment allows a wide variety of cyclical and strength tests. Snubber testing is part of the in-service inspection programme.

Recommendation: Eddy current techniques for the inspection of the piping in the steam generators and condensers is not performed. Eddy current techniques should be adopted for the inspection of a percentage of the piping in heat exchangers, so that eventual degradation of the piping of the steam generators, the condensers and other heat exchangers can be detected at an early stage.

4.08 Stores and Warehouses

Recommendation: The manner in which the storage of spare parts and materials is organized in the centralized warehouse however has led to a number of deficiencies. Racks and spare parts are dusty and dirty, no segregation of different kinds of spare parts and spare material is adopted. Stainless steel is not separated from carbon steel and lays partly on carbon steel racks. There is no procedure for the storage of material with a limited shelf-life. The centralized warehouse and the spare parts should be kept clean in order to maintain the spare parts in an optimal condition. A special storage should be used for stainless steel, with clean room conditions. No carbon steel should be permitted in this storage. Spare parts with a limited shelf-life should have a label with a different colour and an expiring date. These spare parts should be placed together and the expiration dates should be checked on a regular basis.

Good Practice: The bar code system is an effective method for controlling the issue of tools and controlling the inventory in the warehouse.

4.09 Outage Management

Recommendation: There is no foreign material exclusion programme in effect during an outage. A comprehensive foreign material exclusion programme should be developed and implemented during outages.

Good Practice: The reception of contractors at the plant is performed in a way that ensures a high level of awareness of safety and quality. A handbook given to contractors provides them with important information for work on site.

5. TECHNICAL SUPPORT

5.01 Organization and Functions

Recommendation: There are no qualification requirements, or a specific training programme for staff providing technical support. To date, reliance has been place on the lengthly experience of the staff in various positions. With the decentralized system, the lack of a job rotation plan has the potential to results in experts developing in a narrow areas, and a decrease in expertise in the integrated system operation. Consideration should be given to rotating some technical staff from the supporting offices such as Projects or Technical Development through System Engineering positions to ensure that a solid base of systems knowledge is maintained by those supplying service to the Technical Support Office.

Good Performance: A good performance has been observed concerning preparation for outages. The station is already planning the first outage. Some of the preparations for the first outage will be used for the first core load. The outage period is covered by the Technical Specification Document and a conservative approach is being implemented to increase safety. The results of the probabilistic safety analysis study are being used in the preparation of outage safety management.

5.02 Surveillance Programme

Recommendation: Data which is recorded during the surveillance test is not plotted for trend analysis. Senior management were not observed to be completing regular checks of surveillance testing programmes. Parameter trend analyses by graph plotting or probability calculation should be routinely carried out. By such means any degradation of the system can be identified. Consideration should be given to conducting regular checks of logbooks or reports of surveillance tests by both the senior management and independent personnel such as the resident inspector to ensure the completion and acceptability of the results for surveillance tests.

Good Practice: The implementation and application of a thermal fatigue cycle monitoring programme are considered a significant strength. This system utilizes pressure instrumentation and additional temperature instrumentation to verify that thermal cycles are bounded by existing analysis. The utility chose to implement this system at its plants although regulatory requirements can be satisfied without the system.

Good Performance: The thoroughess of the preventive maintenance strategy results in very few surveillance test failures during the periods of operation. Throughout the previous six years none of the technical specification based surveillance tests had failed. In the experience of the team this was a unique achievement and it was a highly creditable performance.

5.03 Operational Experience Feedback System

Recommendation: Events at the plant were seldom investigated thoroughly to identify root causes and all needed corrective actions. The thoroughness of reviewing events should continue to be improved in order to prevent recurrence of events by identifying all direct and contributory root causes and by specifying effective corrective actions. In support of this, the planned root cause training programme should be conducted for operations and other personnel to increase the number of personnel who are able to conduct meaningful event reviews.

