IAEA
International Atomic Energy Agency

OSART guidelines

2005 Edition

Reference report for
IAEA Operational Safety Review Teams
(OSARTs)

Vienna, July 2005

Services Series 12

IAEA SAFETY RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish or adopt standards of safety for protection of health and minimization of danger to life and property, and to provide for the application of these standards.

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Safety standards are coded according to their coverage: nuclear safety (NS), radiation safety (RS), transport safety (TS), waste safety (WS) and general safety (GS).

Information on the IAEA's safety standards programme is available at the IAEA Internet site

http://www-ns.iaea.org/standards/

The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at P.O. Box 100, A-1400 Vienna, Austria.

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Reports on safety and protection in nuclear activities are issued in other publications series, in particular the **Safety Reports Series**. Safety Reports provide practical examples and detailed methods that can be used in support of the safety standards. Other IAEA series of safety related publications are the **Provision for the Application of Safety Standards Series**, the **Radiological Assessment Reports Series** and the International Nuclear Safety Group's **INSAG Series**. The IAEA also issues reports on radiological accidents and other special publications.

Safety related publications are also issued in the **Technical Reports Series**, the **IAEA-TECDOC Series**, the **Training Course Series** and the **IAEA Services Series**, and as **Practical Radiation Safety Manuals** and **Practical Radiation Technical Manuals**. Security related publications are issued in the **IAEA Nuclear Security Series**.

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FOREWORD

The International Atomic Energy Agency (IAEA) has put forward the vision of a global nuclear safety regime that provides for the protection of people and the environment from the effects of ionizing radiation from nuclear facilities, the minimization of the likelihood of accidents that could endanger life and property and effective mitigation of the effects of any such events should they occur.

The strategic approach for achieving the vision of enhancing this regime involves four elements and aims at ensuring that the overall nuclear safety level in Member States continues to improve:

- Improvement of national and international safety infrastructures:
- Establishment and global acceptance of IAEA safety standards;
- Integrated approach to the provision for the application of safety standards; and
- Global network of knowledge and experience.

The IAEA Operational Safety Review Team (OSART) programme provides advice and assistance to Member States to enhance the safety of nuclear power plants during commissioning and operation. The OSART programme, initiated in 1982, is available to all Member States with nuclear power plants under commissioning or in operation. The OSART methodology and its safety services may also be applied to other nuclear installations (e.g. fuel cycle facilities, research reactors).

Conservative design, careful manufacture and sound construction are all prerequisites for safe operation of nuclear power plants. However, the safety of the plant depends ultimately on sound policies, procedures, processes and practices; on the capability and reliability of the commissioning and operating personnel; on comprehensive instructions; and on adequate resources. A positive attitude and conscientiousness on the part of the management and staff in discharging their responsibilities is important to safety. OSART missions consider these aspects in assessing a facility's operational practices in comparison with those used successfully in other countries and when exchanging ideas, at the working level, for enhancing safety.

The OSART programme is based on the IAEA's Nuclear Safety Standard Series (Fundamentals, Requirements and Safety Guides) for nuclear power plants and the Basic Safety Standards for Radiation Protection. The Nuclear Safety Standards reflect the consensus of Member States on nuclear safety matters. The reports of the International Nuclear Safety Advisory Group, identifying important current nuclear safety issues also serve as references during an OSART review. The OSART Guidelines provide overall guidance for the experts to ensure the consistency and comprehensiveness of the operational safety review. Additional guidance and reference material prepared by the IAEA and the expertise of the OSART members contribute to the bases of the review.

OSART reviews are performance oriented in that they accept different approaches to commissioning and operational safety that represent good practices and may contribute to ensuring a good safety record on the part of the operating organization. Recommendations are made on items of direct relevance to safety, whereas suggestions made might enhance plant safety indirectly but would certainly improve performance. Commendable good practices

identified at plants are communicated to other plants where relevant in order to effect improvements.

This revision of the OSART guidelines supersedes the 1994 Edition (IAEA-TECDOC-744).

The IAEA officer responsible for this publication was G. Vamos of the Division of Nuclear Installation Safety.

EDITORIAL NOTE

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I. INTRODUCTION

1.1. PURPOSE

These guidelines have been prepared to provide a basic structure and common reference both across the various areas covered by an OSART mission and across all the missions in the programme. As such, they are addressed, principally, to the team members of OSART missions but they will also provide guidance to a host nuclear plant preparing to receive a mission. In particular the reference documentation is valuable reading for staff at the host nuclear plant.

An OSART review of a nuclear power plant is based on publications describing the plant and its structures, systems and components; the organization, training and qualification of plant personnel; written procedures applicable to the operation of the plant; interviews and discussions with plant personnel; observations of plant material conditions and operating practices; and the records and reports of its operating history. The review focuses on performance in various areas important to safety, the managerial aspects of policy implementation, the control of activities, verification and correction, as well as document control. An OSART review may take place also at a nuclear power project at the critical commissioning phase when many decisions are being taken that will affect operational safety throughout the life of the plant (pre-operational OSART).

OSART guidelines have been developed in the following areas and are presented in Section 3.1 to 3.10:

1. Management, organization and administration
2. Training and qualification
3. Operations
4. Maintenance
5. Technical support
6. Operating experience feedback
7. Radiation protection
8. Chemistry
9. Emergency planning and preparedness
10. Commissioning

Since an OSART may be carried out at any time during the lifetime of a nuclear power plant after the commencement of construction, the areas to be reviewed will depend on the status of the project. Normally areas 1 to 9 will be reviewed at an operational plant. This is the ‘core OSART mission’ offered by IAEA. If the review is carried out close to the time of commissioning the review will use all guidelines from 1 to 10. If the review is requested to be performed in the construction phase, the guidelines for the specific areas related to construction (project management, civil engineering and construction, mechanical equipment installation, electrical and I&C equipment installation, quality assurance in construction and commissioning, preparations for startup and operation) should be agreed upon with the originator of the request, with reference to the relevant sections of the 1994 edition of the OSART guidelines.

It is important to note that an OSART review is a flexible service. The review areas can be tailored according to the request of the host plant. The actual scope of the mission is defined

and agreed during the preparatory meeting, which is normally conducted one year before the mission.

The guidelines are intended to help each expert to formulate his review in the light of his own experience. They are not all inclusive and should not limit the expert's investigations, but are better considered as illustrating the comprehensive requirements for his review. The reviewers should keep in mind that it is practically impossible to cover the whole scope of a given section of the guidelines in the same depth in the timeframe of a mission. Therefore it is expected that based on the advance information and the results of the first part of the review, the experts apply judgement to decide which topics need more in-depth evaluation.

1.2. OBJECTIVES OF OSART MISSIONS

The OSART is intended to be a peer review conducted by a team of international experts with direct experience applicable in the technical areas of evaluation. Judgements of performance are made based on IAEA Safety Standards and the combined expertise of the international team. The review is therefore not a regulatory inspection nor audit against national codes and standards. Instead, it is a technical exchange of experiences and practices at the working level aimed at strengthening the programmes, procedures and practices being followed.

The key objectives of the mission are:

- to provide the host country (regulatory authority, plant/utility management and governmental authorities) with an objective assessment of the status of the operational safety with respect to international standards of operational safety and performance;
- to provide the host plant with recommendations and suggestions for improvement in areas where performance falls short of international best practices;
- to provide key staff at the host plant with an opportunity to discuss their practices with experts who have experience of other practices in the same field;
- to provide all Member States with information regarding good practices identified in the course of the review;
- to provide experts and observers from Member States and the IAEA staff with opportunities to broaden their experience and knowledge of their own field.

1.3. METHODOLOGY FOR OSART MISSIONS

1.3.1. Preparation

On receipt of a request for an OSART mission, an IAEA team leader will be assigned to carry out the following:

- Establishment of liaison contacts at the utility and regulatory authority;
- Arrangement of a preparatory meeting with the plant management and other organizations involved;
- Recruitment of external experts for the team.

At the same time, the plant management in the host country should nominate a contact person with whom the team leader may correspond.

The preparatory meeting, usually attended by the team leader and deputy team leader, is held at the plant site (approximately 12 months prior to the mission) to allow plant management, counterparts and other organizations involved to participate. The meeting covers:

- The main features of the OSART programme;
- The exact scope of the review, reflecting the request of the host plant;
- Plant management's preparation for the review;
- Preparation of the advance information package;
- Logistic support required;
- Financial arrangements.

Following the meeting, the IAEA will recruit the team members and the plant management should designate one counterpart for each area of review, who will be the contact person for the corresponding team member during the review.

The plant should designate a host plant peer with the following characteristics, roles and responsibilities:

- The host plant peer is a company staff member with good overall knowledge of plant, programmes and plant staff. Good English language skills;
- During the three weeks of the mission the host plant peer does not have any plant responsibilities. At the same time the host plant peer is not an IAEA team reviewer. His/her main role is to act as a liaison officer between plant and the IAEA team;
- The host plant peer participates in the OSART team meetings, advises the OSART team members when information may not be complete or correct;
- In case of misunderstanding or issues needing further clarification, the host plant peer advises the OSART team who are the responsible or knowledgeable plant staff in specific areas that could provide clarification to clear the misunderstanding.

1.3.2. Team composition

The team is composed of a team leader, who is always an IAEA staff member, and up to ten experts, and a deputy team leader and up to three observers. The areas of operations and technical support are usually reviewed by two experts. The desired team composition is a majority of external consultants (usually senior managers from other nuclear power plants) and 2 or 3 persons of IAEA staff, including the team leader and the deputy team leader. Every effort will be made to recruit experts from member states, while ensuring that quality of team composition remains of high level. No one from the host country's nationality is included in the team.

1.3.3. The review

The OSART team uses four steps to acquire the information needed to develop their recommendations as set out in the experts technical notes' (Section 3.5). These are:

- review of written material;
- interviews with personnel;
- direct observation of performance, status and activities both at site and at off-site facilities;
- discussion of evaluations/tentative conclusions with experts.

Experts are expected to cover each topic to the extent necessary to be able to make informed judgements. Opportunities for improvement identified should be addressed to the degree required to document the issues in the experts' technical notes with sufficient facts necessary to make the issue understandable and accurate. Formulation of recommendations and suggestions should be based on the identified weaknesses. Similarly, good practices discovered during the process of the review that should be documented for the benefit of other Member States are described in the technical notes in sufficient detail as to be readily understood.

Security issues are not in the scope of the OSART review. However if such issues are identified during the review, they should be brought only to the attention of the plant manager.

Documents
Documents of general interest to the whole team are included in the advance information package (AIP), while those specific to a given area that are to be reviewed only by the expert responsible are set out in the appropriate section of the specific guidelines.

Interviews
Interviews with personnel can then be used to:

- Provide additional information not covered by the documentation;
- Answer questions, and perhaps satisfy concerns arising out of the documentation review;
- Form a judgement of their understanding of the arrangements and their own duties and responsibilities;
- Establish whether the individuals are satisfied with the formal arrangements;
- Form a judgement of their competence, professionalism and commitment to nuclear safety.

The interviews are also used to provide the opportunity for all the important information to be exchanged between experts and counterparts, and therefore should be held at the working level between peers. These interviews should be a 'give and take' discussion and not an interrogation of the counterparts by the experts. Properly conducted, these interviews are possibly the most important part of the OSART mission.

Direct observation
Direct observation of the plant and work activities underway is an important aspect of the review process. A substantial part of the review period is spent at the plant reviewing procedures and practices in use. Plant workers may be interviewed to gain an impression of their technical knowledge, skills, attitudes and morale. The observation of work should include safety practices, use of procedures, drawings and instructions, quality control measures in use, supervision of activities and management control of work. From these observations, the reviewer will form a view of:

- The way the arrangements are put into effect at the point of work;
- The technical knowledge and skills of the work force;
- The attitude and morale of the work-force;
- Supervision of work by management;
- The extent of commitment to safety objectives.

Based upon the interviews and observation the reviewer can then if necessary modify his preliminary view, which was based only on the formal arrangements, to form a judgement of performance. It may be that more than one iteration through document review, interview and observation is necessary in order to gain sufficient facts to form a judgement.

1.3.4. Evaluation criteria

The internationally accepted IAEA Safety Standards serve as main evaluation criteria. Those Safety Standards (requirements and guides), INSAG reports and safety series reports which contain information relevant to the OSART review, are listed in References of the guidelines. OSART members are selected to ensure that a variety of national approaches to operational safety are represented. Each expert invariably has, in addition to his particular area of expertise, knowledge of some other national approaches and some other relevant areas. Coupling this knowledge with the IAEA Nuclear Safety Standards allows the best international standards to be identified.

In the evening of each working day of the review, the team leader calls a meeting of 1 to 2 hours duration where each expert summarizes his concerns developed during the day, including perceived strengths and weaknesses. This creates an opportunity for other team members to contribute their views, further strengthening the experience base of the evaluation. It is important that each expert comes to the meeting prepared to make a concise statement of his findings, in order to allow the other review areas to be discussed at the same meeting.

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

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

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

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

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

- Novel;
- Has a proven benefit;
- Replicable (it can be used at other plants);
- Does not contradict an issue.

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

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

1.3.5. Reporting

Technical notes
During the course of the review, after each evening meeting, each team member writes detailed technical notes on his observations and conclusions, including any recommendations, suggestions, encouragements good practices or good performances. These form the basis of oral presentations at the exit meeting. One or more copies of the technical notes are given to the plant manager prior to the exit meeting.

Each recommendation and suggestion, whenever possible, is referenced to the relevant requirement of an IAEA Safety Standard. The team members are asked to provide feedback on the application of the IAEA Safety Standards (e.g. which parts need to be updated, what issues could not be referenced to the standards).

The technical notes are the 'field notes' of the individual experts and are considered by the IAEA to be restricted documents. As such they are not to be released to be public or derestricted by the utility. A copy of the technical notes should not be provided to the regulatory authority by the utility if the notes will in turn be made public. The utility, however, is encouraged to let the regulatory authority read the technical notes at the plant site.
OSART report

On completion of the review, the team leader will prepare the OSART report, based on the technical notes. This is an official IAEA publication, which summarizes the team's main observations and conclusions including, all recommendations, suggestions and good practices. Before the text is finalized, the utility and regulatory authority concerned are given the

opportunity to offer comments. This report is submitted through official channels to the Member State which requested the OSART. The IAEA restricts initial distribution to itself, members of the review team and the utility and regulatory authority involved. The report is automatically derestricted after 90 days unless the Member State indicates otherwise. Most Member States have improved their transparency with the media and the public by placing the derestricted report on their official public web site.

1.3.6. Schedule

Immediately preceding the review, team members are required to attend a training of about two days duration led by the team leader. This provides an opportunity for them to meet and resolve any questions not covered in these guidelines.

The two weekends in the review period are left free allowing 13 working days which are scheduled as follows:

Day 1: Entry & Introduction Plant entry formalities, introduction to security, radiation protection and industrial safety requirements. General plant tour. Meet counterparts and agree to review schedule.

First two weeks of Review: Each expert schedules his own review hi advance and agrees it with his counterpart on day 1. The second Saturday of the review is a teamwork day so that the experts can complete their technical notes and issue statements.

Monday of the third week: Review of results with the whole team

Tuesday of the third week a.m.: technical notes feedback to plant counterparts
p.m. technical notes finalization

Wednesday of the third week: a.m. Preparation for exit meeting
p.m. Exit meeting

1.3.7. OSART follow-up mission

As a general practice, 18 months after an OSART Mission a follow-up evaluation is conducted. The plant informs IAEA about the response or actions that have been decided to address the recommendations and suggestions of the OSART report. During follow-up visits a team of about four persons including the team leader 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.

After the follow-up mission, during preparation of the final report, the detailed facts should be removed from each issue. As the result each issue will comprise the following:

- Fundamental overall problem;
- It's safety consequence;
- Plant response/actions;
- IAEA comments;
- Conclusions.

1.4. IDENTIFYING ISSUES RELATED TO SAFETY CULTURE DURING OSART MISSIONS

An important aspect to be evaluated by the experts in all areas during the conduct of an OSART mission is safety culture. The concept of safety culture was developed by the International Safety Advisory Group (INSAG) and is explained in the IAEA Publication No. 75-INSAG-4 "Safety Culture". Safety culture is defined "as that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance". INSAG provided pragmatic and practical advice in the report INSAG-15 Key Practical Issues in Strengthening Safety Culture.

Safety culture and safety management are interrelated concepts. The structural aspect of safety culture comprises the organization's arrangements for safety, which is commonly described, as the safety management system for the organization. Organizations having a

strong safety culture will have an effective safety management system with the support and ownership of all staff. However, the safety management system has a broader role in that it provides a framework by means of which the organization ensures good safety performance throughout the planning, control and supervision of safety related activities. The safety management system, in turn, provides a means by which the organization promotes and supports a strong safety culture. The report INSAG-13 deals with management of operational safety in nuclear power plants.

The MOA reviewer reviews management of safety. To form a judgement on the effectiveness of safety culture is a team effort, coordinated by the deputy team leader, under supervision of the team leader. The OSART does not perform a comprehensive review of safety culture. The team identifies facts and issues, which are relevant to safety culture. These issues are brought to the attention of the plant management in the report, leaving the responsibility of assessing these issues and the ownership of the actions based on them with the plant management.

In the appendices to INSAG-4, INSAG-13 and INSAG-15 there is a list of questions, which should be used by the reviewers in order to form judgements as to the effectiveness of safety culture in an organization or in individuals. Some questions are only applicable to some review areas and some to all review areas. The questions are intended to be used by the reviewers in order to aid identification of facts related to safety culture. They are not intended to be asked directly to the plant counterparts by the reviewers since in this case they may only invite obvious yes/no responses. The reviewers should question their counterparts and plant staff about programmes and procedures and observe how people perform work in order to develop their opinions about safety culture. The reviewers should then ask themselves these questions in order to determine if the particular safety culture aspects are apparent in the specific area being reviewed. Further guidance is available in Safety Reports Series No. 11, IAEA-TECDOC-1321, IAEA-TECDOC-1329. The role of the deputy team leader during an OSART mission is to assist the experts to identify facts related to safety culture and highlight the particular aspects of safety culture in their review areas. The team leader and deputy team leader will then organize further activities in the following manner:

- Facts relevant to safety culture should be discussed during daily team meetings;
- During the second week team members will be asked to give the most important strengths and weaknesses (up to 5 each) that they have identified in relation to safety culture;
- Based on this information the deputy team leader will draft summarized conclusions relating to safety culture at the given plant, and this will be discussed during the third Monday's team meeting;
- The final result will be incorporated into the "Management of safety" subsection of the MOA section of the report, with a summary in the executive summary of the report.

2. PRACTICAL HINTS FOR REVIEWERS CONCERNING OBSERVATIONS

2.1. INTRODUCTION

The process used to obtain information on items during the review of operational safety practices in a nuclear power plant should be based on observations, interviews and document reviews with focus on essential aspects of plant performance.

As far as possible important activities and facilities should be witnessed to allow the reviewer to judge operational safety performance. In the following part of the guidelines we provide practical hints for performing observations effectively.

2.2. OBSERVATIONS

A fundamental part of the OSART methodology is the observation of ongoing plant activities. The performance of several individuals is likely to be representative of all personnel within a discipline or group. The results of management's effort to implement station policy and procedures, and the effectiveness of training, are exemplified by these individuals. Therefore, it is inappropriate to treat these observations as a reflection on an individual. Instead, the observations should be treated as being characteristic for the functioning of the organization, and the persons involved should remain anonymous.

Each OSART focuses on those aspects of the utility organization that are important in achieving quality and high standards in the end product. Accordingly, the OSART generally concentrates on those activities that the utility has identified as sufficiently important to require the establishment of some system, such as a written document, to control the activity. This system is first evaluated for its adequacy, i.e. the degree to which it incorporates appropriate details and controls to ensure that the desired result is achieved. As a second part of the review process, the team determines whether or not this system has been implemented, i.e. is the system 'in place' and actually being utilized by the personnel? The final and most important part of the review process is the determination of the quality of the results being achieved by the utility. A significant portion of each review, therefore, is devoted to observing personnel of the utility performing their day to day work. By perfecting observation skills, the expert is able to see conditions and situations that generally are symptomatic. Attention to detail is paramount. The expert must have a broad outlook and be critical of his surroundings and the ongoing activities. Information obtained through observation becomes an important foundation for the overall review results.

Numerous activities at a plant contain the necessary elements that make an observation worthwhile. In selecting an activity and planning for the observation segment of the review, there are several questions that can be considered to help in deciding the most beneficial course of action. Some basic questions with discussion are as follows:

- Is the system/work important to safety? Observations need not necessarily involve safety related work; however, if the work is safety related or important to safety, the results of the observations will carry considerable more impact. That is, work important to safety should be controlled in a manner that promotes excellence. If deficiencies in this type of work are noted, they may be significant in themselves.

- Is the work of sufficient complexity that a written procedure has been developed? For many of the activities that are observed, a procedure has been developed by the utility to ensure that specific steps are accomplished in a required manner such that the end product meets a minimum quality standard.
- Does the work involve several departments or disciplines? Although single discipline observations can be productive, those that require the cooperative effort of several elements of the plant organization often provide a more significant input to the team's effort to evaluate the plant.

In selecting an activity to observe, the expert is looking for performance of an individual that is representative of the utility's ability to train its personnel and implement its policies and procedures. With the appropriate selection of activities, the results of the observations will provide an overall reflection of the utility's performance. Care should be taken not to identify the specific individual, time, and place of the observation. This aids in focusing on the symptomatic results rather than the individual.

2.3. CONDUCTING OBSERVATIONS

Preparation

Preparation is the key element of all phases of a review. The two most important parts of the preparation phase are the determination of ‘what’ and ‘when’. The what to observe can be determined by establishing liaison with the utility to ascertain what activities will be going on during the period of the review. This will enable the expert to plan for specific activities and to conduct the necessary research and study. Other observations will be on an 'as occurring' basis. The 'when to observe' question is answered best by 'the earlier the better'. By conducting results oriented observations in the first few days of an OSART, the expert gains considerable insight into weaknesses within the organization. This then enables him to properly direct his activities during the remainder of the OSART. The guiding principle for preparation is for the expert to read the appropriate procedures, directives, codes, regulations, and similar documents prior to observing the work activity.

Initiating the observation

Most observations should be planned in advance and arrangements made as to when and where the expert(s) will meet with the individual(s) who will be the subject of the observation. Most observations begin at the beginning of the shift or, for particular work assignments, at the beginning of the work. For example, if the subject of the observation is an item of preventive maintenance, the observation should commence when the worker initiates action to obtain the necessary paper work and tools to perform his task.

Experienced OSART members will plan their schedules such that a primary and an alternate objective are always scheduled. For example, a morning schedule could call for a primary objective of observing a work activity and an alternate objective of reviewing documentation so that delays in the work activity will not result hi lost time for the expert. The reviewer merely shifts attention to the alternate objective while awaiting resumption of the primary objective. Reviewers must place due emphasis on the management of their time to avoid wasting it.

Observing

Establishing good rapport with the individuals under observation is important. They should understand that the purpose of the observation is not to criticize them personally, but to look

for both good practices and flaws in station training procedures, policies, and practices and their implementation. Except in the case of *immediate hazard* to plant equipment or personnel safety, reviewers should not interfere with plant evolutions. Questions are a necessary part of an observation, but should be asked at times when they do not adversely affect the performance of the individual being questioned.

The expert should be looking, in a broad manner, at many items during the observation process. The following illustrate the extent of the desired sphere of interest:

- To what degree does the individual being observed understand the basic objectives and policies of the utility regarding quality work and adherence to procedures?
- What training has the individual received that relates to his activities during this observation?
- What are the industrial safety and material conditions in all areas encountered during this observation?
- Do supervisors monitor the work activity? Do they provide appropriate guidance and training?

Subsequent to observing the work activity, the reviewer organizes his notes and commences analysis of his observations. This process generally results in the need for follow-up action in order to resolve unanswered questions. This follow-up may require a return to the physical area of the plant to confirm or gather further information.

2.4. ACTIVITIES TO OBSERVE

The following examples are valid for an operating plant and illustrate the type of activities that generally provide a good indication of overall performance.

- Organization/Administration
    - plant safety committee meeting
    - outage planning meeting
    - plant manager's daily or weekly meeting

- Training
    - simulator training
    - requalification training
    - general employee training
    - training facilities

- Routine Operations
    - shift turnover
    -
    - on-the-job training
    - control room evolutions
    - system/component clearance activities
    - work authorization
- Quality Inspections
    - assistant unit operator outside rounds
    - turbine building operator rounds
    - nuclear plant operator rounds

- accompany industrial safety inspector on tour
- accompany quality control inspector on job
- new fuel receipt and inspection

- Corrective Maintenance
  - resetting of relief valves
  - electrical work on breakers
  - major pump realignment
  - installation of reactor system valves
  - equipment repairs

- Preventive Maintenance
  - rotating equipment preventive maintenance
  - insulation resistance to ground checks

- Surveillance Testing
  - emergency diesel generator testing
  - high pressure safety injection pumps
  - reactor protective system checks
  - ECCS safety valves
  - pressure transmitters
  - room coolers
  - measuring and testing equipment

- Instrument Work
  - radiation protection survey instrument calibration
  - level transmitter calibration

- Radiation Protection Controls
  - radiation work permit
  - control point activities
  - waste compaction
  - swipe surveys
  - hot machine shop work
  - radioactive or contaminated work

- Chemistry Work
  - laboratory analysis
  - steam generator sampling
  - reactor system sampling

2.5. OBSERVATION TECHNIQUES

Take detailed notes. Sometimes apparently irrelevant material becomes meaningful when analysing and summarizing an evolution.

Log times when taking notes. These can be used to correlate plant responses and personnel actions noted by other reviewers in other portions of the plant.

Include procedure numbers and other reference information for follow-up.

Include questions and items to follow-up in the notes. Information could be lost if memory is trusted for recall later.

Include preparatory activities in the observation if possible. Watch the tagout. Watch how the mechanic gather tools and parts.

Do not assume - ask questions. Even if operator A told you the answer, ask operator B. (However, do not entrap people.)

Constantly ask yourself, 'Why is person being observed doing that? Is it the correct thing to do?' Note details.

Do not just observe the activity; observe the individuals and the surroundings. Look under, over, and around. Think beyond the evolution:

- Why doesn't the snubber have oil in it?
- Why is the wrench in use painted red?
- Where did that instrument come from?
- Why does the operator keep changing settings?
- How many management personnel have I seen?

Follow-up after the evolution is completed. Track paper, review the job with supervisors, and question the people who performed the task.

For evolutions of a longer duration, check periodically. Several thirty minute periods spread throughout the day can be meaningful as one 3-hour period.

2.6. OBSERVATION OF RADIATION WORK PERMIT (RWP) CONTROLLED WORK

Observation of radiological work conducted under a Radiation Work Permit can provide valuable insight into the effectiveness of the Radiation Protection Programme:

- Select a job involving significant radiological conditions. Obtain and examine copies of the surveys conducted to support the development of the Radiation Work Permit (RWP). Obtain and examine a copy of the RWP.
- Evaluate the quality of the RWP. Is the work to be done well described? Was the survey timely? Was the survey appropriate for the work? Is the required protective clothing and personnel dosimetry appropriate? Are the radiological protection requirements sufficient to assure safe work without being inappropriately restrictive or complicated?
- Attend the pre-job briefing. Were all persons involved present? How are briefings handled for work that spans more than one shift? Were all the RWP required safety requirements reviewed? Was the work discussed in sufficient detail to ensure that everyone understood exactly what was to be done and what actions were to be avoided? Was it made clear who was in charge? Was the authority of associated radiation protection personnel understood by all?
- Observe the work initiation. Was the work site adequately prepared to control contamination and minimize exposure? Is there sufficient room to remove protective clothing upon completion? Are areas and hot spots clearly marked? Are sufficient supplies and tools on hand to allow and encourage compliance with radiological requirements and to minimize exposure?

- Are radiation protection personnel present during the periods specified by the RWP? Are they fully equipped to do their job? Do they display a cooperative, 'team' attitude? Do they maintain radiological protection discipline?
- Do the workers display an understanding of radiation protection requirements? Do they display an understanding of the ALARA concept and the means to achieve it? Do they comply strictly with requirements?
- Proper supervision of radiological protection work is important. Determine the individual directly responsible for the radiation protection workers involved. Is the supervisor aware of the job? Does the supervisor come to the job site? In what aspects of the work does the supervisor become involved and what errors were detected? What actions did the supervisor take?

2.7. OBSERVATION AND EXAMINATION OF ROOT CAUSE EVALUATIONS

Examination of root cause evaluations can provide useful insight into the strength of the safety culture at the site under review. This applies to all divisions, including the radiation protection organization.

- Determine through record review and direct questioning, what unusual events have occurred recently. In the radiation protection area this might involve exposures above predicted values even though they may not exceed regulatory limits. Unusual contamination events or 'near misses' are other examples of events that require review and evaluation. A good source of information is any notation of changes to the dose equivalent assigned to an individual or special dose equivalent evaluations. Of course, matters that must be reported to the regulatory authority would also fall into this category.
- After developing a list of unusual events, select one or two that seem to be the most important. Verify that investigations and root cause analyses were done. Examine the investigations and root cause analyses.
- The following questions are pertinent: Is there a formal procedure covering investigation and root cause analyses? Is it designed to serve the goal of prevention of recurrence? Does it require a sufficiently thorough analysis? Does it require a determination of causes? Does it require recommendations to prevent recurrence? Does it require evaluation and approval by the appropriate level of management? Does it require submittal to the correct level of management? Does it require determination of compliance with regulatory requirements and reporting, where appropriate, to regulatory authorities? Does it require timely investigation, evaluation and reporting?
- Examine the investigation and analyses report. Was the investigation conducted by a qualified individual? What training and experience did he/she have? Did the individual go to original sources for information? Are there signed statements by the individuals involved or exposed? Was the investigation timely? Was the investigation thorough? Is the investigation impartial? Does it avoid supporting a point of view? Does it reflect an open attitude? Does it reflect a willingness to admit errors?
- Was the evaluation guided only by the facts? Were the causes identified, particularly the root cause? Were any important causes or factors overlooked? Does the investigation report reflect an inherently questioning attitude?
- Examine the recommended corrective actions to prevent recurrence. Were they appropriate? Were they sufficient? Were they practical? Were they

implemented? What follow-up actions were taken by management to assure full implementation?

- Finally, taking the report, cause determinations, recommended corrective actions and management follow-up as a whole, ask yourself these questions: Is this management committed to excellence and has this commitment been transmitted to and been accepted by those under its control? Was the matter handled with an open attitude? Is there indication of wariness toward complacency and a conscious effort to guard against it as reflected by an inherently questioning attitude a willingness to admit error and a clear and willing acceptance of responsibility?

3. SPECIFIC GUIDELINES

3.1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION[1]

The organizational structure of a nuclear power plant (NPP) must support the safe, reliable and effective performance and control of all power plant activities. The organization of the nuclear power plant provides the administrative and functional structure that determines where people are assigned, what they are to do, and how they are expected to accomplish their tasks. Policies, directives, procedures, goals and objectives and performance standards provide administrative controls and management direction to implement the organizational structure, to conduct all power plant activities and ensure safe operation of power plant. The organisational structure establishes formal relationships and lines of communication. Responsibilities and authorities for accomplishing assigned tasks should be clearly defined and communicated within the established organizational structure.

Management monitoring and assessment activities are integral parts of the administrative system to identify areas where performance is achieving the high standards expected by management as well as where performance is deviating from management expectations.

In addition, a sound safety management system should be established at the power plant as an integral part of the overall management system. The safety management system should comprise of those arrangements made by the operating organization that are needed to promote a strong safety culture and achieve and maintain good safety performance.

For this purpose the management, organization and administration (MOA) section of the guidelines includes NPP management practices as well as the quality assurance programme, the industrial safety programme, and document and records management that are also important elements of NPP management and contribute to the safe operation of NPP.

During the review, appropriate attention should be paid to special features of national culture, which may have a strong influence on management practices.

References:[6, 9–11, 15, 18, 24–29, 31–32, 38, 43–44 and 49]

3.1.1. Organization and administration

Expectations

The operating organization should establish for the plants under its control an organizational plan that indicates the general policies, lines of responsibility and authority, lines of communication, duties and number of staff and their required qualifications needed to run the plants. When new construction, retirement or other developments indicate that some critical plant personnel may leave the workforce, management should have plans for filling the openings with competent people.

[1] The IAEA is revising the requirements and guidance in the subject area of quality assurance as established in Safety Series No. 50-C/SG-Q (1996) in new safety standards on management systems for the safety of nuclear facilities and activities involving the use of ionizing radiation. The term ‘management system’ has been adopted in the revised standards instead of the terms ‘quality assurance’ and ‘quality assurance programme’. The new standards will integrate all the aspects of managing a nuclear facility, including the safety, health, environmental and quality requirements, into one coherent system.

The plant's documented organizational structure shall indicate the staffing arrangements within the categories of direct line operating personnel and supporting personnel. Functional responsibilities, levels of delegated authority and lines of internal and external communication for the safe operation of the plants in all operational states, for mitigating the consequences of accident conditions and for ensuring an appropriate response in emergencies, shall be clearly defined in writing. The extent to which the support functions are self-sufficient or dependent upon services from outside the plant organization shall be shown by means of functional organizational charts which include personnel resource allocations and specify the duties and responsibilities of key personnel. Likewise, the transfer of responsibility across interfaces should be clearly defined and understood.

Adequate financial and manpower resources and facilities should be made available to managers for the safe and efficient operation of the plant. Adequate provisions of qualified spares, materials and equipment should be consistent with the need for timely execution of safety-related activities. The management system should be supported by a well established human resources management programme that includes high standards for recruitment and selection of personnel, a well established performance appraisal system, and a promotion and succession-planning system that takes into account attitudes towards safety. A fitness-for-duty policy should be established that ensures individuals are physically and mentally fit to perform their job in a safe manner.

Suitably qualified and experienced persons shall perform all activities that may affect safety. The nuclear power plant shall be staffed with competent managers and a sufficient number of qualified personnel having a proper awareness of the technical and administrative requirements for safety and motivated to be safety conscious. Attitudes toward safety shall be a criterion for the hiring or promoting of managers. Staff performance appraisals shall also include the attitude towards safety.

Supporting activities provided by contractors should adhere to the same standards as plant quality and safety policies. The plant requirements relating to quality and competency of the contractor staff and work product should be at the same standard as the activities carried out by the plant staff. Contractors' staff shall be properly controlled and supervised by the plant staff.

To enable the regulatory body to perform its functions, the operating organization shall render all necessary assistance and shall grant access to the plant and documentation. Mutual understanding and respect between the regulatory body and the operating organization, and a frank, open and yet formal relationship, shall be fostered.

Recently in many countries the nuclear industry has been going through a period of significant changes. These changes arise from the political and business environment in which the industry must operate, and from within the industry itself as it strives to become more competitive. Changes to staffing levels, ways of working or organizational structure should be subject to analysis and independent review when proposed. These changes must be carefully considered with respect to potential impacts on nuclear safety. Changes should be monitored during and after implementation to ensure that they are not detrimental to safety. The need for change should be communicated to the staff and ownership of the need for change established with those involved.

Examples of documents to be available for review during the OSART mission:

- Corporate and plant organizational charts, including functional responsibilities;
- Corporate and plant strategic/business plans, with long term planning of goals and objectives, which should provide appropriate emphasis on safety;
- Final Safety Analysis Report (sections related to the plant organization);
- Selected job descriptions for plant management positions;
- Documentation reflecting the interface control between the plant and other organizations, including contractors;
- The documentation reflecting the staffing and recruitment policy;
- Terms of reference for Safety committees, meeting minutes and the records related to the action tracking system.

Evaluations

The MOA area of the OSART review is unique in the sense that some issues found in other review areas which are generic for the whole organization or apply to several other areas of the OSART review will be included into this section. At the same time duplication of review effort should be avoided by proper coordination of the MOA reviewer.

Organizational structure

Confirm by examination of documents and by interviewing managers that there exists a clearly defined and understood organizational structure. Confirm that the organizational structure covers all the factors that should be taken into consideration to ensure safe and reliable operation of nuclear power plant. Check the functional organizational charts to demonstrate the extent to which the support functions are self-sufficient or dependent upon services from outside the plant organization. Check if these charts include personnel resource allocation and specify the duties and responsibilities of key personnel. Check if the organizational structure provides a clear division of responsibilities and authority between all departments of the plant, and between such departments and other parts of the operating organization and relevant outside organizations providing services, including contractors. The section of the Final Safety Analysis Report describing the design basis for the organizational structure may be useful in this respect.

Check that the interfaces with the corporate organization are clearly defined and understood at the plant. Check that there is no duplication in the assigned tasks and responsibilities between the plant departments. Check if interfaces with the chartered committees (e.g. Safety Committee, Training and Qualification Board) are clearly presented in the organizational charts.

Check that the procedures and policies describing the organizational structure including all necessary interfaces are published and that appropriate training is provided.

Functions and responsibilities

Confirm that there is well-understood division between the responsibilities of the corporate and plant management. Check that the corporate management, while delegating the operating authority to the plant management, maintains the responsibility to monitor the effectiveness of the plant management in particular management of safety at the plant. Check if the corporate management monitors the performance of the plant and takes necessary initiatives and measures to ensure that safety is continuously improved.

Confirm that the different organizations, contractors and plant personnel clearly understand their authority, responsibilities and accountabilities, and check that staffing and resources are

sufficient to accomplish the tasks assigned. Check that the relationship between supervision and subordinates is such that adequate direction and support is provided in the execution of safety-related activities.

Check that position descriptions or other written documents are in place to supplement the plant organizational charts. Check selected position descriptions to confirm that they clearly define the authorities, responsibilities, qualifications and experience for each position or position category. Check if the authorities are commensurate with the assigned responsibilities. Check that clear guidance is provided to power plant personnel or contractors concerning authority and responsibility for the conduct of the operational activities outside normal working hours.

Resources

Check that the corporate management of the operating organization provides sufficient resources to the plant to conduct routine plant activities, to timely respond to plant problems and requests for assistance to achieve established goals and objectives. Check that the resources provided include the human and financial resources, adequate facilities, necessary spare parts and equipment, and necessary technical and administrative services. Check that the resource allocation policy takes into consideration safety priorities. Check the maintenance and modification backlogs to ensure that there are no delayed safety-related tasks or a large backlog due to a lack of resources. Confirm that sufficient resources in personnel and equipment are available at the plant to implement all the operational management programmes (processes).

Check if the plant managers and other plant personnel have the appropriate resources to carry out their assigned responsibilities and accountabilities, in particular those that are safety related.

Staffing policy

Review the plant staffing policy to ensure that the recruitment and selection of personnel is directed to retaining a pool of experienced staff covering a broad range of operational and safety expertise. Check if the necessary pool of knowledge, skills, attitudes and safety expertise is sustained and that long term policy objectives for human resources are met. Check how the motivation and career development aspects are considered in the recruitment and selection process. Check if a balance is maintained between internal promotion and external recruitment to ensure that only well qualified people are assigned key positions. Check the selection criteria and ensure that they are based on the requirements for the position.

Review the succession planning process to ensure that provisions are made to provide suitably qualified and experienced personnel in important technical and managerial nuclear safety-related functions, including the top management of the operating organization. Collect information from all team members whether succession planning is well established in practice throughout the organization. Check whether this aspect is being considered when making any organizational changes.

Check if the policy on the temporary replacement for key positions ensures that the designated replacements are capable of undertaking the defined responsibility of the post.

Ensure that the individual performance appraisal system is effectively used to enhance individual performance, identify training needs, envisage promotion, and includes assessment of behaviour towards safety.

Review the fitness for duty policy and procedures. Check whether it includes consideration for stress management, restrictions on excessive overtime work and need for sufficient rest between shifts, as well as drug and alcohol abuse, prescription medications and psychological status. Check whether random tests assess compliance with the policy but confirm that responsibility remains with management and supervision for continuing behavioural observation of personnel. Check whether an equivalent regulation is applied to contractors and visitors with unrestricted plant access.

