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OSART programme highlights 1995–1996

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. 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. OSART reviews are available to all countries with nuclear power plants in operation, but also approaching operation or in earlier stages of construction, by Pre-OSART missions. 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. Operational safety missions can also be attached to the design review missions of nuclear power plants and are known as Safety Review Missions (SRMs). Teams that review only a few specific areas or a specific issue are called technical exchange missions. All types of missions can be followed by follow-up visits during which responses of the plant to the opportunities for improvement identified during the mission are reviewed.

This report continues the practice of summarizing mission results so that all the aspects of OSART missions, Pre-OSART missions and good practices are to be found in one volume. It also includes results of follow-up visits. Attempts have been made in this report to highlight the most significant findings whilst retaining as much of the vital background information as possible. This report is in four parts: Part I summarizes the most significant observations made during the missions and follow-up visits during 1995-1996; Part II, in chronological order, is an overview of the major strengths and opportunities for improvement identified during each OSART mission and summaries of follow-up visits performed during the period; Part III lists good practices that were identified during 1995 and 1996; and Part IV presents the OSART mission results (OSMIR) database. Each part of the report is intended for different levels in operating and regulatory organizations but not exclusively so. Part I is primarily to the executive management level; Part II to middle managers; and Parts III and IV to those involved in operational experience feedback. Because of widely different plant designs, operating and management styles, cultural practices, and other factors affecting plant operations, no OSART findings were applicable to all of the plants visited in 1995 and 1996. Individual findings varied considerably in scope and significance. However, the findings do reflect some common strengths and opportunities for improvement.

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EDITORIAL NOTE

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BACKGROUND

Many of the challenges faced by those 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 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, operating or regulating nuclear power stations to benefit from experience gained in the course of missions conducted under the OSART programme during the period January 1995 to December 1996.

In 1983, 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 1996, 93 missions had been conducted at 70 nuclear power plants in 29 countries. There had also been 40 follow-up visits to review the implementation of previous OSART results. Sixteen OSART missions and follow-up visits were conducted during 1995–1996 (Tables 1 and 2).

OSART teams 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 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 to management (soft) issues than to hardware. The performance or outcome of the various programmes is given particular attention. OSART teams neither assess the adequacy of plant design nor compare or rank the safety performance of different plants.

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 (SRMs). The results of 77 OSART missions completed by the end of 1996 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; Pre-OSART Mission Highlights, 1988–1990, IAEA-TECDOC-763; OSART Mission Highlights 1991–1992, IAEA-TECDOC-797; OSART Programme Highlights 1993–1994, IAEA-TECDOC-874; and in the present publication.

OSART reviews normally cover eight areas, namely: management, organization and administration; training and qualification; operation; maintenance; technical support; chemistry; radiation protection; and emergency planning and preparedness. Formal guidelines and criteria for evaluating safety culture were formulated and made available to the industry in the form of INSAG-4 in 1991. However, OSART review guidelines and criteria have, from the beginning, included most of the fundamental characteristics of safety culture. Thus safety culture issues have been reviewed by OSART teams, though not always explicitly, as an important part of effective nuclear power plant management. Since October 1992, however, safety culture has been specifically assessed in all OSART missions and follow-up visits, both overall and in each of the eight major review areas.

Over the fifteen-year existence of the programme, significant changes have occurred in OSART methodology, nuclear industry transparency, power plant operational safety practices, and the accessibility to nuclear power plants in eastern Europe and the former Soviet Union for in-depth reviews of operational safety. Over this period, the guidelines and experience of OSART team members have also evolved to reflect the higher standards for operational safety practices now being adopted worldwide.

Definitions currently in use by OSARTs for recommendations, suggestions and good practices are as follows:

Recommendation

A recommendation is advice on how improvements in operational safety can be made in the activity or programme that has been evaluated. It is based on proven, good international practice 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.

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 or 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 a proven performance, activity or use of equipment which the team considers to be markedly superior to that observed elsewhere. It should have broad application to other nuclear power plants and be worthy of their consideration in the general drive for excellence.

During follow-up visits the team ranks the actions taken by the plant and effectiveness of its implementation as follows:

Issue resolved — Recommendation

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

Satisfactory progress to date — Recommendation

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

Insufficient progress to date — Recommendation

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

Withdrawn — Recommendation

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

Issue resolved — Suggestion

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

Satisfactory progress to date — Suggestion

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

Insufficient progress to date — Suggestion

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

Withdrawn — Suggestion

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

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PART I

EXECUTIVE SUMMARY

The summary below reflects the perspective on operational safety performance resulting from the 16 OSART missions and follow-up visits conducted in 1995 and 1996. They took place in Asia (3), central and eastern Europe (6) and western Europe (7). Follow-up visits were conducted 15 to 24 months after the mission.

Operational safety highlights from 1995–1996 were systematically compared to the previous ones in 1993–1994, and sometimes even before, in order to confirm, or not, trends which were observed on the 1995–1996 period in a long term evolution.

Management, organization and administration

Isolation in the international nuclear power community is disappearing. Even in countries with a new or developing nuclear power programme, operators and safety authorities are making contact with foreign peers or counterparts. However, it was noted that some plants do not make full use of operating experience from other plants.

Some countries are facing a difficult economic situation, and where the government is the owner, are unable to provide NPPs with adequate financial resources for all of the required design upgrading programmes and even to carry out all normal activities. Consequently, less significant improvements are postponed or deleted, and maintenance is more corrective than preventive. The increasing necessity of nuclear power competitiveness — in eastern as well as in western countries — challenges organizations where safety culture is still insufficiently rooted in staff and management. In some instances nuclear safety is not clearly indicated by management as the highest priority and not all managers are convinced that the quest for excellence in operational safety leads also to competitiveness.

Organization in former Soviet design plants is complex. Several specialized departments (or 'workshops') were responsible for surveillance, maintenance programmes, engineering, planning, etc., for a specific plant area or type of equipment. Operational shifts are constituted of personnel from these different workshops. This results in a complex co-ordination of plant operations by the main control room staff. Simpler organizations are being studied by some of these plants. It was noticed that all plants seem to have clear written procedures to define roles, responsibilities and relationships.

Management based on goals and objectives, with performance indicators to measure the fulfilment of objectives, is progressing and it is practised today in varying degrees in the majority of plants. In several operating organizations, goals and objectives are an integral part of the plant's business plan — some plants even prepare a strategic plan for three to five years — with action plans to improve their weaknesses. These plans may be adapted for each department through management contracts with department managers. Generally, as you progress down the plant management chain, there is less commitment to effective management based on goals and objectives. Sometimes the business plan remains at the management level, with goals and objectives being insufficiently communicated to, and shared with, the staff to ensure their adherence to them. In countries with a tradition of centralized management and weak delegation, the practice of management by goals and objectives is not so well developed. When they do exist, some goals and objectives are not measurable, and even if there are some indicators — often WANO performance indicators — they are not really used as tools for management.

Communication and human factors remains an area with a large potential for improvement. Communication about strategy, objectives, policy and daily activities, is often insufficient because managers spent too little time in the field, with workers and employees, to explain their expectation and monitor the achievement of them. This was previously discussed in the 1993-1994 report. The value of such a practice is however now recognized by everybody and it is in progress, but its effectiveness has to be improved. When managers are observed in the field they are often not effectively reinforcing desired behaviour.

In some plants, although a punitive approach to discipline is recognized as harmful, there is still a limited acceptance of human error. Besides the human aspect of this problem, this attitude is especially harmful in inhibiting openness, transparency, event reporting and experience feedback. Fortunately this management behaviour has been observed changing for the good.

Several other plants have improved the management of human resources. This includes an annual personnel performance appraisal system, linked with training and in some instances with the promotion system of the company. Although human resources are considered as the most valuable asset of an enterprise, experience feedback in this area is still developing and there is opportunity for improvement.

Training and qualification

Training practices vary considerably and do not follow traditional geographical and cultural classifications. A possible explanation could be that experience feedback exchange in training is less developed than in operations and maintenance areas. Poor exchange of good on-site training practices between departments of a same plant has been observed. However, effective transfer of training practices has also been observed through international plant twinning, showing a fruitful way for improvement.

All plants have a training programme and, in all world regions, more and more of them adopted or are adopting the systematic approach to training (SAT) process, but programmes are not always supported by a training policy and monitored against objectives. Some plants with well educated staff do not fully accept the need for a formal and structured programme.

The programmes do not always include adequate training for managers. A lack of training has often been observed for supervisors and middle managers, especially for the following areas: management, human factors, deficiencies analysis.

Operation area is traditionally the area where training is best developed, however insufficient retraining and refreshment of knowledge were frequently noted. Most of operators have access to a full-scale — but not always full-scope — simulator, even if it is not always on their site, and sites which are not equipped with such simulator have nevertheless multifunctional simulators.

Maintenance area is more and more understood as a key area for safety, hence training is in progress there, sometimes through international co-operation. In some cases contractors staff employed for maintenance and outage tasks are involved in the plant training programme. This is a good practice which shows the way for an area of training still in need of improvement.

Operations

Operation, strictly speaking, of a nuclear power plant is clearly considered by all visited plants managers as the core activity and hence operators are generally well qualified and often well trained, but there is still place for improvement.

Most plants visited have symptom- or state-oriented emergency operating procedures (EOPs). However, development of symptom-based EOPs for former-Soviet design plants, which was started in 1992, is still not completed. The status at the moment of reviewing is follows:

- For WWER-440/230 NPPs, Novovoronezh (3-4) has 22 symptom-based EOPs ready now to be used in control room but basic calculations on transient response had not yet been completed that could modify these procedures. Kozloduy (1-4) is reviewing its first two EOPs and intends to make maximum possible use of the corresponding Novovoronezh procedures. Bohunice (1-2) has developed and uses symptom-based function restoration guidelines since 1993, in parallel with its event-based procedures — which have been completely reviewed and of which the spectrum of initiating events has been extended; optimal recovery guidelines are being developed but the task cannot be completed before the completion of the plant upgrading programme expected in 1999.
- For WWER-440/213 NPPs, Bohunice (3-4) — in co-operation with Dukovany NPP — is developing symptom based EOPs in with a NPPs vendor according to a three year programme (1995-1997).
- For WWER-1000 NPPs, Khmelnitsky still has event-based EOPs but planned to adopt symptom-based procedures that are being developed by Zaporozhe. On the other hand, beyond design basis accident management procedures are being developed by the VNIIAES (in Moscow) and are almost complete.
- As for RBMK NPPs, Ignalina has still event-based EOPs but development of symptom based emergency procedures and beyond design basis accident management procedures is underway.

Beyond the significant improvements observed in this area, it is still noted that certain operators — like maintenance staff in their areas — are not complying with or not using procedures. This is not always corrected by managers and supervisors when they are in the field because they do not always recognize, as an internationally accepted philosophy, that the highest level of safety is ensured by having highly trained and qualified operators consistently using and following well structured and written procedures.

Probably more difficult is the configuration control of an installation, to ensure that the unit is at all times in the status that operators believe it to be in. It needs to be tracked in several areas, according to the plants, such as equipment labelling, operational documentation control, alignment procedure and checking, work authorization process, temporary modification control, field operator round, and shift turn-over. Several recommendations and suggestions were made in these areas, but also some good practices were identified. This area needs permanent attention by everybody; success is never definitive and must be won daily.

Maintenance

The cleanness/housekeeping and material condition of plant structures and equipment have been improved and are generally good. They often meet a high standard in safety-related areas, demonstrating significant progress. However, some plants, spread over the world, present a contrasted status, with some places in poor condition, with numerous lower level material deficiencies that are not reported, including fire hazards. In these plants, there remains a cultural tolerance for material deficiencies that is inconsistent with the safety culture.

Maintenance practices integrate some important safety principles such as the STAR ('Stop-Think-Act-Review') principle and a systematic hazard assessment techniques that are implemented by some plants for any operational activity.

Almost all plants have effective programme for preventive and several for predictive maintenance. The programme includes a vibration monitoring programme and lubricating oil to varying degrees. A motor-operated valve monitoring programme exists at only some stations. However, several plants should enhance efforts to adjust preventive maintenance tasks and intervals based on nuclear plant experience and service conditions and use to address ageing. Beyond traditional maintenance, a few utilities are beginning to develop a reliability-centred maintenance approach that should result in safety improvement and improved efficiency. Despite its great interest, development is slow because of the initial costly investment, hence there is an opportunity of establishing fruitful co-operation.

Outage management is being significantly improved by effective organizations. More and more, outage planning is conducted by a dedicated team, including operations representatives in addition to maintenance staff to facilitate interfaces and manage the outage as a project. In some cases, well adapted technical specifications for this particular status of the plant, including mid-loop operations policy in PWRs, were observed. These improvements lead to enhancing the operational safety, while reducing the shutdown duration, hence increasing the availability of the plant and its competitiveness.

Technical support

Surveillance programmes have progressed and are at present generally comprehensive. In some cases, surveillance programme improvement has resulted in observed improvement in safety equipment availability. However, additional improvements are still necessary, even in some countries with a well developed nuclear industry. In one plant, there was insufficient assurance that all requirements of surveillance were identified and being accomplished. This plant has no common procedure, and each entity of the plant programmes and controls the surveillance tests under its responsibility.

The use of operational experience feedback has made significant progress. All plants have a programme and a methodology for analysis of events, while several of the plants reviewed received ASSET (Assessment of Safety Significant Events Team) seminars. However, even though it is well known since the Three Mile Island and Chernobyl accidents that operating experience feedback is a main source for safety improvement, this still needs to be significantly strengthened. In several plants the thresholds for event reporting and analysis are high, abnormal event root causes are insufficiently analysed in depth and do not address human performance problems effectively. As for 'near miss' events, in several plants they are not reported. Only reporting of events having visible consequence is assured. Safety related equipment failures found during preventive maintenance activities or repaired in service are often not captured and reported as events. Therefore, causes remain unknown, and the opportunity to prevent recurrent failures and potential accidents is lost.

For an effective external operational experience feedback programme, event reporting to external organizations, such as IAEA and WANO, is insufficient and not timely. Obstacles to a fluent exchange include the number of national and international organisms to report, added to the need for translation in English for most of plants.

Radiation protection

Nuclear industry performance is more contrasted here than in any other area, going from the best in the industry to those needing the most improvement.

Many of plants have a satisfactory radiation protection situation, even excellent for some of them, with an effective ALARA programme, hence low collective dose below the ICRP-60 recommendation (around 1Sv/Unit.year for the best plants) and in addition a successful reduction of radioactive wastes.

At the same time, other plants, despite a well written policy, do not effectively manage this area. Some plants have a high collective dose and an excessive number of workers receiving unnecessary radiation doses, in spite of this no ALARA programme is used. In some cases, the failure to comply strictly with general rules for behaviour in radiation controlled areas, such as prohibition from smoking, has been observed and could be a contribution to the number of minor internal contaminations reported.

In some plants, obsolete radiation protection equipment still in operation causes inefficient control of personnel doses.

Chemistry

Working practices and chemistry performance are generally satisfactory. Personnel in this area are often proficient specialists.

The standard of facilities and equipment is a factor of a plant's design and in some cases reflects the lack of financial resources to replace obsolete equipment.

Emergency planning and preparedness

The emergency response organization on and off the site is generally adequately addressed in countries with a well developed nuclear programme, but often less satisfactory in others. However, there are exceptions to both categories, and some countries took advantage of bilateral co-operation to develop effective organizations.

Not all plants are equipped with post-accident sampling systems; some are awaiting funding. Likewise, some facility improvements, such as emergency management centres, have been postponed due to the lack of funds.

In some countries, the policy and means for informing the public and the media in a time of crisis are not always efficiently and timely adapted to the needs for off-site action; they probably would not meet the demands of the public and the media.