5.04 Plant Modification System

Recommendation: There is no formal Nuclear Safety Review Committee at the plant to review the nuclear safety implication of proposed modifications. Detailed technical review of modifications should be the responsibility of such a committee. The necessary steps should be taken to establish a Nuclear Safety Review Committee at the plant as soon as possible.

Good Practice: The complete modification programme at the plant is a model of thoroughness which exceeds those at most nuclear plants. It has a number of outstanding features, including the concept of a single modification file which is the focal point for the life cycle of the modification and which is supported by a flexible and comprehensive computer database. The use of a single project leader who is integrated with the outage organization adds further to the effectiveness of the programme.

5.05 Reactor Engineering

Suggestion: Despite the high educational and qualificational level of the engineers from the Technical Support Department, their involvement in the writing and review of the operating procedures relating to core physics is limited. Consideration should be given to more involvement of the engineers from the Technical Support Department in the writing and review of the operating procedures relating to core physics.

5.06 Fuel Handling

Recommendation: The Technical support personnel responsible for fuel handling have expressed concern with regard to scratches on fuel pins. This problem suggests that greater attention shuld be paid to the inspection of fresh fuel assemblies both at the fabricator and on receipt in the plant. The inspection of fresh fuel assemblies at the manufacturer and after receipt at site should be strengthened. For instance, a set of sample defects which match the acceptance/rejection criteria would be a valuable aid in the visual inspection process.

5.07 Safety Related Computer Applications

Recommendation: Procedures for emergency recovery and backup routines are available but there is not safety classification of software. A safety level classification should be implemented for computer software, similar to that for mechanical or electrical equipment.

Good Practice: The acquisition, evaluation and permanent storage of plant transient data is considered a good practice. If any questions arise concerning historical plant performance, long term data storage capability allows retrieval from laser discs. Trend plots can then be generated from these historical files for comparison with current plant performance. Complete files are maintained with trend plots of historical plant performance for all major transients. Complete transient evaluation reports are prepared and are circulated to plant management for review.

6. RADIATION PROTECTION

6.01 Organization and Functions

Good Practice: In addition to the extensive ALARA control programme, a number of ALARA job guides for specific tasks have been prepared by Health Physics monitors and other "on job" staff from their experience. These documents, which are reviewed and approved by the Health Physics ALARA co-ordinator, provide useful suggestions for subsequent work and copies were available at the Controlled Area Access Point and at the Health Physics Training Unit.

Recommendation: Though all licence conditions refer to dose equivalent in millisieverts, the station operates generally in rem. Since dose reports from contractors are usually received in mSv, there would appear to be a case for bringing everything in SI units. All radiation protection systems should be converted to use SI units at the earliest practical opportunity.

6.02 Radiation Work Control

Recommendation: Many poor radiological work protection practices were observed during the conduct of the mission such as:

- Radiation protection technicians failing to monitor themselves at barriers when existing radiological areas.
- Failure to check puddles of water in the controlled areas for contamination.
- Personnel wearing protective clothing improperly.
- Rooms in the controlled areas open to the atmosphere thus allowing unmonitored releases of airborne contamination.

The radiological work protection practices need to be enforced. The faults identified during the tour require correction on a highpriority basis.

Good Practice: The use of coloured flashing lights as an indication of a high radiation dose rate is seen as a highly effective warning device as well as acting as a barrier. The cable can be attached to a nearby dose rate meter and be programmed to light up whenever a present dose rate is exceeded.

6.03 Internal Radiation Exposure

Recommendation: It is the policy to erect a tent before all work is begun that could release local airborne or gaseous radioactive materials. The system of maintaining an appropriate air flow is to extract the air from the tent via a high efficiency particulate (HEPA) filter to the surrounding operating area. Whilst there is no evidence that any problems have occurred, no routine testing of HEPA filter penetration or seal leakage is carried out. A programme should be developed and implemented to carry out condensation nuclei or another approved form of testing on HEPA filter systems.

Good Performance: A vacuum scavenging system has been installed in the reactor buildings where potentially high contaminated work is performed during annual inspections. Decontamination of these areas can be achieved quickly thus preventing contamination spread.