Determine the scope of those staff services that are provided by contractor personnel. Confirm that contractor personnel are used only for those tasks intended. Confirm that the contractor personnel used in permanent positions are properly trained, supervised and monitored by management.

Interface with the corporate organization

Review whether the corporate operating organization monitors the plant operating and support functions to evaluate performance against stipulated objectives for the safe and reliable operation of the plant. Determine whether the operating organization includes a high level multidiscipline safety review committee, preferably including qualified independent individual(s) (from outside the operating organization), which provides an affective monitoring tool. This committee should not assume accountability of the licensee.

Interface with external organizations

Determine the scope of those staff services that are provided from outside the operating organization. Check that responsibilities remain within the organization for specifying, controlling and monitoring those services, and ensure that contractor and plant activities are effectively coordinated without erosion of the site management responsibilities. Review whether plant quality and safety policies are applied to these subcontracted services.

Check that the plant responsibilities for interfacing with external organizations and making commitments to them are clearly defined and implemented. Confirm that the plant management do not acquiesce to external organizations to the extent that the primary responsibility for safety is compromised.

Check whether the plant has a clearly defined policy with respect to contractors and ensure there is a clear guidance that is understood for the following: quality requirements for work, qualification and experience, verification of capability, site induction training, behavioural standards and expectations, means of providing suitable welfare facilities, means by which safety-related information is communicated, and means by which contractors' safety concerns can be raised and resolved.

Interface with the regulatory body

Confirm that effective arrangements and appropriate documentation exist to ensure that the conditions of the operating licence and any amendments are adhered to. Ensure that licensing documents are identified and their updating approved as necessary by the regulatory body. In particular, periodic updating of safety analysis reports and analysis of inspection and event reports should be evident.

Review whether information is given to site personnel outlining the authority of regulatory inspectors and that effective communication channels exist throughout the operating organization to assure compliance with regulatory requirements and that prompt reporting is executed where specified.

Check the procedure for reporting abnormal events to the regulatory body. Confirm that the threshold for reporting events is consistent with international practice and it is neither too low and an excessive burden to the power plant nor too high and some significant events are ignored. Check if the relevant plant personnel are aware of their responsibility for dealing with reportable events. (Cooperate on this subject with the operating experience reviewer).

Review the relationship between the regulator and plant management. Check if regular discussions between regulator and plant management are held on plant operating experience and other issues. Ensure that there is an identified organization to respond to regulatory body requests. Review to what extent the regulator relies on the plant self assessment and corrective action programmes.

Review the regulatory inspection and audit programme; to what extent is the regulatory organization present in the plant conducting inspections and audits. Investigate the types and thoroughness of inspections and audits, the results achieved and regulatory follow-up on action items.

Check that the regulator does not intervene directly in the management of safety within the operating organization and does not dilute the primary responsibility of the operating organization for safety. Confirm that there is clear understanding by the plant management that they bear primary responsibility for the safe operation of the plant.

Confirm that the power plant management has an opportunity to make its opinion known to the regulatory body as a basis for subsequent discussions if it considers that any action requested of it by the regulatory body could have an adverse effect on safety.

Interface with the public
Check that the operating organization declares publicly that one of its corporate objectives is its commitment to nuclear safety and this objective overrides all other priorities (e.g. demands of production).

Confirm that the operating organization keeps the public informed on the hazards, which arise from a nuclear power plant. Check the means and tools to disseminate such information to the public, in this regard work with the EPP reviewer.

Check if the operating organization provides information on the status of the plant to the public in a regular and timely manner. Check if the public is provided with information on the measures that would be taken in emergencies. Confirm that the public is informed of any significant event and of any enforcement action taken by the plant.

Committees and task forces
Check if the appropriate Committees and arrangements to establish ad-hoc task forces are in place to review, investigate or discuss specific issues or problems (modifications, significant events, safety related reports, organizational changes, etc.). Check that these committees are established at the corporate or plant management level and their responsibilities and tasks are in accordance with assigned authorities. Check that the committees and task forces have clearly defined charters and objectives. Check that committees have an advisory function, and responsibility for final decision rests with a management position in the organization. Check the agenda, records or minutes of the committees' meetings to make a judgement on the significance of the items covered. Check the implementation of the corrective actions established based on recommendations from the committees. Check how committees follow the implementation of corrective actions.

Management of organizational changes

Review the organization's change management policy whether it provides a formal, systematic approach to review proposed changes. Confirm that safety assessment is performed for any change that could affect safety. Check that:

- the safety assessment is independently reviewed;
- the organization has a formal process in place that considers the safety implications of the change;
- for more significant changes, check that advice is sought from a nuclear safety committee;
- for more significant changes, the regulatory review or approval may be required prior to final approval by the company's board.

Confirm that this process is supported and well understood throughout the company, particularly when new management structures are being implemented. Evaluate whether the following principles are applied when assessing the implications and controlling the impact of organizational change:

- changes are classified by operating organizations against agreed criteria from the point of view of their safety significance;
- all proposed changes above a certain agreed level or significance are notified to the regulator (some of them may require regulatory approval);
- a case is made by the operator as to how during and after the planned changes the plant will continue to maintain acceptable levels of safety; this should include both the final position and the arrangements during the transition from the old organizational arrangement to the new;
- a review mechanism is agreed to ensure that cumulative small changes do not impair safety;
- a system to monitor progress against the planned introduction of significant change is developed and any shortfalls rapidly identified so that remedial action can be taken.

Check that organizational changes are communicated with staff and other stakeholders honestly and openly, addressing the safety implications of the changes. Check that the number of different change initiatives which may have an impact on safety being pursued at any one time is minimized, and the total workload imposed on the operating organization to implement the changes in parallel with continued operation is considered.

Confirm that adequate monitoring is in place to provide early warning of negative trends and to allow time to take remedial action before minimum acceptable safety levels are challenged. Confirm that the board of directors and executive management are presented with, and regularly discuss, reports on the results of such monitoring programmes.

Evaluate whether there are detrimental effects on safety due to these changes, e.g.

- inadequate resources to maintain all the components of the plant at a high level of reliability;
- loss of nuclear related expertise at board or executive level;
- understaffing and lack of competent staff;
- over reliance on external sources of expertise that cannot be guaranteed in the long term;
- reduced resources for training and retraining staff;
- shortcuts being taken in maintenance;

- unnecessarily large and prolonged uncertainties about future responsibilities and even job security among key technical staff.

3.1.2. Management activities

Expectations

Management should establish and clearly communicate high standards of performance to promote excellence in the conduct of all power plant activities. Management policies and directives covering conduct of activities should reflect desired high standards. In particular, there should be a clear statement of quality and safety policy according to senior management's commitment. Goals and objectives that promote excellence in plant operation and focus on areas needing improvement should be in place. Good communication of management expectations should be established within the plant and also with outside organizations.

Managers should actively promote and frequently reinforce corporate policies, safety goals and objectives. Plant management should develop goals and objectives that support and complement established corporate goals. Suitable goals and objectives should be established at departmental level to support the goals of the plant management. Where it is reasonable, the goals and objectives of all management levels should be measurable and stated in terms that allow measurement of progress and clear determination of achievement.

Supervisors and managers should fully understand their role and responsibilities and the reasons for required policies. They should display those values and behaviours required to demonstrate that safety is their top priority. A mechanism should exist for plant staff to report safety concerns to management. There should also be a mechanism for staff to report safety concerns to an independent body (e.g. regulator) if they are not satisfied with management response. Senior level managers should make themselves accessible and respond to personnel suggestions. Managers should routinely be in the field to assess and discuss the conduct of work and compliance with management objectives.

Administrative procedures, rules and instructions, covering all aspects of plant operation and applicable to all personnel on site, should ensure safe and effective methods of working and uniformity of performance.

Priorities of management efforts and resource allocation should reflect the safety significance of the issues dealt with, and the risks associated with them. Probabilistic Safety Assessments (PSA) have been performed by many nuclear power plant organizations to identify the potential plant vulnerabilities and understand the relative risk contribution of particular design and operational features. As a result of the availability of PSA studies, there is a desire to use them to enhance plant safety and to operate the nuclear stations more efficiently. PSA has proved to be an effective tool for this purpose as it assists plant management to target resources where the largest benefit to plant safety can be obtained. The current state-of-the art in PSA is considered as sufficiently well developed that the insights from such studies can be used sensibly in the plant safety decision-making process and risk management. However, any PSA that is to be used for such a purpose must have a credible and defensible basis.

Examples of documents to be available for review during the OSART mission:

- Documented policies, goals and objectives of the operating organization;

- Description of plant management programmes;
- Selected job descriptions for management positions;
- Schedule of delegated power of authority;
- Selected management manuals;
- Descriptions of interface control between the plant and other organizations;
- Documentation related to the communication process of the operating organization and the plant;
- Terms of reference for Safety committees, together with meeting minutes and the records related to the action tracking programmes.

Evaluations

Policies, goals and objectives
Confirm that there is a clear quality and safety policy statement confirming management's commitment in relation to setting management objectives, deciding resource allocations, approving management programmes, communication of a high performance standards.

Review the management objectives and programmes to ensure that the safety objectives are adapted to each level of responsibility. Confirm that realistic objectives and timescales are set, and that efforts to achieve these are the properly resourced. Check whether plans for enhancement or improvements are prioritised.

Check that the relevant goals and objectives are established at the appropriate departments to support corporate management objectives. Check that established goals and objectives are measurable, challenging and limited in number to prevent dilution of effort in their achievement.

Check whether action plans are in place for achieving established goals and objectives. Check how the progress toward accomplishment of goals and objectives is reviewed and how the results of reviews are recorded.

Check if a system is established and implemented to recognize and appreciate the contribution of individuals and groups in the achievement of established goals and objectives.

Communication
Review the communication process at the plant. Confirm that the mechanism for downward communication ensures that the management’s directions and expectations are clearly understood. Confirm that personnel are familiar with policies by observing and interviewing individuals at the various levels within the organization. Check evidence that objectives are considered in the daily activities. Check that people know what their roles and responsibilities are in the organization, and how their skills and knowledge are to be used in achieving and maintaining its goals. Observe whether plant managers systematically convey and reinforce the safety policy to the staff. Check that messages not only have been convened but have also been received and understood, and are being acted upon. (Input to be provided by all team reviewers.)
Determine if a mechanism exists for plant staff to report safety concerns to plant management and that managers encourage good safety performance and provide appropriate recognition. Check an additional mechanism for staff to report safety concerns to an independent body (e.g. regulator) if they are not satisfied with management response.

Check the involvement of plant managers in plant work activities and in solving safety concerns. Check how regularly managers are in the field to assess and discuss the conduct of work and the compliance with management expectations and objectives. Confirm that the management is responsive to constructive criticism and feedback from the plant staff.

Check if good communication is in place to reinforce teamwork (in particular communication between shifts both in normal operation and in emergencies). Check that horizontal communication is reinforced to encourage open lines of communication between interacting groups that work together to perform specific functions. Check that team members know and respect the inputs expected of the other members, and of those, such as contractors, who are working alongside them.

Check that managers are coaching their subordinates in the requirement to communicate the need for good standards and adherence to management expectations, and also in the requirement to obtain feedback on the achievement of the implementation of these standards and expectations.

Check that the outside communication process recognizes the broader social framework in which the plant operates, including the maintenance of a constructive dialog with trade unions and other relevant interested groups.

Check that appropriate arrangements are in place to monitor the effectiveness of communications and to act promptly to eliminate identified weaknesses.

Coordination of the operational management programmes/processes
Check if integrated action plans are being established for tasks that require input and collaboration from different groups. Check that the priorities of the tasks are identified for the multifunctional tasks to avoid conflicting demands.

Check that decisions are made at the appropriate level of the organization, taking into account possible effects on safety and other working groups. In this regard see that Operations is playing a pivotal role.

In cooperation with the reviewers in specific operational areas (maintenance, operations, radiation protection) check the coordination:

- among different maintenance groups (mechanical, electrical, instrument and control, and civil);
- among the operations, radiological protection and maintenance groups;
- among the site organizations and contractors;
- among different nuclear facilities (e.g. for the purpose of transportation).

Coordinate input for this review area from other OSART team members.

Procedures
Check that all aspects of the plant programme for safe operation are covered in administrative procedures: strategic and business plans, respectively at corporate and plant level, and are aligned to the goals and objectives of the operating organization. Check that management manuals and job descriptions determine roles, responsibilities and delegations of authority for all managers in key-positions. Check that a system for tracking commitments and corrective actions is established; corrective actions are tracked to completion, and an on-site check of the degree of conformity throughout the plant is conducted.

Evaluate that clear and understandable procedures are in place for any work, which needs to be controlled. Check whether these procedures are in a form that can be used directly at the place of work, whether they identify and address the main risks, and are understandable and are of relevance to those who will use them. Check that shortcuts or 'work-arounds' are not being practiced to compensate for undervalued procedures.

Human factors management
Observe whether human performance and departmental interfaces are analysed to evaluate the efficiency of the entire organization, managers, personnel and the adequacy of operational decision-making.

Check that management monitors and reinforces expected personnel behaviour. Check that personnel are held accountable for implementing accepted standards of performance, and shortfalls in meeting expectations are evaluated, understood and addressed. Observe whether personnel are encouraged to acknowledge errors and seek help, when needed.

Confirm that the NPP regulations relating to the conditions of work, such as working hours and safety are supportive to the safe operation of the power plant.

Confirm that a suitable working environment is provided and maintained so that work can be carried out safely and satisfactorily, without imposing unnecessary physical and psychological stress on personnel. Evaluate whether human factors, which influence the working environment and the effectiveness of personnel are identified and addressed.

Risk informed management
Confirm that probabilistic and deterministic analyses are used in a complementary manner to determine the significance of safety issues. Review what is the management position on periodic safety reviews. Confirm whether probabilistic safety assesment is part of the periodic safety review.

Check how services are provided by the corporate operating organization to assist power plant management in such areas as probabilistic safety assessment, maintenance, surveillance and in-service inspection, organization for human-technology interface, and human performance analysis.

Check whether probabilistic safety analyses are used to adequately support such management principle as graded approach.

General industrial requirements and practices
Check that accepted conventional codes, standards and industrial practices such as statutory periodic inspections, pressure testing and storage of hazardous materials are followed and they are not in contradiction with the nuclear safety requirements.

Check the observance by the power plant of specific transportation requirements for hazardous materials and, radioactive materials in transit.
Confirm that environmental protection measures are an integral part of the power plant management activities and that the appropriate resources are allocated and facilities established to implement these measures. (Several nuclear power plants apply an environmental management system, and certify this system against relevant international or national standards.)

3.1.3. Management of safety

The section management of safety should not be taken to suggest that safety is managed separately from other management activities. Neither should it be seen as an optional extra. The organization's safety management system is generally considered to be an integral part of its overall management system. The review in this area should be closely related with Section 3.1.2 Management Activities. Guidance in the evaluations section for the management of safety is intended to be used throughout the OSART review period to identify weaknesses in specific management controls that may contribute to safe operation of power plant.

Expectations

A safety management system should be applied, integrating management of safety, health, environmental quality and economic matters in a coherent manner.

A policy on safety shall be developed by the operating organization and applied by all site personnel. This policy shall give safety the utmost priority at the plant, overriding if necessary the demands of production and project schedules. The safety policy should demonstrate the organization's commitment to high safety performance and be supported by reference to safety standards, the development of targets and provision of the resources necessary to achieve these targets. The policy should be provided to all staff members for their guidance and clearly understood by all of them and declared to the public as one of the objectives of the operating organization. The operating organization should ensure that adequate resources are available to implement the safety policy.

All functions in the operating organization should encourage and support sound safety management practices at the highest levels of corporate and plant management. Managers, at various organizational levels, should demonstrate their commitment to safety as a top priority.

The risks associated with any operating activity at the plant should be systematically evaluated and measures taken to eliminate or mitigate the identified risks.

The operating organization should demonstrate a commitment to achieving improvements in safety wherever it is reasonably practicable to do so as part of a continuing commitment to the achievement of excellence. The organization's improvement strategy for achieving higher safety performance and for more efficient ways to achieve existing standards should be based on a well defined programme with clear objectives and targets against which to monitor progress.

The operating organization should comprehensively monitor plant operation to ensure its licensee accountability and to evaluate performance against the goals and objectives established for safe operation of the plant. Senior plant management should routinely monitor performance against these goals and objectives, and hold responsible staff accountable for their achievement.

Performance indicators should be established to measure the progress in achieving the goals and objectives. They should be regularly assessed against defined goals and objectives, and the results should be communicated to staff and used to derive corrective actions.

Examples of documents to be available for review during the OSART mission:

- Operating organization's safety policy statement;
- Description of safety review and monitoring programme;
- The operational safety self assessment manuals and procedures;
- The reports from the safety related audits and inspections, including the self-assessment reports;
- Description of work management system (with emphasis on the planning and risk assessment of safety related activities);
- Documentation on the tracking of safety related performance indicators;
- Selected job descriptions of the managers and supervisors;
- Training programme for managers and supervisors;
- Terms of reference for Safety committees, meeting minutes and the records related to the action tracking system.

Evaluations

Safety policy

Check if there is a safety policy statement in the operating organization that expresses the commitment of the organization to develop an effective system for the management of safety. Confirm that economic, health, quality and environmental matters are not considered separately to safety matters. Confirm that the safety policy is supported by reference to safety standards, development of targets and provision of the resources necessary to achieve these targets. Check how the safety policy targets are incorporated in the plant departments' management system.

Confirm that safety (and particularly nuclear safety) is put clearly and unequivocally in first place in requirements from the top of the organization, and there is absolute clarity about the organization's safety philosophy. Review the decision-making process at the plant and departments levels to determine whether and how priority is given to safety in both normal and emergency conditions. Observe the decision-making process by attending meetings and committees, and reviewing their minutes. Evaluate whether managers make use of all useful information and that adequate supporting information is made available.

Management leadership

Confirm that senior corporate managers are responsible for establishing a strong nuclear safety policy. Check if the senior managers have the necessary experience and knowledge to manage the safe operation of power plant. Check that the senior managers are involved in disseminating the safety policy throughout the operating organization.

Check that senior management maintain a focus on safety, and behavioural standards and core values support the implementation of the management system. Evaluate whether a graded approach ensures that appropriate management activities and controls are applied relative to the risk and hazards associated with the safety, health and environmental impact and the costs associated with the product or process.

Confirm that management has established a clear goal to maintain the safety barriers included in plant design but not always needed during normal operation. These safety barriers include fire barriers, ventilation pathways to limit the spread of radiation, seismic restraints, foreign material exclusion barriers and other passive systems.

Confirm that managers are providing leadership and at the same time are developing, in partnership with staff and their representatives, the means of translating the safety goals of the organization into day-to-day reality. Check if the managers demonstrate, by example, motivation to improve plant performance and to achieve the established safety goals and objectives.

Check that the corporate management routinely discuss and review the safety performance of the plant.

Evaluate that management remain vigilant and objectively self-critical. Early signs of any declining performance could be detected by objective internal self-evaluation programme and periodic external reviews.

Safety related activities

Check if the safety related activities are thoroughly planned to ensure that they can be carried out safely and effectively. Check some examples of the safety related operational and maintenance tasks to witness that risk assessment is the integral part of the work management system. Confirm that the results of risk assessment, including compensatory actions, are incorporated into work instructions or control documentation associated with the planned activity. Check if the risk assessment methods are used for the planning of the maintenance and surveillance activities, in particular in determining the optimal surveillance test intervals, the optimal time between equipment overhauls.

Confirm that authority and responsibility is given to each individual or team to stop and review safety before starting a piece of work or beginning to carry out a procedure. Confirm that the requirement to be conservative in safety related matters is emphasized, and there is a clear expectation for staff to check their understanding of a situation, and if necessary seek more information or advice.

Monitoring and assessment of safety performance

Confirm that an adequate audit and review system is established to provide the assurance that the safety policy of the operating organization is being implemented effectively and lessons are being learned from its own experience and from others to improve safety performance.

Check if the safety performance of the power plant is routinely monitored in order to ensure that safety standards are maintained and improved. Check if the features of the organizational structure and management aspects are taken into consideration when monitoring and assessing of the safety performance of the operating organization or of an individual power plant. Check if the senior managers at the corporate and plant level personally monitor the safety performance of the organization and the plant and if they have the necessary experience to review critically trends in safety performance.

Check if the operating organization has a sufficient range of indicators to provide clear picture of its safety performance, in particular to identify trends in human performance and equipment failures. Check if the safety performance of the operating organization is regularly compared with that of the similar organizations. Check the adequacy of the inspections of the workplaces and work practices carried out by the managers to assess compliance with the organization's safety standards.

Check if the safety reviews are independent of the pressure of plant operation. Check that the internal self-evaluation programme is established and implemented to continuously monitor the safety performance of power plant. Check that reviews and audits are carried out by

independent organizations, by experienced industry peers using well established and proven processes, to provide an independent judgment on the effectiveness of the safety management system.

Determine through interviews whether management has a clear understanding of the most important strengths and weaknesses, that the NPP is facing, and is able to evaluate those areas requiring its attention and determine necessary corrective action.

Detection and recovery of deviations
Confirm whether the commitment to minimize existing latent shortcomings in working practices or plant conditions is evident. Check whether plant employees and contractors are aware why specific safety systems and requirements are in place. Check whether staff is encouraged to challenge potentially unsafe practices and identify deficiencies wherever and whenever they encounter them. Confirm that the plant considers failures and 'near misses' as lessons, which can be used to avoid more serious events. Confirm that events that have the potential to be instructive are reported and investigated to discover the root causes, and that timely feedback is given on the findings and remedial actions.

Check the selected reports resulting from the safety performance reviews to witness that they are timely provided to the appropriate management level. Check whether appropriate corrective actions are identified and implemented as a result of the safety performance monitoring and review. Check if actions are completed within the appropriate time-scales.

Check if the completed corrective actions are reviewed to assess whether they have adequately addressed the issues identified in the audits and reviews.

Learning organization
By interviewing the managers and plant personnel confirm that the operating organization is permanently aimed at the safety enhancement. Check that a mechanism is in place to involve the staff in contributing ideas for improvement. Check if managers and supervising personnel are trained on the abilities to recognize and diagnose problems, to formulate and implement solutions and make adjustments as required by experience.

Confirm that the plant has an active self-assessment programme, which uses a variety of means to critically analyse and compare performance with best performers in the industry. Check if the results of this assessment give rise to improvements that are integrated into future planning processes.

Review whether management at all levels regularly assesses the processes for which it is responsible. At senior management level it is appropriate to determine during such self–assessment if the overall performance effectively focuses on meeting strategic goals. Line management is more likely to rely on surveillance and review of work performance. Confirm that management process weaknesses and barriers that hinder the achievement of the nuclear safety objectives are identified and corrected.

Check if nuclear plant operating experience, such as control room supervisor and on-shift work activities, is taken into account in the development of managers and supervisors, particularly in the line operating organisations, and personnel are developed through position rotations, if applicable.

Confirm that employees are encouraged to become aware of what world-class performance in terms of safety means in their jobs. Check if opportunity is given to the managers and plant personnel through exchanges and benchmarks to look outside their organization to learn from the best practices. Check if they are encouraged to share ideas with their peers and to carry out evaluations of their own working practices and performance. Check that mechanisms are provided to enable experience and ideas to be transferred within the organization. Check that the organization retains 'corporate memory' of why and how improvements have been made.

Check to ensure that teamwork is promoted and supported and that learning and individual improvement activities are funded and time is made available for participation. Check that benefits obtained from improvements are widely recognized by individuals and teams.

Ensure that the appraisal process and promotions recognize safety contributions.

3.1.4. Quality assurance programme

Expectations

The operating organization should develop, implement and maintain quality policy and quality assurance (QA) programme. The QA programme should serve as a management tool in verifying or confirming, through meaningful monitoring, that the requirements established within the organization are being achieved. This programme should include details of how work is to be managed, performed and assessed. It includes the organizational structure, functional responsibilities, level of authority and interfaces for those managing, performing and assessing the adequacy of the work. The QA programme should address management measures, including planning, scheduling and resource considerations.

Management in the entire and constituent areas of work should provide and demonstrate support for the effective implementation of the QA programme consistent with specified time schedules for accomplishing project activities. The operating organization is responsible for the establishment and implementation of the overall QA programme. If it delegates to other organization the work of establishing and implementing all or part of the overall programme, it retains responsibility for the effectiveness of the programme in all circumstances.

Quality assurance requirements should be applied to activities such as operations, maintenance, procurement of replacement items, tests or experiments, changes of configuration and plant modification, which may be undertaken by other units of the operating organization or by external agencies. It should remain the responsibility of plant management to ensure that arrangements are in place to control all activities affecting quality.

Safety issues should be the fundamental consideration in the identification of items, services and processes to which the QA programme applies. A graded approach based on the relative importance to safety of items, services and processes should be used. It should reflect a planned and recognized difference in the applications of specific quality assurance requirements.

Independent assessments should be conducted on behalf of management to measure the effectiveness of management processes and the adequacy of work performance, to monitor item and service quality and to promote improvement.

Examples of documents to be available for review during the OSART mission:

- Description of QA organization and responsibilities;

- QA section of the Final Safety Analysis Report;
- Plant quality policy, QA programme and associated documents;
- QA audits and surveillance schedule;
- Periodic QA assessment reports;
- QA audits and surveillance reports;
- Corrective action status report.

Evaluations

Management expectations and overall status of QA
Review the QA organization to ensure that the responsibility, authority, structure and organizational independence of the QA unit are clearly defined. Confirm that the QA system covers all the activities at the plant, such as operations, maintenance, procurement of replacement items, tests or experiments, changes of configuration and plant modification, computer applications. Check if QA system covers such management aspects as plant organization, interfaces within the operating organization and between the operating organization and contractors, training and qualification of the personnel, non- conformance control, industrial safety, fire protection. Confirm that the graded approach is used in the applications of specific QA requirements and this approach is based on the relative importance of the items, processes and services to safety.

Confirm that the QA system covers the services and activities provided by contractors. Check that the QA programme not only provides checks of the quality of the products and services delivered but also the checks of the processes to deliver these products and services. Check, for example, how the operating organization controls the quality of the new fuel provided by manufacturers. Check if the quality assurance system is reviewed by the operating organization when the manufacturer or vendor is changed.

Check that a comprehensive set of QA documentation is available to describe the overall measures established by the operating organization to achieve management goals and objectives.

Determine whether the QA programme details how safety-related activities at and for the plant are to be planned, performed, assessed and improved.

Responsibilities
Check the responsibility of the senior management for the planning, development, implementation and effectiveness of the QA programme. Check if line managers are held accountable for the quality of performance in the areas for which they are responsible. Check that managers monitor the activities in their areas and are responsible for corrective actions and achievement of high quality performance. Check if the managers contribute into establishing the environment in which their subordinates feel the primary responsibility for quality work. Check that the line managers are aware of the results of the quality unit's monitoring activities and use the results of those activities to improve performance. Confirm that the interface is maintained between line managers and the QA unit in determining the scope and the frequency of the QA unit's monitoring activities. Check how the line managers are dealing with the monitoring results provided by the plant QA unit. Check if appropriate analysis is undertaken to determine the root cause of the problems and check the trend of the implementation of corrective actions.
Check that a satisfactory record system is established to file and retrieve QA documents.

QA monitoring and assessment

Confirm that an effective QA monitoring system is implemented at the plant to assist management in evaluating the performance of plant activities and the effectiveness of management programmes. Confirm that QA monitoring activities ensure not only adherence to the established standards and requirements but also enables the management to identify weaknesses in performance or the deficiencies in the programmes. Check that the QA programme monitoring is conducted in an objective manner and in the atmosphere of openness and constructive criticism. Confirm that the persons involved in QA monitoring activities are not directly responsible for the activities being monitored. Confirm that the monitoring activities cover the areas in which performance improvements are needed or where deviations from the standards and requirements have been observed and weaknesses suspected. Check if monitoring process includes the follow–up to make sure that corrective measures have been effective.

Check what methods are established for line management to assess the performance of activities under their control. Check what performance indicators are established to detect the deviations from the established standards.

Confirm that the methods for identification of root causes is specified and implemented for violations, deficiencies, non-conformances and other abnormal occurrences.

Check if the quality monitoring results are adequately documented and evaluated to allow early detection of adverse trends and correction of performance problems. Check if the results of monitoring are regularly reported to the management for the identification of root causes and appropriate corrective measures.

Check if the persons involved in the quality monitoring are suitably qualified, trained and experienced to identify the performance issues in the relevant areas.

Check if the management self-assessment is utilized as a QA tool to identify, correct and prevent management problems that hinder the achievement of the objectives of the operating organization or the power plant.

Evaluation of effectiveness

Collect the main weaknesses and deficiencies observed in other areas by team members; considering that they should have been identified by the plant QA organization, self-assessment or independent assessment, review whether these problems are known and analyzed, causes are identified and corrective actions are on-going.

Based on the findings of own review and the findings in the other operational areas check if the deficiencies are identified on the following matters that are typical items to be covered by the QA system:

- inappropriate verification;
- poor record keeping;
- failure of supervision;
- recurrent deficiencies;
- inadequate training;
- lack of adherence to rules and procedures;
- poor material conditions and housekeeping.

Review whether a system of planned and documented independent internal and external audits is carried out periodically to assess the adequacy and effectiveness of the QA organization and programme.

3.1.5. Industrial safety programme

Expectations

The operating organization should have a general policy to ensure the industrial health and safety of personnel on site is satisfactory. All elements of this policy should be documented in a plant safety manual, while details are included in implementing procedures.

The industrial safety programme should be known, understood and adhered to by all personnel on site. Senior management should be committed to industrial safety, line supervisors should have the authority and responsibility to ensure good industrial safety performance. A suitable organization should be in place that supports the programme and a process should be implemented that routinely reviews the status of industrial safety practices. A risk analysis should be performed prior to any activity.

Examples of documents to be available for review during the OSART mission:

- Administrative procedures which define the plant's industrial safety organization (Description of industrial safety programme, roles and responsibilities of the industrial safety group and other staff related to the industrial safety);
- The operating organization's general industrial safety rules;
- The organizational chart related to the industrial safety programme;
- Routine station safety reports and audits, which reflect the industrial safety items;
- Selected industrial safety procedures;
- Industrial safety exercise reports;
- Reports of the industrial safety inspector;
- Reports of industrial accidents and root cause investigations;
- Annual industrial safety reports.

Evaluations

Policies, programmes and procedures
Review the policy, programme, procedures, plant safety manual and responsibilities assigned to ensure industrial safety in the work place.

Review the industrial safety programme and determine the inclusion and satisfactory content of the following areas:

- Electrical and mechanical evaluation of tools;
- Rules of operating electrical breakers and disconnecting (isolating) switches;
- Protective clothing and equipment use;
- Storage, use and disposal of hazardous chemicals and substances (e.g. asbestos);
- Confined space entry;
- Scaffolding, climbing and lifting equipment;
- Access and opening guards;
- Industrial safety training (e.g. industrial safety training programme, first aid, fire fighting, heat stress, respiratory protection).

Check that the industrial safety programme contains the requirement to review the programme and evaluate the procedures on a set frequency and that there is a surveillance programme for testing all industrial safety hardware on a set frequency.

Industrial safety organization
Review and check that an industrial safety group exists and has a clear organizational structure identifying functions, responsibilities and communication links.

Check if the duties, responsibilities and authority of the industrial safety officers are clearly described in the job descriptions or any other administration procedures. Check that the safety officer reports to line management at the requisite level to ensure sufficient authority and freedom of action in all areas on site.

Implementation of the industrial safety
Review the initial and continuing industrial safety training requirements for plant staff and contractors (input provided by Training and Qualification reviewer).

Check that regular assessment of industrial safety are conducted; performance indicators should adhere to organization objectives and periodically reviewed.

Determine if peer or safety committee overview is assigned and programmatic changes are assessed and implemented as expediently as possible.

Check that routine safety meetings for plant personnel are conducted. Evaluate the effectiveness of these safety meetings by reviewing the subjects discussed and the extent to which information is communicated to personnel.

Ensure that the accident reporting threshold is low enough to capture minor accidents and near-misses events. Confirm that a root cause evaluation is done for accidents that are analysed for trends to determine if preventive measures have been taken.

Check if a system is in place to encourage reporting of industrial safety hazards and that violation of industrial safety practices are considered in individual performance reviewers.

Check if pre-job briefings emphasize industrial safety aspects of the work to be performed.

Adherence to industrial safety requirements
Investigate by inspecting selected areas and activities on the site and by interviewing appropriate individuals whether the safety rules, procedures and instructions are being adhered to satisfactorily. Collect all hazardous situations reported by the team members. Points of particular significance include current validation of safety equipment, such as fire extinguishers and breathing apparatus. The material condition of infrequently used safety equipment such as showers or fire escapes should be monitored. Check that priority assignment is given to any backlog of identified deficiencies in industrial safety work.

Check whether arrangements are in place which require evaluation of health and safety risks prior to start of work. Confirm that staff who actively contribute to safety ethics is rewarded.

3.1.6. Document and records management

Expectations

A document and records management system should be established to ensure the appropriate keeping of all documents relevant to the safe and reliable operation of the plant, including design documents, commissioning documents, documents related to the operational history of the plant, as well as general and specific procedures. Control of documentation should be done in a consistent, compatible manner throughout the plant and the operating organization. This includes preparation, change, review, approval, release and distribution of documentation. Lists and procedures for these functions should be prepared and controlled.

The records system should ensure that records are specified, prepared, authenticated and maintained, as required by applicable administrative procedures in accordance with the QA requirements. Information sources should be integrated, when appropriate, to improve the accuracy, timeliness and availability of the information.

A suitable records storage system should be in place to ensure safe conservation and easy accessibility of all documents and records necessary to operate the plant.

Examples of documents to be available for review during the OSART mission:

- General administrative instructions and procedures related to document control and records management;
- Classification of documents;
- The administration procedures governing process of production, review and approval of the safety related documentation;
- The administrative procedures for the maintenance, revision and modification of operational documentation;
- Selected administrative, operational and emergency procedures (to check their quality and maintenance);
- Selected surveillance, maintenance, in-service inspection records;
- Index of departmental procedures relevant to documentation management.

Evaluations

Production, review and approval
Review the administrative control of documentation. Confirm that production and control of all documentation, in particular procedures and instructions are standardized and enforced by administrative measures. Check if the appropriate document identification system is established and maintained.

Confirm that documents are reviewed and approved before they are issued for use. Check, where it is appropriate, that the review process involves validating the implementation of the document through simulation, mock-up, walk-through or other validation methods.

Check that the operators aids are included in the formal document control system and that there are no illegible operators aids or other safety related documents in use.

Issue and distribution
Check if document issue and distribution system is established, utilizing up to date distribution lists. Confirm that the system ensures that changes to documents are relayed to all

affected persons and organizations. Confirm that temporary changes to procedures and instructions are issued only under appropriate controls that limit their area of application and their period of validity.

Check whether the administrative controls are in place to ensure that out of date procedures are timely removed from use and periodic audits are conducted to ensure that invalid or out of date procedures and instructions are not in use.

Check if plant locations for documents used in safety applications are specified and provisions made for updating these in a timely way. For example, key control room drawings should be updated prior to putting modified plant equipment into services. A list of plant locations and associated documents in a procedure or controlled database could be an appropriate control measure.

Records management system
Review the records management system. Check the arrangements made for the production of all records to prescribed standards and format. Check if administrative procedures are established for issuance, dissemination, review and periodic updating of the records.

Review the records control process by selected sampling (but specific details, in each department, are left to other experts). Check that the records are categorized as permanent or non-permanent according to their importance to safety. Check the criteria for such categorization. Confirm that the records of major safety significance are considered as permanent.

Check if the system of records indexation is established which provides sufficient information to identify both the item and the relevant record. Check that correction of the records is conducted in a controlled way in accordance with the administrative procedures. Check if controls are in place for filing, correcting records or inserting supplements.

Check if periodic checking is conducted to ensure that the records and record supports are not damaged, deteriorating or missing.

Storage and disposal
Review the storage facilities, files, cabinets, archives premises and environment to ensure their suitability for the purpose. Confirm that all safety related records assigned for the permanent retention are stored in a manner as to prevent deterioration. Confirm that fire protection and security are taken into consideration. Check if the safety related records are properly indexed, filed, stored and maintained in facilities that allow retrieval when required. Check that during the retention time the records are easy accessible. Check that there are clear requirements for the duplication of records and separate storage, where it is not practicable to provide suitable storage conditions.

Check if specific package and storing measures are maintained for the records that are processed by special methods (examples of such records are radiographs, photographs, microfilm and magnetic tapes).

Check that clear responsibility is assigned for transferring or disposing of records.

3.2. TRAINING AND QUALIFICATION

To achieve and maintain high safety standards, nuclear power plants are required to be staffed by an adequate number of highly qualified and experienced personnel. To establish and maintain a high level of personnel competence, appropriate training and qualification programmes should be established at the plant and kept under constant review, to ensure their relevance to staff needs. It is the responsibility of the operating organization to ensure that all plant personnel receive appropriate training and that only personnel with suitable qualifications are assigned job functions at the nuclear plant. During employment, qualifications are maintained by participation in continuing training programmes that are directed towards maintaining and upgrading the knowledge and skills of the personnel.

References: [6, 9, 11, 13, 15, 27, 29, 32 and 45]

3.2.1. Training policy and organization

Expectations

The operating organization should formulate an overall training policy. The training policy should be known, understood and supported by all persons concerned. A training plan should be prepared on the basis of the long term needs and goals of the plant. A systematic approach to training should be used for the training of plant personnel. A system should be in place to identify the training needs of all staff following their recruitment. These training needs should be reviewed and revised to take account of organizational changes and changes in plant and processes. Appropriate mechanisms should ensure that a ‘corporate memory’ of safety related events are retained.

The plant manager should be responsible for the qualification of plant staff and should support the training organization with necessary resources including staffing and facilities. He should ensure that cost reduction programmes do not lead to undue limitation of resources being made available for training and retraining staff. Succession planning should be an established practice in the training organization. The training organization should be responsible for assisting the plant manager in establishing, verifying and maintaining the competence of plant staff. The training organization should be well defined including the interfaces with other plant groups. Line managers and supervisors should be accountable for the qualification of their personnel and involved in defining the training needs and ensuring that the training provided reflects operating experiences. Managers and supervisors should ensure that production requirements do not interfere with the conduct of training programmes.

The operating organization should ensure that the qualifications and training of external personnel performing safety related duties are adequate for the functions to be performed.

Qualifications of each individual should be assessed against established training objectives and performance criteria during and after the training and before assignment to a new job and periodically thereafter. Individual training records should be maintained. Persons performing certain functions important to safety should be required to hold a formal authorization.

The plant management expectations, standards, goals and objectives for training should be clearly stated and understood by plant personnel, including the staff of the training department.

Examples of documents to be available for review during the OSART mission:

- Plant organization chart including functional responsibilities;
- Training organization chart showing training staff and interfaces;
- List of regulations, guides and administrative procedures applicable to training;
- Short description of the training centers with a major role in training;
- Job description and training records for full and part-time training staff;
- Results of job and task analysis or other documents relating the adequacy of training content to job requirements;
- Selected training programmes and the individual training plans for diverse personnel groups;
- Reports on the training audits and evaluations of training efficiency;
- Qualification test sheets;
- Training records, including the amount of continuing training provided to different personnel groups during the past two years;
- Training goals, objectives and performance indicators.

Evaluations

Training policy

Confirm that the training policy expresses the commitment by the operating organization and plant management to the training of personnel and an acknowledgement of the critical role that training plays in the safe, reliable operation and maintenance of the plant. Check the training plan whether it is evaluated periodically in order to ensure that it is consistent with current and future needs and goals. Confirm that the systematic approach to training provides a logical progression, from identification of the competences required for performing a job, to the development and implementation of training towards achieving these competences, and to the subsequent evaluation of this training.