Some arrangements with neighbour countries for information about an emergency situation in a plant close to the border remain to be achieved.

Safety culture

Finally, whilst safety culture is not reviewed as an OSART specific topic, it plays a key role in all performance areas. The safety culture concept, launched by the International Nuclear Safety Advisory Group (INSAG) in 1988 with its report INSAG-3 and developed with the report INSAG-4 in 1991, is promoted not only by OSART but also by ASSET and ASCOT (Assessment of Safety Culture in Organizations Team) services, along with other organizations besides the IAEA, e.g. the World Association of Nuclear Operators (WANO) and the Organization for European Co-operation and Development (OECD)/Nuclear Energy Agency (NEA).

The fundamental principles which support operational safety, especially the concepts of safety culture and defence in depth, are well known worldwide and accepted without reserve by the managers of the plants visited and often by staff. This does not mean that all plants apply these concepts and practices, but even those which do not consider their application as a duty. Nonetheless, in some countries safety culture still remains at a theoretical level, more as an ideal than as an objective. That is why recent cases of bilateral co-operation covering a pragmatic approach to the implementation of safety culture in day-to-day activities, based on tested practices, are exemplary. They promote training, accountability and self-assessment of individuals.

The quest for excellence is a permanent struggle which demands perseverance; it is observed that the challenge of potential complacency threatens even those who have reached a high level of operational safety.

PART II

OVERVIEW OF OSART MISSIONS AND FOLLOW-UP VISITS DURING 1995 AND 1996

INTRODUCTION

The second part of this TECDOC presents a summary of each OSART mission (Part II-A) and of each follow-up visit (Part II-B). The summary is extracted from the OSART mission report; it is generally the introduction written by the mission team leader and incorporates comments on the follow-up visit.

Follow-up visits are now a complete part of the OSART process. It is very gratifying to note that in the period 1995–1996, for 98% of recommendations and suggestions, corrective actions have been taken and corresponding issues are either resolved or in satisfactory progress. This reflects a commitment by the nuclear industry to self-improvement.

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PART II-A

OVERVIEW OF OSART MISSIONS

FLAMANVILLE (FRANCE)

Scope of the mission

A full scope OSART mission visited the Flamanville NPP with the purpose of reviewing operating practices and of exchanging technical experience and knowledge between the experts and power plant counterparts on how the goal of excellence in operational safety could be further pursued.

The team was composed of experts from Mexico, Slovakia, Sweden, Switzerland, the United Kingdom and the United States of America and IAEA staff members with scientific visitors (observers) from Bulgaria and the Czech Republic.

Duration: 30 January to 17 February 1995

Brief plant description

The plant consists of two identical pressurized water reactor units rated at 1345 MW net electrical output. The two units, designed by Electricité de France, with Framatome nuclear steam supply system islands, entered commercial operation in December 1986 and March 1987, respectively. The plant is located 25 km from Cherbourg and 340 km from Paris.

Main conclusions

The overall results of the OSART mission showed that the Flamanville management team is committed to high standards of safety and performance at the nuclear power plant. The OSART team found a number of commendable areas of performance, for example:

- A dedicated, motivated staff with strong team spirit who carry out their duties in a professional manner.
- An emphasis on the communication and achievement of plant safety goals and objectives through the effective use of management contracts and performance indicators.
- Sound direction from the corporate organization in the form of strategies, policies and objectives and the use of extensive high quality support from corporate technical departments.
- Successful programmes that have brought radiation doses, radioactive releases and volumes of waste well within international norms.
- The use of analysis techniques for operations and maintenance activities to identify and then selectively reduce to a minimum the risks of failures in equipment and in human performance.

- Effective co-operation between the three nuclear facilities in the Cherbourg area that has resulted in the adoption of a common radiation protection training programme for contractors for Flamanville, COGEMA and the naval shipyard (DCN).

The OSART team came with the purpose of identifying opportunities for improvement. The proposals are primarily intended to encourage the plant management and staff to consider ways to enhance existing programmes and make good performance more sustainable. Proposals for improvement include the following:

- A regular programme of 'walk through' inspections of plant areas by managers should be established as a means of promoting quality and safety and demonstrating their commitment to high standards.

- Administrative control of temporary modifications to the plant should be strengthened. Permanent modifications affecting reactor performance should be carried out promptly.

- Approval of new and amended rules covering surveillance test requirements should be expedited.

- The technical bases behind corporate policies and procedures, together with a greater awareness of international good practices, should be communicated to staff. This should be directed towards stimulating more technical creativity and initiative as well as a questioning approach in staff, thereby enhancing the decision making process.

The importance of nuclear safety has been communicated to the staff but the management team needs to continue its active promotion of safety culture. This could be achieved, for example, by clearly communicating to staff the reasons for conservative management decisions concerning nuclear safety and reinforcing safety culture expectations by direct contact with employees.

A strong commitment to nuclear safety exists at Flamanville. Implementation of the OSART proposals should result in improvements in a wide range of the plant's programmes and should contribute to the continued safe operation of the plant.

HAMAOKA (JAPAN)

Scope of the mission

A full scope OSART mission visited the Hamaoka NPP with the purpose of reviewing operating practices of Units 3 and 4. It was the third such a mission to Japan. The team was composed of experts from Canada, Finland, Mexico, Spain, Sweden, Switzerland, the United Kingdom, and the United States of America, together with IAEA staff members and scientific visitors (observers) from Argentina and the Czech Republic.

Duration: 27 February to 16 March 1995

Brief plant description

Chubu Electric Power Company (CEPCO) is the third largest of the Japanese electric power companies. It has an installed generating capacity of 25 850 MW(e), with Hamaoka NPS providing 3617 MW(e), or 14 per cent of the total capacity. The Hamaoka station is the company's only nuclear power station.

The Hamaoka station is located on the Pacific coast of the Shizuoka Prefecture. It is comprised of four boiling water reactors (BWRs), the first of 540 MW(e) entered service in 1976 and the second of 840 MW(e) entered service in 1978. The capacity of Unit 3 is 1100 MW(e) and that of Unit 4 is 1137 MW(e); they entered service in 1987 and 1993, respectively. Their nuclear steam supply systems were both provided by Toshiba. They are similar in design to General Electric BWR-5 plants. Turbine plant systems were supplied by Hitachi. Each consists of a single main turbine-generator and supporting systems.

Main conclusions

The OSART team concluded that the Chubu Electric Power Company and Hamaoka Nuclear Power Station management team are committed to maintaining high levels of plant safety and reliability and to improving safety performance. The team found many commendable areas of performance, including the following:

- Station management and staff at all levels display a strong commitment to nuclear safety and high standards of work quality.

- Operational safety is evident in the high reliability of station equipment. There have been no reactor scrams at Hamaoka since 1991, and only one in the lifetime of both Units 3 and 4, reflecting reliability well above industry norms.

- The condition, preservation, and cleanliness of plant equipment are of a high standard. The good condition of plant equipment is evidenced, in part, by the low number of open maintenance requests and the absence of activated alarm announciators in the control rooms.

- Radioactive releases to the environment are maintained at very low levels.

- The station makes effective use of national and international nuclear experience to strengthen operations. It has an active programme of international technical exchange.

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

- Strengthening emergency preparedness through better application of station resources, more comprehensive emergency plan procedures and more effective use of emergency plan drills and exercises for training.

- Strengthening the control of chemicals within the station to ensure use consistent with their chemical properties and improving safety facilities in areas where chemicals are used.

- Expanding operator training in the control room simulator and simplifying the format of emergency operating procedures.

- Strengthening chemistry instrument calibration practices and the use of chemical standards.

- Improving the control of station documents.

- Improving the equipment and training of station fire response personnel.

- Strengthening refresher training for most station personnel.

The station's highly stable and reliable operation contributes substantially to nuclear safety and is commendable. However, the team noted that effectiveness of emergency preparedness in Hamaoka was relatively weak in comparison with worldwide standards. Several of the team's proposals for improvement were related to preparations for minimizing the consequences of any emergency situation that could occur.

The high priority placed on stable and reliable operation has resulted, in part, in an extensive preventive maintenance programme that includes significantly more opening and inspecting of plant equipment than at many non-Japanese utilities and extensive use of contractors for hands-on work and technical support. However, these practices contribute substantially to the station's operating expenses, and the long outages used to accomplish this extensive preventive maintenance limit the station's energy availability.

As Japan moves towards deregulating the sale of electricity, significant economic pressures on electric utilities and nuclear power stations may be expected. Experience has shown that such challenges can be met and that safety can be strengthened in the process. However, careful planning and preparation are required. The team encouraged the station to consider strengthening its preparations for maintaining high levels of safety and reliability as economic pressures increase.

IGNALINA (LITHUANIA)

Scope of the mission

An OSART mission visited Ignalina NPP with the purpose of reviewing operating safety performance in the areas of Management, organization and administration; Training; Operations; Maintenance; Technical support; Radiation protection; Chemistry and Emergency planning and preparedness. The team was composed of experts from Canada, Finland, Hungary, South Africa, Spain, Ukraine, the United Kingdom, and the United States of America, together with IAEA staff members and an adviser from Sweden.

Duration: 4 to 22 September 1995

Brief description of plant

The Ignalina NPP contains two RBMK-1500 reactors in operation since 1983 and 1987 (RBMK stands for channel-type large power reactor). These are the most advanced version of the RBMK reactor design series and the only two of this type ever built.

Compared to the Chernobyl NPP, the Ignalina NPP is more powerful (1500 MW versus 1000 MW), and is provided with an improved accident confinement system known as the accident localization system. In most other respects, the units are quite similar to their predecessors.

Main conclusions

The OSART team concluded that the Ignalina nuclear power plant management team is committed to improving operations at the plant. The team found good areas of performance, including the following:

- The Ignalina staff is well educated, with most of the operating staff having university degrees.

- The maintenance department has several different methods of self-assessment. These assessments were found to effectively identify and correct maintenance problems.

- The general material condition and housekeeping at the plant are improving, although some areas still need attention.

- Senior management is present in the working areas of the plant on a daily basis and is very involved in day-to-day operations.

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

- Management should establish more challenging nuclear safety expectations and provide better guidance to the staff for improving safety performance. Plant directives and programmes are currently oriented to compliance with regulations instead of towards higher standards established by plant management.
- Funding for the plant should be improved. The plant has received only 40% of the income due for its output over the past year, and extra care is needed to ensure that safety matters continue to receive adequate funding.

- Radiation doses to plant personnel should be reduced and radioactive contamination practices at the plant should be improved. A comprehensive programme to reduce radiation hazards to as low as reasonably achievable should be implemented.

- The organizational structure needs improvement in order to upgrade the operation of main systems, the effective surveillance of nuclear safety equipment and the sharing of operating experience amongst plant staff.

- Several aspects of emergency planning should be improved. These include technical support for limiting radiological releases and improved training for emergency response personnel.

- Nuclear safety regulation should be strengthened by more focus on the effectiveness of management and safety programmes.

KHMELNITSKY (UKRAINE)

Scope of the mission

This OSART mission was the third to the Republic of Ukraine since its independence. The purpose of the mission was to review operating practices in the five areas of Management, organization and administration; Training and qualification; Operations; Maintenance and Technical support. At the request of the plant, there were no specialist reviewers for radiation protection, chemistry and emergency planning and preparedness. The team was composed of experts from France, Germany, Hungary, Switzerland, the United Kingdom and the United States of America, together with two IAEA staff members.

Duration: 23 October to 9 November 1995

Brief plant description

The plant consists of one WWER-1000 in operation since 1987 and three units in various stages of construction, stopped following the Chernobyl accident. The WWER-1000 is a four loop pressurized water reactor with horizontal boilers. Plans are under way to complete the second Unit but little activity was evident at site on Unit 2 during the OSART review. During the most of the evaluation period, Unit 1 was shut down in order to transfer spent fuel to Russia. The shutdown was necessary because the spent fuel pool is inside containment. This was the first time a fuel shipment to Russia had occurred since startup and, prior to this transfer, the plant had storage capacity left for one more fuel cycle only.

Main conclusions

The overall results of the review showed that Khmelnitsky Nuclear Power Plant is taking initiatives with the assistance of the international community in order to increase nuclear safety. They include the purchasing of a full scope control room simulator and upgrading of operating procedures. Plant management is too narrowly focused on meeting the minimum requirements for nuclear safety as set by the regulatory body. The OSART team made recommendations which go beyond regulatory requirements.

During the review, the OSART team identified areas of good performance, which include the following:

- The Khmelnitsky staff are well educated and work hard to ensure basic plant safety.

- The plant has developed a comprehensive vibration measurement and analysis programme which applies to all plant systems.

- Partial scope simulators are being developed to train staff in activities outside of the main control room.

- The plant fire brigade is well trained, well staffed and well equipped.

In fulfilment of one of the principal objectives of the OSART programme, the team made several proposals for consideration by the management team of the Khmelnitsky Nuclear Power Plant. The proposals are intended to stimulate the station staff to consider ways of improving performance. The proposals for improvement include the following:

- Management should establish higher expectations in the area of Nuclear Safety than the requirements of the regulations of the Nuclear Power Industry of Ukraine.

- The system of payment for the power produced by the plant should be improved. The plant received only approximately 50% of the income due for its output over the past year, and extra care is needed to ensure that adequate funding remains available to devote to safety related issues.

- The quality and use of documentation at the plant should be improved. Many areas are identified where either procedures are not used or where detailed instructions for the performance of safety related tasks are not available.

- Although major plant defects had been identified by the plant and a programme exists to ensure they are repaired, there were many lower defects with the plant. The cumulative effect of these defects could impact on plant safety.

- The development and implementation of a quality assurance programme should be given high priority.

Implementation of the OSART proposals should result in improvements in many of the plant's programmes, and should thus contribute to the safe operation of the plant.

BEZNAU (SWITZERLAND)

Scope of the mission

The Beznau OSART mission was the second in Switzerland. The purpose of the mission was to review operating practices in the areas of Management, organization and administration; Training and qualification; Operations; Mechanical maintenance; Electrical maintenance; Technical support; Radiation protection; Chemistry; and Emergency planning and preparedness. The team was composed of members from Belgium, Canada, France, Hungary, Sweden, the United States of America, with IAEA staff, and observers from Australia, Brazil and Spain.

Duration: 13 November to 1 December 1995

Brief plant description

The Beznau Nuclear Power Plant (KKB) is a two-unit, two-loop Westinghouse pressurized water plant rated at 364 MW(e). Unit 1 was placed in commercial operation in December 1969 and Unit 2 in March 1972.

Main conclusions

A strong commitment to nuclear safety and excellent plant performance exists at Beznau. Beznau staff members at all levels are highly qualified, and they take great pride in their plant and its performance. Many have been members of the staff from the beginning, and the plant benefits from their long experience. Though several senior staff members are nearing retirement, new members are regularly added to the staff at entry level positions. The experience levels and ages of staff members seem to be distributed well enough to cushion against the loss of more experienced personnel. KKB benefits from the excellent Swiss education system and a strong apprenticeship programme. It assigns responsibilities for training to its line managers, a practice which fosters ownership for training and the qualification of personnel within the line departments. Though there are different approaches in the various departments, training appears, with few exceptions, to be quite effective.

The OSART team was impressed with the condition of plant equipment and the quality of plant facilities. The plant is very well maintained and preserved. It has achieved consistently high levels of equipment and plant availability and low levels of unplanned unavailability for the past several years, except during planned shutdowns for installation of an additional safety system and replacement of steam generators. No fluid leaks of any significance were observed in the plant. A high standard of cleanliness was maintained throughout, and physical cleanliness was complemented by radiological cleanliness. The plant was free of loose surface contamination in accessible areas, except where radiological work was in progress. Substantial resources are devoted to maintaining the plant design current and providing the staff with modern tools and equipment.