6.04 Radiation Protection Instrumentation, Equipment and Facilities

Recommendation: The instruments were scaled in differing units - both rad/rem and Sv/Gy. This can be a major source of confusion and is considered unacceptable. The number of models of portable instruments should be rationalized and all instruments reading in rad/rem eliminated or converted to SI units as soon as possible. If replacement of quartz-fiber dosimeters would cause undue delay, conversion should be in advance of this programme.

Good Performance: A sophisticated radiation instrument calibration facility has been installed on site for gamma calibration of portable instruments and pocket alarming dosimeters. Personnel protection safety devices, accurate source to instrument distance measurements and calibration times are controlled from a panel in an adjacent room.

6.05 Personnel Dosimetry

Recommendation: The personnel dosimetry system has been known for five years that it is incapable of meeting the response stability (fading) criteria quoted (which is technically of minor importance) this situation has been perpetuated in subsequent issues of documentation. There appears to be little verification by the licensing authorities or any other body of the systems used by the plant to demonstrate (or otherwise) compliance with the criteria. Additionally, the intercomparison test with relevant national organizations, which could perform an extremely useful validation of the system, does not have the independence or authority to substantiate this. The utilities should initiate discussions with appropriate national bodies to provide real independent validation of the dosimetry system including an external performance test.

Good Practice: A control level of 30 mSv has been established by the plant management to prevent personnel from exceeding the annual limit (50 mSv). The control level is strictly monitored and observed both for plant and contracted personnel. This measure results in an even distribution of dose, and it is a good preparation for the new, stricter international recommendations of ICRP 60.

6.06 Radioactive Waste Storage and Discharges

Recommendation: Airborne monitoring should be included in the environmental monitoring programme in line with international practice. Airborne monitoring is required in order to check and to act as a back up to the stack monitoring programme.

Good Practice: Extensive use of remote manipulators, remote control of valves, TV surveillance of processes, computer controlled cranes with programmed instructions and positions and the design of their control rooms outside the controlled areas allows personnel handling radwaste to avoid exposures to radiation and maintain very low levels of dose.

6.07 Radiation Protection Support during Emergencies

Recommendation: Health Physics staff who are likely to be members of re-entry teams do not receive training in smoke conditions unless they are fire team members. This could leave them as a liability to a professional fire fighting team if involved in radiation monitoring in a fire. Health Physics staff who are likely to be members of re-entry teams should receive training in smoke conditions.

Good Practice: The emergency survey vehicle is equipped with excellent documentation for all off-site measuring points. Locating the measuring points is supported by maps and colour photographs of each point.

7. CHEMISTRY

7.01 Organization and Functions

Recommendation: On the job training (OJT) is conducted within the chemistry and testing sections. However, in the case of the testing section, it is not well structured training, with no document defining the content of OJT for each grade, such as workers and technician. On the job training (OJT) is one of the most important training courses for putting classroom training into practice. The minimum OJT requirements for each grade of personnel should be defined and OJT should be included in structured and obligatory training.

7.02 Chemistry Control in Plant Systems

Good Practice: Computer aided trend analysis of on-line measured chemical values of primary and secondary circuits can be performed rapidly and easily by the shift and chemistry staff. This improves the possibility of discovering abnormal conditions such as condenser leakages.

Recommendation: Water storage tanks do not have nitrogen blanketing or rubber bladders to prevent oxygen in-leakage. This approach make it necessary to supply water directly from the water treatment plant. In case of loss of treated water (from the treatment plant), water storage tanks would then be used, filling the main condensers with water saturated with oxygen. Water storage tanks should be upgraded to prevent the absorption of disolved oxygen. Make up water to the main condenser should be supplied from these tanks instead of demineralized water from the water treatment plant directly.

7.03 Chemical Surveillance Programme

Recommendation: A programme for checking and monitoring emergency diesel fuel should be developed.