Check personnel training records when reviewing the training programme for specific personnel categories to ensure that the amount of training actually provided to various personnel groups is commensurate with that required to maintain the knowledge and ability to safely perform their jobs. Evaluate whether the records are up-to-date, complete, easily retrievable and used by plant managers to ensure that the required training is completed.

Confirm that the training services provided by external organizations are of high quality, and assess whether they are adequately monitored and controlled.

Organization and functions

Confirm that the structure and functions of the plant training organization are well defined and support overall plant operations, by reviewing the adequacy of the following:

- Training administration and programme planning;
- Development of training courses, providing actual training, and evaluating effectiveness (instructors);
- Production of training material, and maintenance of training facilities and equipment.
- Confirm that the training organization is staffed to efficiently carry out the assigned tasks.

Confirm that succession planning is an established practice in the training organization. Share results of your evaluation in this respect with the MOA reviewer.

Evaluate how well goals and objectives are used to monitor and improve the training programmes and the extent to which corporate and plant management periodically review training effectiveness.

Check if formal qualification requirements are in place for the personnel, which is subject to formal authorization/licensing. Check whether these requirements cover such aspects as initial license and renewal of license, re-qualification, medical examination, proficiency requirements, requirements for examinations including written examinations and operating test. Check some selected licenses and the related documentation (application, results of examinations, etc).

Management involvement
Check that the responsibilities and authorities assigned to the full-time training staff compare with those of line managers and supervisors relating to the training and qualification of their subordinates.

Confirm that the policy and role of plant management is supportative in determining needs and in allocating resources for training and ensuring that production requirements do not interfere with the conduct of training programmes.

Check the adequacy of the administrative policies and procedures and the extent of management oversight for ensuring the implementation of the following training programme activities:

- Development of the individual training plans based on needs;
- Allocation of time for training;
- Training course management;
- Enforcement and control of attendance at scheduled training;
- Training records systems.

Check the following for adequacy and the extent of management involvement for ensuring that individuals are qualified to perform their jobs:
- Examinations;
- Demonstration of skills;
- Performance in trainee position;
- Qualification manuals;
- Periodic performance evaluation/reviews.

Interfaces with other plant groups
Check what are the formal communication channels between the training group and other plant groups to ensure that the personnel competence are maintained, training programmes adequately reflect current plant conditions and appropriate modifications are introduced when needed.

Check the interface of the training group with other plant groups to maintain the adequate technical knowledge and skills of the trainers to support their training activities.

3.2.2. Training facilities, equipment and material

Expectations

Adequate facilities should be available for classroom training and individual studies. Representative full-scope simulator facilities should be used for training of the operating personnel. Workshops and laboratories should be equipped with mockup models and actual components for training on plant activities that cannot be practiced with installed equipment (high dose rates, etc.).

Educational training material should be provided to facilitate the trainees' understanding of the plant and its systems. The effectiveness of classroom instruction should be enhanced by the use of visual aids. Detailed technical information should also be available in the training facilities, to be used as reference material.

A programme should be in place for periodic review and timely modification and updating of the training facilities and material when necessary, to ensure that they reflect modifications and changes made at the plant.

Examples of documents to be available for review during the OSART mission:
- List and description of the training facilities;
- Training course material and written material related to classrooms, simulators, laboratories and on-the-job training;
- Simulator certification documentation;
- Records of simulator hardware and software updates.

Evaluations

Training facilities
Check the adequacy of the conventional training facilities by evaluating:
- Classrooms;
- Dedicated study rooms with reference material;
- Equipment such as video recorders, computers, non-full scope simulators, film projectors, overhead projectors and educational models and drawings;
- Offices of the training staff.

Check to ensure that the laboratories and workshops used for practical training are equipped with mockup model and equipment representative of actual equipment used in the plant and are well maintained.

Confirm that the ALARA principles are included in the training programme for the workshops and laboratories.

Check to ensure that computer based training packages and other flexible learning materials are relevant and maintained accurate if they are used.
Check that advantages of e-learning methods are getting gradually utilized.

Simulator facilities
Evaluate the following functional and physical fidelity aspects of the plant specific simulator for its impact on training programme effectiveness:

- Similarity of the simulator control room to the actual control room, including the working environment, such as use of documentation, logging systems and communication systems;
- Similarity of the simulator systems behaviour to actual plant systems behaviour. (It is sometimes possible to adapt system models when the simulator is not plant specific.);
- Simulator capabilities: simulation of randomly selected failure combinations, simulation of severe transients and loss of coolant events, modelling of auxiliary systems;
- Instructor aids: isolated booth, means for freeze and back track of simulation, automatic records of the operator actions and systems behavior, video cameras;
- Methods used to validate the simulator models;
- Updating of the simulator models and simulator documentation, to reflect modifications at the plant;
- Implementation of simulator configuration controls.

Training materials
Check to ensure that training materials are well organized, current and effectively support the plant training requirements.

Review sample course material to determine whether the educational aspects and ease of comprehension have been emphasized.

Check how well the quality of visual aids such as video tapes, films, computer based animations, slides and viewgraphs support the training being conducted.

Confirm that detailed technical information is available in the training facilities.

3.2.3. Quality of the training programmes

Performance based programmes for initial and continuing training shall be developed and put in place for each major group of personnel. The content of each programme should be based on a systematic approach, such as job and task analysis, ensuring the necessary knowledge and skills are incorporated. Training programmes should be in place that address Safety Culture. Such programmes should stress that individuals understand the significance of their duties and the consequences of mistakes arising from misconceptions or lack of diligence. Training programmes shall promote attitudes, which help to ensure that issues of safety receive the attention that they warrant. Training programmes for most NPP positions should include periods of formal training in the classroom intermixed with intervals of simulator, or laboratory, or workshop, training and should include practical training in the plant. This training should be conducted and evaluated in the work environment by qualified, designated individuals.

The adequacy of all training programmes should be periodically reviewed and assessed by both plant management and the training staff. This should include evaluation of training graduate competence in the workplace and adjustment of training programmes as necessary. The programme should be designed to allow for updating when changes in the tasks, plant systems or procedures are made. In addition, a system shall be in place for timely

modification and updating of the training facilities and materials to ensure that they accurately reflect plant conditions.

Examples of documents to be available for review during the OSART mission:

- Quality assurance procedures for plant personnel training;
- Administrative procedures related to the preparation of the training programmes;
- Selected training programmes for different categories of plant personnel;
- Selected training materials for different types of training (self-training, classroom training, simulator training, computer-based training, on-the-job training);
- Objectives and criteria to evaluate training programmes;
- Selected training programme records.

Evaluations

Training programme overview

Review the common features of the training programmes, to get a broad perspective of how well the following have been accomplished:

- Basis and methods used to ensure that the relevant knowledge and skills are included in the initial training programmes for various personnel groups: requirements and standards, degree of involvement by line managers;
- Basis and methods used to develop the continuing training programmes for various groups of personnel: selection of topics to be refreshed, basis for selection of topics (tasks frequency, difficulty, etc.), degree of involvement by line managers, plant modifications, experience feedback;
- Basis and methods used to integrate the topic of quality programmes, nuclear safety, safety culture and ALARA into the training programmes for all groups of personnel;
- Basis and methods used to integrate the insights from probabilistic safety assessment into the training programmes for all relevant groups of personnel. Confirm that important plant risk contributors are considered when establishing the basis for selection of tasks to be included in continuing training. Check whether trainers are familiar with the main insights of the plant specific PSA and discuss how do they use this information.
- Documentation of the training programmes: courses to be included and their respective lengths;
- Documentation of training courses: learning objectives, lesson and exercise plans, instructor guidelines, visual training aids, student reading material, methods for verifying the learning results;
- Material supporting on-the-job training: objectives and performance criteria, tutor guidelines, qualification check sheets, evaluation practice;
- Methods used to assess and improve the training programmes in general, and the individual courses: audits by line managers, QA and other audits, feedback from trainees, use of assessment results for improvements;
- Methods applied for monitoring the changes in tasks, systems or procedures at the plant and for the implementation of the corresponding revision of the

training programmes and material, ensuring the training content reflects the actual status at the work place and that 'negative learning' is avoided.

Confirm that the training programme is upgraded in light of performance deficiencies observed in the field and discovered through plant event analysis.

Initial training

Evaluate some initial training programmes for selected groups of personnel. Check the basis and methods used for their development to ensure that the programmes are based on a systematic analysis of job responsibilities. Assess the adequacy of the programmes scope and the total time allotted to accomplish the initial training. Also, check how well such elements as quality programmes, nuclear safety, safety culture and ALARA have been factored into the programmes.

Check how well the following aspects of the programme have been implemented:

- The tasks required for competent job performance are identified and included in the training programme;
- The training content is defined in learning objectives specifying the knowledge and skills needed to perform the defined tasks;
- The trainees are evaluated against the performance criteria specified in the learning objectives;
- Changes in the tasks, systems or procedures and operating experience are monitored and the training objectives, materials and facilities are revised accordingly.

Evaluate the quality and effectiveness of actual training being conducted by attending training sessions and reviewing the following:

- Quality of the instructor guidelines;
- Quality of the instructor guidance and visual training aids;
- Quality of the student reading material and that the training objectives are included;
- Adequacy of means used to verify and document learning results;
- Quality of the instruction.

Evaluate how well practical training is developed and conducted. The elements of this training should include full scope simulator, laboratory or workshop training, and on-the-job training. With respect to on the job training, evaluate the following:

- Well designed training material;
- Formal structure and well defined contents for each part of practical training;
- Definition of learning objectives for successful completion of training;
- Assignment of qualified, dedicated instructors or tutors and evaluators for each part of practical training;
- Criteria for successful completion of training;
- Effective evaluation of trainee competence and recording of training successfully accomplished.

Continuing training

Evaluate the overall programme for continuing training and the principles used to develop annual training plans. Confirm how well the following aspects of the programme have been implemented:

- Basis for selection of tasks to be included in continuing training;
- Time allocated for continuing training and means to control attendance of individual trainees;
- Training given to complete shift teams, versus individual training;
- Balance between classroom, simulator and other practical training;
- Periodic refreshment of plant systems knowledge;
- Periodic refreshment of emergency operating procedures, safety significant operations, and other important but infrequently used procedures at full scope simulator;
- Incorporation of plant modifications (hardware, procedures) and operating experience, both from the plant and industry wide, into the annual training plan;
- Adjustments of training programmes based on analysis of trends in job performance;
- Training for emergencies;
- Periodic refreshment of general employee topics (see 2.10).

Check some selected continuing training programme records to confirm that they include the following:

- content of the training provided;
- attendance;
- examination questions and answer keys;
- examination results and analysis;
- evaluation scenarios for simulator and plant drills;
- individual and team evaluation results;
- results of programme evaluation and corrective actions.

3.2.4. Training programmes for control room operators and shift supervisors

Expectations

The training and qualification programme for control room operator (CRO) and shift supervisor (SS) should develop and improve the competence to operate a controls of a nuclear power plant and direct those who manipulate the controls in the control room and in the plant.

Their training programme should develop and maintain adequate knowledge and skills to ensure that they are able to:

- Monitor and control the plant systems status in accordance with relevant rules, operating instructions, technical specifications and administrative procedures;
- Conduct all operations in a safe and reliable manner, without causing excessive thermal or mechanical load to the plant equipment;
- Take correct actions in response to various abnormal conditions, and bring the plant to a safe condition, including shutdown, whenever needed.

The training programmes should also include broad knowledge of the fundamentals to provide basis for understanding the operation of systems and integrated plant operations and to diagnose system/component problem.

Examples of documents to be available for review during the OSART mission:

- Job descriptions and training records for control room operators and shift supervisors;
- Qualification requirements, qualification programme and qualification test sheets for operators and shift supervisors;
- List of regulations, guides and administrative procedures applicable to the training of control room operator and shift supervisor;
- Training programmes for control room operators and shift supervisors and their individual training plans.
- Training records, including the amount of continuing training provided to control room operators and shift supervisors during the previous year.

Evaluations

Initial and continuing training

While reviewing the training programmes for this category of personnel confirm that they meet the general criteria specified in the Section 2.3. Check if the training programmes for the control room operators and shift supervisors include the following items:

- Thorough theoretical and practical knowledge of plant systems, their function, layout and operation;
- Operating procedures for normal operation and anticipated operational occurrences and, as far as practicable, for severe accident conditions;
- Routines for normal operation of the plant and the response of the plant to changes that could cause accidents if not counteracted;
- Plant diagnostics, control manipulations;
- Importance of maintaining reactivity control and continued core cooling at all times, including the period when the plant is at low power level or shut down;
- Importance of maintaining the plant within the operating limits and conditions and the consequences of the violation of these limits;
- Locations of all significant amounts of radioactive material in the plant and the controls applied to them;
- Results of any probabilistic safety assessment of the plant to demonstrate the importance of plant systems in preventing plant damage or severe accidents;
- Administrative tasks and human factors such as attitudes, human–machine and human-human (teamwork) interfaces;
- Supervisory techniques and communication skills.

Check the involvement of operations management in the design of training programmes, assessment of training efficiency and the performance of operating crew in the simulator. Check the selected training records of some experienced control room operators and shift supervisors.

Confirm that an adequate programme has been implemented to ensure that the qualifications of the control room operators and shift supervisors are current and that they are formally authorized before being allowed to assume normal or upgraded independent shift duties.

Simulator training

Evaluate, through observation, the conduct of full scope simulator training. Check how well the following have been implemented:

- Structured course programmes;

- Observation and evaluation of the performance of the trainees, both individuals and teams;
- Written plans for each training session;
- Training on normal start-up and shutdown operations;
- Training on how to diagnose and correct small failures that occur during normal operation;
- Coverage of transient and accident situations including actual transients that have taken place in the plant;
- Training on how to analyze risks and conservative decision making;
- Lessons learned from operating experience;
- Simulation of the actual plant atmosphere, such as alarms, administrative controls, use of procedures and technical specifications (operating limits and conditions);
- Shift team training including teamwork, communications, diagnostic and supervisory skills; Application of conservative control room operating philosophies and practices;
- Interaction between the instructor and the trainees during exercises;
- Adequacy of pre-exercise briefings and post-exercise critiques;
- Adequacy of frequency of simulator training cycles and adequacy of practice time on the simulator to maintain operating crew competency.

Check to see how well drills, exercises or walk-throughs are included in the training programme to cover topics that cannot be practiced on the simulator. Examples could be plant shutdown without access to the control room or response to severe accidents.

3.2.5. Training programmes for field operators

Expectations

The field operator training and qualification programme should develop, maintain and improve the knowledge and skills necessary to operate equipment outside the control room in accordance with relevant instructions and procedures, as directed by the control room staff. Their training programme should develop and maintain basic knowledge and skills in similar areas as the programme for control room operators (see Section2.4) but it should emphasize practical work specific topics. Well trained field operators should be able to:

- Monitor the equipment performance and status in the field and recognize any deviations from the normal conditions;
- Conduct all field operations in a safe and reliable manner, without causing unacceptable risks to plant;
- Detect and properly respond to plant conditions with the goal of preventing or, at minimum, of mitigating unanticipated plant transients.

Examples of documents to be available for review during the OSART mission:

Similar to the list in 3.2.4 (applicable to field operators).

Evaluations

While reviewing the training programmes for this category of personnel confirm that they meet the general criteria specified in the Section 3.2.3.

Check to ensure that the training is oriented to the qualifications required for field operator duties, as opposed to utilizing courses developed solely for control room operators. Check if training programmes for field operators provide the trainees with the knowledge and skills to operate and monitor systems and components that the field operators are responsible for.
Check if training provided to the field operators enable them to understand and use plant drawings, procedures, demonstrate watchstanding practices, in particular monitoring equipment, performing tests and lineups, recording data, reporting abnormal conditions, identifying plant material conditions, deficiencies, maintaining plant cleanliness.

Evaluate how well practical training is developed and conducted. Review, especially for utilization of laboratory equipment and other training tools, such as basic principle simulators, computer aided instruction to support theoretical training on fundamentals. Evaluate the extent to which the line organization provided job related input into the design of the training programme.

Determine how the qualifications of the field operators are verified initially and periodically thereafter.

3.2.6. Training programmes for maintenance personnel

Expectations

The training and qualification programme for maintenance personnel should develop and maintain or improve the knowledge and skills necessary for carrying out preventive and predictive maintenance, repairs and plant modifications. Training programmes for maintenance personnel should include plant layout and the general features and purposes of plant systems, quality assurance and quality control, maintenance procedures and practices, including surveillance and inspections, and special maintenance skills. An appropriate emphasis on the safety culture should be included in all aspects of training for maintenance personnel. Training programmes for maintenance personnel should emphasize the potential safety consequences of technical or procedural errors. Experience of faults and hazards caused by errors in maintenance procedures and practices at the NPP or at other plants and in other industries should be reviewed and incorporated into training programmes as appropriate].

Special training provided to individuals should develop their craft skills and ensure qualification on equipment to which they are assigned to work.

Examples of documents to be available for review during the OSART mission:

Similar to the list in 3.2.4 (applicable to the maintenance personnel).

Evaluations

While reviewing the training programmes for this category of personnel confirm that they meet the general criteria specified in the Section 3.2.3.
Confirm that the training programme for maintenance personnel was developed based on a

systematic analyses of job performance. Check that all personnel in maintenance are continuously trained in the ALARA principle, minimization of waste, radiation protection, industrial safety, access control and emergency procedures, as appropriate to their duties, and they are adequately qualified in these areas before being allowed to work in controlled areas. Confirm that the training programme considers aspects of safety risks involved in the several tasks to be performed.

Confirm that special maintenance craft skills are being well developed through the use of good workshop and laboratory training courses, taught by highly qualified instructors. Confirm that the training of maintenance personnel includes the training on mock-ups to reproduce complex situations (such as difficulties of technique, access, or radiation exposure) to recreate past incidents related with poor maintenance practices. Check what type of refresher training has been provided to the maintenance personnel in tasks that are not routinely performed. Certain crafts, such as welding, require periodic requalification and authorization to demonstrate that the individual continues to have the necessary skills.

Check if the training for maintenance personnel provides the trainees with the knowledge and skills necessary to properly select, inspect, use and care for the tools and test equipment used in the performance of assigned tasks. Confirm that the controls are in place to ensure that maintenance personnel are qualified to operate the equipment with which they are assigned to work. Check to ensure that the skill levels are verified, as a prerequisite to carry out demanding tasks.

Check if the training programmes for maintenance personnel emphasize the potential safety consequences of technical or procedural errors. Review that safety culture is emphasized in the training programmes, for example, by placing the highest importance on reporting, investigating and accordingly correcting any indication of failure or any unexpected findings. Confirm that experience of faults and hazards caused by errors in maintenance procedures and practices at the NPP or at other plants and in other industries is incorporated into training programmes as appropriate.

Check if the appropriate administrative training is provided for the maintenance personnel to make them able to locate and retrieve applicable documented information maintained at the site. Check that the administrative training includes, inter alia, work control system, outage management, coordination and interfaces, return to operational states.

Confirm that the operating organization ensures that the competence of external personnel involved in maintenance activities at the NPP is adequate for the functions to be performed, by making suitable arrangements with contractors and other participating organizations as appropriate. Confirm that emphasis is placed on the quality and safety of the working conditions of contractor personnel, and they are aware of the standards required.

3.2.7. Training programmes for technical plant support personnel

Expectations

The training and qualification programmes for technical support personnel based on the specific needs of the power plant should be established to develop and maintain the knowledge and skills of technical personnel to support safe and reliable plant operation. Considerations also should be given to the training needs of contracted personnel to ensure

that the requirements of operating organization are met. Technical support personnel should acquire knowledge of plant systems and understanding of operational methods and environment, so that they can effectively guide and interact with operating and maintenance personnel. These personnel should have knowledge of the operational features of the plant and preferably possess `hands on' experience. In addition to technical training, appropriate training in other areas, such as supervisory and communication skills should be provided. Dependent on the specific technical support groups the appropriate training programmes should cover such subject areas as reactor physics and core management, chemistry, radiation protection, surveillance and testing, planning, performance and plant engineering, safety analyses and reviews, emergency preparedness, records administration and documentation, and quality assurance.

Examples of documents to be available for review during the OSART mission:

Similar to the list in 3.2.4 (applicable to the technical support personnel).

Evaluations

While reviewing the training programmes for this category of personnel confirm that they meet the general criteria specified in Section 3.2.3.

Evaluate the programme established for initial training for some specific groups, such as radiation protection, chemistry and engineers working in the areas of performance and plant engineering. Confirm that the training needs are identified through a logical and systematic approach taking into consideration current knowledge and skills of the individual in relation to those required for the position and job related experience and training.

Evaluate the extent to which the line organization provided job related input into the design of the training programme. Evaluate the adequacy of the programme scope and the total time needed to accomplish the initial training.

Confirm that special technical support staff skills are being developed as needed through the use of good workshop and laboratory training courses, taught by highly qualified instructors. Check whether technical support staff is familiar with the features of safety analysis (probabilistic and deterministic) as part of their training programme.

Check how well the continuing training programmes for each category of technical plant support personnel reflect the special needs required to maintain proficiency to support the safe operation of the plant. Confirm the incorporation of plant modifications and operating experience, both plant and industry wide, into the annual training plan.

3.2.8. Training programmes for management and supervisory personnel

Expectations

The plant should have a management development programme to ensure that an adequate number of experienced and qualified staff are available to fill any manager or supervisor position, in the event that a position is unexpectedly vacated. Training programmes for management and supervisory personnel should emphasize the concept and practices of safety culture. These programmes should emphasize the special problems of managing an NPP, with the exceptional demand for safety and the need for familiarity with emergency procedures.

They should give a thorough understanding of relevant standards, rules and regulations. They should also give a good overall knowledge of the plant and its systems. The managers and supervisors with responsible positions in the emergency preparedness organization should be specially trained for their emergency duties. Special attention should be given to gaining from the benefits of operational experience feedback and root cause analysis for events that are generic or occur frequently at the plant. Training programmes for managers and supervisors, and their potential successors, should also include courses and seminars on management and supervisory skills, coaching and mentoring, decision making, self-assessment techniques, root cause analysis, team training, and communications. The managers and supervisors should also attend continuing training in their areas of responsibility, in order to maintain current technical knowledge and to be able to supervise training of their staff.

Examples of documents to be available for review during the OSART mission:

- Annual training plan for management personnel for the current and a few recent years;
- Any management training programmes offered by corporate organization;
- Selected training programmes for management training.

Evaluations

While reviewing the training programmes for this category of personnel confirm that they meet the general criteria specified in Section 3.2.3.

Confirm that the plant has implemented a policy for ensuring the availability of well trained and experienced persons in managerial and supervisory positions. This policy should include attitude towards safety in the selection criteria.

Evaluate the initial and continuing training programmes for developing and maintaining managers and supervisors technical knowledge, management and supervisory skills and knowledge on plant administration.

Check the availability of and observe (if possible) how well courses are conducted on topics such as:

- Management techniques: leadership and the managers role, planning and scheduling, information transfer, problem solving, decision analysis;
- Supervisory skills: work and people management, training and qualification of staff, interpersonal communication, behavioral sciences;
- Safety issues including risk assessment and conservative decision making;
- Work legislation and other relevant codes, standards and regulations;
- Administrative matters: personnel administration, procurement, budgeting, cost control, interfacing with external organizations.

Evaluate, through interviews, the extent to which key managers provide input and participate in the initial and continuing training programme in job related technical areas. Also determine how they refresh their own knowledge on general employee topics (see 2.10.).

Evaluate the adequacy of the structured training courses, provided to managers with emergency response duties in the areas of emergency preparedness, coordinated participation in drills, and maintenance of technical qualifications necessary to cope with the assigned emergency duty.

Confirm that attitude towards nuclear safety is considered when selecting and promoting manages and supervisors. Look for evidence throughout records, procedures or/and interviews.

3.2.9. Training programmes for training group personnel

Expectations

All training department staff, simulator and technical support engineers, technicians and instructors should be given training commensurate with their duties and responsibilities. Training instructors shall be technically competent in their assigned areas of responsibility and have credibility with the trainees and other plant personnel. They should understand all aspects of the content being taught and the relationship of that content to overall plant operation. In addition, the instructors should be familiar with the basics of adult learning, of a systematic approach to training and have adequate instructional and assessment skills. Instructors should also be given the time necessary to maintain their technical and instructional competence, by secondment or attachment to operating plant on a regular basis, and by continuing training. Personnel in the on-site training department should also be properly trained in matters concerning the policies of the operating organization, in particular safety management and safety culture, the regulatory requirements and quality assurance.

Examples of documents to be available for review during the OSART mission:

- Job description for the key training group positions;
- Training instructor certificates;
- Qualification requirements for training instructors;
- Training programmes for instructors;
- Records of participation and performance in the qualification and continuing training programmes;
- Records of results of training programme evaluation and corrective actions.

Evaluations

Confirm that the plant training group is staffed with adequately trained and experienced persons in all training positions in order to provide valid technical knowledge, skills and credibility with the students.
Evaluate the academic background of the training instructors. Confirm that they have an academic background in an education related subject, such as adult learning or human factors, in addition to a degree in appropriate discipline in their area of responsibility.

Check that qualification requirements are established for the training instructors that include qualifications for instructional, technical and interpersonal skills in areas such as learning psychology, adult education, teacher's role, presentation skills and the use of a systematic approach to training.

Check what methods (secondment, attachment to operating plant on regular basis or continuing training) are used to maintain technical competence of the training instructors and familiarity with the routines and work practices at the work place.

Confirm that a continuing development programme that maintain and improve instructional and technical skills is in place to correct instructor weaknesses and develop desired competencies in the various training settings.

3.2.10. General employee training

Expectations

All new employees starting work at nuclear power plants should be introduced to the organization and their work environment in a systematic and consistent manner. General employee training (GET) programmes should give new employees a basic understanding of their responsibilities and safe work practices, the importance of quality programmes and following procedures and the practical abilities to protect themselves from hazards associated with their work. Hands-on training in radiation protection actions, which are common to all plant personnel, should be provided to all who work in radiological controlled areas. The depth of the knowledge to be provided on each topic should be commensurate with the duty and position of the person. The basic principles of Safety Culture should be taught to all employees. Refresher training on GET topics should also be periodically provided.

Examples of documents to be available for review during the OSART mission:

- General employee training programmes for different subject areas (plant description, industrial safety, quality assurance and quality control, plant security, emergency preparedness, radiation protection);
- Qualification requirements for different personnel groups;
- Trainee evaluation records;
- Records of GET effectiveness evaluation and corrective measures.

Evaluations

Confirm that new employees starting work receive a systematic initial training. Evaluate the quality and effectiveness of actual GET being conducted by attending training sessions and reviewing some of the following course material:

- Safety Culture;
- Industrial safety: electrical safety, rigging and lifting, work in confined spaces, chemical hazards, use of personnel protection equipment, first aid;
- Radiation protection and ALARA techniques (including practical training in protective clothing use and personnel contamination surveys);
- Fire protection, including fire prevention;
- Environmental protection;
- Adherence to procedures;
- Quality assurance and quality control;
- Plant physical security and access control;
- Emergency plans;
- Introduction to plant organization and administration.

Evaluate the adequacy of alternative training courses that can be provided on each topic, to meet the needs of various personnel groups.

Evaluate the assessment methods used to determine that trainees have received the required initial training to work safely in the plant environment and how the result of the training received is routinely monitored and reinforced by management.
Review the methods used to refresh and strengthen the employees' knowledge of GET topics. Specifically, determine how practical examples of lessons learned for plant and industry operating experience are incorporated in the initial and refresher GET programmes.

3.3. OPERATIONS

Operations involves activities that supervises the operating group which controls safe plant operation. Operations main function is to run the plant safely and efficiently while adhering to approved procedures, Operational Limits and Conditions (OLCs) and other regulatory requirements. The operating group has a direct impact on the reactor operations and its associated components and systems through conduct of operations. While the structure of the group varies according to the specific plant or utility, the group is normally composed of shift crews and supporting staff during office hours and is usually managed by title of head of operations. The shift supervisor manages plant operations on each shift. During off-hours the shift supervisor maintains the authority of the plant manager. In addition to this for the purpose of defining review responsibilities in these guidelines operations covers operation facilities, operator aids, work authorization, fire protection and accident conditions.

Two experts usually review the Operations area during an OSART mission due to its direct impact on safety. The standard division of tasks between them is the following:

- Reviewer 1 reviews 3.3.1 “Organization and functions”, 3.3.2 “Operations facilities and operator aids” and 3.3.3 “Operating rules and procedures”;
- Reviewer 2 reviews 3.3.5 “Work authorizations”, 3.3.6 “Fire prevention and protection programme” and 3.3.7 “Management of accident conditions”;
- 3.3.4 “Conduct of operations” including control room and field operations are reviewed by both reviewers, because these activities are the ’end product’ of all related arrangements. They agree who drafts the technical notes for Subsection 3.3.4.

References: [6, 8-11, 15, 18, 27, 29 and 34]

3.3.1. Organization and functions

Expectations
The organization and functions of the direct operating group should ensure that the nuclear power plant is operated safely and conservatively under all operational states and accident conditions. This should include preparation to deal with severe accident conditions.

The organization, qualifications and number of operations personnel should be sufficient for the safe and reliable operation of the plant at power and during shutdowns and outage periods. Succession planning should be an established practice in the operating group.

The responsibilities and authorities of the direct operating group should be clearly defined and understood by all affected personnel.

The operations goals and objectives should be written and defined within the framework of plant policies and be well understood by the operating personnel. In those it should be clear

that nuclear safety has an overriding priority. Performance indicators should be established that encourage these expectations and are reported in periodic assessments.

Plant management should be clearly committed to nuclear safety in plant operations. The frequent presence of management in the field will demonstrate this commitment. Leadership and coaching should contribute to the improvement of safety performance.

Examples of documents to be available for review during the OSART mission:
Organization charts including functional responsibilities;
Written expectations, standards, goals and objectives with supporting indicators;
Reports of the audits and assessments performed over the year including corrective actions implemented or completed as a result of these audits or assessment;
Interface procedures that govern the coordination of work groups during normal operation, anticipated operational occurences, design basis accidents and beyond design basis conditions;
Operating group procedures and administrative controls;
Organizational structures, objectives and responsibilities during normal operation, anticipated operational occurences, design basis and beyond design basis accidents;
Organizational structure during outage conditions.

Evaluations

Functions and responsibilities
The overall responsibility for establishing and implementing the operations programme and managing the direct operating group normally rests with the head of operations.

Verify that the plant management has established and clearly communicated the management expectations and standards for the direct operating group. Determine the effectiveness of how well management expectations and standards are communicated to the operators and if the safety culture is realized throughout the operating organization. Verify that the operators understand the standards by observing procedure compliance, communications and notifications of plant status. Check to see if the operators perform their activities in an atmosphere of avoiding haste.

Confirm that the operations expectations and standards are represented in goals and objectives that are measurable and manageable in number to support this programme and that performance indicators are established to improve performance. Verify that this programme is routinely tracked with the results clearly communicated to the operations group. Confirm that there is a programme of self-assessment that promote continuous improvement and is supported by senior site management.

Review the extent to which the shift personnel of the direct operating group are controlled and supported by the day staff. Through interviews and from review of documents verify that the organization and administrative responsibilities are clearly defined, understood and working well for the following:

- The organizational structure of the direct operating group including all shift and day personnel;
- The responsibilities and authorities of shift personnel during and outside day staff hours, including accident conditions;

- Operations is responsible for the prioritization and has oversight responsibility for the planning and scheduling of work affecting safe plant operation;
- A programme has been established and implemented that controls the plant risk during power operation, shutdown and outage conditions;
- Written guidance is available for operators which provides direction for all operating conditions including beyond design basis and severe accidents;
- The administrative control and effective planning to ensure that exposure of operations personnel is kept ALARA;
- The involvement of shift personnel to the extent necessary in the authorization and performance of:
  - Surveillance testing;
  - Maintenance;
  - In-service testing;
  - Permanent and temporary changes to plant procedures;
  - Documentation of time limitations allowed by OLCs;
  - Permanent and temporary plant modifications;
  - Special operating procedures for tests or one time evolutions.
- The provision to ensure an adequate organization that supervises refueling and shutdown activities;
- The supervision of shift activities by the shift supervisor and the periodic evaluation of shift operations by the head of operations;
- The development and compilation of operational records as well as information to be included in the logbooks;
- The production of operational reports for management, other groups and authorities as required;
- Reporting and investigation of abnormal events including near misses and low level events to reduce the probability of a similar situation recurring as an actual plant event;
- The conduct of routine meetings during operation and during outages within the operational department, and with maintenance, supporting groups and associated management.

Ensure that controls are established which minimize distractions to the shift personnel and the programme enables the crew to remain alert to changing plant conditions. Examples of distractions that should be minimized would be excessive administrative burdens; excessive number of people allowed in the main control room or nuisance alarms or permanently lit annunciators.

Ensure that major evolutions of work in progress at multiple unit sites do not affect the safe operation of the other units.

Determine if ownership is stimulated by adequate delegation of responsibility and if personnel are encouraged to suggest improvements to safety, reliability, quality and productivity. Also determine if personnel are willing to bring problems to their supervisors without fear of retribution.

Confirm that succession planning is an established practice in the operating group. Share results of your evaluation in this respect with the MOA reviewer.

Interfaces with other plant groups
Ensure that interface responsibilities have been defined, are clearly understood and are working well for the co-ordination of the activities of the direct operating group with those of other groups of on-site and off-site organizations.
Confirm that criteria for the shift supervisor to report operational issues, events or abnormalities (both internal and external to the plant) are clear and the process is documented.
Ensure that adequate provisions exist for prompt support to shift supervisors during off-normal staff working hours in case of problems in the field of maintenance, radiation protection, water chemistry, etc.

Ensure that Operations is cognizant of work or activities affecting reactor safety for both planned and unplanned work in progress.

Qualification of personnel
The expert evaluating training and qualification will primarily review Training and qualification programmes and processes. However, during interviews and from observations of control room activities and field work, determine if the experience level and proficiency of the operations staff are appropriate for their assignments and if operations management is involved in training and re-training of operations staff.

Confirm that line management is accountable for the training and qualification of their personnel by checking that operations management has an integral role in the operations training programme, including determining training programme content and assessing final competencies. Additionally, determine that training of operations personnel is monitored by line management to ensure it is adequate and appropriate and that operations personnel maintain competence.

Confirm that a comprehensive continuing training and re-qualification process that embraces all operating personnel is in place and that personnel are required to attend re-training after a significant period of inactivity in operations.

Ensure that each position in the operations line organization is staffed with suitably competent and authorized individuals. The process of selection, training and job rotation should be well programmed to develop and maintain capabilities, safety awareness, and to provide the necessary staff motivation.

Through observations and interviews confirm that operations staff are knowledgeable of and effectively using current work practices and procedures.

Ensure that authorities for the operations line management are commensurate with assigned responsibilities.

Shift staffing
Determine if the staffing level of the shift crews are such that there is sufficient numbers of authorized operators and other staff for the reliable accomplishment of assigned tasks.

Confirm that the plant has an adequate staff based on a credible enveloped scenario, which provides for a fire in the plant and a simultaneous incident condition. Ensure that staffing levels provide adequate redundancy and diversity of the skills needed in accident conditions.

Determine if operations management strives to achieve the strategy of crew concept by use of a consistent shift rotation pattern throughout the year.

Management support of operations
Observe how often the plant management and the head of operations observe operators' activities, become actively involved in the resolution of their problems and how they promote consciousness of safety as their primary focus. This includes management response to audits performed internal and external of the department.

Observe whether the head of operations, shift supervisor and control room operators when properly relieved or not on shift, spend some time walking the plant and observing field operators carrying out their activities. Check if these observations are documented and corrective actions prioritized and tracked. Check if there is a minimum requirement for written field observations.

Determine the effectiveness of managements' review of personnel performance, safety attitudes and response to safety infringements and violations of OLCs or procedures.

Determine if management supports shift operations by ensuring that all necessary requirements such as: qualifications, job descriptions, training, licenses etc. for each shift position are sufficient and adequate to establish and maintain a safety culture atmosphere for his shift. Check that the shift supervisor has appropriate training in leadership qualities along with skills developed for coaching, observation skills and emergency communications to on-site or off-site personnel.

Confirm that regular appraisals of the performance of operating staff are used to enhance individual performance and to prevent complacency.

Confirm that good regular communications occur between senior operations management and control room operators.

3.3.2. Operations facilities and operator aids

Expectations

The facilities and equipment used by the operating staff should be well maintained and adequate to support safe and reliable operation of the plant under all operating conditions.

There should be a programme to control operator aids at the plant. This programme should ensure reliable communications, well identified and labeled equipment, clear of defective or unavailable equipment, good environmental conditions at the plant, clear and ever friendly information systems adequate and well maintained supportive equipment.

Examples of documents to be available for review during the OSART mission:
- Plant labeling and housekeeping instructions;
- Procedure governing operator aids;
- Listing of operator aids.

Evaluations

Check that reliable communications equipment is available to support control room and plant activities during all modes of operation. Confirm that the communication system adequately supports all emergency plan notification requirements.

Check that the number of lit annunciators is sufficiently minimized to support operator awareness of plant and equipment status. Only those annunciators necessary to support status information should be lit. Annunciators are easy to differentiate by their importance.

Check that operators are knowledgeable of the causes of the lit annunciators in the main control room and local panels.

Check that the availability of systems and equipment are clearly displayed to the operator. Defective systems and equipment are clearly indicated and properly labeled.

Check that the lighting, noise and temperature in the control room are adequate and that the instrumentation and annunciators are unobstructed, clearly readable and understandable to the operator.

Check that plant evacuation routes are well lit and clearly marked.

Check that a formal system exists, which is clearly understood by operators, for controlling, maintaining, approving and updating operator aids (i.e. limited instructions on control panels, local panels and plant equipment).

Check that the information provided by the process computers supports the required data necessary to adequately determine short term and long term overview of the plant performance, during normal and abnormal operations. Check the computer alarms have not become a nuisance to the operators because of outdated or irrelevant information.

Check that facilities assuring habitability of control rooms such as emergency ventilation and tightness of the control rooms, as well as monitoring of radioactivity etc. are provided. A supplementary control room is available for the safe shutdown of the plant if the main control room were to become uninhabitable.

Check that the essential facilities and equipment in both the control room and in the supplementary control room are adequate. Check that adequate and controlled supportive information exist in the control room, supplementary control room and auxiliary panels.

Check that cleanliness and good housekeeping are evident in the operators' facilities.

Check that radiation protection, industrial safety, emergency first aid, and fire protection means are adequate to support all modes of plant operation.

Check that plant equipment is easily accessible for field operations.

Check that all plant areas, systems and associated components are clearly and properly identified, such as: isolations, positions of motor and manually operated valves, protection system trains, electric supply to different systems, etc. Particular attention should be paid to

see if there is a clear identification of unit system valves and electrical supplies to avoid erroneous operations or work on the wrong unit, train or equipment.

Review if significant events occurring within the last two years are related to human errors and operations aids. If so, review corrective actions taken.

Check that there is information readily available regarding the location of valves, breakers and switches, pumps, fans and other major equipment.

Check that the following equipment needed to adequately support normal and emergency operational activities is in good working order and readily available to the staff:

- Portable and permanently installed communications equipment at all control stations;
- Currently calibrated survey instruments;
- Control panels and frequently used equipment both physically and environmentally accessible to the operators;
- Radiation dosimeters for accident conditions.

Ensure adequate control of procedures and space available for proper placement of main control room and in-plant working areas procedures.

3.3.3 Operating rules and procedures

Expectations

Operating personnel should operate the plant safely and reliably while keeping the plant's operation within the OLCs, in accordance with the policy of the operating organization and the requirements of the regulatory body. Comprehensive legible operating procedures should be provided for the operators.

Procedures shall be developed for normal operation to ensure that the plant is operated within the OLCs. Either event-based or symptom-based procedures shall be developed for anticipated operational occurences and design basis accidents. Emergency operating procedures or guidance for managing severe accidents (beyond the design basis) shall be developed.