Improvement proposals were developed in each of the nine review areas. Most were related to strengthening Beznau's defence in depth against unexpected plant events and an unexpected decline in human performance. The more significant opportunities for improvements are summarized below.

KKB relies somewhat too heavily on the sustained excellent performance of individuals to achieve good operational safety. The excellent performance of the plant over its lifetime attests to the capabilities of staff members. However, as a consequence of its reliance on individuals, the plant has not established the formal policies and procedures needed to ensure sustained good performance in several areas. Strengthening the framework of management policies and procedures, to provide more clear, conservative guidance to the Beznau staff on nuclear safety matters, should help ensure the continued safe operation of the plant.

Analysis of some operating events is done in insufficient depth to determine all the contributing factors, and insufficient advantage is being taken of the opportunity to examine some low level events for lessons to be learned. Event reviews focus primarily on identifying equipment malfunctions or hardware problems, and not sufficiently on human performance contributions or the adequacy of barriers to prevent human errors. KKB's programme for encouraging a self-questioning attitude among its staff members concerning nuclear safety, and for identifying and determining management contributions to human errors, is less well-developed than at many nuclear power plants worldwide.

Beznau management's stated expectations for actions to be taken before returning the reactor to power after a trip do not require a sufficiently careful examination of the performance of systems and equipment during the trip and are less conservative than those applied at many other nuclear power plants.

Improvements in operator training and qualification appear to be warranted, and the plant was encouraged to examine whether adequate simulator training is provided to control room operating personnel. Industrial safety improvements are also needed, particularly with respect to contractor practices, to achieve the plant's expectations for reduction of accidents and injuries.

BOHUNICE V2 (UNITS 3 AND 4) (SLOVAKIA)

Scope of the mission

An OSART mission visited Bohunice NPP-V2 (Units 3 and 4). Its purpose was to review operating practices in the areas of Management, organization and administration; Training and qualification; Operations; Maintenance; Technical support; Radiation protection; Chemistry and Emergency planning and preparedness. The team was composed of experts from Bulgaria, Canada, France, Germany, the Netherlands, Sweden, the United States of America, together with IAEA staff members and observers from Armenia, China and the Ukraine.

Duration: 9 to 27 September 1996

Brief description of plant

The plant is located in south-western Slovakia in the district of Trnava, close to the village of Jaslovske Bohunice. The site contains an HWGCR type of reactor, which is being decommissioned and four WWER (PWR) type reactors. Units 1 and 2, designated as the V1 plant, are WWER-440 V-230 series. Units 3 and 4 — subject of this OSART —, designated as the V2 plant, are of more recent WWER-440 V-213 design. They have been in operation since 1984 and 1985.

Main conclusions

The overall results of the review showed that Bohunice Nuclear Power Plant is taking many initiatives with the assistance of the international community in order to increase nuclear safety. They include developing good quality assurance and surveillance programmes. Senior plant management is committed to improving performance. The team identified areas of good performance which include the following:

- The general material condition and cleanliness of the plant is good and is the result of a recent extensive upgrade of plant conditions.

- The plant has sophisticated diagnostic and surveillance systems which are state of the art. They include a computer based monitoring system for the emergency diesel generators and extensive diagnostic systems to ensure early detection of leaks on the primary and secondary systems and to facilitate predictive maintenance on important equipment.

- The radiation and contamination monitoring programme outside the radiation controlled area is very comprehensive with remote monitoring of radiation levels from 42 sites around the plant.

- A continuous monitoring system is installed to monitor the presence of fission products in the primary coolant system. The system is connected to the local area network computer system enabling results to be monitored on a screen in the control room and at other plant locations.

In fulfilment of the principal objectives of the OSART programme, the team made several proposals for consideration by the management team of the Bohunice NPP. The proposals for improvement include the following:

- The plant should ensure that the programme used to investigate events adequately addresses both the root cause and the corrective actions needed to ensure prevention of recurrence.

- The plant should ensure that sufficient resources are devoted as soon as possible to upgrading of normal and emergency operating procedures and alarm response procedures.

- The plant should review effectiveness on-site training and emergency planning in order to improve performance in these areas.

- Operation management should establish a policy to improve their ability to identify deficiencies and abnormal plant conditions during plant tours.

- The plant should improve industrial safety. One way to accomplish this is to improve the effectiveness of training provided to workers, inspectors, supervisors and managers.

DAYA BAY GUANGDONG (CHINA)

Scope of the mission

The purpose of the mission was to review nuclear safety management in the areas of Management, organization and administration; Training and qualification; Operations; Maintenance; Technical support; Radiation protection; and Emergency planning and preparedness. The team was composed of representatives from the Czech Republic, Germany, Hungary, Japan, the Republic of Korea, Sweden, the United Kingdom and the United States of America, together with IAEA staff members and observers from Bulgaria, the Netherlands, Pakistan and Slovakia.

Duration: 7 to 25 October 1996

Brief plant description

GNPS is located on Daya Bay in south-eastern China. At GNPS there are two 930 MW(e) net pressurized water reactors. Unit 1 was placed in commercial operation in February 1994 and Unit 2 in May 1994.

Main conclusions

Overall, GNPS has made remarkable progress and has achieved a strong initial operating record as a young member of the nuclear power family. In particular, the OSART team was impressed with the aggressive objectives established at GNPS to guide and motivate all managers and staff to join ranks with the medium-level nuclear power stations of similar design around the world within the next two years, and to become one of the leading nuclear power stations within the next five years in the international context. Throughout the three week mission, the team observed a strong determination and commitment to meet these objectives. The management and staff also demonstrated openness to learn from what the team members had to say and expected the team to provide pertinent proposals for improvement. The team noted that, although GNPS has accomplished significant achievements to date, managers and staff have taken it upon themselves to measure their own performance against the highest international criteria and practices. They have all shown a sense of eagerness to impose upon themselves the most vigorous international standards and performance indicators to compare their existing inadequacies, on the basis of which to identify the needed improvements.

The team has seen that the plant has an excellent framework of management processes and programmes that provide an excellent foundation for plant operation. They are mostly of French origin and so the original programmes are tried and tested. However, they are based on assumptions that may not be applicable to the situation in China and to the particular circumstances GNPS. These differences probably include staff training and previous related experience. There are undoubtedly cultural differences as well. The team believes that there are differences in the degree of lateral communications which has a bearing on the way in which the programmes were intended to integrate with each other. Electricité de France has a large, strong corporate organization that supports and guides many of the power station activities, a circumstance very different to GNPS. There are also differences in the degree of acceptance of responsibility; in France, a more open approach exists, one that is less compartmentalized compared with that seen at GNPS.

There is, therefore, a need to compensate for these differences, a need to adapt the programmes to specific local circumstances. There are a number of issues that need to be taken into account in this process. The team's comments can be summarized under three main headings.

First the team sees that there is a vital need for management to decide the standards it expects of the work force. The management must then clearly and consistently communicate their expectations to everyone, plant staff and contractors alike. On safety matters, the team believes the company should have readily available access to some independent advice, particularly for significant changes in policy, practice or plant design.

Secondly, after making it clear to all staff what is expected of them, there is a need to effectively monitor performance. Supervisory patrols must become more effective in identifying and correcting plant deficiencies and work practices. The management patrols now being implemented need to focus on monitoring the performance of people and the plant against their expectations. The more frequent presence of managers in the field, when done effectively, will have a powerful influence on raising plant operation standards. Hand in hand with this must be a greater willingness of staff to report plant deficiencies. However, for this to work, there must be an easy way for people to determine if a defect has already been reported. Once the reporting process is improved, an organized programme to dramatically reduce the number of deficiencies can begin.

There is a need to raise the standards of much of the training. Considerable efforts have been put into operator training. This has paid dividends for the plant which has a pool of skilled operations staff. The standards achieved for operators needs to be extended to the other branches. If these standards are to be applied equally, there is a need for oversight of training. The training branch has already been charged to do this. Management should first ensure that it is fully equipped to do the task and then insist that it discharge its responsibilities.

The team found that the quality of event analyses was variable. Oversight of the operational experience feedback must become more effective. There is a committee specially charged with monitoring the effectiveness of feedback of operational experience. The committee should be more probing and diligent in its task. It should scrutinize the analysis of each and every event to be confident that all the true root causes have been identified and the right corrective actions prescribed. The inter-section root cause analysis group is carrying out some excellent analyses. Its standards and thoroughness should be emulated.

Effective monitoring of expectations will lead to corrective actions being identified. The plant already has many action plans but need an integrated co-ordinated action tracking system.

Thirdly, the team also identified the need to further strengthen accountability. This should start with making people accountable for complying with programmes and procedures. The team observed examples of a lack of compliance that included monitoring of people and equipment when leaving the radiation controlled areas, the storage conditions of chemicals, tagging for personnel and equipment safety, key control, fire protection, shift turnover, log keeping, and documentation of test records and others.

The points outlined reflect the challenge faced by the plant. With the staff's willingness to learn from others and their determination to excel, and with the management's commitment to becoming an internationally competitive performer, the team believes that GNPS is fully capable of rising up to these challenges and satisfactorily resolving the above inadequacies.

GNPS intends to request a follow-up visit to take place in 1998 to review and assess the plant situation against the recognized international criteria and practices.

DAMPIERRE (FRANCE)

Scope of the mission

The purpose of the mission was to review operating practices in the areas of Management, organization and administration; Training and qualification; Operations; Maintenance; Technical support; Radiation protection; Chemistry and Emergency planning and preparedness. The team was composed of representatives from Belgium, Brazil, Canada, Finland, Japan, Spain, the United Kingdom and the United States of America together with IAEA staff members and observers from the Czech Republic, Hong Kong, Mexico and the Ukraine.

Duration: 11 to 29 November 1996

Brief plant description

The plant is located in the Loire valley south of Paris. It consists of four 900 MW units of the EDF CP-1 standardized design with a 3 loop primary circuit. The units were first connected to the grid between March 1980 (Unit 1) and August 1981 (Unit 4).

Main conclusions

The EDF corporate strategy is to maintain a consistent design basis, policies and standards which are fundamental to personnel and plant safety, while providing each plant with greater flexibility to implement local programmes to optimize plant and human performance. A strong focus on nuclear safety exists but the policy related to fitness for duty should be improved.

The Dampierre 96 action plan coupled with the director performance contract forms the basis for the 1996 goals and objectives. The objectives set are comprehensive, challenging and seek improvements in all key areas of safety. The performance measures which are in use at the plant level for communication with corporate groups are adequate to monitor performance results in safety areas, but more measures should be used at the plant level to ensure that programmes important to future safety performance are being carried out.

The OSART team concluded that the senior managers at Dampierre are committed to improving operation at the plant. The team found good areas of performance, including the following:

- EDF has adopted a systematic approach to training (SAT) methodology for training development, delivery and feedback on training programmes.

- The operating shift reviews situations where the technical specifications must be entered and consults with the plant safety engineer to ensure compliance. This independent review was considered a positive aspect of plant operations.

- The plant has procedures for the outages that are well written, with controls and hold points to ensure proper configuration prior to continuation of plant evolution. The outage procedures also contain sections for operator feedback and operator cautions. The standards for outage operating procedures meet or exceed industry standards.

- Dampierre has a new programme that controls the position of valves important to safety. This programme ensures that valves are locked in their required state after a refuelling outage or an equipment outage. This practice should ensure that systems important to safety are correctly aligned.

- Emergency operating procedures are adequately available in the control room. Additionally, there are procedures that will allow operators to cope with situations beyond the design base accident.

- The predictive maintenance programme is being implemented with the objectives of improving the reliability of the equipment, maintaining a high level of safety and reducing the maintenance costs, and optimizing preventive maintenance. The programme in force is well validated and effective.

- After a surveillance test, the measured data are put into a data base and the historical trends are monitored on a work station screen. This is done to identify potential deficiencies in a maintenance engineering section.

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

- The control room operators do not always monitor critical plant parameters or deal with control room distractions in a timely manner.

- Plant staff do not always comply with the plant policy for the use and modification of operating and maintenance documents.

- The process being used to train operators during refresher training does not ensure that all operators demonstrate proficiency on the completion of training objectives and the time spent on training the use of plant specific normal and abnormal procedures is less than seen at other plants.

- The organizational structure and methods for controlling contamination at the plant do not always ensure that contamination is contained within the controlled areas. In addition, contamination practices within the controlled areas need improvement.

PART II-B

OVERVIEW OF FOLLOW-UP VISITS

CATTENOM (FRANCE)

Scope of the follow-up

At the request of the Government of France, the IAEA carried out a follow-up to the Cattenom OSART mission. The team comprised an expert from the United States of America and two IAEA staff members. The external expert was the team leader of the OSART mission. The purpose of the visit was to discuss the actions taken in response to the findings of the OSART mission that had been conducted from 14 to 31 March 1994.

Duration: 12 to 16 June 1995

Brief plant description

Cattenom NPP consists of four nearly identical pressurized water reactor units rated at 1335 MW net electrical output. The units, designed by Electricité de France, with Framatome nuclear steam supply system islands, entered commercial operation between April 1987 and January 1992. At the time of the OSART mission, 20 of this series of NPPs were in operation in France.

Main conclusions

The follow-up visit team found that excellent progress has been made in addressing and resolving the findings of the 1994 Cattenom OSART mission. This is the encouraging outcome of the significant efforts of the staff at Cattenom and in EDF. The resulting improvements should contribute to the enhancement of operational safety at the nuclear power plant. All the issues have been fully resolved or are progressing satisfactorily to completion. This is the first time in the history of the OSART follow-up programme that no issues have been categorized as having little or no progress.

A new feature of the OSART follow-up programme that has been introduced with this visit is the intention to identify issues whose satisfactory resolution could be of interest to other utilities. Four such topics have been identified during this follow-up visit.

- The initiatives taken by Cattenom to address the question of fitness for duty and drug dependence is an interesting approach to the issue. Cattenom's approach can be seen to be caring in nature whilst still aiming to achieve the objective of ensuring plant safety from anyone whose behaviour might be affected by a dependence on drugs.

- The creation of a central training department has made it easier for workers and supervisors from specific disciplines to meet monthly with a training department special advisor. At these meetings, it has been possible to exchange views on training programmes, determine needed skills and training and to suggest appropriate approaches to training. This has resulted in open and effective communication leading to a number of visible and beneficial training changes.

- Following the completion of a fundamental study of how temporary installations are controlled and carried out, EDF has overhauled the process and set up a clearer, more rigorous system. All staff involved have received initial training in the new system. Further training will be carried out for specific outages and formalized training is part of the initial and continuing training programmes. The new system appears to be well understood, as exemplified by a field operator who was questioned at random.

- The new instructions provided for shift safety staff and the on-call senior manager provides sufficient guidance for responding to non-radiological unusual events. The guidance aims at ensuring that appropriate actions are taken in the short term to protect staff and plant and that specialist staff are called in when coping with events such as a chemical release from on-site or off-site sources.

A characteristic of the response of Cattenom to the findings of the OSART mission has been willingness not only to look at the specific issues identified, but also look at the wider implications. In a number of cases, improvements have been introduced that have exceeded the expectations of the OSART team.

The attainment and maintenance of high standards demands that all staff dedicate themselves each day to strive to do better. There must not be any relaxation in the drive for excellence even though the OSART mission and its follow-up was successful. Indeed, greater efforts are required to overcome the occasional lapses in safety culture thinking that were expressed in discussions with plant and corporate staff.