Good Practice: The coolant degasification system has an on-line NaI detector that monitors the gas emitted through the system. The NaI detector also monitors the radioactive rare gases from the volume control tank in the primary system and reads out in the control room. The detector is useful for identifying fuel defects early and for taking immediate actions for the event.

7.05 Laboratories, Equipment and Instruments

Recommendation: A post-accident sampling system (PASS), is not available, nor are there plans to build one in the near future. After the core melt accident at Three Mile Island in the USA, it has been generally accepted that a post-accident sampling capability of the content of the reactor building is essential to a proper evaluation of the source term for the risks to the population. A post-accident sampling system should be installed. Procedures for obtaining, transporting and analyzing samples under post-accident conditions should be available. In order to permit chemistry personnel to get acquainted with the system, it should also regularly be used in normal operating conditions.

Good Practice: Radioactive liquid and gas samples are taken in the sampling box that has rubber gloves, a glass window and shielding. Then the samples are sealed in the sample vessel and taken out of the box after the outside of the sample vessel is washed. This is effective to prevent radiation exposure to workers and to avoid contamination on the outside of the sample vessel.

7.06 Quality Control of Operational Chemicals

Good Practice: The quality control programme of the Analytical Chemistry Section is exemplary. It contains a very good analysis of all areas in which quality control can improve performance. The extensive Statistical Process Control (control charts); the numerous blind sample analyses; the frequent participation in interlaboratory comparison studies; the choice of only first class equipment, instruments and chemicals; and the severe acceptance criteria for standard solutions make it unique.

Recommendation: Only when the chemical corresponds to the specifications is it added to the systems. However, hydrazine is transferred to the addition tank and used before all the analyses are completed. Hydrazine should not be transferred from the truck to the addition tank until all analytical parameters are checked with the test report from the supplier.

8. EMERGENCY PLANNING AND PREPAREDNESS

8.01 Emergency Organization Functions

Recommendation: A significant difference from practices in other countries is that a member of the plant staff (the Emergency Controller) has the responsibility of deciding what off-site actions should be taken in an emergency (eg. sheltering or evacuation). This responsibility is vested in him by law. It applies both to the stages of an emergency (when off-site organizations may not have had time to mobilize) and to a later stage when off-site organizations would be mobilized. This is an unreasonable responsibility for the person who should be directing all his attention to power station recovery operations. It is recommended that the responsibility for ordering off-site protective actions be transferred to the appropriate Civil Protection agency, so that the plant staff will be able to focus their efforts on-site on mitigating the consequences of any accident.

8.02 Emergency Plans

Recommendation: The mode of operation of the site alarm system should be investigated and clarified and the reason for non-operation of the alarms external to the site buildings determined. Routine testing of the system using the emergency initiation button in each unit control room should be instituted.

8.03 Emergency Procedures

Recommendation: The site has not yet developed a procedure for re-entry/recovery. Other plants have found it advantageous to have a pre-established list of topics to consider following a General Emergency and without such a procedure items may be forgotten and actions may not be co-ordinated with civil authorities. A procedure should be developed to be applied towards the end of a General Emergency to ensure that all the necessary actions, precautions and co-ordination with external agencies take place. The procedure should include such topics as de-escalation, activities including re-entry and recovery, and a checklist of topics needing consideration.

8.04 Emergency Response Facilities

Recommendation: The site has three shelters. They are equipped with essential facilities and supplies but do not offer the comfort necessary to people that work under stress and require extended sheltering. A specification should be developed of the requirements for sheltering of groups of people that may be under stress and require shelter for extended times. The shelters should be improved accordingly.

Good Practice: The radiological monitoring vehicles are equipped with a sampling device which can be separated from the vehicle. The sampling device is programmable and records the variation in dose rate over the sampling period. The sampling device also takes two air and rain samples. The second air sample is only obtained if the air concentration exceeds a preset value. The vehicles can down load the information into an on-board computer, which can also process the data and display the results of the on-board gamma spectrometer.