Guidance provided in the procedures should be clear, concise, verified for its accuracy and validity and adequate to enable trained operators to perform their activities.
All procedures should be properly approved by plant management, controlled by established procedures, and implemented in a timely manner. Operators should be appropriately trained on procedures including changes to existing procedures or new procedures.

Changes to plant procedures should only be performed following an approved procedure that designates the appropriate authorities that must approve the change to the procedure.

An appropriate surveillance programme should be established and implemented to ensure compliance with the OLCs, and that its results are evaluated and retained.

At a multiple unit site documents and procedures should be located at each unit. Procedures should be written to specifically address which unit or component will be manipulated.

Examples of documents to be available for review during the OSART mission:

- List of normal and emergency operating procedures;
- Operational limits and conditions;
- Operating procedures and instructions;
- Operations group procedures and administrative instructions;
- Surveillance test schedules;
- Site license;
- Procedures for operating expectations on procedure usage, format, temporary changes and safety philosophy.

Evaluations

Operational limits and conditions

Review the content of OLCs to ensure that safety limits, safety system settings, limits and conditions for normal operation and surveillance requirements, including tolerances, have been clearly stated.

Check that adequate controls and legible procedures are in place for ensuring that OLCs are complied with and that deviations are properly documented and reported in an appropriate manner.

Confirm that the shift supervisor and operators have a clear understanding of their responsibilities with regard to reporting and documenting infringements of OLCs.

Check if at the multiple unit site the OLCs are located at each unit. Check if the OLCs specific to the unit are distinguishable if the common OLCs volume for all units is used.

Confirm that responsibilities for various aspects of the surveillance programme are clearly identified and understood. This will include formal documentation for entries or exits of time clocks associated with OLCs. Confirm that surveillance test procedures contain control of revisions, authorization, prerequisites, initial conditions, special precautions, control of instruments, reference to the OLCs and the acceptance criteria, along with expectations if the acceptance criteria is not met.

Normal operating procedures

Confirm that the plant operating procedures, surveillance tests, administrative controls etc. as well as supporting reference material such as system descriptions, flow sheets, wiring and logic diagrams are well controlled. Confirm that these can be easily located and are understandable to the operators.

Check that log sheets or equivalent means are used to monitor and record plant parameters. Check completeness, clarity and supportive information in these sheets. Check if abnormal results are identified and documented with subsequent follow-up.

Check that operations documents are kept up to date, and technical details contained in the procedures and reference material are consistent with each other. Check that a systematic approach with assigned responsibilities is provided to keep procedures and reference material up to date and out of date procedures are removed from circulation in a timely manner. Verify that operators are properly trained on new and existing procedures.

Check how the logs are controlled and authorized by a plant procedure or policy. Confirm that the records and logs are documented in ink only.

Confirm that there are adequate mechanisms in place for the operating staff to report document mistakes or potential improvement in operating procedures.
Check that regular reviews are conducted to ensure that the documentation available in the main control room and in the field is up to date and properly controlled, and that any temporary information displayed for the operations staff is current and properly authorized.

Emergency operating procedures
Check that clearly written procedures for anticipated operational occurrences and accident conditions are available for abnormal conditions and accidents included in the plant design basis.

Ensure that adequate emergency operating procedures (EOPs), for coping with design basis accidents, are in place and have been adequately trained on. In addition, check if there are procedures and accident management guidance to cope with beyond design basis accidents.

Check whether the EOPs in place have been developed taking into account the insights from PSA analyses. Check that the EOPs are easily distinguished from other plant procedures. Check if the procedure title is descriptive enough to enable operator quickly recognize the abnormal condition to which it applies.
Check what approach is used at the plant for the EOPs (event based or symptoms oriented). Check if operations understand the inherent limitations of event based procedures and what measures are in place to compensate for these limitations.

Confirm that EOPs are clearly located and identified in the main control room and supplementary control room and periodical inspections are carried out to confirm completeness and validity of EOP's.

Confirm that plant EOPs are regularly used in the simulator and that field operators are also included in the training. Check if EOPs contain location of equipment in the field necessary to complete steps in the emergency procedures.

Check that user-friendly alarm procedures exist in the control room and auxiliary panels and are used as required.

Control of changes to procedures
Confirm that the changes to procedures are carried out in accordance with established plant modification procedures in a controlled manner. Confirm that the methods of the configuration management are used when modifying operating procedure to ensure that other documents remain consistent with the modified procedures.

Check that prior to putting the plant back into operation after modification all relevant documents, in particular relevant operating documentation is timely updated and operators are trained in their use.

Confirm that temporary changes to procedures have been appropriately reviewed and authorized prior to their use.

Check that there is a formal system in place to control and evaluate the duration and number of the temporary changes to procedures and special procedures, and when applicable, incorporated as a permanent revision in a timely manner.

Check that operators have been trained/informed on temporary changes to procedures prior to implementation.

Confirm that procedures are promptly replaced when changes are carried out.

3.3.4. Conduct of operations

Expectations

Operations personnel should be cognizant of and have control over the status of plant systems and equipment in all modes of operation. The shift supervisor should be informed of all the plant activities affecting the status of systems and components. All activities such as performance and results of surveillance tests and maintenance works should be routed via him or his delegate for final approval. Similarly, the operators should be keep informed of plant status.

A policy should be in place that gives direction to the operators on procedure rules and requirements of how a procedure should be used. This policy should include directions for when procedures are to be used as general guidance, are to be followed step-by-step, or need to be signed off for each step. Close adherence to written procedures should be observed in order to ensure correct operation of equipment. The policy should also include directions when a procedure must be physically at the job site, and what actions are to be taken when procedures conflict or are inadequate. Deviation from these procedures should require approval at a level appropriate to its safety significance. Procedure users should be encouraged to provide feedback to procedure writers on inaccuracies, difficulties in use and suggestions for improvement.

The operating departments policies and procedures should reflect an attitude of safe conservative operations. Managers and supervisors should demonstrate and require a conservative approach toward activities affecting the reactor core and safety systems.

Control room activities should be conducted in a businesslike and professional manner. An atmosphere conducive to safe and reliable operation should be maintained. Operators should be alert and attentive to control board indications and alarms. Administrative duties assigned to control room operators should not interfere with their ability to monitor plant parameters and conduct other operational activities. Control room access should be limited to persons on official business only.

The shift crews should routinely monitor the condition of systems and components and make the appropriate records. The important information on the plant status and the relevant operating occurrences should be adequately logged. The operational personnel should conduct regular plant tours to ensure that the status of equipment is evaluated appropriately and abnormal conditions identified. Operational personnel should take appropriate actions to correct or report deficiencies noted during tours.

The shift turnovers should be carried out in accordance with the formal procedure. The procedures should identify the persons involved, their responsibilities, the locations and the

conduct of shift turnovers, methods of reporting of plant status, including provisions for special circumstances such as abnormal plant status and staff unavailability.

Effective reviews should be conducted after a reactor trip or unplanned shutdown to evaluate the causes of the trip and the corrective measures implemented.

A formal communication system should exist for the transmission of orders and for the transfer of information related to the reliable and safe operation of the plant. Oral communication should be clear, concise and understandable.

Examples of documents to be available for review during the OSART mission:

- Regulating guides on plant operation such as OLCs controlling necessary actions when part of the safety equipment is out of service or otherwise unavailable;
- Check sheets for the recording of shift operating data;
- Procedures and checklists governing shift turnover;
- Procedures governing the placement of information and caution tags on plant equipment;
- Procedure governing entry information into shift log books;
- Surveillance schedule;
- Procedure governing in-field operators monitoring requirements.

Evaluations

Determine the efficiency and effectiveness of the plant operating staff by observing actual operating practices on shifts including field operations. This is best done by interviewing personnel, observing shift turnovers, reviewing control room logs, and evaluating the shifts control of temporary changes to procedures and modifications.

Control room

Confirm that operators are attentive and responsive to plant parameters and conditions and that they are being given clear direction by the shift supervisors to perform assigned tasks. Specifically, check how well they perform their activities with respect to the following:

- Reasons for lit annunciator alarms;
- Response to annunciator alarms;
- Response to alarms generated by process computers;
- Equipment isolations and control of work in progress;
- Attentiveness to control room and plant control panels, including constant front panel monitoring;
- Follow-up on unusual events that have occurred during previous shifts;
- Adherence to special instructions and temporary changes to procedures;
- Awareness of temporary modifications;
- Pre-planning and staffing for oncoming shift.

Check that the control room atmosphere is professional and that plant personnel do not hinder operations activities. Verify that the access to the main control room is controlled, presence of unnecessary personnel is limited and working conditions in the control room are quiet.

Verify that all verbal communications within the shift or between the shift crew and the other groups is clear and concise and covers both the provision and receipt of the correct information. Check that the full description of any plant item is given and the phonetic alphabet is used where appropriate. In all communications the sender has the responsibility

for ensuring that the information is fully understood. Confirm that recipients of verbal instructions only proceed when they fully understand the task to be undertaken.
Confirm that there is a general a requirement to stop and review safety before starting a piece of work or beginning to carry out a procedure. Verify the expectation to be conservative in safety related matters by staff checking their understanding of a situation (and if necessary seeking more information or advice).

Check reactor operations and reactivity changes to confirm that a philosophy of conservative operations concerning reactivity management exist at the plant.

Confirm that for any major changes to reactor power a pre-job briefing occurs explaining the effects of the change and resolving any procedures conflicts, policies, work distractions or contingency actions prior to making the power change. After authorization has been granted for the reactivity manipulation it should then be done in a carefully controlled deliberate action.

Determine the effectiveness of shift turnover in transferring and documenting all important information about the plant status, work in progress and events during the shift. Observe shift briefings to determine how well the shift supervisor is communicating his expectations and objectives for each of the shifts activities.

Check for a policy on procedure usage and rules. Verify that operators understand and are following the policy. Shortcuts or failures to follow requirements should not be condoned, even when there are strong operational pressures to do so.

Check that in-coming and out-going operators walk down the control panels and jointly read checklists, log books, recordings, process computer displays and alarm messages to adequately familiarize themselves with system and equipment status.

Determine if the shift crew is routinely monitoring the condition of systems and components by observation, analysis of data and any testing within their responsibility. This include monitoring for abnormal trends of plant parameters.

Confirm that adequate logging is carried out for relevant operating occurrences. The information logged typically contains:

- General plant status at time of turnover;
- Changes of reactor mode;
- Abnormal plant configuration, equipment or systems out of service;
- Changes of major plant systems and equipment;
- Plant events;
- Testing carried out and post maintenance retest;
- Completion of OLCs time clocks;
- Shift turnover;
- Status of OLCs.

Check that system and component status changes are appropriately documented and communicated from local control stations to the main control room in a timely manner.

Determine if activities affecting the status of systems and components important to safety are well planned, authorized and controlled by the shift supervisor.

Confirm that off-normal conditions are easily recognizable to the operators and that the number of control room alarms including process computer alarm messages is minimized. Defective or out of calibration equipment should be work prioritized and clearly indicated to the operator by an approved tagging method.

Check how well the arrangements and procedures are for logging data, inking and dating recorders, processing and saving digitally available plant data files. Verify that the shift crews routinely monitor the condition of systems and components and make the appropriate records on the plant status and parameters and all automatic or manual actions. Check the policy for logging of the activities, collection and archive of the operators' records whether they assure that the necessary information can be easily located and trust-worthy reproduced when a subsequent evaluation is necessary. Determine how well violation of OLCs are documented and reported.

Check if a system exists to prevent the unauthorized access to, or interference for any reasons with, structures, systems and components important for safety, including hardware and software of computer based systems important to safety. Check the effectiveness of the key control system in ensuring that access to restricted areas is well controlled and that the system used for controlling locked valves and breakers is effectively implemented to support system safety and reliability.

Check how well the shift staff investigates apparent abnormalities and malfunctions during their shift and if they are encouraged to report and document unexplained events to their supervisors.

Check whether employees are encouraged to develop attitudes that give them confidence, without fear of blame, to report errors fully, particularly human errors, so that the opportunity can be taken to learn how to further improve the process.

Surveillance testing

Determine if the surveillance test programme is well organized and properly executed to ensure that the required plant safety systems remain operable as much as possible throughout the testing.

Check operations responsibility in the performance evaluation and approval of surveillance test. Check the overall control of the surveillance programme and the shift supervisors awareness and involvement in these controls.

Confirm that surveillance tests carried out by the operations, maintenance or other groups are well prepared and coordinated (refer to the review results in TC area). Confirm that surveillance tests are authorized by shift supervisors prior to performance and the tests results are reported to the operations staff in a timely manner. Check whether the malfunctions observed are reviewed by the shift supervisor against the established OLCs.

Check that the requirements for surveillance procedures included in Section 3.3.3. are met.

Confirm that operations are aware of and avoid pre-conditioning of equipment prior to surveillance testing. Therefore, operations should ensure prior to a surveillance test that the testable equipment has not been exercised, tested or operated in a manner that would invalidate the surveillance test.

Field operations

During plant tours observe field operations, assess fire protection, material conditions, housekeeping and cleanliness and industrial safety practices.

Accompany operators making regular rounds through the plant and evaluate how well observations are made. Check if all relevant areas are covered within specified intervals.

Confirm that a system for documenting problems exists which includes an evaluation for operability impact. Check what are the arrangements to visit the areas which cannot be entered during power operation.

Observe material conditions for components leakage, excessive vibration, unfamiliar noise, inadequate labeling, foreign parts and deficiencies requiring maintenance or other action.

Check if the field operator has documented deficiencies you have observed. Confirm that the field operators report and label deficiencies to avoid repetition of reporting and ease of identification for maintenance. Check if field operators report degradation in the plant that may affect long term reliability of plant equipment or structures.

Conduct a thorough walk through of the plant buildings. Confirm that cleanliness and good housekeeping are evident. Check the following items to assure good housekeeping is being maintained: painting, condition of components, sumps and thermal insulation, the presence of controlled leakage, obstructions, floor surfaces, labeling of components and the posting of signs and directions in rooms, route posting, lighting, and posting and status of doors. Check if the programme of foreign material exclusion is implemented and monitored.

Observe persons working in safety related areas and determine whether requirements, such as those relating to welding, helmets, safety gear, protective clothing, radiation work permits, etc., are being strictly followed. Check if industrial safety problems are routinely reported such as: Firequel leakages, hazardous equipment, trip hazards, etc.

Check familiarization of field operators with fire protection systems and check the fire door status, accumulated fire hazard materials such as wood, paper, trash, oil leakages, etc.

Confirm that adequate means are being used to log data from field operator rounds in log sheets, computerized data basis, etc. These logs should contain reference values to assist the field operator. Trend analysis should be periodically carried out, and when important parameters show reasonable drifts, the cause of that should be investigated.

Check if plant management and supervisors conduct regular plant tours to communicate with field operators.

Check that independent verification is applied as appropriate to activities, involving safety related equipment and systems, e.g. equipment line-ups, positioning components such as valves, switches and circuit breakers.

Determine how effective the operations department is in communicating operating experiences, problems and lessons learned to each of the shift crews and to all other affected departments.

Determine if there is a mechanism for reporting safety shortcomings and improvements. Check if field operators are disciplined or rewarded when operational errors are reported.

Check if field operators are satisfied with the training given, assess the on-the-job training and the involvement of control room personnel with this training. Check familiarization of field operators with the radiation protection procedures such as rules for entering contamination areas, dose limits and emergency exit of radiation areas.

Restart following events or planned shutdowns
Check that the procedures for the restart of the plant after a reactor trip or unplanned shutdown require an effective evaluation of the causes of the shutdown and the implementation of any required corrective actions prior to restart. Evaluate whether restart criteria and decision authority are established and followed. Examine some example cases from the plant history to determine effectiveness of root cause investigation.

Check that the requirements and procedures for the restart of the plant after a refuelling or maintenance shutdown support a thorough evaluation of equipment and system reliability as well as an evaluation of the readiness of the plant for the startup. Take examples such as the latest restart and go through the routines and documentation. In particular check that:

- Required tests that have been carried out;
- Appropriate restart authorization from plant management was given after evaluation of the restart conditions;
- Compliance with operational limits and conditions was confirmed;
- Plant modifications have been completed (if required), tested, trained on and procedures updated.

3.3.5. Work authorizations

Expectations

Work conducted at the plant should be planned, analysed and executed in a manner that is consistent with the requirements of plant operations both during power operation and during shutdown. A comprehensive work planning and control system shall be implemented to ensure that maintenance, testing, surveillance and inspection work is properly authorized and is carried out in accordance with established procedures. A work control process should be integrated into all work groups. By supporting this process operations will be able to better analyze risk when equipment is inoperable and decrease the time important equipment is not available due to inappropriate scheduling of maintenance.

Operations has the responsibility to assist maintenance in the planning and execution of work on plant components and systems to ensure that equipment reliability and availability is maximized.

Emergent work should go through the same safety review process to evaluate risk as work in a planned schedule.

Planning of work, outages, modifications and tests should be well coordinated to assure that the plant remains in a safe condition at all times and in accordance with the OLCs. Better planning and work control also means that control room operations staff, maintenance technicians, system engineers, radiation protection personnel and planners are able better to coordinate their activities. The work management system should ensure that operational tasks

are identified, prioritized and correctly executed. Suitable and sufficient assessments of the risks to health and safety arising from particular activities need to be carried out. The results of risk assessment need to be incorporated into the documentation for the permit to work system.

Examples of documents to be available for review during the OSART mission:

- Lists of degraded equipment and temporary modifications;
- Work authorization procedures;
- Radiological work permit procedures;
- Isolation rules for electrical and mechanical equipment;
- The index of surveillance tests carried out by the operating staff;
- Procedures governing temporary modifications such as the installation of electrical jumpers or lifted leads;
- The index for the administrative procedures governing temporary modifications, work authorizations, equipment isolations, etc.;
- The operating staff surveillance procedures.

Evaluations

Policy and procedures

Check that work authorization procedures clearly define the responsibilities and authorities related to equipment isolation, post maintenance testing and system restoration to service.

Confirm that shift personnel are aware of all systems and components out of service at any time and there are appropriate means to control the configuration of the plant.

Confirm that analysis of risk is conducted before equipment is placed out of service and check that the reliability of redundant safety equipment is verified before any safety related component is isolated. Check that configuration management continues to be assured when systems/equipment are removed from or placed in service.

Determine the existing philosophy for managing multiple unavailabilities of safety related equipment. Check how current approaches are used (risk/safety monitors, avoidance of pre-determined high risk configurations, reducing allowable inoperability time, etc.).

Implementation

Check that, in accordance with operating organization policy, appropriate work control procedures are effectively being implemented. Evaluate how well they are being used, on all shifts, by spot-checking isolations, work supervision, testing and subsequent equipment restoration to service. Confirm the following:

- Rules for electrical, mechanical and radiological isolations are published and adhered to;
- Appropriate safety documents such as work permits, access permits and authorizations for testing are used;
- Isolation procedures or checklists are verified by a qualified person of the direct operations group. Prior to safety related equipment isolation, the availability of the redundant equipment is verified;
- Suitable arrangements are made for locking, tagging or otherwise securing isolation points to ensure safety. Locking devices for breakers and switches are adequate;

- Out of service systems and components are identified by appropriate signs and tags both in the plant and in the control room;
- Provisions exist for authorization to work on non isolated equipment e.g. work under voltage, and how this is carried out. Lifted leads, jumpers and modifications of the software or parameters of computer based safety systems are controlled and tagged;
  The material of different kind of tags, such as isolation, testing, warning, safety position is adequate. Tags are periodically reviewed for accuracy and continued applicability;
- Arrangements exist for transferring responsibilities for the work permits from shift to shift;
- Conventional hazards such as fluids under high pressure, toxic and asphyxiating gases or hazardous chemicals are identified;
- Appropriate arrangements exist in safety documents to control the work of more than one group on a system or component and to control shift work by maintenance or other personnel;
- In multiple unit plants, arrangements exist to prevent human errors resulting from isolating equipment on the wrong unit;
- Controls are in place for activities that may change either radiological conditions or conventional hazards at the point of work;
- Adequate provisions are made for isolation, work, testing and return to service of systems and components in a manner that maintains radiation exposure to personnel at levels that are as low as reasonably achievable (ALARA);
- Specifications covering the cancellation of work are in place to ensure the restoration of systems and components to the correct operable state;
- Reliable administrative mechanisms exist to protect personnel and equipment in situations that equipment need to be tested before completion of maintenance works, e.g.: checking of electrical motor rotation;
- Responsibilities for testing and restoration to service are specified and followed. The shift supervisor must be involved in this process.

Confirm that to maintain configuration control after a refueling or significant outage, equipment line-up lists used are independently verified and filed for subsequent controls. The system should provide traceability of the operators involved in the equipment line ups.

Control of tests and modifications
Confirm that the plant has a clearly defined policy and procedures, that are well understood and being used, addressing administrative control of temporary and permanent modifications.

Check that the policy clearly addresses the authorization, precautions and communications and procedure updates required to initiate, implement and remove modifications. Check the adequacy of the turnover process after completion, such as training and briefing for shift personnel.

Check by examining documents, interviewing plant personnel and observing day to day operational practice that the procedures for initiating, performing, removing and documenting temporary modifications are adequate and followed. Evaluate how well the following areas are being implemented:

- Personnel who are allowed to initiate, perform or remove temporary modifications are clearly designated and the requirements for technical reviews, including safety reviews, are clearly defined;
- Any precautions and restraints on operation with a temporary modification are clearly specified to all personnel, including shift personnel before implementation of the temporary modification;
- The shift supervisor has the authority to veto any temporary modification or test;
- Efforts are made to minimize the number of temporary modifications. Temporary modifications have a limited period. At the end of this period the temporary modification are re-evaluated and converted into a permanent modification or canceled;
- Documentation, proper logging, labeling and tagging of temporary modifications are clearly specified and followed;
- Mechanical and electrical temporary modifications in the field are properly implemented and identified. Examples of mechanical modifications include spool pieces, blind flanges, temporary hoses etc. Jumpers and lifted leads in the back panels in the control room and in the field are adequately controlled and labeled;
- Keys for bypassing safety functions are controlled by shift supervisor and properly safeguarded. The procedures to use these keys are strictly followed;
- Audits of temporary modifications are made to assess their continued applicability and to check conformity of recorded temporary modifications with those in the field.

Check that representatives of operators are included among reviewers of proposed permanent modifications.

Check that necessary changes have been made to the operating procedures and plant documents affected by modifications. The operating group is trained before the implementation of any modification, particularly if operation of safety related systems is affected.

Confirm that non-routine and special tests require a formal process containing step by step procedures in the same manner as required for routine tests.

Check that the procedures being used for non-routine tests clearly specify any special precautions which must be observed, possible risks that have to be analyzed and actions to be taken if a problem arises in the course of the test.

Check that the process contains requirements to instruct personnel involved in the test, specifically operations on the potential risks prior to the test performance.

3.3.6. Fire prevention and protection programme

Expectations

The operating organization should establish and implement a comprehensive programme for fire prevention and protection to ensure that measures for all aspects of fire safety are

identified, implemented, surveyed and documented throughout the entire lifetime of the plant. It is expected that the programme includes at least the following:

- Control procedures for combustible materials and ignition sources;
- Inspection, maintenance, surveillance and testing of fire protection measures;
- Manual fire fighting capability;
- Emergency plans, including liaison with any off-site organizations that have responsibilities in relation to fire fighting;
- Integration of plant fire safety arrangements and liaison between parties involved;
- Review of plant modifications to evaluate effects on fire safety;
- Training in fire safety and emergency drills;
- Impact of plant modifications on fire safety;
- Periodic updating of the fire hazard analysis.

Responsibilities of site staff involved in the establishment, implementation and management of the programme for fire prevention and protection, including arrangements for any delegation of responsibilities, should be identified and documented. The documentation should identify the posts, specific responsibilities, authorities and chain of command for personnel involved in fire safety activities, including their relation with the plant organization. The plant management should establish an on-site group with the specific responsibility for ensuring the continued effectiveness of the fire safety arrangements.

Plant personnel engaging in activities relating to fire safety should be appropriately qualified and trained so as to have a clear understanding of their specific areas of responsibility and how these may interface with the responsibilities of other individuals, and an appreciation of the potential consequences of errors. General training relative to fire hazards, flooding, secondary effects of fires and fire zone protection should be provided to station personnel.

Periodically, drills and exercises should be conducted to confirm the fire prevention and protection programme's implementation and effectiveness. Records should be maintained of all exercises and drills and of the lessons to be learned from them. Full consultation and liaison should be maintained with any off-site organizations that have responsibilities in relation to fire fighting.

Examples of documents to be available for review during the OSART mission:

- Organization chart with functional areas related to fire protection;
- Equipment on-site;
- Fire protection administrative control procedure;
- Fire event reports and investigations of events;
- Fire protection programme;
- Implementing procedures;
- Surveillance procedures for fire detection and suppression systems;
- Fire hazards analysis;
- Training and fire drill records;
- Results of current fire protection audit and corrective actions.

Evaluations

Equipment and systems

Confirm that the fire protection system conforms to good international standards.

Check the portable fire fighting equipment to verify accessibility. Confirm that current surveillance requirements are met and check the equipment located in areas of high fire risk. Examples include fire extinguishers, protective clothing and portable breathing apparatus.

Check that adequate measures are in place for the maintenance of fire barriers such as fire stops, dampers fire doors, cable penetrations and controls are written to ensure that barriers are returned to normal service after maintenance or modifications.

Confirm that the surveillance test programme used to verify the reliability of the fire protection system is adequate. The system should be tested such that adequacy is verified using the suppression mediums adequate to evaluate functionality of system. Verify by surveillance review the adequacy of the fire protection supply system in fire pumps and hose stations.

Check if combustible fire loads or ignition sources have been identified and properly controlled. Confirm that areas important to safety are inspected periodically in order to evaluate the general fire loading and plant housekeeping conditions, and to ensure that means of exit and access routes for manual fire fighting are not blocked. Confirm that the use and storage of combustible materials is restricted.

Check for adequacy of fire detection and suppression systems. Verify adequacy of fire brigade equipment for both on-site and off-site brigades.

Check that plant modifications are scrutinized for their potential effect on area fire loading and fire protection features. Confirm that a review of implications for fire safety is carried out for modifications to the fire protection features, modifications to the protected safety systems or items important to safety or systems that could adversely affect the performance of the fire protection features, any other modification that could adversely affect the performance of the fire protection features, including modifications affecting area fire loading.

Confirm that the fire hazard analysis is reviewed and updated following any plant modification that could affect fire safety. Check that the fire hazard analysis is also reviewed as part of the periodic safety review process and updated as necessary.

Personnel
Check that the qualifications and experience of the on site fire protection and support personnel are commensurate with assigned responsibilities.

Check with the reviewer evaluating training that a good initial and refresher fire protection training programme has been implemented for the appropriate on and off site fire protection personnel. In the review the following topics should be investigated:

- Training personnel qualifications on fire modes and fire fighting techniques;
- Special facilities and equipment for performance based training;
- Training frequency;
- On site/off site common drills.

Confirm through review of administrative procedures and interviews that a fully qualified on-shift fire brigade is available at all times to handle both a fire and a subsequent plant emergency, and that guidance is in place for corrective action relating to any short fall of personnel or equipment. Arrange, if possible, observation of a fire fighting drill.

Confirm that adequate fire control strategies are available to the fire brigade which indicate; fire loading, entrance methods, equipment power supplies, personnel evacuation routes and smoke and water evacuation plans.

Confirm that the local civil fire fighting organizations have received the proper instructions and training, including radiation protection hazards, to interface and support the plant in all types of fire fighting activities. Confirm that responsibilities are clearly established and documented, and radiation monitoring of off-site fire fighters is ensured.

Confirm that local civil fire fighting organizations have clearly defined priorities in case of simultaneous emergencies and regularly participate in drills and exercises.

Confirm that fire protection drills involving all responsible personnel are regularly conducted at the plant.

Determine if compensation methods or actions to minimize risk during degradation of fire protection or plant systems are adequate.

3.3.7. Management of accident conditions

Expectations

Arrangements and procedures should be in place which address the actions necessary following accident conditions at a plant.

The organization and administration of the direct operating group should ensure that the nuclear power plant can be controlled under accident conditions. The shift supervisor should have prompt support from the technical staff while managing accident conditions including beyond design basis accident and severe accident conditions. When the conditions exceed specific limits as per station emergency plan an additional organization structure should be established to take over the responsibility for long term actions to mitigate effects on the environment.

Under extreme situations an operator may be required to deviate from OLCs. The plant should have clear written direction addressing under what circumstances the OLCs may be intentionally deviated from, what permission is necessary prior to the action and any notifications to plant staff or regulators that are required before or after the deviation occurs.

Adequate training and frequent drills using the emergency operating procedures (symptom or event oriented) and emergency plan procedures should be carried out. The members of the operating staff should receive instruction in analysis of accidents beyond the design basis and severe accident as part of their training programme. The training of plant operators should ensure their familiarity with accidents beyond the design basis and the guidance for severe accident management.

The emergency staff and the supporting groups should be trained in performing appropriate, pre-planned actions. All the training should be repeated at sufficient intervals and reinforced through drills involving the full exercise of all emergency team members under conditions, which are as realistic as possible.

Examples of documents to be available for review during the OSART mission:

- Final Safety Analysis Report (Section Accident analysis);
- Description of the on-site Emergency plan;
- List of emergency operating procedures (EOPs);
- Selected EOPs;
- Accident management guidance for beyond design basis accidents, including severe accidents;
- Organizational chart of the emergency staff;
- Description of responsibilities and tasks of the emergency staff;
- Training and retraining programme for the staff involved in accident management.

Evaluations

Assignment of responsibilities

Check that the direct operating group is well organized with clearly assigned roles and responsibilities for controlling the plant under accident conditions.

Check if a policy exists and training has been given on clear direction to the operator on the importance of the operational limitations and actions and when a deviation to the OLCs may be authorized.

Check that, in accident conditions, the minimum shift group composition is sufficient to perform the immediate actions specified by the emergency operating procedures and the emergency plan.

Confirm that there is an adequate organization established that could provide timely response both during and after normal working hours. Verify that the shift supervisor has a type of callout list to expedite off-site support. There should be a strong direct line management which have assigned responsibilities for the following:

- Making long term decisions on how to manage accident situations;
- Providing technical support to the shift supervisor and to the emergency management team; mainly in beyond design basis accident in the areas of core physics, thermohydraulics and radiation protection;
- Early communication with the authorities, the public and supporting organizations;
  Measurement and analysis of radiation and radiochemical conditions at the plant and in the environment;
- Radiation protection for personnel at the plant;
- Fire fighting;
- Repairs and other special measures.

Confirm that the operating group has the necessary technical information available from the technical support centre to recognize and to analyse severe accidents and that the instrumentation and controls in the control room are arranged to optimize man-machine interactions during accident conditions.

Check that provisions for collecting, recording and transmitting all information, decisions and activities are clearly understood by the operating and emergency support staff.

Training for accident conditions

Confirm (together with the training and emergency planning reviewers) that a good performance based training programme has been implemented for the responsible personnel of the operating staff, the staff supporting the shift supervisor and the emergency management team.

Confirm that the operators are familiarized with the EOPs and accident management guidance and the possible means that should be utilized in the case of beyond design basis accidents. Check if the operating personnel are trained in recognizing situations in which the EOPs are not adequate and accident management procedures and /or guidance should be used.

Evaluate together with the training and emergency planning reviewers how well the retraining programme is for the above mentioned personnel in updating their knowledge in accordance with modifications to the plant and new information in the field of accident management as it becomes available.

Confirm that the training programmes adequately addresses the analyses of relevant accidents and the measures to prevent and to mitigate accidents using the EOPs.

Check that the appropriate training means are utilized to train operating personnel for the beyond design basis accidents.

Confirm (together with training and emergency planning reviewers) that realistic emergency preparedness drills are conducted according to a reasonable schedule e.g. once per year and the most severe accidents are also simulated in those drills. Drills exercise all components including management support groups of the emergency organizations. Confirm that the system in place to involve operating shift crews in emergency drills ensures that each crew participates at least once a year.

3.4. MAINTENANCE

The nuclear installations must be regularly inspected, tested and maintained in accordance with approved procedures to ensure that components, structures and systems continue to be available and to operate as intended, and that they retain their capability to meet the design objectives and the requirements of the safety analysis. The operating organization shall prepare and implement a programme of maintenance, testing, surveillance and inspection of those structures, systems and components, which are important to safety.

For the purpose of these guidelines maintenance covers in-service inspection, spare parts, materials and outage management.

References: 1, 5, 6, 10, 11, 13, 15, 18, 27, 32 and 34

3.4.1. Organization and functions

Expectations

Goals, objectives and priorities of the maintenance department should be defined to be consistent with the plant policies and objectives. Maintenance strategies should be developed to address short and long term issues. Performance indicators should be established and used to improve performance. Effective and high quality maintenance programmes should be encouraged by senior management. Feedback from performance results should be used in

accountability reviews and in establishing goals and objectives for subsequent planning periods.

The organization and administration of the maintenance department should ensure the efficient and effective implementation and control of maintenance activities. The organization and staffing of the maintenance department, as well as the responsibilities of the different units and staff in maintenance, should be defined and communicated such that all affected personnel understand them. Succession planning should be an established practice in the maintenance department. Good coordination among different maintenance groups (mechanical, electrical, instrumentation and control, and civil), and with operations and supporting groups, should be established.

Management should demonstrate by example a continuous commitment to safety culture. They should promote safety culture and high performance standards. Their frequent presence in the field should contribute to improved job performance by the use of leadership and coaching techniques.

The organization, qualifications and number of maintenance personnel should be sufficient for the maintenance performed during the operation of the plant, the outage work to be performed by the plant's staff and the supervision of contractor's work. Contractor personnel should be subject to the same criteria as plant personnel. Good initial and continuing training should be implemented.

An emerging trend in plant maintenance and support is the increased employment of contractors to replace traditionally plant-based personnel. Whilst this policy has financial benefits for the utility, it often comes at the expense of safety as a result of lower standards followed by contractors. The policy of relationships with contractors falls within the scope of safety culture development to ensure that the primary responsibility of the utility or plant regarding safety and monitoring is not diluted and to foster the quality factor in the contractors' activities. Emphasis must be placed on the quality and safety of work done by the contractor, who must be aware of the standards required. Contractors should receive the same attention and training in safety culture as utility staff.

Examples of documents to be available for review during the OSART mission:

- Plant organization chart including functional responsibilities;
- Maintenance department organizational chart, including interfaces with other organization units and with contractors;
- Plant nuclear safety policy, operations policy and maintenance policy;
- Maintenance department programme descriptions.
- Selected maintenance personnel job descriptions;
- The goals and objectives of the maintenance department;
- Maintenance department and contractors' performance indicator results (last two years);
- Maintenance department and contractors' performance reports (last two years) including backlog and an indication of excess hours worked.

Evaluations

Functions and responsibilities

Check that maintenance department policies, goals and objectives, and performance indicators are comprehensive and consistent with station requirements. Check that a process is being

effectively used to keep maintenance policies and programmes consistent with current industry best practices.

Confirm that the goals have numerical targets which are designed to improve performance where needed and are periodically reviewed with corrective action being taken as necessary. Check that periodic maintenance indicator reports provide a representative view of maintenance performance, are useful to plant and maintenance management and that they are communicated to the plant staff.

In the maintenance area the following indicators have proved to be useful for monitoring performance:

- Number of outstanding backlogs;
- A measure of non-proceduralized practices or 'workarounds' employed;
- Number of control room instruments out of service;
- Amount of maintenance rework;
- Percentage of spare parts available, as expected, on demand;
- Average life of corrective maintenance actions;
- A measure of the prevalence of human errors;
- Completion of training to agreed time-scales;
- Numbers of minor injuries and near misses (an increasing trend in the reporting of these is to be encouraged, since they frequently represent precursors to more serious accidents);
- Standards of housekeeping.

Check that the maintenance organization is clearly defined, and that staffing resources are sufficient to accomplish assigned tasks. Check that the responsibility and authority of each management, supervisory, technical and craft position is defined, clearly communicated and understood. Check that staff can be supplemented as necessary, so that duties relevant to nuclear plant safety and system reliability may be carried out without undue haste or pressure. Confirm that succession planning is an established practice in the maintenance department. Share results of your evaluation in this respect with the MOA reviewer.

Determine if managers explain their commitment to safety culture to their staff, and if they remind them that haste and shortcuts are inappropriate and adherence to written procedures is essential. Determine if personnel are encouraged to suggest improvements to safety, reliability, quality and productivity. Determine if the concepts of defense in depth and configuration control are well understood and reflected in the safety culture of the maintenance organization.

This would be indicated by items such as:

- Qualified and competent staff;
- Use of self-checking and independent verification techniques;
- Procedural adherence;
- Doing the job right the first time;
- Use of appropriate maintenance skills;
- Minimization of maintenance backlog on important plant equipment;
- Use of appropriate materials and spare parts which ensure consistency with the original design concept through an effective quality assurance programme.

Check if management regularly reviews personnel performance and safety attitudes. Confirm that managers are not only providing leadership but also developing, in partnership with staff, the means of translating the safety goals of the organization into day-to-day reality.

Confirm that managers and supervisors tour the plant regularly to check plant status and maintenance activities. Check if tours are planned in advance and non-conformances reported.

Interfaces with other plant groups
Check if interfaces with supporting on-site and off-site groups are clearly defined and working well. Determine if there is good coordination among the various maintenance groups and an effective interface with the operations department, the radiation safety department, technical support and other plant groups. Processes used between the involved groups should be oriented at identifying and resolving problems in an efficient and safe manner.

Management of contractors
Confirm that the role and responsibilities of external maintenance organizations is clearly defined and understood. Utilities vary in the extent to which they use supporting organizations. Where these supporting organizations play a significant role, the safety management system for the utility needs to embrace their activities, whilst at the same time ensuring that overall control and responsibility for safety rests with the licensee. Check for example, whether staff in the utility required to supervise contractors or other support staff is clearly identified.

Check if contractors involved with maintenance work and/or with plant modifications are subject to the same criteria as plant staff. This applies to setting goals and objectives, organizational structures, professional competence and qualification of all involved personnel, and measurement of performance and evaluation and correction of findings.

Confirm that partnership between contractors and the utility or plant is mutually beneficial. Multiyear contracts extending two or three years into the future enable investment in training, quality and dosimetry to be optimized. This may be implemented through the concept of ‘best quality bidder’ and accompanied by an assessment of the contractor’s performances in quality, industrial safety and radiological protection. This approach would encourage greater convergence of the safety culture of the plant and the contractor.

Qualification of personnel
Training and qualification programmes and processes will be primarily reviewed by the expert evaluating training and qualification. However, during interviews and observation of work activities, determine if the experience level and proficiency of maintenance workers and contractors is appropriate for their assignments. Check if workers are knowledgeable about current work practices and plant procedures.

3.4.2. Maintenance facilities and equipment

Expectations

Working facilities should provide sufficient space and equipment to perform maintenance activities safely and efficiently. Maintenance facilities should be clean and orderly, maintenance tools and equipment should be maintained in good repair. Lifting, loading and transport equipment should be available and there should be provisions for auditing this type of equipment. Consideration should be given to the use of mobile lifting and transport

facilities as a possible means of substantially reducing occupational exposure (for example, filter removing equipment).

Contaminated tools and equipment should be used and stored in a manner which prevents the spread of contamination. Work on contaminated equipment should be controlled in order to minimize radiation dose. Remote controlled equipment should be available for work in high radiation areas where it has the potential to decrease radiation dose at reasonable cost.

In addition to the special equipment essential to maintenance, the plant management should provide special equipment where this could significantly reduce exposure or enhance safety and should provide adequate training in its use.

Measurement & test equipment should be controlled to assure accuracy and traceability. Chemicals and flammable material should be stored appropriately.

Examples of documents to be available for review during the OSART mission:

- General site layout showing the locations of all maintenance facilities (workshops, workshops in controlled areas, decontamination facilities etc.);
- Equipment calibration records.