However, no one can deny that considerable improvements of a lasting nature have been introduced as a result of the OSART mission. Nevertheless, effort is required to complete the actions that have not yet been completed. Many of the changes have been introduced only recently and their effectiveness will need to be monitored, assessed and further changes made as necessary. The implementation of the outstanding actions and the continued monitoring for effectiveness, if pursued with the same motivation and determination that has been applied thus far, should result in Cattenom achieving high standards in operational safety performance.

In short, all issues were found to be resolved or in satisfactory progress.

HUNTERSTON 'B' (UNITED KINGDOM)

Scope of the follow-up

At the request of the Government of the United Kingdom, the IAEA carried out a follow-up visit to the Hunterston 'B' OSART mission from 9 to 13 October 1995. The team comprised an expert from Canada and two IAEA staff members. The external expert was the team leader of the OSART mission. The purpose of the visit was to discuss the actions taken in response to the findings of the OSART mission that had been conducted from 11 to 29 April 1994.

Duration: 9 to 13 October 1995

Brief plant description

Hunterston 'B' Power Station comprises two advanced gas cooled graphite moderated reactors (AGRs) each supplying its own turbine generator. Each unit has a net electrical output of 620 MW(e). Unit 1 began commercial operation in February 1976 and Unit 2 in March 1977. Hunterston 'B' is operated by Scottish Nuclear Limited, a company owned entirely by the government.

Main conclusions

The follow-up visit team found that excellent progress has been made in addressing and resolving the findings of the 1994 OSART mission to Hunterston 'B'. This is the result of substantial efforts by the staff of Hunterston 'B' and Scottish Nuclear Limited, as well as strong management support of improvement of the station. Effective solutions have been developed and corrective actions are being conducted efficiently towards completion. The enthusiasm of the management team and other station personnel for improvement was evident. All of the issues have been fully resolved or were progressing satisfactorily towards completion. This was the only the second follow-up visit in which no issues were found to have insufficient progress.

The follow-up team was particularly impressed with the improvements in the material condition and preservation of systems and equipment, particularly in the turbine plant. The number and severity of oil, water and steam leaks have been significantly reduced, and the slipping hazards from these have been corrected. Though some leakage remains, the progress to date is noteworthy.

Housekeeping and safety conditions in the plant have been greatly improved. The improvements include better cleanliness throughout the plant, reduction in the extent and severity of contaminated areas, more use of non-slip treads on walking surfaces, and better working of emergency equipment and exit pathways.

Training has been improved in several ways, including strengthened management support and involvement. The Station Training Committee is taking a more active role, and managers actively contribute to and increase the effectiveness of training courses. Training attendance has increased, and the use of a six-shift operator schedule has allowed increased simulator and refresher training. Increases in training staff and instructor training are also contributing to training quality. In addition, lesson plans are being improved significantly.

The working environment in the Central Control Room has been significantly enhanced by removal of noise sources, tighter control of personnel access, and reconfiguration of operators desks. In addition, the quantity and availability of procedures has been enhanced as part of an ongoing effort. The number of lit alarm annunciators in the Central Control Room has been reduced by a factor of three, but additional effort will be needed to eliminate the remaining lit annunciators. Field operators are showing increased ownership for other areas of the plant, and are taking a more active role in achieving improvements in plant conditions.

The operating experience feedback programme has been strengthened by including industrial and near-miss information, strengthening the review process for industry and station events, and improving the dissemination of lessons learned from events. Document control has also been strengthened

Reduction of contaminated areas and better segregation of potentially contaminated waste are contributing to a reduction of radioactive waste volumes, and the area radiation and stack monitoring systems have been much improved. Several chemistry improvements are in progress including better facilities for liquid sampling and for gas analysis.

In addition to the above items, the team was pleased to note that management is placing much increased emphasis on establishing a strong safety culture at all levels of the plant staff. TOP teams are being used to strengthen teamwork and address station problems. Performance appraisals are being performed for all station personnel, including those in bargaining units. Performance appraisals specifically address safety performance and attitudes. A special reporting system is used to help ensure that safety culture weaknesses are identified and addressed.

The team was gratified to note that many of the station's corrective actions and plans have gone beyond those specifically recommended by the OSART team, aiming for improvements consistent with those achieved at the best plants worldwide. This is a commendable performance that reflects a positive attitude towards continuing improvement and the achievement of excellence. As economic pressures increase as a result of privatization and other factors, it will be important for the station to maintain a strong, consistent focus on continuing improvement in safety performance as well as economic performance. Industry experience is showing that these go hand in hand.

In short, all issues were found to be resolved or in satisfactory progress.

NOVOVORONEZH 3/4 (RUSSIAN FEDERATION)

Scope of the follow-up

At the invitation of the Government of the Russian Federation, Rosenergoatom and Novovoronezh NPP, the IAEA conducted a technical visit at the Novovoronezh NPP, Units 3 and 4. Previously, a Safety Review Mission had been conducted in August 1991 and a follow-up mission in June 1993. This report presents only the results of the operational safety area. The team at Novovoronezh consisted of four IAEA staff members, one of them covering the operational safety area.

This technical visit was conducted in the framework of the IAEA programme on the safety of WWER-440/230 nuclear power plants. The objective of the programme is to provide both a safety evaluation and advice on measures to improve the safety of the NPPs.

The objective of this technical visit was to update the information available at the IAEA on the status of implementation of safety improvements and to comment on the actions taken in response to the IAEA's technical report on the safety of WWER-440/230 plants (IAEA-TECDOC-640), both on the operational and design issues.

Duration: 27 to 30 November 1995

Brief plant description

Novovoronezh Units 3–4 are of WWER-440/V-179 design, i.e. they are prototypes of the V-230 design series. They started commercial operation in 1974, 1975, 1981 and 1982, respectively.

Main conclusions

Management

Management monitoring of field activities was found to be comprehensive and included a follow-up procedure to ensure noted items were dealt with. However, although plant goals were identified at plant management level in Order No. 1, they were not expanded into departmental goals further down the organization.

Progress continues to be made in the introduction of safety culture with punishment to operators being de-emphasized. This is resulting in more willingness to report errors. Also, all staff now receive training in safety culture.

The quality assurance programme is taking a long time to carry out with the target for completion of Level 2 being the end of 1997. This will leave many Level 3 documents to be upgraded with an unspecified final implementation date for the programme.

Since 1991, many plant staff have visited NPPs in western Europe and North America. Technical exchange agreements or twinning arrangements have been established with the Penly NPP in France and the Gundremmingen NPP in Germany. This has greatly assisted management staff to implement improvements and make them aware of different methods of plant operation. These exchanges are now concentrating on specific issue resolution. An example of this is the co-operation with France which is focused on several projects related to maintenance improvement.

The plant has now established a Nuclear Safety Review Committee, but it only meets once a year and does not conduct an overview of the modification process. The plant believes that this is unnecessary due to other review processes which exist both at the plant and in the design organization. The plant should review this subject again and reconsider the purpose of the Nuclear Review Committee and the frequency of its meetings.

Training

Substantial work has been done to understand and adopt a systematic approach to training (SAT) process throughout the training organization.

- Maintenance training is now being developed with the assistance of EDF. A course entitled 'Plant functioning for maintenance personnel' has been prepared and presented to three groups of maintenance personnel to test its effectiveness. Two more courses are in preparation, for nuclear safety and quality assurance, and for radiation protection. In addition, other courses are under development in initial orientation, outage training and skills training. Requalification training is carried out for special skills such as crane operation, welding, in service inspection and use of explosive devices.

- Training is being prepared for operators based on the symptom based emergency operating procedures which are under development. Shift supervisors now receive courses in control room management and all control room personnel are trained in communication skills.

- Continuing training is now conducted for training staff. Training staff levels have improved, but there are still difficulties with respect to operator training staff.

At present a full scale simulator exists for Units 3 and 4 and a separate one for Unit 5, but neither of them are full scope simulators. Action is currently under way to upgrade the Unit 5 simulator to bring it closer to full scope and to make it more consistent with changes which have taken place in the plant. A multifunctional simulator is under development which will be capable of modelling several different plants including Units 3 and 4. It is planned to be 'full scope' and available before the end of 1996.

Operations

The symptom based emergency operating procedures are under development since 1992. Now, 22 EOPs have been prepared and are being reviewed. A safety function monitoring procedure is included. However, basic calculations on transient response have not yet been completed and this may result in further changes to these procedures.

At the least, discussions indicated that some senior managers are not convinced that operators need to use procedures in an emergency because they are university graduates and are well trained. It is important that the plant management convince themselves that the situation desired is 'well trained competent operators intelligently following procedures which have been carefully prepared, checked and approved'. In this way, every operator can benefit from the integrated knowledge of all staff.

Maintenance

A comprehensive preventive maintenance programme has been developed and will be issued in 1996 in conjunction with the quality assurance programme for maintenance. Preventive maintenance cycles and requirements are identified for all components and systems. These cycles are based on maintenance experience as well as manufacturers requirements. Supporting maintenance procedures are being prepared and will be completed by the end of 1996.

Emergency planning

Outstanding issues regarding emergency response procedures have been resolved. The arrangements for public information are now developed and include special arrangements for the 10 km radius area and more conventional arrangements for the 50 km radius area. Procedures for communication with the press have also been developed. Procedures to evaluate the development of the accident and the mitigation of its consequences are now in place and a copy of the civil defence implementing procedure is now held in the (temporary) emergency management centre.

A well developed training and drill programme now exists, with a yearly complete training drill.

The emergency management centre has not been built due to lack of funds. A temporary crisis management centre exists in the basement of the Novovoronezh hospital and a second similar centre exists on site. These locations are equipped with only limited communication facilities. A study on the habitability of the main control room following a range of potential accidents is in progress. An appropriate post-accident sampling system is planned and funds have been requested from EBRD.

A technical support centre which will provide emergency support to all plants in Russia is under construction in Novovoronezh.

In short, most issues were found to be resolved or in satisfactory progress.

KOZLODUY (BULGARIA)

Scope of the follow-up

At the invitation of the Government of Bulgaria and Kozloduy NPP, the IAEA conducted a technical visit at the Units 1 to 4 of the Kozloduy NPP. Previously, a Safety Review Mission had been conducted in June 1991, a follow-up mission in April 1993 and a consultative mission in July 1994. This report presents the results of the operational safety area. The team at Kozloduy consisted of three IAEA staff members, one of them covering the operational safety area.

This technical visit was conducted in the framework of the IAEA programme on the safety of WWER-440/230 nuclear power plants. The objective of the programme is to provide both a safety evaluation and advice on measures to improve the safety of the NPPs.

The objective of this technical visit was to update the information available at the IAEA on the status of implementation of safety improvements and to comment on the actions taken in response to the IAEA's technical report on the safety of WWER-440/230 plants (IAEA-TECDOC-640), both on the operational and design issues.

Duration: 15 to 19 January 1996

Brief plant description

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

Main conclusions

The focus for the review of operational safety issues was to determine, how well the organization, new programmes and procedures and daily operation of the plants were functioning.

Kozloduy has accomplished much work to improve the operational safety of Units 1-4 and is continuing its efforts to complete those activities that will further improve the safety of the plant. Many programmes and procedural controls are in place and working effectively.

The overall effort to resolve operational issues will be reviewed during the full scope Operational Safety Review Team (OSART) mission scheduled in 1998 for the Units 1-4.

Management

Plant modifications are being effectively controlled with specialists assigned to the technical support division to assist in conducting safety analysis. However, due to the extensive comments provided by the operations department, further management attention and involvement is needed to implement the new temporary modification procedure.

Satisfactory progress continues to be made to upgrade safety significant maintenance procedures. However, with the large number of procedures left to be upgraded, management support is required to continue progress on this issue.

Training of managers is being pursued through a series of quality assurance and safety culture seminars. The most recent safety culture seminar was conducted in December 1995. However, a greater effort is needed to provide this training to all middle level managers.

The introduction of a new organizational structure, that organizes operations and maintenance as separate divisions, appears to be an effective effort to control work and increase the number of technical specialists in areas where quality is most important. A good effort has been made in the preparation of job descriptions for key positions and further effort is now needed to clearly explain to each employee his/her responsibilities. However, progress has been slow and will be continuous while experience is being gained. Careful attention should be paid to the interface responsibilities between the new department units and the existing maintenance work practices.

Training

The areas in need of priority attention are :

- The development of technical training for maintenance personnel, including the construction of maintenance training workshops, and the conduct of quality assurance training for middle managers.

- The training of instructors to adequately prepare training materials to a systematic approach to training (SAT) standard.

- The development of training material to train operations personnel on the compact simulators.

Although many activities have been accomplished in the area of training and qualification of plant employees over the past five years at Kozloduy, much work remains to be done. It is recognized that there is senior management support for most training activities. However, additional resources and strong management attention is required to bring the quality of training programmes up to recognized international standards.

It is recommended that action be taken to continue a strong technical exchange with the training programmes in France and other countries to further assist in the development of quality training programmes.

Operations

A programme for revision of operational procedures is well under way with about 70% of the necessary procedures revised.

The development of symptom based emergency operating procedures (EOPs) needs to be carefully evaluated by senior plant management. Although a plan to develop symptom based operating procedures (EOPs) is in place, efforts to develop the procedures have been slow and management at Kozloduy is encouraged to monitor its progress. It is recognized however, that Kozloduy NPP personnel regularly take part in the WWER-440/230 Working group meetings as part of the 'Lisbon Initiative' for the development of the EOPs. The Russian design Novovoronezh NPP EOPs are being used as the reference procedures.

Senior managers need to evaluate the status of EOP development and produce a realistic approach to complete this project. This should be done with experiences already gained from developed symptom based emergency operating procedures at other reactors of similar design. Completion of this project needs decisive management attention.

Alarm response procedures (ARPs) are developed for Unit 1 and are in a trial phase before implementation on Units 2–3–4. Although it was observed that operators were taking the correct immediate actions in accordance with management expectations and specifically designed procedures, without referring to the new ARPs, management is encouraged to instruct their operators to use the new ARPs as much as possible to verify their correctness during their trial phase. Experience at other plants has shown the benefit from training operators to use the ARPs regularly to verify the correctness of all immediate actions taken and any follow-up actions to be taken.

Maintenance

The programme to review and revise maintenance standards is well under way with revisions to safety related procedures receiving high priority. Currently, there is a plan for writing or revising 10 procedures per year. However, this will be a difficult task to maintain on schedule with the modification work planned on all four units in 1996. Continued effort by the maintenance department is needed, and management support is required to complete this project.

Emergency planning

Emergency planning at Kozloduy was found to be progressing satisfactorily. A good effort has been made to upgrade the emergency management centre for Units 1–4 and reconstruction plans are well under way for Units 5 and 6. Procedures and plans have been implemented for the adequate support of access control and accountability, and for the identification of potassium iodine intake and monitoring following a severe accident. Training drills and exercises are well co-ordinated and a good corrective action process is in place.

Off-site planning and co-ordination of protective actions in Romania, within the 30 km radius of Kozloduy, have been addressed on a functional level. A communication network has been established between all Mayors in affected Bulgarian and Romanian towns. However, discussions need to continue at the government level to reach contractual agreements on the developed 'Decree for emergency planning and readiness'.

In short, all issues were found to be resolved or in satisfactory progress.

BOHUNICE V1 (UNITS 1 AND 2) (SLOVAKIA)

Scope of the follow-up

At the invitation of the Government of Slovakia and of Bohunice NPP, the IAEA conducted a technical visit at the Units 1 and 2 of the Bohunice NPP from 6 to 8 May 1996. Previously, a Safety Review Mission had been conducted in April 1991 and a follow-up mission in April 1992. Subsequently, a Consultants Meeting on Safety Improvements of WWER-440/230 NPPs had been held in September 1994. The report presents only the results of the operational safety area. The team consisted of three IAEA staff members, one of them covering the operational safety area.