8.05 Emergency Equipment and Resources

Recommendation: The arrangements for radiological monitoring at the emergency management centre are inadequate. An assessement should be made of the radiological hazards that could develop within and immediately outside the emergency management centre and arrangements made to install equipment confirming the safety of the Commission.

Good Practice: The corporate headquarters uses a voice messaging system to contact on-call personnel. This Site Event Reporting System provides a play back of the notification message and any other pertinent information to individuals who have been automatically alerted by electronic pagers or direct calls. This significantly reduces time normally consumed in person to person notification.

8.06 Training, Drills and Exercises

Recommendation: The last major exercise at the plant was carried out to years ago and it was noted that there was no action plan to follow up the recommendations arising from this exercise. A formal system should be developed for ensuring that recommendations arising from drills and exercises are followed up and necessary changes made to the emergency arrangements.

Good Practice: For qualification of some key response positions, a competency interview is undertaken before an authorization panel. This is an added measure for ensuring that critical emergency response staff have been adequately trained and are qualified to act in their response roles.

8.07 Liaison with Public and Media

Recommendation: The emergency organization set up in the capital contains a large information group to provide advice to the authorities and information to the public. This information route to the public is not fully integrated with that provided by the Government. A review should be carried out of the means of integrating press briefings and information flow from the capital with that provided by the municipality, so as to ensure that consistent statements would be made by all organizations involved in the emergency response.

Good Practice: The use of a continuous media briefing or interview strategy by utility spokespersons is considered a highly effective way of operating in a nuclear emergency. Vital technical updates are communicated rapidly. The utility is seen by media as open and helpful. This strategy tends to pre-empt questions to the utility spokesperson when official media/press conferences are later conducted. Exercises at other Corporation sites have confirmed the effectiveness of this emergency information strategy.

9. COMMISSIONING

9.01 Organization and Management of Commissioning

Good Practice: The technical memorandum covering the selection, qualification and training of commissioning staff is a clear, concise and comprehensive document that describes staff profiles and initial and continuing training for commissioning activities.

9.03 Training in Commissioning

Good Practice: The programme carried out at the plant, for initial, continuing and specific training is excellent. This system is easily auditable using the computerized training matrix. This matrix presents names and post profiles against training courses. The date in this matrix is used to indicate the participation of an individual in a given course.

9.04 Preparation and Approval of Test Procedures

Good Practice: During flushing and equipment testing, local and remote controls to stop rotating equipment is installed and removed, by procedure, before and after testing. This feature provides a quick and additional protection to the equipment during initial energization and the early stages of commissioning.

9.05 Control of Test and Measuring Equipment

Good Practice: When an instrument is found out of caliabration, an evaluation is made using a computer programme of the impact on the procedures where this instrument was used. This increases the reliability of the process.

9.06 Conduct of Test and Approval of Test Results

Good Practice: The team briefing before commencement of a test is established by procedure and was demonstrated to be effective in improving co-ordination and communication during the test.

Recommendation: It was observed in some of the test procedures in progress that the prerequisites and initial conditions were not systematically signed off, although the actions specified in the procedure were satisfied. One of the tests was already in progress for several days. In two cases it was discovered that the blocks specifying names, signatures and dates of completion of the test in the front page of the procedure, were signed before commencement of the test. The procedures were written following the step by step format but it was not clear in the procedures whether the engineer conducting the test was supposed to sign off every step or just at the end of the page. During audits of the testing programme, quality assurance personnel should verify that the test procedures are sequentially completed, pencil writing is not used in the procedures, procedure changes are documented and that the conduct of the test adheres to the established guidelines.

9.10 Interface with Engineering

Recommendation: Verbal evaluation of field changes, before their endorsement on the site is jointly performed by the responsible engineers of commissioning and engineering, but, the procedure controlling the process, 'Commissioning Engineering Query Request' overlooks this part of the process. The Commissioning Engineering Query Request procedure should be revised to include the assessment of the responsible engineers of any field change prior to its endorsement by commissioning.