Evaluations

Confirm that the size and arrangement of maintenance facilities promote the safe and efficient completion of work in a clean and orderly manner. Facilities are provided for work on contaminated and non-contaminated equipment. Adequate training facilities, with necessary mock-ups, are available and used to support training for complex or major maintenance tasks.

Check that contaminated refurbished equipment is segregated and stored in a manner to prohibit cross contamination and minimize radiation dose.

Determine if proper tools, equipment and consumable supplies are available to support work, and if contaminated tools are adequately marked and segregated. Check that specific equipment is provided and used to reduce exposure or enhance safety and that adequate training is provided in its use. Check that special tools, jigs, fixtures, etc. are identified and stored to permit retrieval when needed. Confirm that unserviceable tools and equipment are controlled to prevent use.

Check if equipment is made accessible for maintenance activities (platforms, scaffolding, etc.).

Check that lifting, rigging, scaffolding and electrical equipment are identified, periodically inspected, stored appropriately and are in good working condition when made available for use. Determine if mobile lifting and transport facilities are used to reduce occupational exposure.

Confirm that adequate decontamination facilities for tools, parts, and equipment are available and used to minimize radiation doses and exposure to contamination. Also determine if remote controlled tools are being used, as appropriate, to minimize radiation exposures.

Confirm that measuring and test equipment is calibrated and controlled adequately to ensure accuracy and traceability. Ensure that test equipment that is out-of-tolerance is promptly

removed from service and that corrective measures are taken where unreliable test equipment has been used. Confirm that calibration laboratory is suitably furnished, properly lighted and air-conditioned.

Check that only chemicals and flammable materials which are needed and approved for maintenance activities are retained and that they are suitably labeled and appropriately stored. Confirm that not needed chemicals and parts are not allowed to accumulate in maintenance areas.

Check if loading, lifting and transport equipment is available for movement of heavy and/or large items. Ensure that heavy loads are not transported over safety related systems and equipment. (See also Section 3.4.5.)

3.4.3. Maintenance programmes

Expectations

Comprehensive programmes should optimize safe and reliable performance of plant systems and components over the lifetime of the plant. They should be established for in service inspection, plant ageing and predictive, preventive and corrective maintenance.

These programmes should be fully integrated with plant operation and modification activities. They should be routinely reviewed and updated, as required, to take into account on site and off site operating experience and modifications to the plant or it's operating regime. Methodologies such as probabilistic safety analysis and reliability centered maintenance techniques should also be reviewed and updated. Risk assessment techniques can also contribute to determining maintenance and inspection requirements.

The power plant should establish a programme that takes into account the plant equipment ageing process through the various activities of operation, surveillance and maintenance.

Preventive maintenance (PM) should minimize the potential for breakdown (corrective maintenance) of important equipment by the early detection and correction of equipment degradation. PM activities should be scheduled and carried out according to a defined programme.

Predictive maintenance activities should be used to monitor the condition of installed equipment and systems where appropriate. The results of predictive maintenance activities and surveillance tests should be properly trended to permit full effectiveness of the preventive maintenance and lifetime management programmes.

The corrective maintenance programme should provide for effective reporting and timely correction of equipment degradation.

The in-service inspection programme should be established to examine systems and components of the plant for possible deterioration so as to judge whether they are acceptable for continued safe operation of the plant or whether remedial measures should be taken. In service inspection programme should be implemented in accordance with plant policy, regulating requirements and OLCs.

Recently in the nuclear industry as a response to economic pressures there are initiatives to improve efficiency and reduce costs. In the maintenance area this may lead to increases in the time periods between maintenance or inspection outages to improve capacity factors; shortening maintenance and refueling outage time to improve capacity factors. These initiatives should be managed in such way that possible detrimental effects on the quality and effectiveness of the maintenance programmes could be avoided.

Examples of documents to be available for review during the OSART mission:

- (PM) programme description including predictive maintenance and in service inspection programme description;
- Flow diagram for the maintenance work control process (may be part of a general work control procedure);
- Regulatory guide for in-service inspections;
- Procedures for PM planning and scheduling;
- List of items included in the PM programme;
- PM schedule for the review period;
- Records of PM performance indicators including rescheduled and outstanding PM activities;
- Selected PM procedures (including task descriptions, parameters to be checked, hold points and inspection instructions for independent quality control inspection, frequency of task performance, acceptance criteria, material requirement/specifications documentation, tools and spare parts);
- Documentation related to the plant ageing management;
- A selection of completed work packages from the past six months;
- In-service inspection planning;
- In-service inspection schedule;
- In-service inspection procedures;
- Pre-service examination results;
- In-service inspection results.

Evaluations

Preventive maintenance programme

Determine if regulatory requirements and supplier recommendations have been appropriately considered in establishing the frequency and extent of preventive maintenance.

Check that PM activities are scheduled and performed at the established intervals. In particular, risk assessment can be used to determine the most appropriate surveillance test intervals, the optimal time between equipment overhauls and the appropriate rules governing the release of safety related equipment for maintenance. Check that waivers or deferrals of PM activities are minimized and authorized only for justified plant conditions and after an appropriate technical review.

Determine if the PM programme is periodically evaluated for effectiveness and if appropriate corrective actions are implemented, when required. Appropriate reports and records should be kept of equipment history and revisions to the PM programme on the basis of PM experience.

Determine if predictive maintenance activities are used to supplement and strengthen the PM programme and enhance equipment reliability e.g. vibration, thermography, oil analysis, temperature trends, acoustics. Check a few examples of maintenance programme modifications based on predictive maintenance activities or results. Determine if the

predictive maintenance techniques being used are consistent with current industry good practices. Also ensure that identified degraded or problematic equipment is being reported and acted upon, e.g. a programme to monitor motor operated valves (MOV's) should be included. Another important example to check is whether results of erosion prediction calculations and wall thickness measurements are used as input to the PM programme.

In service inspection
Check by observation and through interviews that the in-service inspection programme is effective in implementing plant policy, regulatory requirements and the OLCs.

Check that appropriate procedures exist for performing the inspections and examining the results. Check that procedures and equipment are qualified to assure the required capability, reliability and reproducibility of the examination system.

Check that examiners are properly qualified to execute the inspections and analyze the results.

Confirm that appropriate reviews and analyses are made and corrective actions are taken when inspection results do not meet acceptance criteria. Confirm that documentation of in service inspection results is accurate, complete, easily retrievable and accessible to other departments.

If the frequency and extent of in-service inspection is modified due to experience feedback, check whether such modifications were properly approved by management and by the competent authorities.

Corrective maintenance
Determine, through inspections in the plant and interviews, if equipment deficiencies are promptly reported to maintenance for correction. Confirm that repairs to structures, systems and components are performed as promptly as practicable. Priorities shall be established with account taken first of the relative importance to safety of the defective structure, system or component. Determine if the status of reported deficiencies is adequately tracked and periodically reviewed to determine if PM programme adjustments are necessary.

Confirm that following any abnormal event, the operating organization revalidates the safety functions and functional integrity of any component or system which may have been challenged by the event. Necessary remedial actions include inspection, testing and aintenance as appropriate.

Confirm that repairs to or replacement of defective items are carefully controlled, particularly when current standards require approaches and techniques that differ from those used in the original manufacturing process. In such situations, the standards to be applied to the repair or replacement should be considered by the operating organization by way of the formal plant modification arrangements. Current standards should be applied whenever possible.

Lifetime-management (ageing management)
Review whether the plant has a programme to manage the plant ageing process, addressing physical degradation of plant systems, structures and components as well as their obsolescence, both of them being likely to occur during the plant life cycle. Check how physical degradation phenomena are analyzed and understood. For the part of degradation caused by the various activities of operation, surveillance and maintenance, observe what is

done to eliminate or mitigate them by modifying practices and procedures. This programme may be prepared in co-operation with other similar plants.

Determine if the programme to manage the ageing process contains elements such as:

- Identification of components that are susceptible to ageing degradation that could affect plant safety;
- Adequacy of current methods for inspection, surveillance, maintenance and testing for the detection of ageing problems;
- Appropriate records to enable the ageing process to be tracked.

3.4.4. Procedures, records and histories

Expectations

A policy governing the use of procedures and the handling of deviations from the procedures should be implemented and communicated to staff.

Maintenance procedures and other work-related documents should identify preconditions, precautions, provide clear instructions for work to be done and should be used to ensure that maintenance is performed in accordance with the maintenance strategy, policies and programmes. The procedures should normally be prepared in co-operation with the designers, the suppliers of plant and equipment, and the personnel conducting activities for quality assurance, radiation protection and technical support. They should be technically accurate, properly verified, validated, authorized and periodically reviewed.

Priority should be given to amending and updating procedures in a timely manner. A mechanism should be implemented which enables users to feed back suggestions for the improvement of procedures.

Maintenance instructions issued to craftsmen should be compiled in accordance with quality assurance requirements and should point out the risk impact of the work on nuclear and personnel safety and identify the countermeasures to be taken and specify post maintenance/modification testing required. The required level of skill and methods of procedure use should be stated. Routine activities involving skills that qualified personnel usually possess may not require detailed step-by-step instructions; they should nevertheless be subject to control by means of general administrative procedures.

Human factors and ALARA principles should be considered in the preparation of maintenance instructions.

Maintenance history should be used to support maintenance activities, upgrade maintenance programmes, optimize equipment performance and improve equipment reliability. Appropriate arrangements should be made for orderly collection and analysis of records and production of reports on maintenance activities. Maintenance history records should be easily retrievable for reference or analysis. The use of computerized maintenance history handling would facilitate this process.

Examples of documents to be available for review during the OSART mission:

- Administrative procedure for the preparation and issuance of maintenance procedures and work instructions;

- Selected safety related corrective maintenance procedures (two or three for mechanical, electrical and control equipment);
- Selected PM procedures;
- Selected predictive maintenance procedures;
- Work authorization instructions;
- Selected equipment troubleshooting (fault finding) procedures;
- General administrative procedural controls or general safety instructions;
- Administrative procedures related to maintenance history;
- Maintenance history files on one or two systems or components;
- Setpoint register (instrument calibration figures, relief valve settings, electrical plant protection settings etc.);
- Quality assurance procedure for setpoint registration;
- Root cause analyses of component failures.

Evaluations

Procedures
Check that a policy exists governing procedure usage:

- When a procedure must be followed or signed off step-by-step or used for guidance;
- Action to be taken when deviation or conflict occurs.

Check that appropriate procedural controls and safety instructions are specified for maintenance activities. Check that preparation, review, approval and revision of procedures and other work related documents are properly controlled and completed in a timely manner.

Confirm that the need to be consistent with the procedural requirements is well understood and that step by step sign off, self checking and independent verification are carried out as required.

Confirm that documents used in lieu of procedures (such as excerpts from vendor manuals) receive the same review and approval as procedures.

Check that procedures and work instructions used to perform maintenance activities are technically accurate, easy to understand, up to date and readily available to the users.

Check that detailed work instructions include the following, where appropriate:

- Personnel qualifications required for usage;
- Identification of the plant system and components to be worked on;
- Specification of the necessary tools, material and equipment, including calibration records;
- Sufficient guidance for the task to be performed in a safe, practical and efficient manner;
- Breakdown of the task into sequential steps with sufficient detail for the work to be done by a competent person without direct supervision;
- Adequate drawings and illustrations;
- Identification of special tools, equipment or techniques needed at appropriate steps in the sequence, e.g. installation and removal of temporary devices;

- Details of interfaces with work carried out by other personnel;
- Warnings of potential dangers to plant or personnel and clear specification of precautions to be taken (including environmental and seismic events);
- Radiation protection provisions;
- Identification of hold points where progress to the next step is dependent upon independent review. (Checklists for signature by persons authorized to carry out this function are a useful aid to achieving compliance with the instructions);
- Inspection instructions and related acceptance criteria, including post maintenance and post modification testing;
- A process to record the identification numbers of test equipment, torque wrenches and quality assured spare parts used during the activity.

Determine if an effective programme exists to review procedures periodically for technical accuracy, human factors and the inclusion of in-house and industry operating experience, including near miss incidents.

Check that procedural problems, including human factor problems, are promptly resolved and that action to be taken if the procedure cannot be followed is clear. Check that maintenance personnel and contractors are encouraged to identify procedural problems and to provide feedback. Verify that a process is in place that ensures these problems are promptly resolved, once they are identified.

Determine if temporary changes to procedures are sufficiently controlled, including appropriate review and approval. Check whether these temporary changes are promptly incorporated into permanent revisions when appropriate, limiting the number of temporary procedures and their lifetime.

Maintenance histories and records
Check that adequate history records are maintained for systems and equipment important to plant safety and reliability. Review samples of the records and interview personnel to check that the documentation of maintenance work and inspection/test results is sufficiently complete. Check the retrievability and security of maintenance history records.

Determine if maintenance histories are periodically reviewed and analyzed to identify adverse equipment performance trends and persistent maintenance problems, to assess their impact on system reliability, and to determine root causes. Determine if the resulting information is used to improve the maintenance programmes on all affected equipment and is considered for inclusion in the lifetime management programme.

Check a few completed maintenance reports and root cause analyses to determine if maintenance was adequately documented and the root causes were properly identified and appropriate action taken.

3.4.5. Conduct of maintenance work

Expectations

Maintenance should be conducted in a safe and efficient manner to support plant operation. Personnel should exhibit competence and professionalism, which result in quality

workmanship when performing assigned tasks. Personnel should demonstrate also a questioning attitude before, during and after the work is completed. Programmes and documentation should support this attitude.

Work should be performed in accordance with policies and procedures and be consistent with ALARA and waste minimization principles.

Maintenance personnel should be attentive to identifying plant deficiencies and responsive to correcting them with the goal of maintaining reliability and availability of equipment and systems and keeping them in optimum material condition, consistent with the design requirements.

Managers and Supervisors should routinely observe maintenance activities to ensure adherence to station policies and procedures. Post maintenance and modification testing should be systematically and thoroughly conducted.

Examples of documents to be available for review during the OSART mission:

- Work authorization procedures;
- Flow diagram for the general work control procedure;
- Industrial safety manual or procedures;
- Industrial safety accident and near miss reports for the past year;
- Radiological work practices document or procedures;
- Radiological control incident reports for the past year;
- Event reports including root cause analysis involving maintenance activities for the past year;
- Maintenance and condition report backlog;
- Maintenance rework statistics.

Evaluations

Obtain a representative picture of how maintenance is conducted at the plant by observing maintenance work in the field and interviewing maintenance workers. Work in controlled and contaminated areas should be included. Observe work on mechanical systems as well as electrical and instrumentation work. During these work observations, pay particular attention to the following items, and determine if they are consistent with plant policy and good industry practices:

- Maintenance managers, supervisors and craftsmen are involved in planning activities to understand work objectives and constraints and to minimize personnel exposure. Pre-/post job briefings should be effectively used;
- Approved and current issue maintenance procedures and work documents are used in a questioning, self checking and rigorous manner;
- Correct tools and support equipment duly calibrated and checked in the proper manner are used where necessary;
- Surveillance testing procedures are rigorously adhered to without exercising or preconditioning the equipment under test;
- Foreign material exclusion methods are evident;
- Clear identification of temporary modifications are apparent, a list is available and communicated to operations;
- Equipment isolation verification and tagging are appropriate;

- Control of materials, spare parts and replacement equipment are appropriate;
- Coordination of work activities with support groups such as radiological protection, quality control and stores are appropriate;
- Industrial safety practices (hard hats, scaffolding, safety belts, ear protection, safety glasses, confined space entries and unique hazards) are appropriate;
- Scaffolding and rigging equipment is properly tested and routinely checked;
- Electrical cables are suitably protected and do not represent a hazard in themselves;
- Radiological safety practices, including the use of protective clothing, respiratory equipment, forced air hoods and ALARA principles are appropriate;
- Work site cleanliness, orderliness, lighting, accessibility and escape routes are clear and hazardous areas identified, neutralized and barriered as needed;
- Cleanliness are maintained throughout the plant including infrequently visited areas, enclosures and cabinets;
- Work sites are cleaned up with tools and scaffolding returned to designated storage locations when no longer needed;
- Work site environment are controlled to ensure satisfactory working conditions exist for the duration of work;
- Minimization and segregation of waste is regularly carried out.

Check that maintenance work is started only after obtaining authorization, and is performed by qualified personnel. Determine if adequate resources are available for maintenance during day and night shifts.

Check that procedures are followed, as required. This may entail general compliance, step-by-step compliance or step-by-step sign off. Confirm that procedures in general and specifically these used in the field do not contain unauthorized information or corrections.

Confirm that an adequate clearance (tagging) system is in use for the protection of equipment and the safety of personnel during maintenance and that the system is understood and used correctly. Confirm that personnel are safety conscious in the conduct of their work and use safety equipment as appropriate. Check that an accurate transfer of pertinent information occurs at turnovers.

Check that managers and supervisors routinely observe maintenance activities and ensure adherence to station policies and procedures. Check that the work groups are instructed on specific jobs, are knowledgeable of any special requirements and are aware of the impact of their jobs on nuclear safety. When unexpected events or conditions arise check that personnel seek appropriate guidance before proceeding.

Check that contractors and other non-utility personnel conducting plant maintenance operate under the same control procedures and to the same standards as plant maintenance personnel and are properly supervised.

Confirm that appropriate personnel (e.g. operations, engineering and maintenance) perform the necessary post-maintenance or post modification testing, document and review the results

and return equipment to operation only when it is fully ready for service. Ensure that responsibilities for post maintenance and post modification testing are clear and appropriate. Following maintenance check that the plant is not returned to service before completion of a documented check of its configuration and all deviations have been investigated and closed out.

Confirm that there are no indicators of behaviour and attitudes which are not likely to be conducive to the development of a sound safety culture. Such indicators may be: poor housekeeping standards, lack of attention to alarms or non-repair of malfunctioning equipment, overdue maintenance work or poor information recording and archiving systems.

Check that rework is documented and it causes are investigated.

3.4.6. Material conditions

Expectations

The material condition of the plant should be maintained in such a way that its safe, reliable and efficient operation can be ensured. Plant managers and supervisors should define the required standard and conduct frequent tours of plant areas in order to confirm that high standards are maintained.

Deficiencies should be identified, controlled and eliminated.

Examples of documents to be available for review during the OSART mission:

- Plant material condition reports;
- Work requests for corrective maintenance;
- Schedule for management tours of plant facilities;
- Documented follow-up of the results of management tours, and corrective actions issued;
- Backlog of corrective actions programme.

Evaluations

Material conditions

All team members are to make tours in their areas of responsibility in order to get the broadest picture of the material condition of systems and equipment. The observations should be evaluated and may be used in Section 4.7 to determine effectiveness of work control process.

Systems and equipment should be in good working order. Examples of this include the following:

- Temporary modifications and repairs are minimized. A process should exist to evaluate, control and track temporary repairs;
- Fluid system leaks are minimized, identified and controlled leaks should be segregated to avoid personnel and equipment harm;
- Equipment is appropriately protected from adverse environmental conditions. Wiring and terminals should be protected and undamaged and cable trays should be in good condition;
- A process exists to ensure instruments, controls and associated indicators are calibrated, as required to maintain the appropriate degree of accuracy;

Indicators are not out of scale or inoperable. Records are functioning correctly and paper is available;
- Good lubrication practices are evident;
- Fasteners and supports are properly installed and in the "as designed" position; Pipes do not move excessively;
- Equipment, structures and systems are properly preserved, insulated, free of corrosion and grounding (earthing) cables are securely fastened where necessary;
- Thermal insulation is in good condition;
- Rotating equipment is appropriately protected and does not vibrate excessively. Chain or belt drives are properly adjusted;
- Filters and strainers are not clogged by observing excessive differential pressure and conducting visual checking when possible;
- Leaks are collected, tagged and followed;
- Fire barriers are effective e.g. fire doors able to close, electrical cabinet doors and panels closed and secured;
- Valves have sufficient packing to allow tightening. Valve stems are properly lubricated;
- Hoses are in good condition and show no evidence of leakage;
- System and component labeling is consistent, accurate and easy to read;
- Stairs and ladders are properly secured;
- Lighting is adequate and in good repair;
- Painting and coating are in good shape;
- Access to emergency equipment is clear.

Control measures
Check if the deficiencies found are locally identified and reported to the main control room and that a structured system exists for this purpose.

Confirm that all deficiencies that may impair personnel and equipment safety are adequately protected from e.g. steam, oil and chemical leaks.
Check if there is an established deficiencies/abnormalities reporting criteria for all plant personnel but in particular maintenance and operations and that the threshold for the reporting criteria is sufficiently low to detect the poor material conditions and low level deviations.

3.4.7. Work control

Expectations

A comprehensive work planning and control system that considers defense in depth should be used to ensure that work activities are properly identified, prioritized, authorized, scheduled and carried out in accordance with appropriate procedures and completed in a timely manner. The work planning system should maintain high availability and reliability of important plant systems. Outage planning should be integrated into the work control process.

Effectiveness of the work control process should be monitored via appropriate indicators and corrective action taken when required. Plant defects should be tracked to completion and records kept of work performed. These records should be accessible for review when necessary. The work control process should contain an effective operational feedback system and a systematic analysis of root causes of rework or repetitive failures.

Work scheduling should allocate parts, materials, resources and expertise at the appropriate time for completion of the preventive and corrective programmes and make provisions for adequate post-maintenance testing.

Improved planning and work control can increase the productivity of plant maintenance, which, in turn, can lead to a reduced maintenance backlog. This is likely to decrease the number of equipment problems with a beneficial effect in reducing the number of plant events and challenges to safety systems. Good coordination should be established among maintenance work groups, operations, other support groups and external agencies where appropriate.

Examples of documents to be available for review during the OSART mission:

- Flow diagram for the maintenance work control process (may be a part of a general work control procedure);
- Organization chart for outages;
- Administrative procedures relevant to work planning and control;
- List of temporary changes of plant equipment;
- List of incomplete corrective maintenance work.

Evaluations

Check that work planning is timely and thorough. Check if considerations such as material, tools and manpower requirements, coordination with other departments, safety considerations, radiological protection requirements and quality control requirements are sufficiently taken into account. Check that troubleshooting activities are covered by appropriate work documents.

Work to be conducted should be clearly described by approved work authorization documents that address the following topics:

- Operating constraints;
- Isolation requirements;
- Scope of work;
- Boundaries of the work area and proximity of sensitive equipment;
- Access to the work area;
- Protection from radiological and industrial safety hazards;
- Work procedures to be used;
- Post maintenance and post modification testing.

From observations made during plant tours confirm that important deficiencies are registered in the work control process.

Observe a maintenance and operations staff meeting concerning maintenance priorities and work scheduling. Determine if the system used to prioritize work is effective. Determine if the backlog of work is effectively managed.

Determine if procedures for managing additional workers are adequate and ensure good work performance.

Confirm that temporary repairs are minimized and replaced by permanent repairs when conditions permit. Check that temporary repairs are approved, well identified, documented and appropriately reviewed.

Check that appropriate reviews are conducted after maintenance or modification work to determine if equipment and systems are ready to be returned to service.

Confirm that work planning is used effectively and includes considerations such as:

- Advance preparation and approval of maintenance and modification work packages, including work procedures;
- Operational configuration constraints;
- Contingencies established for discovery and emergent work;
- Procurement and provision of parts and materials;
- Scheduling and provision of manpower, which takes into account the estimated radiation dose for staff and contractors;
- Provision of equipment and services to support the work schedule;
- Coordination of work groups;
- Scheduling system and equipment outages in a way which ensures that adequate defense in depth is provided for all safety important functions and operational risk is reduced as much as possible taking into account PSA insights, where available.
- Training of personnel for special work, including the use of mock-ups where appropriate;
- Establishment of safe working environments;
- Facilities and space required;
- Supervision of contractors.

Determine if training of personnel, including off-site manpower, is effective with respect to special techniques and radiological protection requirements. Optimum use should be made of mock-ups to verify the effectiveness of proposed techniques, to train personnel and to ensure that radiation doses will be ALARA.
Determine if radiation dose accumulation is effectively monitored during performance of high-dose work and confirm that appropriate dose controls are in place. Determine if planning and coordination of high-dose work minimizes radiation doses.

Determine if post-maintenance and modification testing requirements are clearly defined and planned and acceptance criteria are adequately specified. Confirm equipment and systems meet design intent prior to return to service.

Confirm that the use of combustible and chemical materials conform to safety standards and plant procedures.

Check that protective measures for radiological, fire, flooding and safety hazards are adequate. Check that maintenance equipment is properly secured in seismically and environmentally qualified controlled areas.

Determine if the work management system provides an accurate status of all outstanding scheduled and completed work.

Confirm delays and deviations from the work schedule are reviewed and appropriate action is taken.

3.4.8. Spare parts and materials

Expectations

Materials management should ensure that necessary parts and materials, meeting established quality or design requirements, are made available and are suitable for use when needed throughout the lifetime of the plant. Regular QA audits should be conducted.

Spare parts and materials important to safety should be accompanied by documentation indicating that all requirements specified in the purchase order have been met.

Adequate storage facilities, equipment and administration should ensure a correct management of materials. Suitable environmental conditions should exist and fire protection means should be provided.

Examples of documents to be available for review during the OSART mission:

- Procurement, receipt, storage and issue procedures;
- Samples of purchase orders and specifications;
- QA documentation.

Evaluations

Procurement
Check that the responsibility for procurement, receipt, storage and issue of spare parts and materials is defined and clearly understood.

Check that procurement specifications are clear and unambiguous, include current technical and QA requirements and include a requirement that no substitutions of materials or components should be made without advising the purchaser.

Supplier information should specify storage and shelf life requirements.

Confirm that a process exists to ensure that spares are purchased to the same or equivalent technical standards and that QA requirements are the same as the plant items they are intended to replace. Check that items are obtained only from suppliers who are approved in accordance with QA requirements.

Check the completeness of certificates for selected spare parts, which are important to safety.

Confirm that a process exists to procure replacement parts for the lifetime of the plant and that spares and materials can be obtained on a high priority basis when needed.

Determine if shipment/receipt inspections of spare parts and materials provide sufficient assurance of compliance with design, procurement specifications and QA requirements and check if appropriate action is taken for non-conformances.

Determine if the process for certifying commercial-grade material and parts for use in systems important to safety is adequate.

Check if contractor materials are subjected to similar inspection and control.

Check if materials and parts needed for outages are ordered well in advance, so that the material is available on site and in time to support the outage schedule.

Storage

Evaluate the material storage facilities to determine if they provide adequate support to the plant in terms of space, suitability, accessibility etc. Evaluate warehouse administration and the interface with maintenance planners. Determine to what extent parts and materials are available when needed in the plant. Confirm that cost reduction programmes have not led to unreasonable reduction of spare part inventory arising from changes in procurement and stock policies.

Check that materials are stored and identified in a manner that permits timely retrieval. Check if adequate stock records are maintained, purchase orders are tracked, and safety related parts and materials are readily traceable from the supplier to installation. Check if proper engineering approval is obtained for any deviations from design specifications for parts or material.

Confirm that storage facilities are operated in a manner that takes into account fire protection and special environmental requirements for storing certain components, in particular:

- Light sensitive elastomers/polymers;
- Electro-static sensitive components;
- Temperature/humidity sensitive materials and components.

Check that spare parts with limited life are stored separately and clearly marked to indicate acceptable periods of use.

Confirm that material with special hazards like corrosives, stainless steel and halogens, stainless steel in direct contact with other metals, especially carbon steels, flammables, radioactive materials etc. are properly segregated and that adequate procedures are in place to control their receipt, storage and use.

Control

Check if preventive maintenance activities are performed on certain spare equipment (e.g. rotating large electrical motors).

Check if chemicals and materials used by station staff or contractors are labeled to enable them to be controlled.

Check that appropriate minimum, maximum and reorder levels are defined for warehouse stock and reviewed periodically.

Check that a process exists to deal with surplus, repaired and returned parts.

Confirm that obsolete, non-conforming or damaged spare parts are stored separately and controlled to prevent inadvertent use.

Check to determine if access to storage locations is controlled.

Confirm that regular QA audits are conducted. Review non-conformances reported and status of corrective actions.

3.4.9. Outage management

Expectations

Outage management organization and administration should ensure the safe and effective implementation and control of maintenance activities during planned and forced outages. Outage planning and performance should take into consideration safety, quality and schedule in this order. Programmes and plans should reflect this.

Outage planning should be a continuing process involving past, next scheduled and future outages. Milestones should be determined and used to track preoutage work. Planning should be completed as far in advance as possible as circumstances may cause the outage to begin earlier than intended.
The tasks, authorities and responsibilities of different organizational units and persons should be clearly understood. This is especially important during outage periods, when the organization may be temporarily modified. Nuclear safety during shutdown must be given careful consideration.

ALARA principles and waste reduction should be embedded in programmes and planning.

Examples of documents to be available for review during the OSART mission:

- Plant organization chart during outage periods;
- Administrative procedure for outage preparation, performance, control and review;
- Outage schedule;
- Plan of outage preparation meetings;
- Outage review report.

Evaluations

Outage organization and control
Check the administrative procedures for outage management. Ensure that tasks and responsibilities are clearly defined. Check the outage organization to determine if interfaces between maintenance and other groups are clearly defined and operating personnel remain cognizant of maintenance, modification and testing activities.

Check if outage organization and control has proven to be effective in improving safety and reliability. Check that safety, quality and schedule in this order is embedded in programmes, procedures and attitude.

Review the most recent outage review report, the lessons learned and recommendations for the next outage preparation. Determine what improvement actions have been taken in response to the report. Check if there is established a post-outage follow-up.

Check deterministic and probabilistic tools and means used to assess and minimize the safety risk before during and after outages. Coordinate this checking with the reviewer of operations.

Check that adequate reviews have been conducted on safety related work that was not completed during the outage.

Planning and scheduling
Determine if outage planning and scheduling activities provide for safe, timely, and orderly completion of outage work. Consider the following aspects:

- Freeze dates are scheduled to limit growth of outage work scope. Adequate reviews are conducted to include work after freeze dates;
- System and equipment outages are scheduled to provide sufficient defense in depth for cooling the reactor core and as a minimum to meet the OLCs;
- Personnel are trained for special outage work including the use of mock-ups where appropriate;
- Adequate provision of resources is allotted for operational testing at optimal points in the schedule.

Confirm that ALARA principles and waste reduction programmes are taken into consideration during planning and scheduling of outages. Confirm that all groups are involved in this strategy.

3.5. TECHNICAL SUPPORT

Technical support covers al on-site activities of the technical and engineering groups involved in surveillance testing, plant performance monitoring, plant modifications, reactor engineering, fuel handling, and application of plant process computers. The integration of technical support with its specialist functions into the plant organization is important in order to support and ensure the safe operation of the nuclear power plant.

Due to its special significance, operational experience feedback is reviewed by a dedicated reviewer, therefore this review area is discussed in Section 3.6.
References: [6-7, 9-13, 15, 17-18, 29-30, 33-34, 42 and 48]

3.5.1. Organization and functions

Expectations

The goals and objectives of TS should be written and defined within the framework of plant policies and goals and be well understood by all personnel. In those it should be clear that nuclear safety has an overriding priority. Performance indicators should be established that encourages these expectations and standards and are reported in periodic assessments.

The organization and administration of the technical support should ensure effective implementation and control of technical support activities. Effective implementation of the various technical support functions can be accomplished by having a separate section that is responsible for all such activities or by having various in-plant and off-site sections providing different support. Either method should be implemented with a well-defined organization and written assignment of responsibilities, but it should be clear that overall responsibility for safety remains with the owner of the plant.

The interface between TS and other plant on site and off-site groups should be clearly specified. Good coordination between the TS, Operations and Maintenance groups is of utmost importance.

The responsibilities and authorities of the technical support personnel should be clearly defined and understood by all affected personnel. The organization, qualifications and number of technical support personnel should be sufficient to accomplish assigned tasks contained in the technical support area. A system should be implemented to ensure that any person carrying out safety related work should be suitably experienced and qualified for that function whether they are plant based or from another organization.

Design changes should be made with a full understanding of all the design information for the plant and the specifications for each system and component. Both deterministic and probabilistic assessment approaches should be used to justify and evaluate the impact of the major plant design and/or operational practices changes. The assessment process should be sound and based on safety analyses of high quality and adequate scope. Periodic safety reviews should be performed at a regular basis. The necessary knowledge of the overall plant design should be retained in a form that is practically and easily available to the operating organization over the full operating lifetime of the plant. This may be achieved by setting up a 'design authority', that means a design capability within the operating organization, or by having a formal external relationship with the original design organizations or their successors.

Plant management should clearly be committed to nuclear safety while providing technical support services. The integration of knowledge of the human factors into the routine day to day safety work, for example in the planning and implementation of a major plant modification or in the investigation of an incident, may provide a fruitful means of improving safety performance. Leadership and coaching should contribute to the improvement of safety performance. Line management should be accountable for the training and qualification of their personnel.

Examples of documents to be available for review during the OSART mission:

- Organizational chart and manning table for the technical support activities of the plant;
- Administrative procedures for technical support;
- Objectives, responsibilities and job descriptions of the technical support group staff;
- Final safety analysis report (FSAR) section dealing with technical support activities.

Evaluations

Functions and responsibilities

Check that the technical support functions are appropriately represented so that station management adequately considers recommendations.

Check that the technical support organization is clearly defined, and that staffing and resources are sufficient to accomplish assigned tasks. Confirm that all the topics contained in the technical support area of these guidelines are included in the organization. Responsibilities

and authority for each management, supervisory, technical and craft position should be clearly defined in writing and understood.

Check that there is a formally designated entity ('design authority') within the operating organization that takes responsibility for maintaining the design integrity. However, it might not have all the detailed, specialized knowledge required of all the systems and components important to safety. In such case it should assign its responsibilities for some parts of the plant to other entities ('responsible designer') that do have that knowledge. Even in this case it should retain sufficient knowledge of all aspects of the design to enable it to understand the results of the 'responsible designers' work, and to understand the implications of that work for the rest of the design.

Check whether a plant specific PSA model has been developed and whether any PSA applications have been developed and implemented to optimize plant operation. For any of such applications it should be checked that adequate system exists for development, review, approval, implementation and monitoring of the application impact. Confirm that technical support personnel have good knowledge on the assessment techniques used for this application and understanding of any relevant PSA limitations.

Check that administrative procedures exist for all the technical support activities. Ensure that job descriptions, which list experience and qualifications, are available.

Check that the appropriate safety goals and objectives, and associated performance indicators, for all the technical support activities, have been established in accordance with plant management goals and objectives.

Confirm that personnel are safety conscious in the conduct of their work and actively encouraged to develop methods to improve safety, quality and reliability. Also determine if personnel are willing to bring problems to their supervisors without fear of retaliation.

Check that managers explain their commitment to safety culture to their staff, that they remind them that haste and shortcuts are inappropriate and that adherence to written procedures is essential.

Confirm that the effectiveness of technical support is adequately maintained and periodically assessed based on the results of the activities carried out. Goals are based upon management expectations.

Interfaces with other on site and off site groups

Confirm that interfaces with supporting on site and off site groups are clearly defined and working well. There is good coordination between those groups/individuals carrying out different technical support activities and the operations and maintenance department.

Check to ensure that the scheduling of work during outage and operating periods is controlled between various groups in such a way that the unavailability of systems or equipment is controlled and minimized.

Check how well overtime is being controlled. The use of contractor support personnel is well controlled with clearly established roles and responsibilities for all technical support

activities. The backlog of work is not excessive when compared to well performing plant elsewhere of a similar design.

Ensure that adequate provisions exist for prompt technical support of operations after day staff working hours in case of problems.

Determine the effectiveness of the support received from the head office or any other off-site organization but check that responsibility for safety remains with those personnel at the plant.

Qualification of personnel
Training and qualification programmes and processes will be primarily reviewed by the expert evaluating training and qualification. However, during interviews and from observation of work activities, determine if the experience level and proficiency of the technical support staff are appropriate for their assignments and if technical support management is involved in training and re-training of technical staff. Determine technical support personnel satisfaction with current training.

Confirm that all technical support staff are knowledgeable of and effectively using current work practices and procedures. Confirm that the knowledge and ability of the contract engineering support personnel meet the plant qualification requirements for the performance of tasks assigned to them.

Check to ensure that each position in the technical support line organization is staffed with suitably competent and authorized individuals. Ensure that the process of selection, training and job rotation is well planned to develop and maintain capabilities, safety awareness, and to provide the necessary staff motivation. Check that personnel demonstrate interest in all areas of plant safety.

Check to ensure that authorities for the technical support line management are commensurate with assigned responsibilities.

Management role in technical support
Check how often the plant management and the head of appropriate departments observe technical support activities, become actively involved in the resolution of problems and how they promote consciousness of safety as their primary focus. This includes management response to audits concerning technical support activities.

Determine the effectiveness of managements' review of personnel performance, safety attitudes and response to safety infringements and violations of operating limits and conditions (OLCs) or procedures.

Check that the technical support management has appropriate training in leadership qualities along with skills developed for coaching, fitness for duty response, observation skills and emergency communications to on-site or off-site personnel.

Confirm that regular appraisals of the performance of technical support staff are used to enhance individual performance and to prevent complacency.

Confirm that regular communications occur between senior managers and the rest technical support personnel.

Safety issues need a multidisciplinary approach, with the participation of different specialists and professional groups. Confirm that these issues are not dealt with one by one, but in an integrated manner. Confirm that the work is organized in a way that allows an integrated approach, for example in the planning and implementation of a major plant modification or in the investigation of an incident. Check that consideration is given to technical problems, human factors and organizational aspects in a coordinated and integrated manner.

3.5.2. Surveillance programme

Expectations

A comprehensive and adequately documented surveillance programme should be established and implemented to confirm that provisions for safe operation, which were made in the design, and checked during construction and commissioning, continue to exist during the life of the plant. At the same time, the programme should confirm that safety margins are adequate and provide a high tolerance for anticipated operational occurrences, errors and malfunctions.

A surveillance test programme should verify that the plant systems and components relevant to safety are continuously ready to operate and are able to perform their safety functions as designed. Such a surveillance test programme should also detect ageing trends to prevent potential long term degradation.

In addition a surveillance programme should detect and correct any anomalous condition before it significantly affects safety. The anomalous conditions which are of concern to the surveillance programme should include not only failures or deficiencies but also trends, analysis, of which may indicate that the plant is deviating from the design intent.

The surveillance programme should be clearly documented and cross-referenced to the operating limits and conditions and safety analyses. The surveillance procedures should specify surveillance requirements, identify acceptance criteria, persons responsible for performance of surveillance activities, periodicity of each surveillance activity.

The surveillance programme should be modified if necessary in accordance with the evaluation of the data generated during surveillance and reevaluation of the safety analysis report. The established frequency and extent of surveillance should be periodically re-evaluated to establish that they are effective in maintaining the systems, structures and components in an operational state.

Examples of documents to be available for review during the OSART mission:

- List of surveillance tests planned to be conducted during the mission;
- Operating limits and conditions (in many countries included in the technical specifications);
- FSAR sections dealing with surveillance requirements;
- Description of how the surveillance programme works;
- Administrative procedures which define the organization, objectives and responsibilities of surveillance personnel;
- Integrated list of the surveillance tests and its implementation programme; Selected surveillance procedures;
- Evaluations, which have been performed on data collected by the programme.

Evaluations

Programme requirements
Confirm that an adequate programme exists for the plant, in terms of surveillance, testing, inspection, data evaluation activities and any necessary corrective actions.

Confirm that the surveillance programme is clearly documented and cross-referenced to the operating limits and conditions (OLCs) and safety analyses and that evaluation of the data generated during surveillance is used to refine the programme periodically.

Confirm that the surveillance programme is exhaustive and consistent, covering every safety related component/system.

Confirm that the surveillance programme, including such things as procedures and surveillance frequency, is periodically audited and revised as necessary to take into account operating experience, modifications to the plant, plant aging and insights from probabilistic safety assessment.

Confirm that there are organizational charts for the programme which are clearly documented and up to date, identify individuals responsible for specific functions and ensure clear communication links among the individuals responsible for programme requirements. Confirm that specific requirements in case of test failure are clearly documented.