This technical visit was conducted in the framework of the IAEA programme on the safety of WWER-440/230 nuclear power plants. The objective of the programme is to provide both a safety evaluation and advice on measures to improve the safety of the NPPs.

The objective of this technical visit was to update the information available at the IAEA on the status of implementation of safety improvements and to comment on the actions taken in response to the IAEA's technical report on the safety of WWER-440/230 plants (IAEA-TECDOC-640), both on the operational and design issues within the safety upgrading programmes on site.

Duration: 6 to 8 May 1996

Brief plant description

The site contains an HWGCR type of reactor, which is being decommissioned, and four WWER (PWR) type reactors. Units 1 and 2, subject of the follow-up visit, are of an older design called the WWER-440 V-230 series. Units 3 and 4, subject of an OSART mission held 9–27 September 1996, are of a more recent design called WWER-440 V-213.

Main conclusions

The focus for review of operational safety issues was to determine, how well the organization, new programmes and procedures and daily operation of the plants were functioning since the implementation of the short term reconstruction projects.

Of the outstanding issues reviewed, all showed satisfactory progress. This is a significant improvement from 1994, where 'little or no progress' had been made on many of the significant management issues, however, document management was reviewed again and determined that even though satisfactory progress had been made, much work was left to be done in the area of upgrading maintenance working level documents.

Bohunice has accomplished much work to improve the operational safety of Units 1 and 2 and is continuing its efforts to complete those activities that will further improve the safety of the plants. Many programmes and procedural controls have been put into place as a result of a strong management team and the implementation of a new Quality Assurance Policy. This was evident by the good housekeeping and materials condition of the primary plant and reflects a strong management commitment to influence positive changes.

Management

The quality assurance programme (QAP) as a systematic tool of Bohunice NPP management has been developed and implemented. It is done according to the project. The QAP covers all activities within the Bohunice NPP.

A quality policy has been issued which is based on nuclear safety and the management established the targets for 1996 within the scope of this policy.

The introduction of a new organizational structure that organizes individual department responsibilities to effectively integrate work control appears to be working well. A good effort has been made to clearly outline responsibilities by the development of individual employee job descriptions.

There is a continuing programme to improve management skills for top and middle management by participating in international activities which enriches them in management approaches and skills. The following are examples;

- International Nuclear Safety Programme (Lisbon Initiative) for Management and Operation Control.
- IAEA-TC project RER/4/011 Improving NPP Operation management.
- Managers and supervisors course, organized by the Japanese government.
- Co-operation with Nuclear Electric.
- Project Management Course.
- Procurement Course.
- Event analysis and operational experience feedback course.
- Annual WWER-440 site managers meeting.
- Twinning with Grohnde NPP / Germany and Nogent NPP / France.

The principles and features of safety culture were issued and discussed with managers and with shift personnel at working meetings. Managers have explained and discussed the safety culture approach with their staff in order to improve the current conditions.

Safety culture principles have been included into personnel training. The efficacy of this measure was observed, as it had a beneficial effect on cleanliness, on the good materials condition of the primary plant and on the professionalism of the staff, particularly the control room staff.

An ASCOT self-assessment support mission will be held in September 1997.

The plant performance and safety indicators are evaluated regularly and are used as a management tool for evaluation of plant performance and for initiating corrective actions if needed. The number and severity of safety significant events has also decreased.

An independent review by an external organization of all plant modifications is ensured prior to approval by the regulatory body.

Technical committees for the supervision of V1 and V2 plant modification processes have been established. Procedures have been implemented for the operation of modified equipment or systems prior to putting the plant into operation. PSAs are used for assessing plant modifications when applicable.

A new plant procedure for event investigation at Bohunice NPP was introduced in December 1995. This procedure divides plant events into two categories: safety related events, which have to be analyzed to find out the root causes and less significant events.

A new feedback group was established for event investigation. All members of this group were trained in INPO HPES methodology for root cause analysis. This methodology is going to be applied to event investigation process. An annual report about event trending is regularly provided to plant management.

Areas needing improvements are obtaining necessary information from maintenance personnel for analyzing near miss events and improvements in human factors investigations.

Training

The system of personnel training is continually updated. Basic theoretical training is carried out on the level and category of each professionals background. Simulator training is conducted for control room operations staff and reactor physicists. Part of the training is training of the staff on NPP and on the job training outside the plant.

In the framework of IAEA TC project SLR/0/003 "Upgrading of NPP Training Infrastructure", a competence analysis of selected posts (operations and maintenance) which started in 1995 is being performed.

Within the PHARE/TACIS project the multifunctional simulator will be delivered to Slovakia at the end of 1996 or at the beginning of 1997. This simulator will complete and enhance the simulator training.

Construction of a training centre for maintenance staff commenced at the NPP site. The centre is dedicated to theoretical and practical training of Bohunice and Mochovce staff.

Training on the simulator follows the theoretical classroom training. The refreshment training is conducted twice a year for five days. The training is performed on the basis of an established three year programme which is adapted every half year to include modifications corresponding to operations requirements (failures in the country and abroad, changes in regulation, etc.). This schedule provides good operational feedback into the continuing training programme.

Operations

Special procedures have been developed to shut the plant down using the emergency control room and for a seismic event. A new type of fire emergency procedure for all safety related areas is in place.

The old event oriented procedures have been reviewed to reflect the results of new studies and to extend the spectrum of initiating events.

Bohunice NPP are developing plant specific symptom based EOPs of the Westinghouse type. The first version of several procedures was developed and tested on the simulator by operators. During the next upgrading of the plant, full implementation of new EOP is expected. However, the continued development of symptom based emergency operating procedures needs to be carefully evaluated by senior plant management. Although a plan to develop these procedures is in place, efforts for full implementation have been slow, probably owing to the absence of all the information necessary on the final state of the plant following reconstruction.

Maintenance

No comment.

Emergency planning

In 1995 an updated off-site emergency plan was issued reflecting government requirements of independent Slovakia.

The status trees of critical safety function and guidelines for appropriate function restoration have been implemented and are being used by control room and technical support centre personnel.

Efforts are now under way to develop additional guidance and procedures for each of the affected emergency buildings, similar to that developed at other NPP facilities.

In short, all issues were found to be resolved or in satisfactory progress.

FLAMANVILLE (FRANCE)

Scope of the follow-up

At the request of the Government of France, the IAEA carried out a follow-up to the Flamanville OSART mission. The team comprised three IAEA staff members, all of whom were members of the original OSART team. The purpose of the visit was to discuss the actions taken in response to the findings of the OSART mission conducted from 30 January to 17 February 1995.

Duration: 3 to 7 June 1996

Brief plant description

The plant consists of two identical pressurized water reactor units rated at 1345 MW net electrical output. The units, designed by Electricité de France, with Framatome nuclear steam supply system islands, entered commercial operation in December 1986 and March 1987 respectively. The plant is located 25 km from Cherbourg and 340 km from Paris.

Main conclusions

The follow-up team found that good progress had been made in addressing and resolving the findings of the 1995 Flamanville OSART mission. Almost half of the issues are fully resolved and an equal number are progressing satisfactorily to completion. There is, however, one issue whose progress is insufficient. A redoubling of efforts and some redirection of resources will be needed if all of the issues are to be fully resolved on a reasonable time-scale.

A characteristic of follow-up visits is that some issues are resolved only shortly before the follow-up visit. This was true of the Flamanville follow-up. It illustrates, perhaps, one of the benefits of the follow-up, in that its timing provides a stimulus to complete work that might otherwise drag on. Where the improvement was implemented only a short time before the follow-up visit it has proved impossible to check the effectiveness of the remedial measures. Greater efforts are required not only to complete the outstanding actions but also to ensure that the effectiveness of the measures continue to be monitored, assessed and corrective actions taken as necessary. At Flamanville, there were also cases where the desired improvement was introduced by means that were only provisional. In some cases, an internal memorandum was used to introduce the change whilst awaiting the formal amendment and issuing of the appropriate procedure. Given these circumstances the issues were not judged to be resolved but rather that progress was satisfactory. However, no one can deny that improvements of a lasting nature have been and will continue to be introduced as a result of Flamanville's response to the OSART mission.

During the follow-up visit, the IAEA team identified two issues which were resolved by Flamanville NPP in an outstanding manner and which might be of interest to other utilities and plants. These were:

1. Plant-wide participation of staff in developing new strategies:
    - Development of the plant's five year strategy
    - Operations alarm strategy
    - Field operators responsibilities
    - Training in infrequent operations

The approach adopted by Flamanville has helped to engender a sense of ownership of the new strategy or solution and has motivated staff to achieve the objectives and goals.

2. Significant improvements in international technical exchange.

In short, most issues were found to be resolved or in satisfactory progress.

HAMAOKA (JAPAN)

Scope of the follow-up

At the request of the Government of Japan, the IAEA carried out a follow-up visit to the Hamaoka Nuclear Power Station OSART mission. The team comprised an expert from the USA and two IAEA staff members. All three follow-up team members participated in the Hamaoka OSART mission conducted from 27 February to 16 March 1995.

During the visit, team members met with senior managers of the Hamaoka station and their staffs to assess the effectiveness of the power plant's response to each recommendation and suggestion provided by the Hamaoka OSART mission.

Duration: 10 to 14 June 1996

Brief plant description

Chubu Electric Power Company (CEPCO) is the third largest of the Japanese electric power companies. It has an installed generating capacity of 25 850 MW(e), with Hamaoka NPS providing 3617 MW(e), or 14 per cent of the total capacity. The Hamaoka station is the company's only nuclear power station.

Main conclusions

At the time of the follow-up visit, excellent progress had been made towards resolving the findings of the 1995 OSART mission. All but one of the 40 issues were considered to be resolved or were progressing satisfactory towards their resolution.

This is an exemplary result. In addition, the station staff has analysed in more depth numerous areas related to the findings and developed improvements beyond those proposed by the OSART. The enthusiasm of Hamaoka's management and staff for improvement was evident.

The follow-up team was particularly impressed with the improvements in emergency planning and preparedness, chemistry, and training, as described below. However, they did offer comments to help strengthen the station's response to several of the issues.

A team of station managers was charged with evaluating needed improvements to the station's emergency planning and preparedness, in light of the OSART recommendations and experience in Japan with earthquakes and other emergencies. The team has initiated numerous enhancements to the programme and has begun an active process of identifying more opportunities for improvement. The elements of a strong programme are now in place or in development. Considerable additional effort will be required to complete current improvement plans and demonstrate their effectiveness through appropriately challenging drills and exercises, but station managers seem committed to achieving planned improvements.

In the chemistry area, the station staff actively sought improvement opportunities during the OSART mission, and made good use of the experience of other utilities in pursuing improvements. In particular, the newly-developed programme for the control of chemicals in the plant reflects high standards. When it becomes implemented, it has the potential to rank among the industry's most effective.

Several Japanese utilities are pursuing improvements in operator training, and Hamaoka appears to be a leader in this regard. Improvements in symptom based emergency operating procedures make them easier to use and minimize chances for errors in execution. Increased simulator training time is being provided for operators. Training of operators in communicating during emergencies emphasizes use of repeat-backs, acknowledgements, and other techniques that enhance communications reliability. In addition, the station will install a full scope, control room simulator for Units 1 and 2, so that all control room crews will have the benefit of plant specific simulator training.

Notable improvements in other areas include better identification and control of keys needed when responding to emergency conditions, and the training and readiness of the fire brigade for initial response to plant fires.

The overall impression is that substantial operational nuclear safety improvements have been achieved and others are in progress. Considerable effort remains before many of the desired improvements are actually achieved. Continuing diligence and management support will be needed to ensure timely completion of planned improvements, but Hamaoka personnel appear to be firmly committed to this effort.

In short, most issues were found to be resolved or in satisfactory progress.

LEIBSTADT (SWITZERLAND)

Scope of the follow-up

At the request of the Government of Switzerland, the IAEA carried out a follow-up to the Leibstadt OSART mission. The team comprised three IAEA staff members, all of whom had been members of the original OSART team. The purpose of the visit was to discuss the actions taken in response to the findings of the OSART mission conducted from 21 November to 8 December 1994.

Duration: 11 to 15 November 1996

Brief plant description

The Leibstadt nuclear power plant comprises a single unit with a General Electric boiling water reactor BWR-6 and a MK III containment. The plant is owned and operated by Kernkraftwerk Leibstadt AG (KKL). Leibstadt NPP is situated some 40 km from Aarau, the capital of Aargau, and some 50 km from the city of Zurich.

The unit was brought into commercial operation in December 1984. Power output was raised from 3012 MW(th) to 3138 MW(th) in 1986. The BWR-6 nuclear steam supply system (NSSS) was supplied by General Electric Technical Services Company (GETSCO).

Main conclusions

The follow-up team found that good progress had been made in addressing and resolving the issues identified by the 1994 OSART team. More than half of the issues were found, two years later, to be fully resolved and the resolution of another one third were progressing satisfactorily to completion. There were, however, a number of issues, the progress of which the follow-up team judged to be insufficient. These relate to the development of a more structured approach to on-site training and of ways to capture the best ideas and principles of each department's training and applying them to others; ensuring that all those involved in providing training have themselves been trained in instructional techniques; the elimination of the use of clear plastic sheeting in the containment and near the fuel storage and suppression pools; and a programme to regularly check the reliability of the plant parameter computer display system (ANPA) installed at the offices of the regulatory authority.

During the follow-up visit, the IAEA team identified two issues which were resolved by the Leibstadt NPP staff in an outstanding manner. These were:

- An analysis of all materials deposited in the containment and not belonging to the equipment or fittings in the containment, as originally designed, was carried out with respect to seismic and pool swell considerations. The degree of thoroughness of the analysis and the rigour with which the plant applied its results are worthy of their being drawn to the attention of other utilities and plants.

- A procedure for the exclusion of foreign materials was implemented shortly after the 1994 OSART mission. Illustrated training materials of high quality were developed and staff, including contractors, were thoroughly trained in the implementation of the procedure. In addition, a three-man team of inspectors were present throughout the last outage to police adherence to the requirements of the foreign materials exclusion procedure. Their report at the end of the outage is illustrated with colour photographs showing good and bad examples of practices that they observed. Their report will be used to enhance both the procedure and future training. The impression gained of conditions in the plant as a result of all this work is very positive. The overall approach by Leibstadt staff, the quality of the training, the rigour with which the requirements of the procedure were applied and the result are worthy of their being brought to the attention of other utilities and plants.

In short, most issues were found to be resolved or in satisfactory progress; one was withdrawn.

PART III

GOOD PRACTICES IDENTIFIED DURING OSART MISSIONS CONDUCTED IN 1995 AND 1996
A report generated from the OSMIR database

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1.2. Plant organization and management

Hamaoka 3/4, BWR 1100, Japan
The plant uses licensed chief reactor engineers to provide the station manager with independent, expert advice on nuclear safety matters. These engineers have taken special training in reactor safety subjects and have demonstrated a high level of knowledge in a series of licensing examinations. Though some of these engineers have management responsibilities, their advisory role is kept independent of line management and production pressures. In addition to advising the station manager, they provide coaching and guidance to other line managers and supervisors on matters related to nuclear safety.

Beznau, PWR 364, Switzerland
The annual personnel performance appraisal system at the plant includes hourly workers as well as salaried personnel. The appraisals are used to determine promotions and pay adjustments, as well as provide feedback on performance. Decisions are made together by the section head and the worker, taking into account strengths and weaknesses in areas such as quantity and quality of the work, technical knowledge, working technique, flexibility, cooperation, and discipline. The process is respected and liked by the workers, and is effective as a tool for their professional development. It helps maintain a high quality staff.