Good Practice: The process for controlling field changes used in the plant ensures that the initiator (originator) always receives a response to his concern. As the modifications suggested by engineering require the approval of the initiator prior to final implementation this requirement is always meet.

9.12 Plant Handover

Good Practice: The plant handover process is comprehensive, well documented and detailed. The Clearance Certificate is used to make the plant subject to the requirements of the safety rules prior to energizing. The Clearance for Station Operation Certificate is used to allow operation and routine maintenance of the plant by the Operations staff before the plant has been contractually taken over. These documents record the history, deficiencies and temporary modifications, or additions to all system procedures and documents.

9.13 Work Control and Equipment Isolation during Commissioning

Good Practice: The full involvement of the Operations Group in the equipment isolation process enhances personal safety and trains the personnel for normal plant operation.

Recommendation: After the permit for work is issued, either the Construction Group or a contractor performs the work. It was noticed that no retesting was specified in any of the documents controlling the work, although it was observed that the post-work testing was effectively carried out. After any intervention it is necessary to ensure that the equipment is operable to the same standards as were required during the Plant Completion or Station Commissioning Procedures. This could be attained by specifying the test required before the permit for work is released. Post maintenance retesting should be specified and documented by the commissioning engineer responsible prior to the clearance of any permit to work to assure quality of work performed.

9.14 Control of Temporary Modifications

Recommendation: It is crucial in a plant to maintain configuration control. One process to be considered is the implementation or restoration of temporary modifications, mainly when dealing with cables, therefore the Temporary Change Forms are carefully developed to prevent any mis-operation and to ensure, at any time, a close control of the temporary modifications in progress. Once the temporary modification is implemented special precautions are reported to the groups affected by the change for awareness and industrial, equipment and nuclear safety. Temporary Change Forms are important document where any changes or amendments should be properly documented. No special log sheet for jumpers and lifted leads or special precautions are included in the temporary change form. A Temporary Change Modification was found that was out of the specified duration date. In order to improve the control of the temporary change system, the Temporary Change Form should incorporate the time limit for the temporary change, a special log sheet for jumpers and lifted leads and special precautions. This would improve the Temporary Change Programme control, reliability and tracking system.

Appendix A
OSART MISSIONS CONDUCTED DURING 1991 AND 1992

MISSION NO.	TYPE	COUNTRY	PLANT	PERIOD OF REVIEW	MISSION REPORT NO.	STATUS OF MISSION REPORT	YEAR
50	T	CHINA	GUANGDONG	21 JAN–1 FEB	NENS/TEX/91/5	DERESTRICTED	1991
51	O	SWEDEN	RINGHALS 3/4	14 JAN–1 FEB	NENS/OSART/91/48	DERESTRICTED	1991
52	S	SLOVAKIA	BOHUNICE 1/2	8–26 APRIL	WWER–RD–022	DERESTRICTED	1991
53	S	BULGARIA	KOZLODUY 1/4	3–21 JUNE	WWER-RD-033	DERESTRICTED	1991
54	O	BULGARIA	KOZLODUY 5	15 JULY–2 AUG	NENS/OSART/92/53	DERESTRICTED	1991
55	S	USSR	NOVOVORONEZH 3/4	12–30 AUGUST	WWER-RD-034	RESTRICTED	1991
56	S	USSR	KOLA 1/2	9–27 SEPTEMBER	WWER-RD-035	RESTRICTED	1991
57	T	CSFR	DUKOVANY	14–25 OCTOBER	NENS/TEX/92/6	DERESTRICTED	1991
58	O	SOUTH AFRICA	KOEBERG	4–22 NOVEMBER	NENS/OSART/92/56	DERESTRICTED	1991
59	O	GERMANY	GRAFENRHEINFELD	25 NOV–13 DEC	NENS/OSART/92/55	DERESTRICTED	1991
60	O	FRANCE	BLAYAIS	13–31 JANUARY	NENS/OSART/92/57	DERESTRICTED	1992
61	O	FRANCE	FESSENHEIM	9–27 MARCH	NENS/OSART/92/58N	DERESTRICTED	1992
62	O	JAPAN	FUKUSHIMADAINI 3/4	23 MAR–10 APR	ENS/OSART/92/60	DERESTRICTED	1992
63	T	BRAZIL	ANGRA I	11–15 MAY	NENS/TEX/92/7	DERESTRICTED	1992
64	O	USA	GRAND GULF	3–21 AUGUST	NENS/OSART/92/63	DERESTRICTED	1992
65	P	UK	SIZEWELL 'B'	26 OCT–13 NOV	NENS/OSART/93/63	DERESTRICTED	1992