Check to ensure that the programme covers both failure and deficiency detection and effectively evaluate equipment, materials, software, and human performance. Check if the programme identifies the trends, analysis of which may indicate that the plant is deviating from the design intent.

Confirm that the surveillance programme is sufficiently oriented to the trending and monitoring of performance parameters of the systems and components of the plant to detect any age-related degradation at an early stage

Confirm, as part of the control of surveillance procedures, that documentation exists, which defines procedures for preparing, validating, revising and administering surveillance procedures. Ensure the correctness, comprehensibility and usability of the procedures, and the timely implementation of revisions to the procedures.

Administrative controls
Confirm that an adequate administrative system (which may be documentation or computer based) exists for the surveillance activities. This system should be able to identify all the procedures and cross reference to the basis for the surveillance activity. The basis should include not only technical specifications and regulatory requirements, but also safety analyses which identify the safety and reliability basis for the surveillance activity. Check that the last completion date for a surveillance test is properly recorded. The system should also identify the organizations and identify staff who are responsible for these functions. Ensure that there are clear requirements for initiating and completing the test.

Surveillance procedures
Confirm that the procedures have a consistent format across different surveillance activities. Confirm that surveillance test procedures contain the following information e.g.: revision

number, authorizations, prerequisites and resources, initial conditions, special precautions, control of test equipment, acceptance criteria, reference to the OLCs and hold points where necessary. Confirm also that surveillance procedures include restoration of plant and equipment to normal operating mode. Check that acceptance criteria clearly differentiate between safety requirements and predictive maintenance data.

Check to ensure that procedures used for surveillance tests contain sufficient information to ensure safe plant operation during testing and that the tests accurately simulate system actuation functions.

Surveillance scheduling
Confirm that a master scheduling system is used to accurately control the times at which all surveillance activities are to be performed. A typical tolerance used in some countries for the deviation from a required test time interval is plus or minus 25% of the interval. Check that cumulative test time interval extensions do not affect the overall surveillance programme.

Check that the scheduling system coordinates the surveillance programme with all other activities to avoid conflicts.

Conduct of surveillance testing
Witness the execution of one or more selected tests to ensure that the tests are actually conducted correctly. Confirm that adequate communication takes place before during and after the test is performed. This communication should include plant operators and cover an understanding of the objective of the test, prerequisites, hazards, success and failure criteria, the data to be collected in the test and actions to be taken if a failure or deficiency is identified. Check off and tag out procedures along with sign off procedures should also be used.

Confirm that the test is conducted under as near as possible real conditions without preconditioning of the system or equipment prior to the test. Confirm that differences have been properly analyzed by designer and manufacturers.

Review some of the selected surveillance procedures and determine whether appropriate data forms are filled in to show the main parameters and functions of the components with specified acceptance criteria. Confirm that prompt corrective action is taken when the surveillance criteria is not met.

Confirm that instrument and equipment used for surveillance testing are accurate and are regularly calibrated.

Post testing activities
Confirm that corrective action following a failed surveillance test includes timely notification to the shift supervisor, commencement of a deficiency repair and communication to the regulator if required. Applicable regulatory reports should be originated timely. The results of a satisfactorily completed surveillance test should be evaluated by the plant with an independent review is being conducted. Trending of results, even when these are well below safety limits, should be carried out to indicate potential equipment deterioration.

Check that there is a clearly identified process to evaluate the implications for performance, reliability, and safety of the data collected in the surveillance activities. There is also be a

clear feedback process in which the results of the evaluations are transmitted to the responsible groups affected by the results.

Assessment of the effectiveness of surveillance programme
Check whether indicators are specified, to evaluate the effectiveness of the surveillance programme. Confirm that the indicators cover all relevant aspects of the effectiveness of the surveillance programme, including incident detection, failure detection, equipment performance, frequency, reliability and safety. The indicators relate to the effectiveness of the general programme as well as the effectiveness of individual parts of the programme. Check that the outputs of these indicators are used to improve the surveillance programme.

Check that the effectiveness of the overall surveillance programme, including such things as procedures and surveillance frequency, is periodically evaluated to improve it.

Control of special tests
Check that special tests, which have no previously defined procedures, are adequately controlled. Check that before a special test is carried out the plant has established that there is no other reasonable way to obtain the required information. Confirm that documentation available includes adequate preparation and briefing of personnel involved in the special test, specifically the shift supervisor, prior to the test performance. Confirm that the appropriate regulatory authorities are informed before the special tests are conducted and that provisions have been made to ensure that the plant is brought back to a normal operating condition as soon as the test is completed.

3.5.3. Plant modification system

Expectations

An overall plant modification programme should encompass all intended changes of: structures, systems, components and process software of power plant, operational limits and conditions, instructions and procedures.

The design authority, or a responsible designer in its assigned area, should review, verify and approve (or reject) design changes to the plant. Design changes include field changes, modifications and the acceptance of non-conforming items for repair or use without modification.

A plant modification programme for permanent and temporary modifications should be established to ensure proper design, review, control, implementation and documentation of plant design changes in a timely manner. All changes requested should be reviewed, controlled, installed, tested and documented according to plant safety rules and procedures. The plant safety level after a modification should be within the design basis for the plant.

This programme should ensure that the safety significance of a modification is adequately assessed before implementation and that its impact on reliability and design configuration is also considered.

The plant modification programme should be integrated in to the overall plant configuration management system that identifies documented design requirements, ensures the design is properly implemented, and controls plant changes throughout the life of the plant.

Examples of documents to be available for review during the OSART mission:

- List of permanent modifications implemented in last 2 years;
- Current list of temporary modifications in force at the plant;
- FSAR sections with requirements on plant modifications;
- Modification control procedure;
- QA manual section on document control modification requirements;
- Maintenance work control procedure;
- Drawing control procedures;
- Configuration management manual and procedures.

Evaluations

General overview

Responsibility for plant modifications could be distributed across different areas of the organization. Interview personnel from the technical support, maintenance, operations, training and QA groups with regard to modification implementation, control and training.

Requirements to the modifications programme

Check to ensure that the plant modification programme and procedures for modifications have a clear, well understood flow path for request, design, review, implementation, testing, updating of documentation, and training and validation if required. In this flow path simulators should be included.

Confirm that written administrative procedures defining the responsibility for and coordination of plant modification activities are in place and include all organizations with a role. This will include contractors, suppliers and the head offices.

Confirm that the design process of a modification adequately considers the impact of codes, standards and design configuration.

Confirm that criteria based on prioritization of proposed modifications according to their safety benefit exist and are applied. Check that the modification process categorizes all modifications according to their safety significance and that they are subsequently implemented accordingly.

Check that controls for the temporary modifications are similar to those for the permanent ones. Additionally refer to the operational area, work authorizations (3.3.5.).

Confirm that after a modification is implemented there are provisions to determine its effectiveness to ensure that the original objectives of the modification have been achieved.

Check how well the ALARA principle is considered during the modification process.

Implementation of the modifications programme

Check that appropriate formal, interdisciplinary, technical review and approval take place for all plant modification requests. Confirm that an initial safety assessment is carried out before starting a modification to determine whether the proposed modification has any consequences for safety and whether it is within the regulatory constraints for the plant design and operation. Check that the extent and complexity of the additional assessment needed depends on the nature and extent of the consequences of the modification for safety. Check that safety

significant modifications are subject to comprehensive safety assessment, which includes deterministic and probabilistic analysis whenever needed. If a plant specific model for PSA is available and reliable, check whether a quantitative evaluation is performed to quantify the impact of the modification on the plant safety, in order to support the decision making process or to point out associated compensatory measures. If plant specific PSA model is not available check whether there are other means, which assesses the modification, impact on safety.

Check to ensure that the criteria and guidance for reviews and approval responsibilities for modifications, in accordance with their safety categorization, are clearly defined and that the plant nuclear safety committee (or the organization with similar responsibilities) is involved in reviewing appropriate modification proposals at an early stage. Requirements from operations and maintenance are taken into account as well as ALARA considerations. Operations and maintenance personnel are involved in reviewing the modification package along with other departments who may have an interest.

Confirm that a designated 'design authority' ensures that the knowledge of the design, which is needed for the safe operation, and maintenance of a plant is available to all parts of the operating organization. The knowledge of the design that must be available for the process of controlling design change includes:

- A detailed understanding of why the design is as it is;
- The experimental and research knowledge on which the design is based;
- The design inputs and outputs;
- A detailed knowledge of the design calculations;
- An understanding of the inspections, analysis, testing, computer code validation and acceptance criteria used by participating design organizations to verify that the design output meets the design requirements;
- The assumptions made in all the steps above;
- The implications of operating experience on the design.

Confirm that the testing procedure of an installed modification is clearly defined and that plant personnel are involved in developing the testing programme, although a special turn-over group (contractors/off-site people) may be responsible. The operations shift should be informed well in advance of any modification testing and the testing should be properly documented.

Check that when a plant modification is implemented, the work request authorization should clearly identify the modification with the reference number and supporting information.

Check that appropriate procedures are updated and all the appropriate personnel are trained on the modified system.

Confirm that OLCs are reassessed and revised, as necessary, following any safety related modifications at the plant or any changes to the safety analysis report, and also on the basis of accumulated experience and technological developments.

Confirm that care is taken and procedures are in place to avoid two or more potentially conflicting modifications being designed and undertaken coincidentally on the same part of the plant or on interrelated parts of the plant.

Confirm that the responsibility for revision of all documents such as drawings, procedures, set points, OLCs, system description, training manual, provisions for plant simulator, vendor equipment manuals and spare part lists is clearly assigned and being implemented.

Check how thorough the QA involvement was during the modification process to ensure that all updating of controlled drawings, documents and required training was completed before the actual operation of the modified system or equipment.

Check whether the procedure for obtaining approval to implement a temporary modification is the same as that for a permanent modification. The process for temporary modifications should allow for rapid review and assessment of any proposed modifications that have to be undertaken urgently. Such urgent actions, however, should neither reduce levels of safety nor bypass the obtaining of regulatory approval as necessary. Check that the number of temporary modifications should be kept to a minimum, and a time limit is specified for their removal or conversion into permanent modifications. Check how temporary modifications are identified at the point of application and at any relevant control position.

Configuration management
Check that the plant activities are effectively managed to verify that the plant configuration and operation conform to design requirements and design documents. Confirm that configuration management programme is established and implemented at the plant. Confirm that the programme identifies documented design requirements, ensures the design is properly implemented and controls plant modifications, including those of a temporary nature, throughout the life of the plant. Confirm that an appropriate system is established and implemented to ensure that changes to the plant are properly identified, screened, designed, evaluated and documented.

3.5.4. Reactor core management (reactor engineering)

Expectations

Reactor core management should ensure the safe and optimum operation of the reactor core without compromising any OLCs based on design, safety or nuclear fuel limits. Maximum effort and priority should be assigned to maintaining fuel integrity. The core management programme should also provide tools to control and ensure that only approved fuel is loaded into the core.

Core management programme should include appropriate numerical methods and techniques to predict reactor behaviour during operation so as to ensure that the reactor will be operated within OLCs. The core parameters should be monitored, trended and evaluated in order to detect abnormal behaviour and ensure that actual core performance is consistent with core design requirements. To ensure that fuel cladding integrity is maintained under all core operating conditions, radiochemistry data that are indicative of fuel cladding integrity should be systematically monitored and analysed for trends. An adequate fuel failure contingency plan or policy should be established and implemented to ensure that corrective actions for failed fuel are taken.

A core management should also include the surveillance activities for the early detection of any deterioration that could result in an unsafe condition in the reactor core.

The personnel involved in the core management should be well qualified, have clear responsibilities and authorities and be readily available to support plant operations during all modes of operation.

Examples of documents to be available for review during the OSART mission:

- Organization of the core management group (on-site/head office), job description for the group members.
- OLCs related to the core;
- Core operation monitoring procedure;
- Surveillance procedures related to core management;
- Heat balance procedure for the plant;
- Shutdown margin procedure;
- Refuelling programme and procedures;
- Nuclear design and core physics characteristics for the current cycle;
- Core performance analysis report for the previous cycle;
- The start-up test evaluation (for example comparison between start-up test results and nuclear design and core characteristics) for the current cycle;
- Evaluation and reviews of proposals for changes to fuel design/specification.

Evaluations

Programme scope and content

Check that there is a written description of core management functions. If some of these functions are carried out by external to plant organizations such as corporate organization, contractors, etc., their role and responsibilities should be clearly specified.

Check that the core management programme includes such core management functions as core performance monitoring, fuel depletion calculations, reactivity calculations, neutronic calculations and thermal-hydraulic state calculations, to ensure that core operation is within the licensed constraints.

Functions, responsibilities and qualification

Confirm that the personnel responsible for different core management tasks are suitably qualified and experienced. Responsibilities are clearly defined between on-site and head office personnel and contractors. Job descriptions and qualification requirements for different core management tasks are clearly identified. Check that the training programme for the personnel of core management group are clearly identified and include on the job training. Check if reactor engineers are readily accessible by the shift engineer during non-routine activities, such as fuel loading and first startup after fuel loading to ensure adequate shutdown margins exist at all times.

Check that reactor engineering personnel have a role in writing/reviewing operating instructions as appropriate.

Core management procedures

Review selected core management procedures. Confirm that procedures are clear and understandable (reference to design information or vendor manuals should be specific enough to prevent errors or improper use) and consistent with any necessary limits and conditions, the FSAR and vendor requirements. Confirm that there are reactivity control procedures for shutdown margin calculations, including estimated critical positions. Confirm that there are

also startup test procedures after refuelling and core operation procedures including flux mapping (as necessary depending on reactor type) and control rod sequencing recommendations. Check selected surveillance procedures related to the core management and the trending and monitoring of surveillance results. Confirm that procedures applicable to nuclear instrumentation calibration and flux mapping surveillance specify a frequency depending on reactor type at which these procedures are required to be implemented.

Check that the refuelling procedures ensure that safety requirements are complied with. Confirm that the physics test programme after refuelling verifies the core design. The operators are trained in core changes due to refuelling.

Confirm that required operating procedures and computer software (if required) are updated in a timely manner after refuelling and subsequent testing.

Check if the involvement of the plant's personnel in the reload core analysis process is sufficient to ensure that the input data correctly represent plant conditions and configuration.

Check how well the fuel management programme and related procedures ensure that fuel assembly movements and histories are kept up to date and that accurate records of the control and receipt of nuclear material and shipments of fuel are kept.

Core monitoring and trending

In many cases, the parameters that affect fuel behavior are not directly measurable. Confirm that in such cases, they are derived by calculation from measured parameters such as neutron flux distribution and temperatures, pressures and flow rates.

Confirm that core conditions are monitored and compared with predictions to determine whether they are as expected and are within the limits. Check if appropriate action should be taken to maintain the reactor in a safe condition if the core conditions do not conform.

Review how thoroughly the core management group carries out trending and monitoring of important parameters for the safe and reliable operation of the core.

For BWR plants:

- Core performance parameters: core flow versus core pressure drop, control rod positions, thermal power level, xenon concentration and average burnup.
- Power distribution parameters in the core: minimum critical power ratio (MCPR), maximum average planar linear heat generation rate (MAPLHGR), relative assembly power versus design power;
- Reactivity control parameters: control rod positions (number of notches inserted) versus burnup, control rod exposures and control rod scram times.
- Performance of in-core flux monitoring system.

For PWR plants:

- Core performance and reactivity control parameters: core temperature rise versus secondary power, quadrant power tilts, boron concentration versus burnup;
- Core parameters: thermal power level, core detector power level, control rod positions, core measurement credibility;

- Power distribution in the core, maximum peaking factors (magnitude and location), limits to departure from nuclear boiling ratio (DNBR).

For GCR plants:

- Core performance parameters: thermal power, flux measurements, channel power histories, channel gas outlet temperatures, peak fission gas pressures, gag positions, core flow, fuel irradiation histories;
- Power distribution parameters: fuel temperature histories, radial form factors, axial form factors, quadrant symmetry;
- Reactivity control parameters: control rod positions, shutdown margins, control rod drop times, sensor rod movement, availability of secondary shutdown and hold down systems;
- Other parameters: monitoring of trip margins, detection of failed fuel, coolant composition and pressure, moderator temperatures, gag vibration, circulator vibration.

The conclusions of the reactor engineering performance should be reported to plant management in a timely manner, e.g. on a monthly basis.

Check whether important parameters affecting core performance are routinely trended to detect deviations from normal. Check if anomalous or unanticipated indications are promptly investigated and conservative actions are taken.
Check that for operation at reduced power or in the shutdown state, consideration is given to the need to adjust the set points for alarm annunciation or the initiation of safety action in order to maintain the appropriate safety margins.

Core monitoring tools and techniques
Confirm that the computational methods and tools for in-core fuel management are adequately validated, benchmarked, updated and maintained. Furthermore, independent verification of computational results (ideally, using diverse people, tools and methods) is performed for significant core management calculations.

Check if approved backup analytical techniques for important computer functions, involving reactivity control, core performance, and fuel integrity are provided in procedures, and appropriate personnel are knowledgeable in their use.

Control of fuel integrity
Confirm that a fuel integrity monitoring programme is established and implemented. Check whether this programme includes the monitoring of fuel operating parameters, the use of lead test assemblies, the inspection of irradiated fuel and, in special cases, hot cell examinations.

Confirm that there is a reactor coolant monitoring regime, appropriate to the reactor core design, which can provide an early indication of loss of fuel clad integrity, for example iodine concentrations and iodine ratios for PWRs.

Confirm that fuel integrity parameters (fission product activity, iodine concentration and iodine ratios, also off-gas activity for BWRs) are trended. Confirm that the reactor engineers aware of and informed on the chemistry analysis of reactor coolant water. A sipping programme is established to detect and locate leaking fuel assemblies.

Confirm that thorough root cause investigations have been conducted and resulting action plans are assigned to appropriate groups for dealing with failed fuel and that policies are established for potential reloading of leaking fuel.

Confirm that a failed fuel action plan is established with necessary key elements such as actions levels for fuel investigation activities, restriction of power operations etc.

New designs of fuel or modifications to fuel
Confirm that prior to operating a core with fuels of more than one type, the operating organization ensures that the fuel of new design or modified fuel is compatible with the existing fuel and that the core designer has access to all the relevant information.

Check whether a lead test assembly programme is considered to assess the behaviour of fuel of new design or modified fuel under the conditions expected in subsequent reloads.

Confirm that experimental feedback and research and development programmes covering power ramp tests, reactivity initiated accident tests and loss of coolant accident tests (analytical or global) are taken into consideration to demonstrate the behaviour of fuel of new designs under normal and accident conditions.

3.5.5. Handling of fuel and core components

Expectations

The handling programme for fuel and other core components should provide measures to prevent damage to the nuclear fuel and to prevent inadvertent criticality and loss of appropriate cooling when fuel assemblies are being transported, stored or manipulated. For purposes of radiological protection, precautions to be taken in handling unloaded fuel, core components and materials and any disassembly operations should be specified in the procedures. It should also ensure that all procedures and controls adequately reflect radiation protection requirements and plant policies for ALARA considerations.

The comprehensive fuel handling programme should include receipt, transfer, inspection and storage of nuclear fuel. Fuel handling planning should accomplish fuel loading and unloading safely in accordance with a core management programme as well as safe storage, handling and preparation for dispatch of the irradiated fuel. Fuel elements should be traced by means of an appropriate system to maintain a thorough fuel inventory and history. Each core component should be adequately identified and a record should be kept of its core location, orientation within the core, out of core storage position and other pertinent information so that an irradiation history of the component is available.

Examples of documents to be available for review during the OSART mission:
- Organization chart and responsibilities for fuel handling operations;
- List of fuel storage and handling operations procedures;
- Fuel handling sections of the FSAR;
- Site plan showing approved storage locations for fuel and core components;
- Job description of all personnel involved in fuel handling;
- Fuel inspection specifications and records;
- Fuel inventory records system;
- Surveillance programme for core components;

- Core components records related to the location, orientation and storage positions.

Evaluations

General considerations
Check whether assessment tools and means are available to assess and reduce the risk from fuel handling activities at the plant.

Check if a policy for exclusion of foreign material is adopted. Confirm that procedures are in place to control the use of certain materials such as transparent sheets, which cannot be seen in water, and loose parts. Confirm the effectiveness of this process by observing the status of the new and used fuel storage and reactor cavity during refueling operations.

Check that there are limitations for moving heavy loads in areas where fuel elements are situated and that heavy loads cranes are parked in safe positions when not in use.

Check whether there have been any changes to fuel design or supplier and if so whether they were controlled according to the relevant procedures.

New fuel storage and inspection
The ultimate safety objectives of a fresh fuel handling programme are to prevent inadvertent criticality and to prevent damage to the nuclear fuel when it is being transported, stored or manipulated.

The operating organization should ensure that the fuel has been adequately designed and has been manufactured in accordance with design specifications, and that only approved fuel is loaded into the core.

It is necessary to establish precise responsibilities for the fuel from the moment it is delivered to the site and to investigate the arrangements for receipt, inspection, storage and handling. At an appropriate point before being loaded into the core, the fuel is inspected by approved personnel in accordance with quality control procedures. This is to ensure that the fuel has not been damaged as a result of transit to the site or in subsequent handling operations. To be assured in that:

- Check the designation of approved storage areas and the limitation of personnel access;
- Confirm that storage is only in an approved manner, taking into account means to prevent critical configurations and to prevent deterioration during storage;
- Check that there are adequate provisions and criteria established for excluding fuel or fuel components which do not meet specifications;
- Check that procedures are observed for correct compilation of records of fuel in storage to avoid mistakes in identification;
- Check that radiological, fire prevention and flood prevention measures are specified and complied with.

Evaluate how well the following activities have been carried out:

- Confirm that inspection procedures include checking of transport containers for cleanness, fuel and containers for transportation or handling damage,

fuel for obstructions, correct identification of fuel and correlation of manufacturing and delivery documents. Final inspection is carried out following fuel manufacturing;
- Confirm that stipulated acceptance standards are adhered to;
- Check if there is a contingency plan for the case when the fuel is damaged or does not meet the acceptance criteria and that procedures are being followed.

Loading and unloading fuel and core components

The manipulation of fuel and core components into and out of the core in accordance with the refuelling programme will vary considerably with reactor type. To ensure adequacy of the programme:

- Check that there are clear fuel handling procedures and core loading/unloading pattern including arrangements for holding it in an intermediate storage;
- Check that key refueling operations are verified and signed off in confirmation by an authorized person;
- Check that any core components such as instrumentation, flow regulators, neutron absorbers etc., which have been added since fuel manufacturing are included in the core loading procedures;
- Check that there is a clear identification of the fuel and core components to be loaded or repositioned in the core;
- Check that there are appropriate authorization and clearance with the control room supervisor before handling activities are commenced in the core;
- Check that there is adequate supervision of refuelling activities by operations personnel which are supported by adequate communication between the reactor location, control room, and spent fuel pool;
- Check that there is independent verification by personnel not directly involved in the operation, that handling fuel into and within or discharge from the core is achieved at the specified location and the fuel is correctly positioned, i.e. its position in the channel or its orientation if appropriate;
- Check the effectiveness of control associated with implementation of instrumentation changes and monitoring of plant conditions during refuelling;
- Check how well radiation protection provisions are controlled for handling irradiated fuel or components and any disassembly operations, e.g. reconstitution of fuel;
- Check the special arrangements for discharge and handling of mechanically damaged failed fuel; examination of adjacent component or location from which failed fuel is discharged;
- Check the arrangements for discharge and handling of leaking fuel;
- Check that refuelling machines are operated only by authorized persons, the machines are maintained in specified condition and operational status, e.g. override of interlocks is authorized only in abnormal fuel handling conditions, connection and disconnection limitation and coolant requirements are observed;
- Check that all operations necessitating changes to pressure circuit integrity are subject to appropriate verification;

- Check that when a significant quantity of fuel is being loaded into a shut down reactor, the subcritical count rate is monitored to prevent an unanticipated reduction in the shutdown margin or an inadvertent criticality.
- Check that procedures are strictly adhered to, that adequate use is made of checklists, that comprehensive records are kept and that these are correctly processed.

Handling and storage of irradiated fuel and core components

Usually the design of the plant makes provision for storage of fuel on a temporary basis until it is in a satisfactory state for dispatch from site. This storage may be dry or in water according to the installation.

Irradiated core components require also special conditions for storage. This applies to all types of reactivity control devices or shutdown devices, neutron sources, dummy fuel, fuel channels, instrumentation, flow restrictors, burnable absorbers, samples of reactor vessel material, and other items such as storage containers or shipping casks.

To be sure that the irradiated fuel and core components are handled in proper way and stored in appropriate conditions:

- Check that irradiated fuel and core components are only stored in approved locations;
- Confirm that the programme for inspection of irradiated fuel is in place to follow-up the performance of fuel elements in the core and to predict their further behaviour;
- Confirm that all movements of irradiated fuel should be performed in accordance with written procedures. Key operations should be verified and signed off in confirmation by authorized personnel.
- Confirm that procedures exist to ensure that irradiated fuel is stored in approved configurations, with neutron absorber limits if necessary, to ensure that criticality requirements are met;
- Check that the condition of the coolant is controlled by the surveillance programme to avoid overheating and corrosion of the fuel and buildup of activity, and to maintain the purity and inventory of the coolant;
- Confirm that all radiation protection requirements are complied with and that equipment is correctly used to minimize doses;
- Check that there are adequate records of the identification and history of all storage facility contents;
- Check that records for the core components are kept to identify their core location, orientation within the core, out of core storage position and other pertinent information so that an irradiation history of the component is available;
- Check that there are procedures in place to ensure that fuel is not moved out of the storage facility until it is cooled in accordance with local safety limits.
- Check that appropriate emergency operating procedures are established to manage anticipated events and design basis accidents in the handling and storage of irradiated fuel.

3.5.6. Computer based systems important to safety

Expectations

A programme for utilization of computer based systems should be established and implemented to support and verify the safe operation of the plant. Utilization of computer based systems may vary greatly between different plants. The programme for utilization should therefore clearly define the categorization of the applications in terms of their safety significance. This section of the guidelines refers (if not stated specifically) to both safety systems and safety related systems.

Organizational responsibilities for computer based applications should be well defined and meet the needs for ensuring safe plant operation. This includes well organized documentation and provisions for emergency recovery of failed software applications.

To ensure the appropriate operation of different computer based systems according to their design functions a relevant section should be established in the quality assurance programme.

Examples of documents to be available for review during the OSART mission:

- Overview of all computer based systems and applications at the plant including a statement of their importance to safety;
- Administrative procedures, which define the organization, responsibilities and objectives of personnel for operation and maintenance of computer based systems along with their qualification and experience;
- The relevant sections of the QA documentation to cover hardware and software;
- Selected procedures;
- Log books for permanent and temporary software/hardware modifications;
- List of documents for hardware and software maintenance;
- Procedures for modifications, updates and correction routines.

Evaluations

Programme for utilization of computer based applications

Confirm that an adequate programme exists for the utilization of computer based applications.

Confirm that the programme for utilization of computer based applications clearly and correctly defines the categorization of these applications in terms of importance to safety. In the programme, there should be definitions of the systems and/or specific equipment that are to be defined as computer based systems and what constitutes a computer application important to safety.

Confirm that the programme includes adequate procedures to control software and hardware modifications and includes the necessary validation and verification process. Check that a structured change process under an effective system for configuration management is in place to govern both hardware and software changes. Confirm that the possible common mode failure of computer based safety systems that employ redundant systems using identical versions of the software are considered during the modification process.

Confirm that the modification of the computer based system during on-line operation, and in particular of its software is only allowed if supported by detailed justification. Modification to those parameters that might require variation during the operation of the plant (such as trip

settings and calibration constants) are undertaken using engineered facilities that have been shown to be fit for the purpose.

Check how well the organizational responsibilities for the computer utilization programme meet the programme objectives by reviewing how responsibilities are shared between the plant and its corporate head office (if applicable) and how the management and end-users view the effectiveness of computer capabilities.

Confirm that personnel for operation and maintenance of computer based systems understand the safety implications of their job and demonstrate a proactive attitude to safety.

Quality assurance programme for computer based systems and applications
Check that the quality assurance programme addresses the following items: organization and responsibilities, documentation, software quality, validation and verification, database organization, emergency recovery, backup routines, maintenance system, security, modification, update and correcting routines, dependent on the degree and usage of computer applications on site.

To give assurance that the programme is achieving appropriate standards, check:

- That there are adequate rules governing development of software;
- That there are manual backup procedures and that these are being correctly followed;
- Adequacy of storage facilities for backup copies;
- That modifications and tests have been carried out in accordance with procedures and performance and test results are available;
- That the ambient operating conditions for computer based systems are specified and being adhered to;
- That maintenance and repair activities are carried out in accordance with appropriate procedures and that test results for repaired equipment is available;
- Training programme and records;
- Records of system availability and log of faults reported by all users.

Documentation for computer based systems and applications
Check that documentation is well organized and confirm that documents have been updated to reflect the actual computer based applications. Confirm that procedures for preparing, revising, administrating and storing of documents are followed.

Check that procedures and written documentation clearly state the requirements in terms of emergency recovery, backup routines, modification, update and correcting routines, system security, maintenance, verification and validation.

Review documentation and logs for permanent and temporary software/hardware modifications for the last year to determine adequacy and adherence of personnel for operation and maintenance of computer based systems to existing procedures and regulations.

Effectiveness of computer based applications
Interview end-users about their attitude to the utilization of computer based applications.

Determine if plant personnel fully understand all necessary functions of computer based applications. Check whether adequate initial and refresher training is provided.

Confirm that feedback from regulatory bodies, the plant, the nuclear facilities and institutions is taken into account in accordance with the established system. Confirm that the plant or the company participate, in formal or informal users' groups.

Maintaining the availability and performance
Confirm that measures are taken by the plant to assure the supply of spare parts, as well as hardware and software specialist assistance from vendor or other institutions. Confirm also that training assistance from vendor or another institution is available. If test systems are used at the plant or available at another location, review that they are used according to procedures.

Check that access to hardware and software on computer based systems is limited to authorized persons working in accordance with written procedures and that any changes made are fully documented.

Check that there are adequate arrangements to ensure that only the authorized version of the software can be used and that any backup data which is loaded is representative of the current plant state and has been communicated in a manner appropriate to its safety significance, i.e. important information should be communicated in writing.

Confirm that after failure of a hardware component, corrective actions are limited to one-for-one replacements of hardware and to the reloading of the existing software modules. Check that calibration data are of a sufficiently high accuracy not to degrade the computer based system's reliability. Confirm that for safety systems, such data are generated automatically by a system that has been developed to the same standards as the computer based system, or the process for the generation of calibration data is described and demonstrated to be diverse.

3.6. OPERATIONAL EXPERIENCE FEEDBACK

A well implemented operational experience (OE) programme is characterized by the following features: management aligns the organization to effectively implement the OE programme in order that plant safety and reliability are improved; OE is reported in a timely manner to reduce the potential for recurring events in-house and in the industry; sources of OE are considered in the OE programme to improve plant safety and reliability from the lessons learned; OE information is appropriately screened to select and prioritize those items requiring further investigation; analysis is performed on appropriate events, depending of their severity or frequency, to ensure root causes and corrective actions are identified; corrective actions are defined, prioritized, scheduled and followed up to ensure effective implementation and effective improvement of plant safety and reliability; OE information is used throughout the plant to effectively improve plant safety and reliability; OE information is analysed and trended, and the results are used to improve plant safety and reliability; assessments and indicators are effectively used to review and monitor the plant performance and the effectiveness of OE programme.

The review of the OE programme is a cross-functional process. Therefore any input from the reviewers of other review areas is beneficial to support the review of the OE programme.

References: [1, 6, 11, 24, 26-27, 36, 39, 41-42 and 48]

3.6.1. Management, organization and functions of the OE programme

Expectations

A programme of OE is in place. The programme covers all areas of the OE feedback process. Effective use of OE is part of the safety culture. Management is committed and involved in promoting and reinforcing the use of OE to improve plant safety and reliability. Policy, goals, objectives and management expectations are clearly defined and communicated. The programme is developed in procedures for the management of the internal OE including low level events and near misses, external OE, periodical assessment of OE activities and programme review.

Duties, responsibilities, authorities and lines of communication within the plant organisation are clearly defined and understood. Duties, responsibilities, authorities, lines of communication and interfaces of corporate organisations as well as other external organisations in the OE process are clearly defined and understood. Tools like methods, criteria etc are provided to perform the tasks of the OE feedback process. Adequate resources are allocated for the OE programme including coordination. A group is identified to manage the process.

Active participation in OE activities is implemented throughout the plant in a blame free atmosphere. Supervisors and managers actively reinforce effective use of OE information by personnel.
Personnel are held accountable for effective analysis and timely implementation of lessons learned from OE information. Comprehensive monitoring of the tasks carried out in OE process is performed for compliance with the targets defined.

The effectiveness of the OE process is monitored regularly. A clear feedback process exists in which the results of the monitoring are transmitted to the responsible groups affected by the results.

Examples of documents to be available for review during the OSART mission:

- Short description of the OE programme and its relation to other programmes (e.g. QA programme, ALARA, maintenance rule etc.);
- Goals and objectives in the area of OE;
- Detailed organization chart and staffing of all units of the organisation in charge of OE feedback including the coordination group of OE (if a separate group exists) in the plant and in the corporate office, or list of personnel involved in coordinating the main activities related to OE;
- Definition of duties and responsibilities as well as of interfaces between plant and corporate office (or other external organization), in the area of OE. Roles, objectives, composition and meeting frequency of OE Committees (if they exist);
- Short description of the following programmes: use of external OE, use of internal OE, low level events and near misses programme;
- Relevant procedures in the area of OE and list of all procedures related to OE (simplified OE process logic diagrams may help to provide good understanding and avoid unnecessary procedures translation).

Evaluations

Functions and responsibilities
Check that IAEA, international and national guidance/requirements have been taken into account in developing the plant strategy in the OE area.

Confirm that the scope of the OE process includes the reporting of low-level and near miss events. Check that the scope of the OE process includes the requirement to trend and review generic issues to determine unresolved safety issues. Check whether these reviews include operational data other than plant event/deviation reports (e.g. quality assurance non-conformance's, plant operational performance data, task risk analysis results, external events). Confirm that the OE processes are adequately specified and expectations are clearly understood by plant personnel.

Check that the roles and responsibilities of personnel involved in processing operational safety performance data are adequately specified. Confirm that the roles and responsibilities of personnel responsible for event investigation, analysis, corrective action development and implementation are adequately specified. Verify whether accountability process are established and implemented in practice.

Interfaces with other on site and off site groups
Check that specialist staff, other than dedicated OE review personnel, is involved in the analysis of OE information and the development of corrective actions. Verify that relevant plant organizations are involved in the OE programme. Interview plant personnel at different levels and key management to determine general awareness and involvement in the programme and understanding of their responsibilities.

Confirm that there are effective channels of communication with external sources of OE information.

Qualification of personnel
Check that OE personnel are suitably qualified with adequate experience and training. Verify that root cause investigators are suitably trained to adequately investigate and analyse the event information.

Management role in operational experience feedback
Review the overall strategy of the plant for the use of operational performance information, in order to determine whether there is a clearly expressed management expectation committing the plant staff to enhancing the prevention of operational failures through the use of OE information.

Verify that the organization is committed to excellence in safety performance through the use of OE. Check that management expectations of personnel are specified with regard to reporting abnormalities. Check whether measurable goals and objectives are specified regarding effectiveness of the OE programme (such as back log of corrective actions, timeliness of analysis, number of reworks/recurrent deficiencies). Check that regular effectiveness reviews are specified and accountability meetings are organized to regularly monitor the effectiveness of the process and the achievement of specified goals and targets.

Determine the involvement of corporate organization and plant safety committees in the OE process, and confirm that their responsibilities are clearly defined and understood by plant and corporate. Confirm that adequate resources are devoted to the OE processes (equipment, personnel, finance).

3.6.2. Reporting of operating experience

Expectations

OE is identified and reported in a timely manner according to well established criteria and procedures. Problem identification and reporting is strongly encouraged and reinforced at all levels in the organization.

Significant events, minor events, low level events, near misses and potential problems are identified and reported, including equipment failures, human performance problems, procedure deficiencies and documentation inconsistencies.

Dissemination of OE to plant personnel and dissemination of significant experience to other nuclear power plants are timely performed.

Examples of documents to be available for review during the OSART mission:

- Reporting criteria for events;
- Graphs of production by unit for the last 3 years (showing power evolution, scheduled, unscheduled and refuelling outages);
- List of significant events reported to the regulator in the last 3 years;
- List of the significant events shared with the nuclear community in the last 3 years;
- Indicators used for trending the timeliness of reporting.

Evaluations

Evaluate whether event and deviation reporting is comprehensive. Check that reporting of minor events, low level events and near misses is actively encouraged. Review the internal and external reporting criteria and confirm, that the reporting threshold is low enough to accumulate sufficient material to draw realistic conclusions.

Review whether reporting of deviations, events, precursors, etc. is carried out by all levels of personnel, sections, departments, etc. throughout the plant organization. Verify that all staff contributes to reporting in a reasonably uniform manner.

Confirm that the reporting process is user friendly. Check that the relevant plant personnel are fully aware of the process. Check that the reporting requirements are communicated to plant personnel during initial and refresher training. Review what other methods are used to convey management's expectations on reporting.

Review whether there is a tendency in reporting either equipment, procedural or personnel deficiencies. Check if there is physical evidence in the plant of unreported deficiencies, event precursors or error likely situations (e.g. defective equipment, poor material condition, poor or unsafe working practices, un-controlled operator aids, lack of document control, etc.). Check whether feedback of field activities is captured and introduced in work control information in

order to report the lessons learned after performing the work (by means e.g. specific paragraph in the post-work format). Review that important problems that should be in the higher level of OE and corrective actions, are not being reported instead in the lower level and near misses programme. Evaluate how comprehensive is event reporting and whether information is centralized.

Confirm that there is a declared policy of no-blame reporting in an accountability environment. Evaluate what is the staff perception, verify that the environment is not considered punitive.

Evaluate how accessible is the event report information to plant personnel. Check that applicable OE information has been disseminated to appropriate personnel in a timely manner. Check whether the workers/engineers have received this information and considered it.

Review whether the criteria for reporting to external organizations (regulatory authorities, utility and international organizations, etc.) comply with the requirements of external organizations in ensuring learning opportunities are maximized. Evaluate if off-site reporting is adequate. Check whether there had been events that should have been reported off-site that were not. Evaluate whether there had been events reported off site that were not appropriate. Confirm that recent plant events were shared with the external nuclear community. Determine if the sharing was voluntary or forced by national authorities. See if there were any obvious events from the review of operational history that should have been shared and follow-up to see if they were.

Verify the timeliness of sending the report to regulatory authorities. Ask for the ratio of late reporting by the plant to the regulator. Verify the timeliness of sharing events with the external community (e.g. international industry reference uses as reporting time objective 4 weeks following a significant event and 20 weeks for reporting the results of the analysis).

Check whether reports are tracked to ensure that analysis is complete and corrective actions are defined. Evaluate whether relevant review programmes (e.g. QA, surveillance testing, management tours, etc.) identify deviations.

Check whether the results of routine managerial plant walkdowns reflect the deviations/events/issues reported by plant personnel into the OE process. Evaluate whether the results of the plant walkdown by the OSART team members reflect the results of recent managerial walkdowns.

Check that the deviations/events/issues etc. reported by plant personnel are reflected in QA non-conformance reports. Evaluate whether the plant is pro-active or re-active in its failure prevention programme. Check if the plant is able to determine how many events are detected/reported through surveillance programmes (prior to being put into service, by preventive maintenance or surveillance) versus operational failures. Review how many deviations are reported as a result of quality verification prior to service. Check whether measures are taken to prevent deterioration in service. Review how many deviations are reported as a result of surveillance programmes to detect unforeseen degradation in service.