1.4. Regulatory and other statutory requirements

Dampierre, PWR 937, France
While modifying the station quality assurance manual and the associated plant procedures, a series of flowcharts were developed and incorporated into the plant quality assurance manual to easily illustrate the relationships between station documents and station processes. For example, all documents related to the maintenance process such as organization, maintenance procedures, planning, execution, record keeping, operating experience and staff training can be easily found in the flowchart under maintenance. Plant management staff were observed to frequently use the flowchart to locate information. This tool no doubt contributes to good awareness of the quality assurance manual and the supporting procedures. It is also useful when updating quality assurance documentation by ensuring that related documents are also checked.

1.5. Industrial safety programme

Flamanville, PWR 1382, France
Three times a year the plant management holds industrial safety meetings for all employees. These half day meetings are held as a number of small group meetings in parallel. A member of the management team attends a portion of each group meeting. The meetings reinforce the importance of industrial safety, review the status of current industrial safety action plans and promote employee feedback to management on how to improve industrial safety. These meetings are an excellent way for management to discuss the importance of industrial safety directly with employees in an open non-threatening forum.

Flamanville, PWR 1382, France
The utility corporate resource division provides NPPs with two excellent experience feedback manuals. One provides experience feedback on industrial safety. The other provides experience feedback on ALARA. The utility NPP experience reports selected for inclusion in the manuals are thorough and contain valuable lessons which have been learned in the utility nuclear programme. The presentation format for these manuals has recently been enhanced. The new format is clear and includes clarifying diagrams and pictures.

2. TRAINING AND QUALIFICATION

2.1. Organization and functions

Hamaoka 3/4, BWR 1100, Japan
The Nuclear Training Centre (NTC) at the plant has an excellent process for maintaining a staff of qualified instructors with current plant knowledge. All instructors have recent, extensive operations and maintenance experience, and they are rotated back to the plant every three to five years to allow new instructors to bring fresh ideas and current plant experience to the NTC. The average experience of instructors is 15 years.

The NTC has designated a training engineer in each plant section who assists in the development and conduct of section training. It has also provided instructor certificates to an additional 149 station personnel who periodically assist in conducting training courses. The extensive involvement of plant personnel in developing and conducting training exceeds that observed at other nuclear plants, and appears to be contributing significantly to the effectiveness of training.

2.2. Training facilities, equipment and material

Khmelnitsky 1, WWER-1000, Ukraine
The concept of using local simulator panels in a system where the actions on one panel are integrated into effects on other systems allowed for simulator exercises incorporating control panels remote from the control room. This enhances training effectiveness. The local simulator allows for completeness of control room operator training where operations are carried out at stations remote from the main control room. The effective training of remote staff in a simulator environment can also be carried out.

Dampierre, PWR 937, France
An interactive video training (VFI) programme is available in the training centre to provide live training on theoretical nuclear concepts (thermodynamics and vessel yielding techniques). The training is being conducted by professionals and shared with other nuclear plants in the country. The VFI experiment aims at exploring the possibilities of putting training and work sites closer by using modern training technologies (Tele-tutorship).

This shadowing system is designed for trainees who are faced with availability problems due to work constraints (posted shift teams, for instance). This training may also be a solution for small groups located in remote areas and for whom it is desirable to share training resources.

At the plant, four trainees from the Operation Departments are taking a VFI training course called Unit Yielding where the main principles of thermodynamics are taught. Trainees have the opportunity to ask questions during practical exercises.

The system is connected to the telephone network. It has two screens (one to view the participants and the other one to view working documents), a projector connected to a computer to transmit documents and an adjustable camera.VFI may also be used in broader communication contexts (video conferences, work meetings), because 10 utility nuclear sites are equipped with this system.

The VFI project has been developed by the Corporate Nuclear Power Division and it is an example of the gas and electricity national utilities tele-tutorship launched by the Government in the framework of the Learning companies programme (other big companies in the country are currently working on similar projects).The VFI system is used by three Learning companies and two training centres. It is based on the structure and functioning mode of Resource Centres of the plants.

2.3. Control room operators and shift supervisors

Hamaoka 3/4, BWR 1100, Japan

Shift supervisors are responsible for directing and leading family (team) training of their shift personnel in the control room simulator. This allows the shift supervisor the opportunity to conduct training according to the needs of his crew and to reinforce his expectations for performance, attitude and safety awareness among his crew members. It also provides an opportunity for the shift supervisor to transfer his experience and expertise to the junior members of the shift. During the training session that was observed, the assistant shift supervisor and experienced reactor operators also took an active role in training other crew members. This strong line management role in training contributes to training effectiveness.

2.5. Maintenance personnel

Beznau, PWR 364, Switzerland

The vocational training programme conducted by the plant for apprentices is very comprehensive. The plant considers it a strategic task to educate and train qualified craftsmen, and considers apprentice training the most useful and efficient method for providing basic vocational training. The following qualifications are considered to be decisive for the future of each apprentice:

- broad, fundamental, technical expertise
- process-oriented thinking and acting
- flexibility and ability to learn
- independence and sense of responsibility
- ability to work in a team
- ability to communicate and provide/accept criticism
- endurance and convincing power.

Individual training plans are developed for each new trainee for a four-year apprenticeship period. The plans include both theoretical training in a vocational school and practical training in workshops and on the job. The training teaches the essential professional fundamentals and promotes the aforementioned qualifications. In the case of obvious strengths in an apprentice, and if the apprentice is interested and willing to accept a higher learning load, the theoretical education is extended so the apprentice can graduate with a higher certificate called a vocational baccalaureate. Upon completion of their apprenticeship training, individuals may obtain employment at the plant or at other national companies needing their skills.

The existing infrastructure for and the current know-how of the staff in charge of educating apprentices is also used for other purposes such as retraining of personnel, conducting internships for students of a national institute of technology, and training of qualified employees for management functions.

Apprentice training helps ensure the formation of new generations of well qualified craftsmen for the plant and other national companies.

Bohunice, WWER-440, Slovakia
Pre-outage training at the plant is impressive. Two full days training is provided to all 700 maintenance staff immediately before an outage. This is specifically designed to enhance safety awareness and performance during the outage. The first day is focused on general safety refresher training covering nuclear safety, industrial safety, radiation protection and quality assurance. Industrial safety sessions are presented by training centre staff who seek to encourage a questioning attitude to safety using the stop, think, act, review (STAR) principles.

The second day of training reviews specialized skills needed for particular outage work the groups will undertake. This includes hazards and risks, and reviews experience from previous outages. The second day is more focused to the needs of particular groups. It includes videos and computer based training material, produced at Bohunice, which covers specific outage tasks. Contractors staff received five days training before the outage, which is organized and presented by the plant.

2.6. Technical support personnel

Beznau, PWR 364, Switzerland
Effective continuous and long term training plans are used by the chemistry section to help achieve high levels of technical knowledge and performance by section personnel. Some of the features of the programme are as follows:

- All workers receive basic training with well defined requirements covering all analytical methods used in the laboratories.
- On the job training is conducted by an experienced laboratory assistant and is based on established instructions and procedures.
- Refresher courses and additional professional training are given after several years of experience or when new equipment is commissioned.
- The courses support progression through the three following levels of worker qualification:
    - knowledge to carry out work on the basis of instructions and procedures;
    - ability to explain, describe, differentiate and compare work and results;
    - general overall knowledge to manage, evaluate, develop and interpret work and tasks;

In this way, all the members of the chemistry staff are able to do all section tasks after a short (2–3 year) period of training. With refresher courses and additional professional training, their proficiency and performance are maintained or increased. As a result, the chemistry section always has adequate members of qualified staff available for any analysis needs.

2.10. General employee training

Flamanville, PWR 1382, France
The three separately owned nuclear establishments in the area carrying out different activities, one of which is the NPP, have standardized the radiological training given to contractors. This consists of four days of general training applicable to all three establishments and one day of site specific training. This avoids contractors being confused by being given different training in quality and radiation protection at each facility and should improve the credibility of the nuclear industry in general by projecting an image of good organization.

3. OPERATIONS

3.1. Organization and functions

Hamaoka 3/4, BWR 1100, Japan
All shift operators except the shift supervisor and assistant shift supervisor make patrols through the plant at least once a shift to monitor plant status and the condition of plant equipment. The shift supervisor and assistant shift supervisor make patrols once a week. This, along with regular maintenance patrols, helps to ensure that abnormal situations are detected early and allows prompt corrective action for abnormalities. It also helps maintain operator proficiency through frequent exposure to plant equipment and controls. In many stations, control room operators do not have the opportunity to leave the control room during their shift for rounds or other activities.

Bohunice, WWER-440, Slovakia
The process used at the plant to ensure that shift personnel are prepared for duty after a period of absence from the control room is good. If the period of inactivity from control room work exceeds two months the licensee's license automatically expires. If this period is between three weeks and two months the licensee needs to work on shadow training for one or two days on shift. The length of the shadow training is defined by the head of the operation management section. This practice exceeds those seen in some other countries and systematically ensures that the operators maintain their ability to fulfill the assigned shift function after period of absence from the control room and prior to being assigned shift duties.

3.3. Operating rules and procedures

Flamanville, PWR 1382, France
The revised technical specifications that will be in force prior to the next outage this year include unit fallback times for combinations of unavailabilities of vital equipment. The fallback times are based on the results of probabilistic safety assessments. In the event of simultaneous unavailability of vital equipment, a decision tree guides the operators to easily determine the unit fallback time that results from the combination of two or more items of equipment being unavailable. This approach maintains the defence in depth principle by prescribing more conservative limits for multiple unavailabilities.

Bohunice, WWER-440, Slovakia
During the review of the emergency diesel generator (DG) surveillance test the effectiveness of the DG monitoring system, implemented by the Electro-equipment Section of the Operation Division, was noted. The scope of surveillance of the DG includes a PC based monitoring system which is permanently installed. The system simultaneously monitors all six DGs. At each DG twenty four discrete and four analog parameters are monitored and recorded at an interval of 140 seconds (including 20 seconds pre-history) when an initiating discrete signal is received. The

software enables all signals to be recorded, to transfer the information to the plant network and in particular to the control room. The assessment programmes enable retrieval and data processing (printing of protocols, reviewing of the data and comparison with the previous records, calculations, zoom, etc.). The system has been in permanent operation since initiation. For the last three years all startups and shutdowns of the DGs have been recorded and analysed. The system enables continuous monitoring and precise diagnostics in a timely manner and hence provides the necessary basis for reliable operation of the DGs.

3.4. Operating history

Hamaoka 3/4, BWR 1100, Japan
The low scram frequency achieved at Hamaoka NPS indicates the effectiveness of efforts to maximize plant reliability. The station has experienced only one scram and one unplanned shutdown in Units 3 and 4 since 1989. Measures that have been used to achieve this notable performance include the following:

- A comprehensive preventive maintenance programme during annual inspections.
- Installation of digital triplex systems to eliminate unnecessary transients caused by feedwater and recirculation flow control instrument failures.
- Implementation of additional selected rod insertion (SRI) to avoid reactor operation in the core instability region.
- Use of titanium condenser tubing to minimize condenser tube leaks.
- A strong emphasis on self-checking and analyzing the causes of near miss events.
- Permanent barriers to protect safety related instrument and control racks from inadvertent bumping or damage.

3.5. Conduct of operations

Hamaoka 3/4, BWR 1100, Japan
Specially-designed drain cups are provided to collect drainage from plant equipment and instrument racks. These caps are fitted to the drain piping and serve to minimize splashing and prevent foreign materials from entering the drains. Various cap designs are used, depending on the radioactivity, temperature, and frequency of drainage flow. Some of the caps have viewing windows with internal wipers to keep them clean. This feature permits checking the amount of drainage with the cap in place.

Hamaoka 3/4, BWR 1100, Japan
Surveillance tests on emergency core cooling systems are supported by the plant process computer, which displays the test procedures step by step on a Cathode Ray Tube (CRT). The colours of procedure steps on the CRT automatically change to reflect test progress as plant components are operated to establish prerequisite conditions and perform the tests. This system provides the operators with a clear indication of test progress and helps to eliminate errors in the performance of tests.

3.6. Work authorization

Flamanville, PWR 1382, France
The development and use of requalification criteria for post maintenance testing of safety related equipment is very effective in ensuring that the correct safety characteristics are identified and verified in accordance with the appropriate procedures. Requalification criteria sheets have been prepared for more than 30 types of equipment. The sheets contain information on:

- acceptance criteria;
- outage conditions that are required for the test;
- reference to the commissioning start-up procedure that was used to test the equipment in question;
- reference to the post maintenance test procedure; and
- department in charge of the test.

This practice maintains consistency in selecting the post maintenance tests and ensures that the correct procedures are used and the correct acceptance criteria are applied.

4. MAINTENANCE

4.1. Organization and functions

Beznau, PWR 364, Switzerland
The plant has developed an impressive array of special tools for carrying out maintenance work, including inspections and repairs in high radiation areas. The plant took the initiative of developing its own special tools, because manufacturers and suppliers of heavy components were not prepared in the early 70s to provide acceptable tooling for work on steam generator tubes and other equipment. The tools range from the simple to sophisticated, computer-controlled equipment such as manipulators for inspection and maintenance of steam generator tubes and tubesheets. The following tools are among those developed for the maintenance of steam generators:

- telescopic tools to sleeve tubing from outside channel head manholes
- tools to perform various repairs with a remote manipulator
- tools to insert and weld sleeves and plugs into tubesheets
- pneumatic drilling equipment for tubesheets
- measuring equipment, including laser marking equipment
- tools to colour-code tubesheets
- a remote controlled camera for use in channel heads.
- equipment to extract drilling cores from the channel head of dismounted steam generators for examination

Other special tools include:

- equipment for drilling into pipes while preventing debris from entering
- equipment for replacing pressurizer heater elements
- equipment to cut openings (for instruments) in panels
- equipment to separate the body and bonnet of welded valves
- equipment to machine the mating surfaces between the upper and lower low pressure turbine casings
- remote controlled pneumatic drilling equipment to repair seized bolts.

This array of special tools has helped the plant reduce radiation exposure to personnel and improve the quality of work through use of more efficient, remote controlled work techniques. Since the tool designers and developers are members of the plant staff, repair and troubleshooting capabilities for the tools are enhanced. In addition, the opportunity to develop these tools has provided a challenge and motivation for maintenance personnel.

4.2. Maintenance facilities and equipment

Dampierre, PWR 937, France
Rigging equipment is classified in different categories according to load capacity and thread dimensions. Each category is assigned a colour code and all the individuals in the category are painted according to these categories. This is controlled by a table in which colours are displayed versus load capability and fundamental dimensions. This approach helps in the selection of the correct items, providing additional information to the user and preventing human error.

4.3. Maintenance programmes

Beznau, PWR 364, Switzerland
The plant tests the effects of ageing on electrical components by using increased temperatures to accelerate ageing. Electrical parts and components to be tested are placed in a thermal box (autoclave) at a temperature of 50°C, 10°C above the maximum permissible ambient temperature in the plant. This results in accelerating ageing by a factor of two. Test pieces are electrically energized and are operated in simulation of their actual use in the plant. This ageing method, which was introduced in consultation with the regulatory authorities, provides the following advantages:

- The thermal box test facility is easy to operate.
- Commercial grade industrial products may be qualified for nuclear use in a cost-efficient manner.
- Accuracy in predicting in-plant service life is good due to the small acceleration factor (two) and the equivalence of operating conditions to test conditions.
- Since tests are carried out at the power plant, data on malfunctions and end of life effects are available to the plant operator immediately. Thus, corrective measures can be taken with minimum delay.