O = OSART
P = PRE-OSART
T = TECHNICAL EXCHANGE
S = SAFETY REVIEW MISSION

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QUESTIONNAIRE ON IAEA-TECDOCs

It would greatly assist the International Atomic Energy Agency in its analysis of the effectiveness of its Technical Document programme if you could kindly answer the following questions and return the form to the address shown below. Your co-operation is greatly appreciated.

Title: **OSART mission highlights**
Number: **IAEA-TECDOC-797**

1. How did you obtain this TECDOC?

[ ] From the IAEA:
- [ ] At own request
- [ ] Without request
- [ ] As participant at an IAEA meeting

[ ] From a professional colleague
[ ] From library

2. How do you rate the content of the TECDOC?

[ ] Useful, includes information not found elsewhere
[ ] Useful as a survey of the subject area
[ ] Useful for reference
[ ] Useful because of its international character
[ ] Useful for training or study purposes
[ ] Not very useful. If not, why not?

3. How do you become aware of the TECDOCs available from the IAEA?

[ ] From references in:
- [ ] IAEA publications
- [ ] Other publications

[ ] From IAEA meetings
[ ] From IAEA newsletters
[ ] By other means (please specify)
[ ] If you find it difficult to obtain information on TECDOCs please tick this box

4. Do you make use of IAEA-TECDOCs?

[ ] Frequently
[ ] Occasionally
[ ] Rarely

5. Please state the institute (or country) in which you are working:

Please return to:

R.F. Kelleher
Head, Publishing Section
International Atomic Energy Agency
P.O. Box 100
Wagramerstrasse 5
A-1400 Vienna, Austria

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Appendix B
REVIEW AREAS OF MISSIONS CONDUCTED DURING 1991 AND 1992

PLANT	MAO	TQ	OP	MA	TS	RP	CH	EPP	CO	FP
ANGRA I	•		•	•	•			•		
BLAYAIS		•		•			•			
BOHUNICE 1/2 *	•	•	•	•	•			•		•
DUKOVANY				•						
FESSENHEIM	•	•	•	•	•	•	•	•		
FUKUSHIMA DAINI 3/4	•	•	•	•	•	•	•	•		
GRAND GULF	•	•	•	•	•	•	•	•		
GRAFENRHEINFELD	•	•	•	•	•	•	•	•		
GUANGDONG	•	•	•	•	•	•	•	•		
KOEBERG3	•	•	•	•	•	•	•	•		
KOLA 1/2*	•	•	•	•				•		•
KOZLODUY 1-4*	•	•	•	•				•		•
KOZLODUY 5			•	•	•	•	•			
NOVOVORONEZH 3/4*	•	•	•	•				•		•
RINGHALS 3/4	•	•	•	•	•	•	•	•		
SIZEWELL 'B'	•	•	•	•	•	•	•	•	•	

*In these safety review missions only the operational safety review areas are presented in the report.

MAO = MANAGEMENT, ADMINISTRATION AND ORGANIZATION
TQ = TRAINING AND QUALIFICATIONS
OP = OPERATIONS
MA = MAINTENANCE
TS = TECHNICAL SUPPORT
RP = RADIATION PROTECTION
CH = CHEMISTRY
EPP = EMERGENCY PLANNING AND PREPAREDNESS
CO = COMMISSIONING
FP = FIRE PROTECTION