3.6.3 Sources of operating experience

Expectations

Sources of industry operating information are identified, access to these sources are formally established and systematically screened. These sources include organizations (IAEA, NEA, WANO, INPO, National Regulatory Body, Owners Groups, Vendors and Manufacturers, Engineering designer etc.) and publications (IRS, SER, SOER; National Regulatory Body Generic Letters, Bulletins, Notices; Vendors, Manufacturers and Engineering designer problem information; Utilities and Industry event reports). Sources of OE include good practices as a source of improvement.

Sources of in house OE are identified, information from and access to these sources are formally established and systematically screened. These sources include areas such as: significant events, low level events and near misses, quality reports, reports and data from operation activities, maintenance testing and in-service inspection, surveillance reports, results from plant specific safety assessments, training feedback, no-blame reporting programme, performance indicators.

The source of OE is linked to all learning opportunities and the owner of these opportunities recognises its potential.

Examples of documents to be available for review during the OSART mission:

- Sources of internal and external OE;
- List of event reports from external OE and good practices, considered during the last 3 years by the OE programme.

Evaluations

Determine the relationship of the utility/plant with national and international organizations (IAEA, NEA, WANO, INPO, National Regulatory Body, Owners Groups, Vendors and Manufacturers, Engineering designer etc.) and with publications (IRS, SER, SOER; National Regulatory Body Generic Letters, Bulletins, Notices; Vendors, Manufacturers and Engineering designer problem information; Utilities and Industry event reports). Review the availability and accessibility to these sources by the plant OE group and other operational experts.

Review material, such as shift operating logs, for events that should have been considered for investigation in the OE programme. Ask counterparts/peers/plant personnel about plant events they have become aware of. See if they were considered in the OE programme.

Review number and recurrence of deviations from OLCs, justifications for continued operation, retests, and reworks. Ask counterparts/peers about issues of this type that they have become aware of during their evaluation. See if they were considered in the OE programme.

Review availability and accessibility by the plant OE group of source products such as: quality reports, reports and data from operation activities, maintenance testing and in-service inspection, post-work reports of lessons learned, post outages critiques, results from safety self assessments, training feedback. Assess if they are taken into account effectively in the screening process for consideration in the OE programme.

Review the consideration by the OE group of evolution of the plant performance indicators and plant parameters as possible information source of areas were issues from OE programme could effectively contribute in the search for opportunities for improvement. Review the effectiveness of the no blame reporting system as a source of OE. Review identified good practices. Assess if they are taken into account effectively in the screening process for consideration in the OE programme.

3.6.4. Screening of operating experience information

Expectations

OE information is appropriately screened, to select and prioritize the information for further investigation. Screening criteria for in-house and industry OE are clearly established and the criteria for the subsequent level of investigation and distribution are defined.

The screening is performed in a systematic and timely manner. The sources for screening and their corresponding frequency of screening are defined. Screening is performed by individuals with a broad knowledge of plant operations or by a multidisciplinary group.

Examples of documents to be available for review during the OSART mission:

- Screening criteria for events;
- Procedures related to the use of external OE, use of internal OE, Low level Events and Near Misses programme;
- Procedures of reporting to the regulatory and other off-site authorities;
- List of events for the last 3 years with direct causes, root causes and corrective actions, together with a short description of the event;
- Graphs of production by unit for the last 3 years (showing power evolution, scheduled, unscheduled and refuelling outages);
- Minutes of the screening meetings or screening committee meetings;
- Latest summary report of OE.

Evaluations

Check that screening criteria for in-depth investigation and root cause analysis are established. Verify that responsibilities for this decision making are clear. Evaluate whether timely screening for the need of reporting or assessment of effect on plant evident. Check if there is any evidence of dissatisfaction from receivers (e.g. regulatory bodies and other off-site authorities, utility, international organizations, etc.) regarding timeliness of reporting. Check if there is a backlog of events to be analysed and if so, how significant these events are.

Check that the threshold for exclusion/inclusion of events is established. If so, evaluate whether that threshold is appropriate. Review whether the plant reporting criteria are adequately defined and they are comprehensive. Review the screening process of in-house events and verify the screening includes low-level events, near misses and precursor events.

Review the comprehensiveness of the screening criteria for reporting to the regulatory body whether they cover all safety significant events. Comment on the comprehensiveness of the screening criteria for reporting to other external bodies (Health and Safety, Environmental, etc.) whether are all relevant deviations covered. Evaluate whether all reported safety relevant deviations are currently identified in the screening process and analysed to learn the lessons.

Check that when screening criteria are met, the priorities and actions to be taken are specified in writing.

Determine how external experiences are made known to the plant. If a pre-screening is done outside the plant, for example by a corporate office organization or national utility group organization, determine what criteria they use. This is necessary to ensure all applicable information is forwarded to the plant. Verify that external OE reports are screened adequately. Review whether the amount of information introduced into the plant OE process is adequate (neither too little nor too much). Evaluate whether it can be digested or on the contrary there are missing opportunities.

Check whether the personnel responsible for screening are suitably experienced. Confirm that they have adequate resources to conduct their duties.

Review how does the staff determine whether an external OE report is relevant to the plant. Evaluate whether relevant external OE reports are adequately assessed and timely circulated for information.

3.6.5. Analysis

Expectations

Analysis is performed on the selected events in accordance to their level of safety significance, severity and frequency to ensure that root causes and corrective actions are identified. Criteria for performing a full root cause analysis, a simplified analysis, and a trending analysis are clearly defined in the OE programme, and procedures are developed.

For significant in-house events, including scrams, plant transients and important human performance and equipment problems, a rigorous investigation with full root cause analysis is performed, including causal factors, generic implications, and discrepancies between expected and actual plant responses and or personnel actions.

For low-level events and near misses, minor events, no consequential events or any other useful error likely information and potential problems, the level of analysis required is clearly defined such that generic implications, precursors of declining performance and root causes of adverse trends can be identified. Determination of corrective actions allows to correct latent weaknesses and to prevent recurrence.

Personnel who have appropriate knowledge, experience and skills perform investigations/analysis. Event participants are involved in developing and implementing corrective actions, as necessary.

Investigation of events is initiated promptly to preserve information and physical evidence and to interview participants while the events are fresh in their memories. Investigations are carried out in a timely manner.

Investigation/analysis take account of previous similar events and precursors from both internal and external sources. Investigations/analysis are subject to objective review to ensure that root causes have been identified, which are then addressed by effective corrective actions.
Examples of documents to be available for review during the OSART mission:

- Methodology used for event analysis and trending;
- List of events for the last 3 years with direct causes, root causes and corrective actions, together with a short description of the event;
- Reports of root cause analyses performed in the last year;
- Reports of root cause analyses related to human performance performed in the last 3 years.

Evaluations

Method and content of analysis
Check that the methods utilised are adequately defined and regularly used (e.g. HPES, ASSET, etc.). Evaluate whether the methods utilized are adequate to identify direct and root causes, together with contributory factors. Evaluate whether the methods used address equipment, procedural and personnel issues adequately. Check if failed barriers, organizational weaknesses and error likely situations are considered. Check whether the investigation confines itself to the causes of the event or where the investigation/analysis has identified other weaknesses deemed important, even though they may have had no direct relevance to the actual event, they are also acted upon to resolve.

Confirm that the investigation/analysis method utilized is appropriate to the significance of the event. Check whether adverse trends are considered during an event investigation.

Verify that similar internal or external events are considered during the investigation/analysis process. Confirm that the sources or database of information relating to similar events or precursors are easily accessible, retrievable and easy to use by those carrying out the investigation/analysis. Evaluate if effectiveness of corrective actions taken to previous similar events is considered during an event investigation.

Verify that analyses of events or group of low-level events and near misses are performed to identify root causes or precursors of declining performance. Confirm that periodically the database is reviewed and that a methodology is established to perform root cause analysis to an accumulation or trend of low-level events and near misses in the same area or with a similar pattern.

Quality of analysis
Confirm that the plant has sufficient suitably trained, knowledgeable and experienced investigators/analysts to adequately process the event information. Review the investigation reports whether they exist for all safety relevant deviations. Comment on the quality of the information available in the analysis reports. Evaluate whether all the direct and root causes are identified, together with contributory factors. Confirm that the corrective actions proposed are clearly related to resolution of the causes. Review and comment on a selection of representative event reports for adequacy and completeness.

Check whether there is a process to review the quality of the investigation/analysis reports. Check to ensure that analysis of significant events or group of events or trends are reviewed by the plant safety committee (or equivalent body) on a regular basis and verify their concurrence with the recommended corrective actions from the analysis.

Carefully review the plant's operational history for the past 3 years. Review past events, repeated events, events that appear similar to known external experiences. The review should allow assessing the plant capabilities of identifying, analyzing and correcting the direct and

root causes of the event, and any contributing factors. Different alternative approaches for simplified review methodology based on expert experience/knowledge may be used to comment on the comprehensiveness of the plant analysis. Participate in a root cause investigation activity or meeting to observe and determine the degree of adequacy and effectiveness of the process.

Timeliness of analysis
Review the investigations, whether they conducted in a timely manner. Check if there is a procedure for gathering information from event participants as promptly as possible after the occurrence. Confirm that immediate reviews of events with significant plant impact are carried out in a timely manner (e.g. reactor trips, safety system actuation, fuel handling events, etc.).

3.6.6. Corrective actions

Expectations

The results of OE reviews and analysis are used to identify corrective actions. Corrective actions address fundamental causes of problems, rather than the symptoms to avoid recurrence of events.

Corrective actions are prioritised, scheduled for implementation, and effectively implemented. Dates for actions are commensurate with the importance of the item, station priorities, and the consideration of preventing the recurrence. Operating shift crews are promptly briefed on events and compensatory measures are taken to prevent recurrence.
Corrective actions are tracked for completion to verify their final implementation. Review of corrective actions status and effectiveness is periodically done. Management receives feedback on the review results.

Examples of documents to be available for review during the OSART mission:
- Criteria for prioritisation of corrective actions;
- Indicators used to trend the timeliness of the corrective actions;
- List of events for the last 3 years with direct causes, root causes and corrective actions, together with a short description of the event;
- List of the most significant events in the life of the plant in terms of safety significance, lessons learned and corrective actions;
- Identification of recurrent events with they causes and precursors;
- Corrective actions related to human performance;
- List of action plans currently on going as a result of OE feedback;
- Summary of highlights of self assessments and external assessments performed on the effectiveness of the operational experience programme in the last 3 years.

Evaluations

Identification of corrective actions
Check the existence of criteria for conservative decision making to define corrective actions and to set their time schedule. Confirm that appropriate corrective actions from external events are placed and tracked where necessary. Verify that the corrective actions proposed are

relevant, specific, comprehensive, realistic, achievable, measurable, and they can be implemented in a timely manner.

Review the process for agreeing corrective actions and the time scales for completion. Check whether persons responsible for implementation are involved in the development of the actions and the corrective action programme.

Check that corrective actions are systematically prioritized to specific criteria. Evaluate whether these criteria consider relevance to safety. Check that risk analysis is carried out when considering prioritisation. Review how the prioritisation of actions is decided and what criteria are considered.

Confirm that short term corrective action programmes are put in place when the proposed comprehensive actions require considerable time to fully implement.

Implementation of corrective actions

Evaluate whether corrective actions resulting from immediate reviews of events with significant plant impact are implemented in a timely manner. Check if deficiencies, which have an immediate effect on safe operation, have been considered and rectified prior to continued operation. Verify that operating shift crews are promptly briefed on events to prevent recurrence.

Review whether the appropriate level of management is held accountable for completion of the corrective actions. Check if every corrective action has an assigned responsible group or person to own, coordinate, follow-up and review its effectiveness. Check if regular accountability meetings are held with responsible personnel and progress against targets is reviewed. Evaluate whether the meetings are effective in achieving progress against targets. Comment on the number of outstanding corrective actions and the number of overdue actions of a certain nature (equipment, personnel, procedures). Check if they are concentrated on one department.

Tracking of completion of corrective actions

Confirm that an effective system is in place for tracking the progress of outstanding actions. Check whether any corrective actions have been closed before verifying their effectiveness. Check if any issues have been closed prior to the completion of a corrective action. Check whether any issues have been considered closed following the development of a plan to implement corrective action, rather than following full implementation of corrective action.

Review of effectiveness of corrective actions

Confirm that there is a procedure to review the effectiveness of corrective actions. Check whether corrective actions effectiveness is evaluated in practice. Review selected fully implemented corrective actions. Evaluate whether previous corrective actions have been effective in eliminating the direct causes, root causes and contributors to events (e.g. initiating events, flawed defences, event likely situations and organizational weaknesses). Verify that previous corrective actions have prevented recurrence of the event.

3.6.7. Use of operating experience

Expectations

OE information is used throughout the station. Personnel are aware of management expectations to use OE information.

OE information is easily accessible to station personnel.
Personnel are aware and knowledgeable on how to access it.

Use of OE in personnel work activities (i.e. pre-job briefings and pre-evolution briefings, work planning, shift briefings etc.) is carried out to remind the personnel involved of lessons learned and precautions from OE, to enhance the personnel alertness and to reduce risks.

OE information is used in training. It is compiled in training modules for operators' simulator training and in training of plant personnel in other areas.

Examples of documents to be available for review during the OSART mission:

- Short description of the following programmes: use of external OE, use of internal OE, Low level Events and Near Misses programme
- Outline of human performance enhancement programmes;
- Good practices considered in procedures' review in the last 3 years;
- List of events introduced in the training programme in the last year;
- Training programmes directed to corrective actions in human performance in the last year;
- List of action plans currently on going as a result of OE feedback;
- Summary of highlights of self assessments and external assessments performed on the effectiveness of the operational experience programme in the last 3 years;
- Evolution of the indicators used to monitor plant safety performance and of the indicators used to track the effectiveness of the OE programme.

Evaluations

Availability of information on OE
Review that plant personnel are knowledgeable of recent relevant significant events, both internal and external. Check that relevant OE information is readily available to all concerned plant personnel. Check if the information is apparent in the plant (OE bulletins, notices, posters, etc.). Check whether there are regular meetings of plant personnel at different levels where relevant in-house and industry event information is presented and discussed.

Determine the involvement of the corporate organization in the OE programme and their effective and coordinated use of the information to support the plant activities and communicate with other corporate utilities and external organizations. Determine how much workers/engineers are aware of significant incidents/accidents in the nuclear industry, specially those involving similar technologies affecting the plant.

Application of OE
Search for evidence of prompt decision and action regarding the use of OE following events with significant plant impact (e.g. reactor trips). Check that lessons learned from previous events are disseminated and used in pre-job briefings. Evaluate whether the information is provided in a timely manner and pre-job (just-in-time). Review whether the lessons learned from immediate reviews of events with significant plant impact have been timely disseminated by pre-operation briefings, directed reading programmes, etc. Verify that industry OE information is used during in-house events analysis.

Check that management/supervisory staff carries out regular staff briefings on safety issues and lessons learned. Evaluate whether these briefings are effective in enhancing the performance of personnel. Attend OE meetings to observe and verify the involvement of participants and the effectiveness of the meetings. Attend plant daily meetings to observe and verify if OE issues are addressed and receive appropriate attention.

Determine the extent of use of good practices in the activities of the plant. Check if good practices are considered when reviewing procedures or issuing new procedures.

Use of OE in training
Confirm that lessons learned from recent external and internal events are included in refresher training (e.g. simulator training). Check that other disciplines than operations (e.g. maintenance) are included in the agenda. Attend training sessions to observe and verify if OE issues are addressed and included in the training programme.

3.6.8. Database and trending of operating experience

Expectations

Databases related to events, deficiencies, anomalies, deviations, are established to facilitate an integral view and analysis of OE from the point of view of organizational aspects, human factors, equipment failures, work management and maintenance deviation reports. For significant events, low level events (minor events), and near misses (non consequential events, potential problems) database trending system representations (trending parameters) are established to provide transparent data presentation that facilitate diagnosis of monitored performance, identification of patterns, identification of abnormal trends, identification of recurrences, quick plant management overview and action focus. Trend analysis is carried out on regular basis and results of analysis are reported to management. Actions are taken to correct identified adverse trends with potential for undesirable consequences.

Examples of documents to be available for review during the OSART mission
- Methodology used for event analysis and trending;
- Evolution of the indicators used to monitor plant safety performance and of the indicators used to track the effectiveness of the OE programme;
- List of events for the last 3 years with direct causes, root causes and corrective actions, together with a short description of the event;
- List of the most significant events in the life of the plant in terms of safety significance, lessons learned and corrective actions;
- Graphs of production by unit for the last 3 years (showing power evolution, scheduled, unscheduled and refuelling outages);
- Latest summary report of OE;
- Trending of human performance.

Evaluations

Check whether events are categorised or coded in any way (e.g. plant code, equipment, personnel, procedures, management process, direct causes, root causes, significance, reporting criteria met, etc.). Evaluate whether the criteria for categorisation or coding are specified adequately for trending purposes. Check if the application of consistent categorisation/coding is apparent.

Evaluate whether the trending system utilised is comprehensive in specification (equipment, personnel, and processes, etc.). Check that the system is capable of allowing user friendly and flexible searches on trends to be conducted. Confirm that regular trend reviews are carried out. Review the reports prepared and summaries issued. Evaluate whether they are relatively timely and relevant.

Verify that adverse trends are reviewed and corrective actions are taken. Check whether routine management reviews and significance reviews are carried out and actions are taken based on the results of the reviews. Check whether this is evident in the action plans of the plant.

Review how the key issues are identified. Comment on the key safety issues. Check whether equipment, procedural and personnel issues are identified. Comment on their ratios.

Review what are the unresolved key safety issues identified by the trending process. Comment on their significance to safety (consequences, causes). Comment on the priority given to corrective actions by the plant. Evaluate whether these unresolved safety issues show a weakness in: the ability to identify issues before they result in failures or events, the ability to adequately and comprehensively analyse the identified issues, or a failure to implement appropriate and comprehensive corrective measures in a timely manner. Check if the ability to identify, analyse or correct issues has been evaluated over the years.

Check whether the significance to safety of the consequences of the events has been trended over the years. Check whether positive or adverse trends have been commented upon. Review whether sources of experience data such as equipment failures, quality assurance, quality control, maintenance rule, ALARA, industrial safety are linked to the OE programme.

3.6.9. Assessments and indicators of operating experience

Expectations

Self assessments and independent evaluation are periodically performed to determine the effectiveness of the OE programme and the effective use of OE information. Self-assessment evaluates all steps of OE process. Management receives feedback on the self-assessment results. Results of self-assessment are used to identify weaknesses in the OE programme and to make the needed improvements.

Indicators are used to monitor the safety performance of the plant. The trends of indicators are evaluated during self-assessment. Examples of these indicators are: recurrent safety systems unavailability, industrial safety events, reactor scrams, volume of low-level waste, radiation doses.

Indicators are used to track the effectiveness of OE programme. Examples of these indicators are: average time for initial screening of OE documents, number and age of reports awaiting evaluation, number and age of corrective actions awaiting implementation, recurrent events and root causes, reworks, ratio of events detected through surveillance and quality programmes versus operational failures or degradation in service.

Benchmark with industry indicators is performed and results of the comparison are considered to determine opportunities for improvement.

Examples of documents to be available for review during the OSART mission

- Summary of highlights of self assessments and external assessments performed on the effectiveness of the operational experience programme in the last 3 years;
- Graphs of production by unit for the last 3 years (showing power evolution, scheduled, unscheduled and refuelling outages);
- Evolution of the indicators used to monitor plant safety performance and of the indicators used to track the effectiveness of the OE programme;
- Recurrent event, recurrent root causes and repetitive corrective actions;
- Minutes of the plant and corporate Safety Committees;
- Latest summary report of OE.

Evaluations

Check whether self-assessment of the effectiveness of the OE process is conducted on a routine basis. If not, review how the plant determines the effectiveness of its programmes in enhancing the prevention of operational failures.

Check that the overall timeliness of OE process in responding to events is regularly reviewed. Check if the overall timeliness of corrective actions progress is regularly reviewed. Check whether the overall quality of analysis and adequacy of developed corrective actions is regularly reviewed. Check whether effectiveness of the corrective actions validated.

Review whether regular consideration is given to the applicability and adequacy of the performance indicators.

Check whether the recommendations from previous self assessments and reviews have been acted upon and improvement has been attained. Check if the results of previous report are compared with the present situation. Search for repeat events and look for repeat corrective actions. Check whether the self assessment has been performed by personnel with sufficient authority to initiate changes to the process.

Confirm that periodic (annual, semi-annual etc.) reports are issued on OE process effectiveness, identifying weaknesses and areas for improvement. Check whether corporate and plant management receives regular reviews of the safety performance of the plant and the effective use of OE to improve the performance. Check whether plant and corporate Safety Committees assess the effective use of OE to improve the performance.

3.7. RADIATION PROTECTION

The radiation protection (RP) regime established and implemented by operating organization at nuclear power plant should ensure that in all operational states doses due to exposure to ionizing radiation in the plant or due to any planned releases of radioactive material from the plant are kept below prescribed limits and ALARA. Controls for RP during operation of the plant, including the management of radioactive effluents and waste arising in the plant, should be directed not only to protecting workers and members of the public from radiation exposure, but also to preventing or reducing potential exposures and mitigating their potential consequences.

References: [2-4, 6, 11, 14, 19-22, 35 and 42]

3.7.1. Organization and functions

Expectations

The RP goals and objectives should be clearly defined in the safety policies of the operating organization and communicated to the personnel and the management of the power plant. To achieve these goals and objectives well structured RP programme should be established and implemented. The programme should be documented in the plant policies and procedures and shall meet the requirements of the International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources (BSS). The management should ensure that the RP policies and procedures are well understood by the plant's personnel. The RP programme should be clearly oriented to the achievement of a level of performance in RP that is well above minimum regulatory requirements.
Effective implementation of the RP programme should be supported by establishing written procedures requiring high performance in RP, periodic monitoring and assessment of performance and holding personnel accountable for their performance. Performance indicators should be established that encourage the management expectations and standards and are reported in periodic assessments.

The RP function in the operating organization shall have sufficient independence and resources to enforce and advise on RP regulations, standards and procedures and safe working practices. Sufficient staff, equipment and funding should be provided to successfully implement the RP programme. An independent RP group (in some countries known as the Health Physics Group) should be established, which has the authority to enforce RP regulations, standards, procedures, safe working practices, and appropriate health physics surveillance. Succession planning should be an established practice in the RP group. The RP manager at the plant should have direct access to the plant's manager on the matters relating to the radiation protection. The RP organization should be well defined and understood, including the interfaces with other plant groups.

All levels of management and workers should be committed to RP requirements and safe work practices within their level of responsibility. The RP group as well as the workers and management should be trained and qualified in RP issues to a level appropriate to their responsibilities. All personnel of the plant should be aware of radiological hazards and of necessary protective measures.
The RP programme shall provide for health surveillance of site personnel who may be occupationally exposed to radiation to ascertain their physical fitness and to give advice in cases of accidental overexposure.

The operating organization shall verify, by means of surveillance, inspections and audits, that the RP programme is being correctly implemented and that its objectives are being met, and shall undertake corrective actions if necessary. The programme shall be reviewed and updated in the light of experience.

The principal objective of incorporating QA principles into RP should be to improve safety by establishing confidence in the results of RP. Additional benefits should be the strengthening of efficiency and effectiveness by establishing a system for improving RP based on the use of relevant experience (lessons learned), the identification and prompt correction of deficiencies, and the monitoring of performance.

Examples of documents to be available for review during the OSART mission:

- Organizational chart of RP together with functional responsibilities of each position;
- Appropriate sections of the FSAR addressing the RP matters;
- RP standards, goals and performance indicators used at the plant;
- RP procedures;
- RP section of the NPP annual report;
- Staff training and qualification records;
- Audit, investigation and routine reports;
- Job descriptions for RP staff;
- Relevant parts of the QA Programme.

Evaluations

Radiation protection policy

Check whether management has well developed policy statements regarding RP, especially regarding the ALARA principle. Determine whether all levels of management and workers have a responsibility for RP and safe work practices within the limits of their authority and training. Determine if management and the RP group have taken adequate measures to motivate workers to comply with RP requirements.

Review the approach used to control radiation exposures arising from the operation of the plant. Determine how RP policies, criteria, procedures, administrative limits, goals, etc. are set. Identify which parameters or performance indicators are used to evaluate the effectiveness of the RP programme (e.g. collective dose of individual work groups including contractors, total NPP collective dose, level of contamination, frequency and severity of unplanned exposures in excess of administrative and regulatory limits, activity released in gaseous and liquid effluents, frequency of unmonitored releases to the environment, etc.).

Check whether the plant management is aware of which work groups, work activities and plant systems are associated with large collective doses and/or large individual doses. Evaluate how problems are identified, assessed and reviewed for trends and how deficiencies are corrected. Determine if radiological events are subjected to formal root cause analysis and evaluate how lessons learned from past occurrences are incorporated into revised plant policies, procedures and practices. Determine if the staff are familiar with lessons learned and operating experience in other similar plants.

Determine if the performance indicators and significant radiological events are reported to plant management and plant Safety Committee (or equivalent body). Determine if plant staff are being routinely informed and updated on goals, performance indicators, significant radiological events and lessons learned from these events.

Determine how well the plant management ensures that appropriate QA activities are performed with respect to RP activities such as document control, equipment calibration, record management, etc.

Evaluate how well the plant management monitors and evaluates RP performance and effectiveness and if it is subjected to internal and external audits. Confirm whether management is aware of how its radiation protection performance compares with other plants of similar design.

Review the overall role and scope of the RP programme and determine whether senior management is committed to good radiation protection and safe work practices. Confirm that the programme includes the recommendations by ICRP and IAEA, including the ALARA principles.

Check whether the RP programme ensures that all persons (employees of power plant and contractors) assigned to work in radiation areas have been qualified for such work.

Check whether operational aspects of the plant relating to the RP programme are periodically reviewed either in the light of experience, particularly if plant modifications are introduced, or if new requirements of the regulatory body become applicable during the operational life of the plant.

Functions and responsibilities

Review the allocation of the functions and responsibilities in RP between operations, maintenance and other departments of the plant and specialized RP group. Identify the main tasks performed and services provided by the RP group.

Evaluate the independence and authority of the RP group. Determine if the RP group has the authority to stop work if radiation protection practices are judged to be unsafe.

Investigate if the resources (both human and physical) of the RP group are sufficient to perform its responsibilities and if additional resources such as additional professional and technical personnel can be made available when the necessity arises. Confirm that succession planning is an established practice in the RP group. Share results of your evaluation in this respect with the MOA reviewer.

Determine if the RP manager participates in plant policy making functions and has direct access to the plant manager. Check whether there is a process for staff to report safety concerns. Determine if the guidance and work of the RP group is considered and if plant management implements their recommendations.

Review the role of the RP group in the development of site-specific technical standards and specifications associated with radiation protection aspects of NPP operations (e.g. specifications for radiological instrumentation, protective equipment, dosimetry, etc.).

Determine the role of the RP group in reviewing or jointly approving certain operating manuals, maintenance procedures etc. governing reactor and auxiliary systems where occupational radiological hazards may be present.

Interfaces with other plant groups

Identify the types of interactions of the RP group with the operations group, the technical support group and the maintenance group, etc. with respect to the day-to-day application and implementation of radiation protection regulations, standards and practices throughout the NPP.

Determine if the RP group reacts in a timely manner to requests made by operations and other groups. Determine how different points of view are resolved. Identify examples of types of difficulties that were resolved in the past. Determine if problem areas are still unresolved and check their schedule for resolution.

Review some examples of the cooperation of RP group with other departments associated with planning activities associated with radiological hazards.

Evaluate the special provisions, if applicable, for organization and supervision of contractors.

Qualification of personnel
Training and qualification programme and processes will be primarily reviewed by the reviewer evaluating TQ. However, during interviews and observation of work activities, determine if the experience level and proficiency of the RP group, other plant staff, contractors and visitors are appropriate for their assignments. Check if personnel are knowledgeable of current work practices and plant procedures.

Review the training, experience and qualification requirements for each position in the RP group.

Check if special training, such as training on mock-ups and the rehearsals of the work planned, is provided for persons who work in high-radiation zones, so that the time spent in such areas can be minimized.

Check that plant personnel, including contractor personnel, are specifically trained and qualified in the use of protective clothing and special protective equipment, as appropriate. Check that persons handling, issuing or decontaminating protective clothing and respiratory protective equipment are also appropriately instructed.

Determine that the technical content of the RP training programmes (both for RP staff and for all other staff) are technically sound, current and relevant to the duties and responsibilities of the trainees.

Coordinate the above review with the reviewer of training (Section 3.2).

Health surveillance
Check if arrangements exist for the health surveillance of occupationally exposed personnel in accordance with recommendations of ICRP and IAEA.

Check that medical advice is available following any over-exposure or suspected over-exposure to external or internal radiation in excess of values specified by the competent authority.

Quality assurance in radiation protection
Review whether QA programme is established for radiation protection.

Check, whether management is responsible for:
- Establishing, implementing and maintaining the QA programme;
- Ensuring that the RP personnel are competent to perform the work;
- Ensuring that items, services and processes which do not meet criteria are identified and promptly corrected;
- Ensuring that documents establishing the RP programme are prepared, reviewed, approved, issued, distributed, authorized and revised as appropriate;
- Establishing a record management system that provides for the identification, filing, safe storage, maintenance, retrieval and disposal of records;

- Establishing a procurement system which ensures that purchased items meet established criteria and perform as expected;
- Establishing which work needs testing for acceptance.

Check, whether operational staff is responsible for:

- Planning and performing work in accordance with appropriate standards, approved procedures, work instructions and any other established requirements;
- Using sound scientific and engineering principles and verified inputs in the design process;
- Procuring items, equipment and materials from qualified vendors under controlled conditions;
- Ensuring that items, equipment and services are inspected or tested to demonstrate that they will perform as intended.
- The calibration of measuring devices is an example of such testing.

3.7.2. Radiation work control

Expectations

The exposure from the sources of external and internal radiation at nuclear power plant should be reduced to such dose levels that are as low as reasonably achievable (ALARA). This principle should apply both to individual and to collective doses. The responsibility for optimizing occupational exposure should lie both with management of different levels and with the RP group. Work in controlled areas should be authorized in accordance with appropriate procedures. Control of the access and exit from radiological areas should be established and maintained. A programme for monitoring of radiological conditions should be established for designated areas.

Examples of documents to be available for review during the OSART mission:

- Site RP standards, or pertinent extracts on occupational exposure control.
- Classification of areas (controlled, supervised);
- Classification of zones according to radiation levels and contamination;
- Selected radiation work authorizations or permits (including also ‘high hazard’ work) and procedures governing their issue;
- Selected radiation survey records;
- Procedures for removal of equipment from the controlled area;
- Details of routine workplace monitoring programme.

Evaluations

Radiation work authorization

Evaluate the procedures used for advance planning of work to be undertaken in controlled areas, where it is possible that significant radiation or contamination levels may occur. Review the role of the RP group in the planning of activities at the plant involving risk of significant radiation exposures, especially in giving advices on the conditions under which work can be undertaken in radiation and contamination zones.

Evaluate the radiation work permit (RWP) process and its implementation. Determine if RWPs are prepared and issued only by individuals who have been fully trained in the plant's RWP procedure and have been authorized by line management and/or by a RP manager. Determine whether the content of the RWP provides all information necessary for worker protection.

Review some of the recent RWPs. Check completeness of the information and instructions presented in the RWP in addition to a description of the work. Check whether the RWP is signed by an authorized member of the RP group signifying that the described work can be performed safely if the specified precautions are followed.

Determine what special provisions are made for unusual hazards. Check that special procedures exist for planning RWPs for `high hazard' work where very high radiation fields may exist, where there is a likelihood of encountering airborne activity or significant changes in radiological conditions. Review the guidance provided in these procedures with respect to provisions for undertaking detailed hazard analyses, mock-ups, rehearsals as well as any special arrangements, special radiological monitoring, protective clothing, use of cameras for remote surveillance of work, etc.

Since workers' knowledge is vital to external and internal exposure control, review the information provided to radiation workers. Question workers and observe their activities at radiation job sites to evaluate their grasp of the essential information and whether they follow procedures.

Confirm that, due to a rigorous implementation of the ALARA principles for radiation exposure, individual and collective doses are reasonably low.

Control of designated areas and individual work sites
Observe the demarcation, posting and control of controlled areas.

At access points to controlled areas, observe if workers typically read and sign RWPs, observe if they receive appropriate briefing and receive additional dosimeters and protective equipment,

Evaluate the physical layout of the access points to controlled areas, which should be kept to minimum. Determine whether access points are suitable for the dissemination of information and the issue of special personnel dosimeters and protective equipment, etc. Observe several examples of work involving significant radiation hazards to confirm the appropriate application of protective measures.

Evaluate whether adequate manual or automatic personnel contamination monitors are present at the exit points from controlled areas and observe if all personnel use these monitors before exiting as a verification that they are free of contamination.

Review the plant programme for movement and transfer of tools, equipment and materials out of controlled areas. Ascertain that the flow of tools, equipment and materials across the controlled area boundary is minimized. Evaluate if workers or RP personnel undertake appropriate radiological surveys at the exit point for release of articles to ensure that contamination and radiation are below specified levels. Observe if manual or computer assisted systems are used at the access control point to verify that the worker status is current with respect to his/her dose record, training, respirator fit test and any other special requirements.

Determine if individual work sites are marked off and posted with actual radiological conditions. Determine that step barriers and associated provisions for contamination control are present.

Check whether special shielding and low radiation 'waiting areas' are provided, where appropriate. Observe if areas in which exposure rates exceed specified values are locked to prevent unauthorized entry. Verify that the placement of postings and the labeling of hot spots provide precise information on localized radiation conditions.

Check whether an appropriate system exists to control radiological conditions in hot chemical labs and workshops. Check the frequency of radiation surveys in those areas. Check the suitability of RP equipment both stationary and portable used by the workers.

Determine whether a system for contaminated tool storage is in place. Special provision should be made for the inventory, storage and retrieval of tools and special equipment used during outages.

Workplace monitoring programme
Determine that the work place monitoring programme adequately characterizes radiological conditions (including internal exposure hazards) in an accurate and timely manner. Observe an actual survey and determine if the programme of routine surveys is sufficiently comprehensive to provide required information on radiation conditions inside and outside controlled areas. This programme should include provisions for identifying trends in radiation levels, problem areas and hot spots.

Check if the workplace-monitoring programme is comprehensive enough to identify changes in radiological conditions in controlled or supervised areas.

Review the programme for producing, maintaining, retrieving and using workplace monitoring records to assure that effective use can be made of this information.

Determine that the plant has a ‘leak reduction’ programme as well as good ‘housekeeping’ practices. Where leakage of contaminated liquids cannot be prevented, ensure that it is controlled through the use of dams and collection devices. Evaluate how the plant minimizes the spread of contamination.

Observe how personnel contamination monitoring is performed and assess the adequacy of the locations selected for personnel contamination monitoring. A programme of effective response to the detection of personnel contamination, including, recording, decontamination, cause determination, prompt corrective action and exposure assessment, should be in place. Review records documenting this programme to evaluate its effectiveness.

3.7.3. Control of occupational exposure

Expectations

The occupational exposure at the power plant should be so controlled that the dose limits recommended by ICRP and IAEA are not exceeded. The optimization of protection and safety measures, or the application of the ALARA principle (to keep doses as low as reasonably achievable, economic and social factors being taken into account), should be carried out. In examining working procedures and activities, the reduction of doses should be given the highest priority. A hierarchy of control measures should be taken into account in optimization. Firstly, removal or reduction in intensity of the source of radiation should be considered. Only after this has been done should the use of engineering means to reduce doses

be considered. The use of systems of work should then be considered and, lastly, the use of personal protective equipment.

Dose monitoring of individuals and management of dose records should comply with requirements established by the regulatory authority and should be consistent with the applicable recommendations of ICRP and IAEA. Exposures related to working in controlled areas, should be individually monitored and recorded in order to ensure that the ALARA principle is met and that regulatory limits are not exceeded. In situations where significant concentrations of airborne activity are anticipated, appropriate internal dosimetry should be available, including whole body counters. Provisions for indirect monitoring as an additional method for evaluating internal exposure should exist.

Examples of documents to be available for review during the OSART mission:

- Site RP standards, or pertinent extracts on radiation dose control;
- Occupational exposure assessment records (for the plant personnel and the contractors);
- Report of overexposures (if applicable);
- Procedures for external dose monitoring;
- Procedures for monitoring internal contamination;
- Procedures for monitoring airborne activity and surface contamination;
- Programme for dose planning and limitation of exposure;
- Procedures for cleaning and decontamination of areas and equipment.

Evaluations

Optimization of radiation protection

Confirm that in the optimization, all relevant factors are taken into account, such as:

- The balance between doses to workers and doses to the public;
- The balance between present doses due to discharges and future doses due to confinement of the same radioactive substances solidified as waste;
- Exposures arising from different tasks;
- Requirements relating to nuclear safety, conventional safety and radiation protection;
- Options for radioactive waste management and decommissioning.

Check that the compromise between the various factors is considered. In most situations, a qualitative approach based on professional judgement may be sufficient to make decisions on the most favourable level of protection that can be achieved. Confirm that in situations that are quantifiable, cost–benefit analysis or other quantitative decision aiding techniques are used.

Implementation of the ALARA principle

Determine that the ALARA principle is involved in all stages of work planning and execution. Determine how all levels of plant management of all technical and maintenance groups express their commitment to the ALARA principle and incorporate it in day-to-day actions and work practices. Identify specific examples of the practical means by which the ALARA principle is being implemented.

Check if practical methods such as listed below are used for dose reduction:

- Reducing radiation levels in work areas;
- Reducing surface and airborne contamination;

- Reducing working time;
- Optimizing the manpower of the working team;
- Increasing the distance from the dominating radiation source;
- Providing temporary shielding means;
- Identifying low dose areas where workers can go without leaving the controlled area if they work is interrupted for a short time.

Review the use of individual and collective dose goal setting as part of the ALARA programme. Determine if individual plant organizational groups (e.g. operations group, maintenance group, technical support group, etc.), monitor their own collective doses.

Identify what specific arrangements or provisions are undertaken to reduce individual and collective doses for each work group, including contractors. As a prerequisite for approval of individual doses beyond administrative limits, verify that work supervisors and managers are obligated to report on specific measures they will employ for workers under their authority to fulfill the ALARA principle.

Determine if management makes special provisions, to recognize individuals who have made suggestions or implemented actions, which have resulted in significant reduction of individual or collective dose.

Review the source reduction programme. Identify some practical means to reduce radioactive products, for example pH optimization, cobalt reduction, appropriate water chemistry, feedwater cleanup, hot spot removal, etc.

Review the actual collective doses and maximum individual doses received for the past two years and determine the effectiveness of the programme as compared to other facilities and best international practices.

Confirm that investigation levels are set in terms of measurable quantities such as individual doses, intakes, dose rates or contamination levels. Investigation levels are often a component of an ALARA programme. Check that a review of the situation to determine the causes and, if necessary, to initiate further measures to control exposures is prompted if an investigation level is exceeded.

Confirm that the results of an ALARA programme are introduced in reports generated by periodic review. Check that these reviews include comparisons of the exposures for repetitive jobs from one iteration to another, as well as comparisons with the results achieved at similar facilities elsewhere in the industry (benchmarking). Check that this review process is further be used to evaluate and analyse performance such that corrective actions can be specified to address any adverse trends.

Internal contamination monitoring
Review the plant procedures for the control of personnel contamination. Determine that eating, drinking, smoking and chewing items in controlled areas is prohibited (or if it is allowed, sufficient compensatory measures are applied).

Evaluate workers', including contractors, understanding of the reasons for contamination control measures and the importance of full compliance with requirements.

Determine if internal contamination monitoring for intakes of radionuclides is performed on plant staff and contractors upon initial entry to the plant, at periodic intervals thereafter, upon final departure and following accident/incident where an intake of radioactive material could have occurred.