4.5. Conduct and control of maintenance work

Flamanville, PWR 1382, France
An exhaustive risk analysis is carried out before starting corrective maintenance. This requirement is considered to be a good practice, particularly as it includes the need for a risk analysis before commencing troubleshooting activities. The quality plan (PDQ) requires:

- Analysis of the work conditions: unit status, equipment status, equipment required, technical specification application, duration.
- Technical risk due to the activity: foreign material exclusion, use of specific tools, risk of spare parts errors, source of electrical supply, safeguard protection, loss of equipment protection regulation, control rod dropping, cable snapping, other risks.

- Analysis of external risks: protection against rain or frost, start and stop of redundant equipment, jumpers and lifted leads, dilution, containment rupture, other risks.
- Analysis of interfaces risks: change of tagging (wrong alignment), worker co-ordination, incomplete maintenance test.
- Analysis of the reconfiguration after post-maintenance test: precaution when placing the equipment back in service, such as: jumper and lifted leads, alignment, sensors, checklist.

These analyses help avoid actions that could lead to incidents. This procedure was initiated three years ago and has been well accepted by maintenance personnel. It has provided a good improvement on corrective maintenance applications.

Hamaoka 3/4, BWR 1100, Japan
A tool-box meeting is held each day between work supervisors of the utility on site and the field supervisor and work team of the main contractor to discuss the scope of planned work, safety measures and other matters. The interaction between workers and managers during these meetings contributes to the proper performance of safety related maintenance activities.

Hamaoka 3/4, BWR 1100, Japan
Maintenance equipment isolation is checked by the plant work supervisor and the field supervisor of the main contractor prior to work by contractor personnel. The supervisors visit the work site together to ensure adequate preparations are made and that the equipment to be worked is properly identified with maintenance tags. The maintenance tags are a different colour than equipment isolation tags. This practice contributes to the safety of workers and help assure that the correct equipment is worked on.

4.6. Material conditions

Hamaoka 3/4, BWR 1100, Japan
Maintenance section managers and staff members make routine patrols to monitor the condition of station equipment. This increases their awareness of plant conditions and helps to identify equipment problems early. The results of patrolling are documented in reports that are reviewed and approved by the deputy manager of maintenance.

Hamaoka 3/4, BWR 1100, Japan
Temperature indicator tapes are stuck to bearing housings and surfaces of important equipment to allow quick and easy observation of operating temperatures and aid in the early detection of abnormalities. One case was observed where a tape indicating high temperature on a pump bearing initiated more accurate temperature monitoring. This helps to increase the reliability of operating equipment.

5. TECHNICAL SUPPORT

5.2. Surveillance programme

Khmelnitsky 1, WWER-1000, Ukraine
Rotating machinery vibration diagnostics has been developed and implemented at the plant. The vibration monitoring is expanded for all items of rotating machines at the plant. The system is well organized and documented. The vibration measurements, analysis and diagnostics are performed using state of the art tools and methodologies. The monitoring of vibration is synchronized with surveillance tests of the pumps. A large experimental database has been obtained in the last 5 years. The system is effectively used for defect diagnostics, preventative

maintenance and maintenance planning. There is a clear correlation between the vibration monitoring, decreasing trend of defects and increasing availability of rotating machinery at the plant.

Bohunice, WWER-440, Slovakia
Extensive diagnostics systems are used at the plant to ensure early detection of integrity violation and other degradation of main technological systems. Technical systems used for diagnostics include leakage monitoring in both primary and secondary system, vibration monitoring of main circulation pumps and reactor, loose parts monitoring of reactor and steam generators, reactor stability monitoring, and service life monitoring of main components in primary system.

The use of diagnostics analysis methodologies effectively supports the enhancement of plant reliability. A diagnostics department is responsible for the system and provides information to operations personnel on a weekly basis, or more frequently as the need arises. The use of diagnostics methods is carried out to ensure that an early detection of degradation in safety significant systems take place. Diagnostics equipment and sufficient resources are allocated in one single diagnostics control centre. Results from the measurements are effectively provided to shift personnel as well as to responsible departments to implement necessary corrective actions.

5.3. Operational experience feedback system

Daya Bay, PWR 980, China
The safety technical advisors, on shift engineers of the safety and licensing branch, provide reports to senior station personnel on the safety status of the reactors, containment and safety systems. The team was impressed by the fact that individuals are assigned the responsibility of preparing the weekly report that contains statements on the safety status of the plant over the previous week including the root causes of significant events. These are accompanied by frank remarks that draw the attention of managers to areas where they should direct their attention. The reports are also reviewed by the training branch as one input to operators continuing training. The team identified the clarity of the message and the use made of the report for training as a good practice.

5.4. Plant modification system

Hamaoka 3/4, BWR 1100, Japan
In the modifications planning phase, independent reviews of significant modifications are conducted by evaluation committees at headquarters and at the station. This helps to ensure that the potential relevance of modifications to plant safety and reliability is adequately understood before substantial resources are committed to the modifications.

Beznau, PWR 364, Switzerland
The plant's living probabilistic safety assessment (PSA) is used effectively as a tool for evaluating potential plant improvements. Twelve years ago, the plant began a full scope, level-1 PSA. This PSA included external events and used plant specific component failure data. In the last five years, the PSA programme and models have been maintained as a living PSA and used for the evaluation of proposed improvements. Three years ago, an updated, level-2 PSA was completed. A dedicated group from the plant staff manages the PSA programme in order to ensure the model continues to reflect the actual plant configuration and to keep the PSA current with the state of the art. The PSA is now being extended to cover the low power and shutdown modes of operation.

The benefit of the following potential plant improvements have been evaluated using the living PSA model and PSA techniques:

- implementing procedures for alignment of the emergency bunker cross connections (AC power, well water);
- keeping an old safety injection (SI) pump, which was replaced by a new pump in the emergency bunker, as a standby;
- automation of emergency boration during anticipated transients without scram (ATWS) events;
- a second electrical grid connection to emergency bunkers;
- different configurations for an auxiliary feedwater system upgrade;
- a containment filtered vent system.

In one excellent example of results, the safety benefit of two different configurations of a large nuclear cooling backfit project was analyzed: a two-train system and a one-train system. The PSA quantified the benefit of the final backfit project configuration (one train) to be almost as high as the two-train system, and much more cost effective.

The PSA also helped identify other relatively simple and cost effective ways to improve the safety of the plant. These included improvement of procedures, strengthening of an important wall, improvement of electrical cabinet anchors and strengthening of cable trays.

5.5. Reactor engineering

Hamaoka 3/4, BWR 1100, Japan
Core power stability calculations are performed for new core configurations to ensure that stability margin requirements are met throughout core life. This is of increasing importance as the use of more advanced fuel designs and loading patterns tend to reduce the stability margins of BWR cores.

Hamaoka 3/4, BWR 1100, Japan
A thorough, methodical approach is used to ensure that cladding integrity of the fuel is maintained during plant operations. Key elements in the approach include elimination of foreign material intrusion, extensive QA/QC during the manufacturing process, pre-loading inspections of fuel, and conservative margins to thermal limits. Strict adherence to preconditioning guidelines and tight water chemistry control also contribute to good fuel cladding integrity. As a result of implementing this approach, Hamaoka Units 3 and 4 have never experienced any fuel defects.

Beznau, PWR 364, Switzerland
Reactor core surveillance functions are well structured and performed effectively. The plant has recently installed an on-line, real time computer program, using a three dimensional core model, for continuous surveillance and monitoring of the reactor core. The real time functions (surveillance of Fq, $F\Delta h$, DNBR, axial-offset, xenon and samarium worth, power tilts, rod positions, etc.) are used by the operators in the control room to monitor core status. Nuclear engineers and operators use the program for a variety of additional tasks, such as assembly-by-assembly checks of current core conditions, predictive analysis of core performance, estimated critical condition (ECC) calculations, shutdown margin calculations, load swing analyses, and lifetime depletion calculations. The accuracy of these calculations is comparable to those of the codes used for core design. All measured and calculated data are stored in the plant computer and can be retrieved at any time. The programme will also be installed on the compact simulator for operator training.

The implementation of this system allows the operators in the control room and nuclear engineers to have much better control of the core, learn more about core physics and get accurate predictions to help plan power manoeuvers. This contributes to increased reactor safety.

5.6. Fuel handling

Hamaoka 3/4, BWR 1100, Japan
Hamaoka NPP's use of a fully automatic refuelling machine contributes to the safe movement of fuel. All fuel movements needed during each outage are determined in advance of the outage and programmed into the computer that controls the refuelling bridge. During fuel movements, operation of the refuelling bridge is performed from a control room that overlooks the refuelling floor. Three persons monitor and supervise fuel movements from the platform of the refuelling machine. Dummy fuel assemblies are used for refresher training, which typically occurs two weeks before the outage. Use of computer controlled fuel movements reduces chances for errors, and improves positioning accuracy.

6. RADIATION PROTECTION

6.1. Organization and functions

Beznau, PWR 364, Switzerland
The plant staff members are provided radiation protection training that goes significantly beyond that normally found in plants employing radiation protection specialists as the primary means of monitoring and controlling radiological hazards. The training is specifically designed to enable personnel to take more responsibility for their own radiological protection than at many other plants. It also provides all staff members with a greater appreciation of the challenges faced by radiological controllers and the need to support their efforts.

All staff members are oriented to radiation protection by means of a two-hour training programme covering radiation hazards and radiation protection requirements, both general and plant specific. This is followed by additional radiation protection training tailored to individuals' duties. For example, engineering, operations, maintenance and middle management staff members attend either a two day or four day training course in their first month as employees. This training is plant specific and is delivered by either the head controller or deputy head controller for radiation protection. These personnel also complete five days of more general radiation protection training at the nearby polytechnic institute. To maintain knowledge and skills, two days of refresher training is provided every three to five years, depending on each individual's position and duties.

Radiation protection professionals also receive excellent training. After completing at least a three-year apprenticeship and one year of practical health physics work at the plant, potential controllers take a 65 day radiation protection course at the polytechnic institute. This course is officially recognized by the regulatory authorities, and an examination must be successfully completed at the end of the course. Radiation protection assistants, who monitor equipment and materials when they leave the controlled zone and conduct general airborne and surface contamination surveys, receive 10 days of training at the polytechnic institute. In addition, one or two days of formal retraining at the polytechnic institute is required for all radiation protection personnel every two years.

The extensive radiological protection training provided to staff members serves to increase awareness of radiological hazards and to strengthen radiological protection of personnel.

6.2. Radiation work control

Hamaoka 3/4, BWR 1100, Japan
The permanent radiation protection posters used at the plant provide clear, easy to read identification of radiological conditions in posted areas. On these posters, the international radiation symbol is shown, the magnitude of the radiation field is identified by a number (1, 2 or 3), and the level of loose surface contamination is identified by a letter (A, B, C, or D). The number-letter codes cover the full range of possible radiological conditions. Additionally, the letters and numbers are printed on a colour coded background that indicates the relative magnitude of the hazard.

Beznau, PWR 364, Switzerland
The plant has implemented a progressive process of management intervention to complement radiological protection training and procedures and help ensure uniform application of good radiological practices by individuals. The intervention process is applied when radiological performance of individuals does not meet management expectations. It begins with informal counselling and progresses as high as counselling meetings with the plant manager.

If individuals do not use appropriate radiation protection practices, they are warned by a radiation protection controller and requested to correct their behaviour. If that is not successful, the individual's access to the radiologically controlled zone is withdrawn, pending further corrective action. At the earliest opportunity, the head of the radiation protection section and the individual's line manager meet with the individual to discuss the importance of using approved radiological practices. Following this meeting, access to the controlled zone is normally restored. If problems persist, the individual is counselled by the head of the health physics and chemistry department and, if necessary, the plant manager.

This process is applied for persons of all seniorities.

This progressive management intervention has helped create barriers against improper radiological actions that are noticeably stronger than at many other nuclear power plants. Only once in the past year were radiation protection procedures repeatedly violated, and that involved a contractor.

Bohunice, WWER-440, Slovakia
Effective dose limitation programmes are used by the RP Department and this results in a good performance with respect to individual dose. This practice is outstanding with respect to East European plants. Some of the features of the programme are as follows

Dose equivalent limits and ALARA principles are implemented and comply with ICRP 60 recommendations.

There is a plant daily dose limit from 1 mSv which is reported to the management by RP.

An evaluation system about failures of the expected dose is used. When the real dose is higher than the expected dose, for instance, the evaluation starts.

The maximum individual dose per one RWP is 1 mSv.

Dampierre, PWR 937, France
The use of the plant's dosimetry control system, operated by the risk prevention group, provides real time control of personnel doses measured on electronic dosimeters within the reactor

radiological controlled area (RCA) and assists in predicting doses, dose limits and exposure times.

The system, which is connected to the human resources personnel database, giving access to the utility's national dosimetry database, is also used during outage preparation to predict doses for each stage of the work. During outages, the dosimetry control system is used to compare actual doses with predicted doses so that discrepancies between forecast and real situations can be monitored effectively.

7. CHEMISTRY

7.1. Organization and functions

Beznau, PWR 364, Switzerland
The job rotation practised in the chemistry section is effective in maintaining the skills of the six workers so that all of them remain competent to carry out all analytical tasks without the need for retraining. Workers rotate tasks and work positions every two weeks. However, each person retains personal responsibilities, such as periodic revision of the laboratory handbook, preparing orders, co-ordination of maintenance and modifications, and service contracts. In this way, the technical knowledge and proficiency of chemistry personnel are continuously refreshed, and high quality is maintained in chemistry activities.

Beznau, PWR 364, Switzerland
An interdepartmental corrosion working team is effective in reducing corrosion of plant systems and its effects. The team is headed by the special tasks engineer of the health physics and chemistry department, and its members consist of the head of the operations department and the quality assurance (QA) section heads of the service, mechanical and electrical departments. Corrosion analyses, carried out by research institutes, have enabled a corrosion damage map of plant systems to be produced.

Changes in the chemistry programme and the material of plant components have been implemented to minimize corrosion in areas identified as susceptible during the analyses. For example, the change to a modified boron/lithium chemistry helps minimize activity build up due to corrosion product transport. Another example is the prohibition of chloride-containing gaskets and lubricants from the reactor pressure vessel flange. The team is currently defining places and components in the units that are damaged or may be damaged by stress cracking, a corrosion mode normally more prevalent in boiling water reactors. The team's work is contributing to the improvement of chemistry control in the units.

7.2. Chemistry control in plant systems

Hamaoka 3/4, BWR 1100, Japan
Effective procedures have been implemented to remove total organic carbon (TOC) from condensate demineralizers and corrosion products from idle condensate and feedwater piping before startup of the reactor. Prior to startup, the station establishes condensate and feedwater flushing flow from the hotwell through the condensate filter demineralizers (FDs) to the reactor, bypassing the deep bed condensate demineralizers (CDs). This flushing process continues for eight days, allowing the filter demineralizers to remove most corrosion products. The reactor water cleanup (RWCU) system is kept in service throughout the flushing to aid in water purification. Water is returned from the reactor to the hotwell through the RWCU blowdown line to be recycled through the FDs.

During this time, the CDs are flushed to radioactive waste to rinse off the resin decomposition byproducts (benzylsulphonic acid and trimethylamine) generated during shutdown. This prevents the ingress of these impurities into the reactor when the CDs are placed in service during startup.

This cleanup method has been determined to be effective by monitoring reactor coolant impurities during subsequent shutdowns. No longer have large spikes in sulphate concentrations, known as "hideout return", been observed. (This phenomenon is more common in PWRs, but has been observed in numerous BWRs as well.) Most national BWRs are now using a similar cleanup technique.

Hamaoka 3/4, BWR 1100, Japan
Water contaminated with organic compounds is sent to the fuel pool, where radiation from stored spent fuel breaks down the compounds so they can be more easily removed by demineralizers. This practice has significantly reduced the quantity of radioactive waste resin that is generated during removal of organic contaminants.

Hamaoka 3/4, BWR 1100, Japan
A procedure used before reactor startup reduces reactor water dissolved oxygen so that oxidizing conditions that can promote stress corrosion cracking during startup are prevented. Reactor coolant is heated to 80°C using decay heat and pump heat from the recirculation and residual heat removal pumps. The mechanical vacuum pump and steam jet air ejectors are then used to evacuate entrained air from the system via open main steam line drain valves. Within about two hours, the oxygen concentration is normally below the 200 ppb target value, and the startup is continued.

Hamaoka 3/4, BWR 1100, Japan
Collection of chemistry data using a hand held computer is efficient, reduces chances for errors, and enhances analysis of chemistry data. Data is manually entered into the hand held unit, then it is placed into a transfer device to automatically download the data into the main chemistry database. The hand held unit displays the previous data entry for each parameter, so users can readily identify significant changes during rounds. Although the use of hand held computers has become common in collecting operations data at nuclear stations, it is uncommon to see use of this equipment for chemistry data.

Ignalina, RBMK 1500, Lithuania
The reactor cavity gas sampling system has been modified so that the gas chromatographs have effectively become discontinuous on-line analysers. The gas samples that pass through the gas chromatographs are returned to the cavity. This not only enables chemistry staff to perform rapid sampling and analysis if required but also reduces personnel exposure as a result of grab sample activities.

Beznau, PWR 364, Switzerland
The pH adjustment of primary coolant is carried out by using LiOH that contains isotopically pure Li-7. This prevents the production of additional tritium by the Li-6 (n, alpha) H-3 reaction, resulting in a considerable reduction in coolant tritium activity. This has the beneficial effect of reducing the release of tritium into the environment.

7.3. Chemical surveillance programme

Bohunice, WWER-440, Slovakia
A continuous monitoring system is installed to monitor fission products in the primary coolant. The system consists of a pure germanium detector with adequate shielding. The measurement is

made in a bypass stream of the chemical cleanup system (comparable to the volume control system in a western PWR). The measuring cell consists of a 20 mm diameter and 50 cm long tube. Calibration is carried out using standard samples in a similar cell. The measurement time depends on the activity level in the coolant and is between 1 and 8 hours. This means that every 1 to 8 hours a new spectrum of coolant activity is provided. The system is connected to the network and the results can be monitored on a screen. The system provides operations with trendable data of fission products in the primary coolant and early indication of fuel leakage.

7.4. Chemistry operational history

Hamaoka 3/4, BWR 1100, Japan
The chemistry computer database has about 130 analysis codes that are useful in analysing chemistry data and producing reports. One analysis code calculates reactor pH and conductivity using anion and cation data from the on-line ion chromatograph and other manually input data. During a demonstration, the system quickly calculated reactor pH values consistent with those read by on-line monitors. This analysis is used to quickly and independently confirm the accuracy of on-line monitors.

7.7. Radiochemical measurements

Dampierre, PWR 937, France
Each twin unit chemistry section has at its disposal a complete alpha-spectrometry set. This equipment will only be used if the alpha-total measurement is above the detection limit. The fact that this measuring device is present on a nuclear power plant site is above international standards. The available redundancy is rather exceptional. These alpha-spectrometers were brought to the plant site in the light of the use of mixed oxide (MOX) fuel elements. That type of fuel is already present in Units 1 and 2 and will be loaded into the Unit 4 reactor next year. With the above mentioned equipment the chemistry sections are able to monitor efficiently an eventual alpha-contamination of the primary system and connected circuits.

The training programme to get acquainted with this equipment has been elaborated in cooperation with the training centre. This programme is integrating the Radiation Protection and Environmental Department doctrine on the subject and is essentially based on the Radiation Protection and Environmental reference procedure, for both the sample preparation and the measurement activities.

This equipment can also be used on fluids other than primary water. So it is an essential tool, especially for reactors with MOX fuel, to determine the origin and the amplitude of an eventual alpha-contamination.

8. EMERGENCY PLANNING AND PREPAREDNESS

8.2. Emergency plans

Bohunice, WWER-440, Slovakia
The plant teledosimetric system is an on-line monitoring system of emergency and environmental radiation measurements for both on-site and off-site. Its use for normal environmental monitoring provides added value and maximizes detection of any system faults. The system is comprised of the following:

- A ring of 24 gamma dose rate monitors for 1&2 and 3&4 plants.
- A cluster of 15 fixed points in villages within 6 km of the site.
- Four full monitoring stations in areas of greatest population; includes gamma dose rate, radioiodine activity and aerosol activity measurements.
- Also included is data acquisition from the on-site real time meteorological measurements, and other plant measurements such as stack emissions and hermetic chamber dose rates.

This information is remotely available to both the plant dosimetry control rooms and the main computer in the external dosimetry lab. The system reduces reliance on the dispatch of off-site radiation monitoring teams. Detection of radiological environmental releases can be quickly determined.

Bohunice, WWER-440, Slovakia
An effective emergency warning and notification system exists at the plant to provide prompt notification to members of the site emergency response organization, towns and villages within 30 km and other response organizations. The system is a combination of several computer aided subsystems. The system is comprehensive, diverse and regularly tested to ensure reliability. The system is comprised of the following integrated components:

- Zuzana — an automatic telephone notification system using state and reserve telephone network. The system notifies 106 home and work locations of site employees and 213 telephone contacts in villages and towns within the 30 kilometer planning zone.
- HADOS — 1400 radio receivers within the 30 km zone which receive an alphanumeric code related to emergency notification. The HADOS signal is transmitted on the transmission network of the power supply system. The national authorities also receive transmission of this coded signal as well as verbal notification.
- HERKUL — 413 sirens in the 30 km zone are activated by a remote transmission signal on the power supply system.

This system reduces reliance and demand on staff resources for manually making notifications and warning. This provides greater time to deal with the other priority actions in an emergency situation.

8.6. Training, drills and exercises

Beznau, PWR 364, Switzerland
The plant constructs emergency exercise scenarios to test perceived weaknesses in the emergency preparedness programme. By testing areas of the programme that are potential weaknesses, important needs for improvement are identified more effectively, and corrective actions can be completed more timely. Examples of how this approach has been used to test and improve the plant's response capability are as follows:

- During a limited scope drill, the transfer of emergency staff functions from the administration building to the bunkered safety systems emergency staff room were exercised three times to maximize efficiency.
- Last year, a rapid release of radioactivity was used in the exercise to evaluate the problem of alerting the local communities and region of lower consequence, prompt releases. This was a weakness identified in earlier federal exercises.

- Last year, the rapid release scenario of the exercise focused attention on weaknesses in federal plans for providing information to the media during the early stages of an emergency.
- Eight years ago, the emergency exercise scenario involved a fire in the switchgear room, a vulnerability identified in the plant probabilistic safety assessment.

Many plants conduct exercises to demonstrate their strengths. The plant's approach is more effective for achieving improvements in emergency preparedness.

PART IV

"OSMIR" OSART MISSION RESULTS DATABASE

DESCRIPTION OF THE DATABASE

OSART mission results have been incorporated into a database known as **OSMIR**, an acronym for **OSART Mission Results**. The database covers all missions since January 1991 up until the most recent mission, the official report of which has been published. The results of follow-up visits are also included.

The information included in the OSMIR database is the same as the results contained in mission reports, except for minor editing such as replacing plant/utility specific terms and abbreviations with more universally understood terms.

To date the results of 36 OSART missions and 18 OSART follow-up visits have been incorporated covering the reviews carried out from 1991 to 1997. The information is filed according to:

- Mission identification: plant information, e.g. name, country, reactor type and size, mission dates, type of mission, etc.

- Mission results: currently over 1800 recommendations, 1150 suggestions and 300 good practices, each of which is categorized by review area (9) and topic (76) together with a statement of the issue related to each recommendation and suggestion.

- Follow-up visits: includes information on the actions taken by the NPPs in response to each recommendation and suggestion of the original mission, and IAEA team members' judgement on the effectiveness of remedial actions and progress made in implementing the improvements.

Results are defined in the OSART Guidelines, 1994 Edition, IAEA-TECDOC-744. Using this definition, the results are classified in OSMIR as:

Search key:	**Result:**
R	. Recommendations
S	. Suggestions
G	. Good Practices

OSMIR is composed of several tables and contains all technical and administrative references described below:

Technical:	**Administrative:**
. Plant name	. Mission No.
. Reactor type and size	. Country
. Plant status	. Mission dates
. Mission type	. Report status date

One table in OSMIR contains all the OSART mission results in memo fields. Each recommendation and suggestion is logged in two member fields named *issue* and *result*. The issue explains what the problem is, while the result recommends or suggests a specific action to solve the problem. Consequently, to fully understand the concern, both *issue* and *results* should be retrieved together. In some instances *issues* are not provided.

An other table in OSMIR contains the OSART follow-up visit results. These results are logged in three memo fields, *Plant Response, IAEA Comment* and *Status of the Issue*. Not all OSART missions have follow-up visits.

Examples of searches that can be made in the database range from global searches, for example, all findings related to a review area, e.g. training and qualification, to specific searches, for example, looking for recommendations of generic significance for a given topic at WWER plants that have been assessed during a follow-up visit as having been satisfactorily responded to.

Availability

OSMIR has been offered to nuclear power plants, utilities, regulators, research institutes and organizations directly involved in the fuel cycle, as a source of information that can help them strengthen nuclear safety performance.

The OSMIR database has been set up using MS Access 2.0. Consequently, to readily operate this database the user should be familiar with Windows and Access. The tables however, can be exported to other databases in the market, such as: Paradox 3.X/4.X, FoxPro 2.0/2.5/2.6 and dBASE III/IV. Copies of OSMIR are supplied on one diskette in compressed (zip) format using the compression/de-compression software programme "WINZIP".

To receive an OSMIR database diskette, a request should be send to the address below:

M. Domenech
NSNI-OSS
International Atomic Energy Agency,
Wagramer Strasse 5, P.O. Box 100
A-1400 Vienna, Austria
Fax: +43 1 20607
E-mail: M.Domenech@iaea.org

LIST OF KEY TOPICS

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1 Corporate organization and management
2 Plant organization and management
3 Quality assurance programme
4 Regulatory and other statutory requirements
5 Industrial safety programme
6 Document and records management
7 Site access control (optional)

2. TRAINING AND QUALIFICATION

1 Organization and functions
2 Training facilities, equipment and material
3 Control room operators and shift supervisors
4 Field operators
5 Maintenance personnel
6 Technical support personnel
7 Radiation protection personnel
8 Chemistry personnel
9 Management personnel
10 General employee training

3. OPERATIONS

1 Organization and functions
2 Operations facilities and operator aids
3 Operating rules and procedures
4 Operating history
5 Conduct of operations
6 Work authorizations
7 Accident management
8 Fire protection programme

4. MAINTENANCE

1 Organization and functions
2 Maintenance facilities and equipment
3 Maintenance programmes
4 Procedures, records and histories
5 Conduct and control of maintenance work
6 Material conditions
7 In-service inspection
8 Stores and warehouses
9 Outage management

5. TECHNICAL SUPPORT

1 Organization and functions
2 Surveillance programme
3 Operational experience feedback system
4 Plant modification system
5 Reactor engineering
6 Fuel handling
7 Safety related computer applications

6. RADIATION PROTECTION

1 Organization and functions
2 Radiation work control
3 Internal radiation exposure
4 Radiation protection instrumentation, equipment and facilities
5 Personnel dosimetry
6 Radioactive waste storage and discharge
7 Radiation protection support during emergencies

7. CHEMISTRY

1 Organization and functions
2 Chemistry control in plant systems
3 Chemical surveillance programme
4 Chemistry operational history
5 Laboratories, equipment and instruments
6 Quality control of operational chemical
7 Radiochemical measurements

8. EMERGENCY PLANNING AND PREPAREDNESS

1 Emergency organization and functions
2 Emergency plans
3 Emergency procedures
4 Emergency response facilities
5 Emergency equipment resources
6 Training, drills and exercises
7 Liaison with public and media

9. COMMISSIONING

1 Organization and management of commissioning
2 Commissioning programme
3 Training in commissioning
4 Preparation and approval of test procedures
5 Control of test and measuring equipment
6 Conduct of test and approval of test results
7 Maintenance during commissioning
8 Interface with operations
9 Interface with construction
10 Interface with engineering
11 Initial fuel loading
12 Plant handover
13 Work control and equipment isolation during commissioning
14 Control of temporary modifications

TABLE 1. OSART MISSIONS IN 1995 AND 1996

MISSIONS				AREAS									REPORT
#	TYPE	PLANT, COUNTRY	DATES	MOA	TQ	OP	MA	TS	RP	CH	EPP	DR	
78	OSART	Flamanville, France	30 Jan.- 17 Feb. 1995	x	x	x	x	x	x	x	x		D
79	OSART	Hamaoka 3&4, Japan	27 Feb.- 16 Mar. 1995	x	x	x	x	x	x	x	x		D
81	OSART	Ignalina, Lithuania	4-22 Sept. 1995	x	x	x	x	x	x	x	x		D
84	OSART	Khmelnitsky-1, Ukraine	23 Oct. - 10 Nov. 1995	x	x	x	x	x					R
86	OSART	Beznau, Switzerland	13 Nov. - 1 Dec. 1995	x	x	x	x	x	x	x	x		D
90	OSART	Bohunice 3&4, Slovakia	10-27 Sept. 1996	x	x	x	x	x	x	x	x		D
91	OSART	Daya Bay, China	7-25 Oct. 1996	x	x	x	x	x	x	x	x		D
93	OSART	Dampierre, France	11-29 Nov. 1996	x	x	x	x	x	x	x	x		D

ACRONYMS:

CH	=	Chemistry
D	=	Derestricted
DR	=	Design review
EPP	=	Emergency planning & preparedness
MA	=	Maintenance
MOA	=	Management, administration & organization
OP	=	Operations
R	=	Restricted
RP	=	Radiation protection
SRM	=	Safety Review Mission[(1)]
TQ	=	Training & qualification
TS	=	Technical support

[(1)]In Safety Review Missions, only the operational safety review areas are presented in the report.

TABLE 2. FOLLOW-UP VISITS IN 1995 AND 1996

MISSIONS				AREAS									REPORT
#	TYPE	PLANT, COUNTRY	DATES	MOA	TQ	OP	MA	TS	RP	CH	EPP	DR	
73	OSART	Cattenom, France	12-16 June 1995	x	x	x	x	x	x	x	x		D
74	OSART	Hunterston B, UK	9-13 Oct. 1995	x	x	x	x	x	x	x	x		D
55	SRM	Novovoronezh, Russia	27 Nov.- 1 Dec. 1995	x	x	x	x	x	x	x	x	x	R
53	SRM	Kozloduy 1&4, Bulgaria	15-19 Jan. 1996	x	x	x	x	x	x	x	x	x	R
52	SRM	Bohunice 1&2, Slovakia	6-10 May 1996	x	x	x	x	x	x	x	x	x	R
78	OSART	Flamanville, France	3-7 June 1996	x	x	x	x	x	x	x	x		D
79	OSART	Hamaoka 3&4, Japan	10-14 June 1996	x	x	x	x	x	x	x	x		D
77	OSART	Leibstadt, Switzerland	11-15 Nov. 1996	x	x	x	x	x	x	x	x		D

ACRONYMS:

CH = Chemistry
D = Derestricted
DR = Design review
EPP = Emergency planning & preparedness
MA = Maintenance
MOA = Management, administration & organization
OP = Operations
R = Restricted
RP = Radiation protection
SRM = Safety Review Mission[(1)]
TQ = Training & qualification
TS = Technical support

[(1)]In Safety Review Missions, only the operational safety review areas are presented in the report.