Determine if proper use of protective equipment is emphasized through practical training and through posted instructions at major entry areas.

Determine that the programme for the control and monitoring of airborne contamination is compatible with the plant's design to maintain air flow from clean to contaminated areas. Wherever possible, local portable ventilation systems (including filtration) should be employed in lieu of personnel respiratory protection devices.

When engineered measures cannot be employed, ensure that personnel respiratory protection devices, supported by a documented programme of training, quantitative fit testing, confirmatory monitoring, where appropriate, are employed to optimize personnel internal exposure. Determine if such a programme includes formal training and procedures regarding selection, issue, cleaning and repair of respiratory protection devices.
Determine if a programme of air sampling and airborne exposure tracking over time is employed. Determine if such a programme includes timely air sampling and evaluation, which is coordinated with the worker's presence in the area. Determine that the protection factor provided by each respirator is considered.

Determine if internal exposure due to intakes of radionuclides is assessed in accordance with methods approved by the regulatory authority and in compliance with current international recommendations.

Check that appropriate records that document internal radiation exposure of individuals are maintained in retrievable and legible form.

External radiation monitoring
Determine if all personnel who enter controlled areas are provided with appropriate individual dosimeters e.g. whole body and extremity, for the types of radiation and exposure conditions to be encountered and, as appropriate, equipment capable of monitoring potential radiation exposures.

Confirm that dosimetry operations are performed and qualified persons interpret results. Confirm that appropriate methods are employed to ensure that doses resulting from exposures to gamma, beta and neutron radiation are accurately recorded in unified personal dose equivalent units.

Identify the quantity and types of individual dosimeters and review applicable procedures for recovery, processing and recording of results.

Review the provisions for monitoring visitors to controlled areas of the plant and the requirements for recording their doses.

Review personnel dosimetry results over time and verify that trends are sought, reported and used as a basis for action. Review the latest annual report to the authorities. Determine how previous contractor and visitor exposures are obtained and how reports of contractor and visitor exposures received at the plant are made available for future use.

Determine that appropriate workplace monitors or alarmed electronic personal dosimeters or direct reading dosimeters are available and worn in controlled areas to give an immediate assessment of dose for control purpose. This should be in addition to the dosimeters described previously. Review if extremity dosimeters are available and worn if required.

Review the methods governing the assignment of effective doses, especially from unusual events or high or unplanned exposures to unknown radiological conditions or significant skin contamination. Determine how suspect or anomalous results are handled.

Review the procedures and methods used to obtain a formal dose assessment in the event of loss of a dosimeter and in the event of unexpected or unusual dosimeter readings. For situations where variable or non-uniform radiation fields are present, confirm that supplementary dosimeters are used.

3.7.4. Radiation protection instrumentation, protective clothing and facilities

Expectations

Adequate radiological instrumentation, protective clothing, facilities and equipment both for normal and emergency situations should be provided as part of the RP programme. The equipment and devices used to obtain radiological measurements and doses should be calibrated, maintained and used so that results are accurately determined.

An adequate quantity of protective equipment and clothing should be available.

Examples of documents to be available for review during the OSART mission:

- List of types and numbers of fixed and portable radiological instruments;
- Calibration and maintenance programme for RP instrumentation;
- Location of fixed instruments for radiation monitoring of areas and processes;
- Layout of the RP laboratories, the locker rooms and stores for RP material;
- Arrangements for access and exit to the controlled area(s);
- List of special instruments (dose rate alarm, dose alarm) and contamination monitors (fixed and portable);
- Procedures for users of RP instrumentation, protective clothing;
- Standards and procedures for operations and calibration of equipment used for monitoring for assessment of internal and external exposure;
- Calibration records;
- Inventory of RP equipment reserved for emergency use.

Evaluations

Portable and fixed dose rate and contamination measurement instrumentation
Review the inventory and the conditions of instruments used for work place monitoring including those measuring alpha, beta, gamma and neutron radiation. Review the location of fixed and portable instruments for monitoring personnel contamination, and observe radiological monitoring of areas and processes.

Determine that the number of work place monitoring instruments is adequate during normal operations as well as outage. Confirm that fixed area monitoring equipment is operating and

provides dependable information at appropriate locations. Evaluate the location of fixed personnel contamination monitors relative to traffic flow.

Review the calibration facilities and equipment, which involve the use of large radiation sources if it exists at site, and evaluate whether necessary measures for safe operation are in place. Interview personnel responsible for calibrating, testing and maintenance of instruments. Review calibration and quality assurance procedures and check calibration and QA and test records. Determine when calibrations are performed, such as prior to the first use of the instrument, after repair or maintenance and when readings are suspect.

Determine whether there is an established schedule for routine calibration of all portable and fixed dose rate measurement instruments. Review the calibration and test records for the instruments and check whether the instruments are marked with the latest date for calibration and labeled with key response information for the user. Observe whether the portable instruments are functionally checked before use or daily.

Individual dose monitoring equipment
Review the facilities and equipment used for internal contamination monitoring through direct and indirect methods.

Review the facilities and equipment used for external dose monitoring.

If other laboratories on a contract basis provide some individual monitoring services, review the contractual conditions, reporting and quality requirements for the services supplied.

Evaluate the methods and models used to convert the reading of the dosimeters to equivalent and effective dose. Check that they are consistent with appropriate international recommendations and also comply with regulatory requirements.

Confirm that the calibrations are traceable to a national or secondary standard dosimetry laboratory (or accredited laboratory) and that adequate QA procedures are applied.

Review the results of international or national comparisons if available.

Gaseous and liquid effluent monitoring equipment
Review the installed monitoring system for gaseous and liquid effluents. Determine if normal effluent release paths are continuously monitored and there is alarm and termination of releases if specified limits are exceeded.

Determine if the effluent monitoring equipment is properly calibrated.

Review the equipment for counting of effluent samples and check the adequate QA procedures are applied.

Determine what monitoring equipment is available and what sampling procedures are in place to detect and to measure releases through normally unmonitored effluent pathways. Review plant systems and layout for possible unmonitored effluent pathways.

Environmental monitoring instrumentation and equipment
Determine what equipment is available for routine environmental monitoring.

Review the equipment for counting of environmental samples and check that adequate QA procedures are applied.

Instrumentation and equipment for emergency situations
Review instrumentation provided for emergency measurement and analysis in plant and confirm that monitoring ranges are adequate. Check that this emergency equipment is properly calibrated.

Review instrumentation and facilities provided for emergency environmental monitoring to ensure adequacy. Confirm that samples can be safely obtained, transported and analyzed.

Protective clothing and equipment
Review the types and quantity of protective clothing and respiratory protective equipment. Ensure they are appropriate for the hazards that are anticipated at the NPP.

Check the rules specified for using protective clothing and equipment. If protective clothing and respirators equipment are cleaned and maintained at the site, check the facilities and determine that appropriate monitoring equipment and techniques are applied to articles, which are being returned to service.

Review quantity and adequacy of miscellaneous supplies such as shielding, signs, ropes, stands, etc.

Facilities
Confirm that adequate facilities are provided for laundry and storage of protective clothing and that change and shower rooms and personnel decontamination facilities are available. Review special provisions for portable showers and for decontaminating skin and wounds.

Facilities for temporary storage of radioactive waste, contaminated materials, equipment and tools, as well as protective equipment, should be provided. Check storage conditions and segregation of stored items.

Check if appropriate decontamination facilities are available to control the quantity of contaminated items. Look for decontamination procedures.

3.7.5. Radioactive waste management and discharges

Expectations
The generation of radioactive waste should be kept to the minimum practicable in terms of both activity and volume, by appropriate operating practices. The operating organization should establish and implement a programme to safely manage radioactive waste and monitor and control discharges of radioactive effluents. The operating organization should perform a safety analysis for radioactive discharges, which demonstrates that the assessed radiological impacts and doses to the general public are kept as low as reasonably achievable. Any authorized discharge limits should be included in the OLCs. Radioactive waste and effluent releases should be documented as required and an environmental monitoring programme should be in place.

Examples of documents to be available for review during the OSART mission:
- Plant policy and strategy for radioactive waste management;

- Sections of FSAR related to the waste management and discharges of radioactive effluents;
- Plant effluent release limits;
- Procedures for the monitoring and control of gaseous and liquid releases;
- Procedures for the management of radioactive waste;
- Radioactive waste inventory in terms of volume and activity;
- Record of radioactive waste dispatch from site.

Evaluations

Radioactive waste management
Review the radioactive waste management programme and observe the way it is implemented. Review the procedures for collection, characterization, treatment, storage, handling, conditioning and labeling of radioactive waste and the programme for waste volume reduction (if any). Confirm adequacy of records, confirm adequacy of the programme against good international practices, e.g. as described in reference [14].

Evaluate how goals are set to reduce the radioactive waste (in terms of activity and volume) and how progress in meeting these goals is reported to management. Check what practical means are utilized to reduce the generation of gaseous, liquid and solid radioactive waste. Determine if site personnel are trained and participate in the efforts to keep the generation of radioactive waste to the minimum practicable.

Check the adequacy of the system and procedures for classification and segregation of the radioactive waste.

Check that approved containers, segregated storage areas or special storage locations are used to ensure that radioactive waste is segregated from other stored material.

Interview the RP personnel regarding procedures for handling radioactive waste and check the use of warning signs and tags. Interview workers involved in transportation of waste to determine their knowledge of actions to take in accidents or emergencies.

Check that the areas where radioactive waste is stored are classified appropriately.

Gaseous and liquid effluents
Determine if radioactive material in gaseous and liquid effluent releases to the environment is within authorized limits. Confirm adequacy of records.

Determine how the annual ALARA goals are set for effluent releases. Confirm that operating actions which adversely effect these goals are subject to an ALARA review and special authorization.

Review the procedures for approval, monitoring, trending and controlling effluent releases. Review effluent release permits, record keeping and reports.

Environmental monitoring
Review the environmental monitoring programme, considering the arrangements for sampling, the environmental media sampled and the radionuclides monitored. Review the

analytical procedures used to analyze environmental samples. Evaluate the adequacy of the sampling points used.

Determine if approved methods are used for calculating doses to critical groups and to population including the use of site-specific data or default values for dispersion. Review environmental monitoring results for trends and comparison with effluent monitoring results.

Review past actions in this area with regard to reporting, mitigation and corrective action.

3.7.6. Radiation protection support during emergencies

Expectations
The programme for RP support during emergencies should be comprehensive and serve the purpose of optimizing both worker exposure and the exposure of the general public to the extent consistent with emergency conditions.

Procedures and qualified personnel should be in place to provide technical and operational support during emergency interventions. Periodic training and practical exercises should be undertaken to ensure an effective response in the event of an emergency.

Examples of documents to be available for review during the OSART mission:
- A general description of the plant's emergency plan with emphasis on the part played by the RP organization;
- Emergency procedures, which apply to the RP organization.

Evaluations

Radiation protection emergency procedures, equipment and supplies
Review the RP emergency procedures. Confirm that they clearly detail RP responsibilities regarding on-site interventions, including evaluation of radiological conditions and support of emergency entry and repair teams, and off-site interventions if available.

Determine that appropriate procedures are in place regarding maximum doses during emergency interventions.

Review the storage locations for emergency equipment and supplies. Confirm that appropriate numbers of required instruments are present, operable and in calibration and that adequate supplies are available.

Emergency training for radiation protection personnel
Review the training provided and verify that appropriate refresher training is given at least, annually, to each individual. Confirm that all RP personnel have successfully completed the most recent training.

Determine the extent to which RP personnel are involved in emergency training, drills and exercises.

Review the critiques of past emergency drills and exercises and confirm that identified problems have been corrected.

3.8. CHEMISTRY

Chemistry involves activities of chemical treatment to maintain the integrity of the barriers retaining radioactivity, including fuel cladding and primary circuit. The chemistry activities have a direct impact in limiting all kinds of corrosion processes causing either direct breach of safety barriers or weakening of them so that failure could occur during a transient.

In addition the chemical treatment includes consideration of its effects on the out-of-core radiation fields that in turn influence radiation doses to which the workers are exposed. Plant radiochemistry is included in the chemistry considerations for the purpose of these guidelines.

References: 6, 9, 11, 12, 18 and 37

3.8.1. Organization and functions

Expectations

The operating organization should establish chemistry policy for nuclear power plants. The policy should state the goals and objectives of chemistry programme and the expectations of the management concerning the implementation of this programme at the plant. Performance indicators should be established that encourages these expectations and are reported in periodic assessments.

A specific chemistry group should be established at the plant to implement chemistry control programme. The organization of the chemistry group should contribute to safe operation, define responsibilities and establish lines of communication inside and outside the group. The position of this group in the organization should reflect its relevance. The interfaces between the chemistry group and other groups should be clearly specified especially as regards to allocation of authorities. The chemistry group should be consulted when issues affecting chemistry are being addressed. Qualifications and number of chemistry personnel should be sufficient for assigned responsibilities and to support all plant operations. Succession planning should be an established practice in the chemistry group.

The chemistry group's expectations, goals and objectives should be derived from the plant policies and objectives and defined in line with vendor recommendations and international good practice. They should be well understood by the chemistry personnel.

The monitoring of the chemistry group's performance and its programmes should include self-assessment of managerial processes and work performance.

Examples of documents to be available for review during the OSART mission:

- Written management expectations, standards, goals and objectives with supporting performance indicators.
- Organization charts of the plant and the chemistry group including functional responsibility;
- Job descriptions including responsibilities and authorities of key personnel;
- Organization of the staff (including shift personnel if applicable);
- Records of audits and assessments performed over the last 12 months including corrective actions implemented or completed as a result of these audits or assessment (check for consistency with other areas).

Evaluations

Functions and responsibilities
Check that appropriate goals, objectives and performance indicators for chemical activities are established in accordance with corporate management goal and objectives. Confirm that those indicators are regularly used to improve chemistry performance.

Confirm that the role of the chemistry group is properly understood and supported by plant management, and that the chemistry staff is kept fully informed of plant policy. Confirm that the chemistry staff has the authority to influence decision making relating to matters of a chemical nature.

Check that staff are fully informed of their job qualifications and understand their responsibilities. In the event of unavailability of specialist staff (sickness, out of hours) there should be adequate instructions available for other professional chemistry staff to carry out the required chemistry functions satisfactorily. Confirm that succession planning is an established practice in the chemistry group. Share results of your evaluation in this respect with the MOA reviewer.

Confirm that assessments of plant chemistry performance are carried out and are reported to management and to involved plant groups (e.g. operations, maintenance and safety supervision). Check that there is management support to conduct self-assessments, identifying, reporting and resolving deficiencies.

Check that authorities for the chemistry line management are commensurate with assigned responsibilities and with those of their plant counterparts, and that chemistry services are oriented as a support for operations functions.

Check that contractor tasks, responsibilities, authorities, expectations for performance, and interfaces are clearly defined and understood. Check that chemistry contractors use station-approved policies, procedures, and controls and the same quality standards as station chemistry personnel.

Interfaces with other plant groups and other organizations
Check that interface responsibilities have been defined, are clearly understood and are working well for the co-ordination of the activities of the chemistry group with those of other groups of on-site and off-site organizations as appropriate.

Check adequate information flow between plant groups; adequate speed with which abnormal chemical conditions are brought to the attention of the operations group; and adequate communication with other laboratories and organizations. Confirm that chemistry staff react in a timely manner to requests made by operations or other groups.

Check that chemistry specifications as well as technical specifications are well known, understood by other departments, especially by operation department and health physics department.

Determine the importance given to chemistry at the plant by interviewing personnel from different groups, in particular from operations and radiation protection.

Confirm the existence of an effective response system in the case of transgression of specified chemistry limits. It should include required actions by other plant groups.

Qualification of personnel
Training and qualification programmes and processes will be primarily reviewed by the expert evaluating TQ. Nevertheless, during interviews and from observation of work activities, determine if the experience level and proficiency of the chemistry staff are appropriate for their assignments.

Check that positions in the chemistry line organization are staffed with suitably competent and authorized individuals. The process of selection, training and job rotation should be well programmed to develop and maintain capabilities, safety awareness, and to provide the necessary staff motivation. Check that the job rotation rate is maintaining capabilities for replacement on short notice for all key functions.

Check that line management is accountable for the training and qualification of their personnel.

Confirm that chemistry management has an integral role in the chemistry training programme, including determining training programme content, periodic review of the needs and assessing final competencies.

Confirm that all chemistry staff are knowledgeable of and effectively using current work practices, procedures and equipment. Check that training courses for the chemistry staff includes techniques for recognizing unusual conditions and adverse trends.

Check that objectives, responsibilities, and implementation schedules of changes to plant equipment, procedures, and processes affecting chemistry are clearly communicated to affected personnel, and appropriate training is provided.

3.8.2. Chemistry control in plant systems

Expectations
The plant should have established and implemented a comprehensive chemistry control programme. This programme should be implemented by clear procedures and monitored by adequate performance indicators. The concerned plant staff should have a good understanding of the programme, procedures and indicators.

The chemical treatment should take into account plant material concept and any change in plant material concept should be evaluated by the chemistry group.

The generation and transport of radioactive products within the primary system should be understood, controlled and minimized.

Some results of the chemistry analyses are issued through computer software. Check this software is timely reviewed.

Chemical treatments should be optimized with respect to environmental and radwaste aspects. There should be a written concept of such optimization along with procedures to support implementation of this concept.

Examples of documents to be available for review during the OSART mission:

- Description of the plant chemistry control programme;
- Plant chemical specifications;
- Overview schematics and technical descriptions of the primary and secondary circuits, cooling and service water systems.

Evaluations

Chemistry control programme

Check that the operating organization establishes a water chemistry control programme to specify acceptable water chemistry regime, define a chemistry analysis system, monitor water chemistry and provide procedures to ensure that the chemistry is kept within specifications.

Check that a comprehensive chemistry programme at the plant includes such chemical activities as sampling fuel oils and lubricants, identification and control of delivered chemicals and materials, post-accident sampling, etc.

Determine whether the primary coolant chemistry approaches the aim of minimizing corrosion, corrosion product transport, and activity buildup. Check that the chemistry group considers current conditions that impact on the chemical treatment (e.g. presence of stellite, fuel damage and level of crud on the fuel).

Review the start-up and the shutdown chemical treatments and check that the plant is being operated according to the specifications. Confirm that pressures to shorten outages and accelerate plant start-up do not compromise this aim.

Determine whether water chemistry practices, including reagent make-up, raw water treatment and condensate polishing procedures are in compliance with specifications and consistent with internationally accepted good practice. Review the materials concept and how it relates to the chemistry control used.

Check that changes to plant equipment, procedures, and processes are evaluated taking into account the chemistry control aspects.

Confirm that the chemistry group is committed to the policy of minimizing radwaste production. Review procedures and practices for water clean-up system (e.g. evaporators, resin banks) and sampling system to confirm that they are efficiently operated to minimize environmental impact.

Check that care is taken to remove and control organic impurities of raw water used for the production of demineralized water.

Determine whether erosion and corrosion in the condensate and feedwater system is minimized.

Check the performance of the chemistry control during start-up and shutdown phases.

Water chemistry at PWR and WWER power plants

Review the chemical treatment of the primary system (e.g. constant pH_T, Li/B treatment for PWR or K + Li + ammonia / B and ammonia + H_2 treatment for WWER plants).

Review the secondary side chemistry. Check if the circuit is being operated according to AVT (All Volatile Treatment) or HAVT (High All Volatile Treatment). Check on the use of non-volatile chemicals to protect the steam generators (phosphate, boric acid).

Confirm that total organic carbon is controlled in the secondary systems. Check usage of condensate polishing system if it is installed.

Confirm that corrosion product transport into the steam generators is minimized. Confirm that erosion corrosion is minimized and monitored. Confirm that crevice corrosion in steam generators is evaluated, and corrosive metals (such as Cu, Pb) in steam generators are under control.

Water chemistry at BWR power plants
Check that the chemistry control at BWR power plants are focused on the decreasing the impurities into the reactor coolant to the practical and achievable minimum. Confirm that the reactor water is adequately controlled for the conductivity and the concentration of chlorides. Check that the concentration of iron and copper are adequately controlled in feedwater.

Check that chemistry staff are aware of the relation between water chemistry and Intergranular Stress Corrosion Cracking (IGSCC). Determine how oxygen in feedwater is controlled. Check that the injection rate of hydrogen is adequately controlled based on measurements of oxygen or of corrosion potential in the recirculation water.

Water chemistry at HPWR power plants
Check that the plant is being operated to the specified chemical parameters, especially D_2 gas in each cover gas system should be within specification to prevent explosion.

Review the heavy water analysis and tritium analysis procedure. Check that the heavy water specifications are kept properly.

Ensure that the chemical poison system is maintained within specifications.

Chemistry control for primary circuit
Check from the records that the chemistry control has kept the pH and reagent concentrations within the specified range.

Check that dissolved hydrogen and oxygen levels are within specifications, and that impurity levels, in particular corrosion products, chloride and fluoride are maintained well below the upper limits.

Check from the records the efficiency of the coolant purification system during cold shutdown and review the isotopic patterns for any abnormal occurrence.

Check that crud level in the primary system is minimized.

Chemistry control for secondary and condensate polishing circuits
Check from the records that chemistry control has kept the pH, conductivity and reagents levels within the specified bands.

Verify that the impurity levels are kept well below the upper limits.

Through observations ensure that the documented performance of on-line monitoring equipment is effectively tracking secondary condensate.

Verify that sludge quantities recovered during overhaul are properly quantified, characterized and minimized (PWR).

Verify from the records that the wet or dry conservation conditions during outages are within the specifications.

3.8.3. Chemistry surveillance programme

Expectations

The chemistry surveillance programme should include the monitoring, sampling and trending of chemistry and radiochemistry parameters at specified frequencies to ensure the timely detection and correction of abnormal or unacceptable trends and conditions. The chemistry surveillance programme should reflect chemistry specifications for all phases of plant operation including shutdown periods and when systems are taken out of operation for prolonged periods.

Procedures for analysis and measurement should be available and well understood by the personnel of the chemistry group. Personnel doing the analysis should be technically qualified and their performance periodically assessed. Analysis techniques should be appropriate, safe and evaluated results should be transmitted in a timely manner to the appropriate operational personnel. The chemistry data should be constantly evaluated to identify chemistry control problems and analytical errors and to remove the deficiencies.

Examples of documents to be available for review during the OSART mission:

- Operational and limiting values;
- Chemical and corresponding technical specifications;
- Sampling and analytical schedule (normal and abnormal operation);
- Chemical procedures, methods of sampling and analysis, recording of results;
- Quality assurance manual for laboratory measurements and on-line monitors;
- Monthly and annual reports - graphic displays;
- Procedures for effluent control of gases and liquids;
- Records of results, frequency of control analysis, double checks, calibration of instruments and intercomparison;
- Procedures for conservation systems during outages;
- Specifications and management of decontamination of systems and components.

Evaluations

Procedures, schedules and analysis methods

Determine the effectiveness of chemistry procedures in accordance with chemistry specifications, schedules and methods of analysis by means of a combination of interviews, discussions and observations. Check that the staff fully understand the procedures, methods and the reason for the analysis. Confirm that adequate procedures are available for dealing with plant transients and for handling abnormal or demanding workloads. Confirm that procedures contain the actions required if specifications are exceeded.

Confirm that the chemistry surveillance programme includes not only chemical parameters that are the subject of the technical specifications but also the diagnostic parameters that provide useful information for determining and preventing the cause of the out-of specification situations (for example the origins of impurity ingress). Such a programme should recognize slow, long term changes in equipment conditions and chemistry.

Confirm that clear procedures for radiochemistry measurements exist and are being followed. Check the effectiveness of procedures to monitor the integrity of the fuel. Verify that procedures for determination of the most important transuranium elements, pure beta emitting nuclides and to estimate the concentration of these nuclides are accurate and being adhered to.

Check that chemistry procedures take into consideration human factors to minimize personnel errors and enhance ALARA principles.

Check that the sampling plans are conforming to recommended frequencies and timing and provide timely detection of chemistry trends. Check that sample points are purged and re-circulated, based on plant conditions, to obtain representative samples. Check that collected volumes are appropriate for the analytical methods. Check that time delay between sampling and analysis is properly taken into account. Check that sampling systems for corrosion product measurements are adequate. Confirm the accurate labelling of samples.

Review and evaluate the effectiveness of the instrumentation calibration and maintenance, including on-line instrumentation. Procedures should clearly define equipment calibration periodicity and checks.

Check that appropriate standards are used and that the quality of water used to prepare standards and reagents is satisfactory.

Check that control of gases and liquids effluents including non-radiological effluents, resulting from chemistry activities is conducted in an appropriate way.

Check that sampling and analysis work practices maintain personnel dose as low as reasonably achievable and minimize the risk of radioactive contamination.

Results of analysis
Normal and abnormal values as well as the relationship between different parameters should be known. Check that intercomparison analysis with external laboratories is regularly carried out.

Check that corrective actions are established and taken before chemistry specifications are exceeded.

Check that abnormal values have been properly reported and investigated, including the corrective actions taken. Check that the analysis results are timely communicated to other appropriate groups.

Check that analysis results and quality control measurements are properly recorded, documented, archived and retrievable.

Confirm that the quality of the analysis results is in accordance with suitable QA procedures. Check that the accuracy criteria for the chemistry analyses are established and maintained.

Check that the responsibilities for QA are defined and the QA programme is implemented and evaluated.

3.8.4. Chemistry operational history

Expectations

The results of analysis and investigations must be adequately trended, evaluated and reported. Records should be available and easily retrievable. Lessons and experiences from previous events and history, including from other plants should be considered in the plant chemistry.

Examples of documents to be available for review during the OSART mission:

- Trends of the most important parameters;
- Reports on abnormal chemistry occurrences;
- Most recent monthly report;
- Last annual report;
- Fuel cycle reports covering start-up, operational and shut-down chemistry.

Evaluations

Evaluation and trending

Check that careful examination of chemical data is carried out to identify long term trends and transients. Check that trend analysis is carried out to promptly identify adverse trends in plant chemistry and take effective corrective measures. Check that short term (hours to days) and long term (weeks to months) trends are assessed.

Check that the performance of the chemistry surveillance programme is monitored and evaluated and corrective measures are taken for improvement.

Reporting

Confirm that the responsibilities for reporting and assessment are clearly defined. Review the reporting frequency and scope of information. Review, evaluate and discuss:

- Internal and external reports;
- Responsibilities for reports;
- Reports on abnormal situations, input and output;
- Access to records;
- Safe storage and retrieval of documents and information including data backup system.

Review plant reports of the analysis of condenser tube leakage, malfunction of the demineralized water plant, activity spikes in the primary coolant, steam generator leakage or any other relevant transients.

Confirm that the investigations are conducted into any unexpected changes in the normal chemical conditions, even when these changes are within operational limits. Check if they include non-consequential events and near misses.

The results should be documented. Check whether the analysis and data collected are complete and accurate.

Operational experience feedback
Check to see that chemistry reports receive appropriate chemistry and operating management review.

Check the review of incidents including other plants. Check that lessons learned have been incorporated into plant policies, procedures and training, as appropriate. Confirm that events involving human factors are considered.

Check that results of recent developments and international and national recommendations have been considered by the plant.

3.8.5. Laboratories, equipment and instruments

Expectations

The laboratories should have adequate space, supplies and equipment. The sampling systems should be reliable and safe for use, including post accident sampling systems. Necessary and adequate instruments for performing the analysis should be available and calibrated.

Water and water/steam circuit sampling systems should be available which ensure representative samples including dissolved and insoluble species.

Installation and work practice should be in accordance with good industrial safety and ALARA principles.

Examples of documents to be available for review during the OSART mission:
- Layout of sampling systems inside the buildings;
- List of major equipment;
- Procedures for the disposal of hazardous industrial or chemical waste;
- Maintenance and calibration plan.

Evaluations

Facilities and equipment
Ensure that the chemistry facilities and equipment are adequate. Confirm that equipment to collect and analyze samples for radioactivity are provided. Determine whether there is a laboratory (suitable protected or located), which can be used after a serious accident at the plant has occurred.

Check that human factors have been considered in the chemistry facilities and equipment arrangement. Check the proper lighting of work places.

By review, discussion and observation, determine the appropriateness and adequacy of the instrument handbooks and their availability. Check that chemistry staff are familiar with their contents.

Calibration standards, sources and procedures should be available. Instrumentation should be calibrated and maintained by qualified staff. All equipment should be in good condition.
Check whether the analytical equipment is properly calibrated according to schedule and whether standard solutions are prepared and kept properly with a validity period defined.

Check logbooks and labels indicating the status of analytical equipment and instruments.

Check that laboratory redundancy is provided to ensure analytical services at all times.

Procedures for the storage, replacement and ordering of chemicals and other products, including hazardous chemicals should be available and properly followed.
Check general good housekeeping. Confirm cleanliness of the working areas and sampling points, including contamination levels. Review results with MOA reviewer.

Check that eating, drinking, smoking, and chewing are not allowed in the laboratory.

Review industrial safety in the laboratory (protection against fire, solvents, hazardous chemicals) as well as the availability and use of protective equipment, instructions and facilities such as eyewash and showering facilities.

Check the flow rate measurements at ventilation hoods, including the storage and venting conditions of low flashpoint liquids.

Check the test system and test procedure, including the periodicity of tests.

Check for proper radiation shielding wherever it is necessary.

Post accident sampling system
Confirm that post-accident sampling facilities are available. Confirm that primary coolant and containment atmosphere can be properly evaluated.

Confirm that procedures for obtaining, transporting and analyzing samples under post-accident conditions are available. Check that a sample can actually be collected safely taking into account accident radiation levels.

Check that the operation of the post-accident sampling and analysis systems are maintained, tested and documented on a regular basis.

3.8.6. Quality control of operational chemicals and other substances

Expectations

The purity and nature of chemicals and other substances, which might have an impact on safety, related systems should be specified and controlled. Before being used the specified values should be verified by certification or by chemical analysis.

Examples of documents to be available for review during the OSART mission:
- List of allowed chemicals and other substances;
- Procedures to check or analyze the chemicals and other substances;
- Procedure for handling chemicals in the ‘field’.

Evaluations

Confirm that bulk chemicals, laboratory chemicals, spent resins, corrosive agents, cleaning agents are properly labeled, handled, stored and disposed.

Confirm that there is a list of chemicals and other substances allowed into the controlled area. Check that there is sufficient documentation to ensure satisfactory quality control over the use of the chemicals and substances.

Check whether the following requirements are met:

- Periodic sampling of operational chemicals and other substances used in safety related equipment (e.g. diesel fuel oil, lubricants, boron solutions);
- The identity of all delivered chemicals and other substances (acids, bases, ion exchangers, lubricants etc.) is verified;
- Chemicals which might directly influence the coolant, or material surfaces should be used only on the basis of a certificate of purity or after chemical analysis;
- Check that the plant has in place procedures which ensure that the proper lubricants are used;
- Unsealed and partly emptied containers should be controlled in such a manner that the quality of the remaining product remains in a satisfactory condition;
- Check control of reagents to ensure that shelf lives are not exceeded or that purity is not compromised.

3.9. EMERGENCY PLANNING AND PREPAREDNESS

Emergency preparedness is the capability to take actions that will effectively mitigate the consequences of an emergency for human health and safety, quality of life, property and the environment.

This section refers to emergency planning and preparedness both on-site of the nuclear plant (operator responsibility) and off-site area (mostly local and state authorities responsibility). As a general approach only the on-site emergency planning and preparedness is the subject of the review. In this case requirements related to off-site emergency planning and preparedness will be evaluated only so far as the nuclear plant interacts with off-site EPP organizations. Further off-site review should be done on a case-by-case basis, depending on the scope defined in the request for the OSART Review.

The practical goals of emergency response in a nuclear or radiological emergency are:

- To regain control of the situation;
- To prevent or mitigate consequences at the site;
- To prevent the occurrence of deterministic health effects in workers and the public;
- To render first aid and manage the treatment of radiation injuries;
- To prevent, to the extent practicable, the occurrence of stochastic health effects in the population;
- To prevent, to the extent practicable, the occurrence of adverse non-radiological effects on individuals and among the population;
- To protect, to the extent practicable, the environment and property;
- To prepare, to the extent practicable, for the resumption of normal social and economic activity.

The goals of emergency response are most likely to be achieved by having a sound programme for emergency preparedness in place as part of the infrastructure for protection and safety. The practical goal of emergency preparedness is to ensure that arrangements are in place for a timely, managed, controlled, coordinated and effective response on-site and off-site (at the local, regional, national and international level), to an emergency.

For that purpose, an emergency preparedness programme is necessary that includes national, local, and on-site response organizations. In a consolidated approach, the elements to be evaluated may be addressed by the operator, the local authorities or the national authorities, or by a combination thereof, so long as the arrangements are well coordinated. Weaknesses at one level could be compensated at another.

References: [6, 9, 15, 18, 23, 25-26, 40, 46 and 47]

3.9.1. Emergency programme

Expectations

Arrangements including clearly assigned authorities and responsibilities, organization, coordination, personnel, plans, procedures, facilities, equipment and training should be in place that provide reasonable assurance of an effective response in the case of any nuclear or radiological emergency at the site that meets the practical goals of emergency response.

An effective administrative framework should be available for the planning, implementation, co-ordination and control of emergency preparedness activities. This framework should be well documented, defining responsibilities and authorities and appropriately consider the requirements of the regulatory authority.

The operating organisation policy should ensure that all emergency preparedness activities at the plant are properly organized and are integrated with those of the operating organisation's headquarters organization, the relevant emergency services, the local and national authorities, with due consideration to interface implications. Authorities and responsibilities should be well established and clear among all organizations involved.

The organization should ensure that adequate human and financial resources are allocated, that critical response functions are covered and that the state of preparedness is properly maintained, regularly tested and updated. All emergency planning and preparedness activities should be properly covered by the QA programme.

A close and co-operative relationship should be maintained between on- and off-site response organizations.

The response organizations periodically should conduct a review in order to ensure that all the events (including those of very low probability) that could necessitate an emergency response are addressed by the emergency arrangements. This includes a review and appropriate revision of the emergency arrangements before any revisions to existing operations or new operations are commenced on the site or nearby that may result in events warranting an emergency response.

Examples of documents to be available for review during the OSART mission:

- National policies (regarding emergency response);
- Response organizations (for emergency operations)
- On-site emergency plan;
- Off-site emergency plan(s).

Evaluations

National policy (this includes all States with territory in the emergency zones)
Analyze the adequacy and consistency of the co-operation between bodies involved in the emergency preparedness. Identify the governmental body or organization whose function is to coordinate overall emergency preparedness activities (national co-ordinating authority) at the national level.

Review the national policy/laws/regulation, etc regarding the assignment of responsibilities for emergency planning and preparedness. Confirm that the critical response functions/responsibilities of the operator and other response organizations are clearly assigned and are understood and agreed to by all response organizations. The arrangements for response to a nuclear emergency should be coordinated with the arrangements for response to conventional emergencies.

Review the statutory orders and requirements of the regulatory body as they apply to the operating organization and public authority to determine if these are adequately implemented. Confirm that commitment and relationships between the organizations involved are adequate.

Basic foundation
Review the operating organization policy in order to determine that the responsibilities and authority for emergency preparedness activities are clearly defined and understood. The following should be included:

- Adequate staffing and resources are assigned to specific emergency tasks;
- Proper co-ordination (on-site/off-site) is ensured;
- Support is available to assist authorities in emergency planning;
- Emergency preparedness activities (on and off-site) are covered by the QA programme;
- The staff is familiar with the operating organization's policy for the emergency response capabilities;
- Managers and supervisors are committed and involved in the review, supervision and reporting of emergency preparedness activities.

Basic emergency preparedness functions
Review the documentation available and practices applied in order to identify how well the following functions are being implemented:

- Development, maintenance and revision of emergency arrangements and associated procedures;
- Support in the development and maintenance of off-site emergency response arrangements for various interfacing public authorities;
- Development and maintenance of good working relationships with interfacing off-site organizations;
- Experience feedback from training, drills, exercises, and effective implementation of corrective actions;
- Timely corrective actions for QA non-conformances;
- Coordination of on and off-site the emergency preparedness activates (e.g., training of on-site personnel and off-site supporting bodies) and vital interfaces (e.g. communications);
- Conduct of realistic drills and exercises that test on and off-site response;
- Maintenance of emergency response infrastructure in a state of readiness;

- Involvement of plant management to the EPP control and to potential resolvement of emergency situation;
- Creation of clear and functional managing system (with proper defined competencies) for potentional emergency situation.

3.9.2 Response functions

Expectations

The emergency preparedness arrangements in place should provide for reasonable assurance that the response functions discussed in this section can be performed effectively during an emergency.

Examples of documents to be available for review during the OSART mission:

- On-site emergency plan;
- Off-site emergency plan(s);
- National policy documents regarding emergency response;
- Public information programme;
- Public information and education brochures;
- Probabilistic safety analysis;
- Descriptions of the local area, population, languages spoken, special populations, and weather condition;
- Maps showing emergency zones, special facilities, population disruptions, and transportation network.

Evaluations

Establishing emergency management and operations

Determine how well the arrangements provide for prompt execution, management and co-ordination of the on-site and off-site response and that the implementation of the on-site response does not impair the performance of the continuing operational safety functions.

Check how well the arrangements deal with the following:

- Responsibility for directing the overall response (on-site and off-site) and the on-site response;
- Transition from normal to emergency operations;
- Avoid overloading the control room;
- Control access to the control room;
- Co-ordination of the on-site response with the off-site response.

Identifying, notifying and activating

Determine how well the arrangements provide for promptly determining the appropriate emergency class, initiating the on-site and off-site response actions.

Check how well the arrangements provide for the following:

- A classification system consistent with international standards;
- Criteria or emergency action levels (EALs) for declaration of an emergency, usable in the control room under emergency conditions, consistent with international standards;

- A person on site with the authority and responsibility (without consultation) for classification, initiation of the on-site response and notify the off-site officials;
- Off-site officials are continuously available and can act promptly;
- Declaration of an emergency class initiates the appropriate level of coordinated response on and off the site;
- Sufficient personnel to perform initial response actions;
- Regularly tested primary and backup communication between on- and off-site and pre-formatted messages and confirmation/authentication procedures;
- Compatibility with shift personnel duties, under emergency conditions;
- Promptly notifying the IAEA of a transnational emergency.

Taking mitigating action

Determine how well the arrangements provide for promptly taking action to minimize the consequences of an emergency.

Check how well the arrangements address the following:

- The emergency operating procedures and arrangements for taking mitigating actions address severe conditions including those beyond the design basis.
- Technical assistance for the operational staff and access to support from the designer and builder.
- On-site damage control, fire fighting, and security response teams with protective equipment, monitoring instruments, lighting, and damage control supplies and communications equipment ready availability for anticipated emergency conditions.
- Off-site police, medical and fire fighting services adequately equipped, with access to the facility and, trained and drilled in cooperation with the on-site response.

Taking urgent protective action

Determine how well the arrangements provide for promptly taking urgent protective action on site and off site in order to render first aid, prevent deterministic effects and to avert dose consistent with international standards.

Confirm that operational intervention levels (OILs) are consistent with international standards for: evacuation, stable iodine prophylaxis, decontamination of people and vital equipment, immediate medical treatment, and immediate food restriction.

Check whether arrangements for taking urgent protective actions for the full range of potential emergencies include:

- Emergency zones, contiguous across national borders, consistent with international standards within which arrangements are made for implementation of urgent protective actions 1) before or shortly after a release in order to substantially reduce the risk of severe deterministic health effects and 2) taken promptly based on monitoring OILs;
- Criteria, based on event classification and off the site monitoring OILs for making urgent protective actions recommendations and arrangements for the revision of these recommendations;

- A position, on the site at all times, with the authority and responsibility to recommend protective actions to officials off the site promptly upon the declaration of an emergency;
- Promptly (within 30 minutes of classification) notifying and providing a protective action recommendation to off-site officials including those in other States within the emergency zones.

Check that off-site jurisdictions within the emergency zone have made arrangements to take appropriate urgent actions to protect emergency workers; permanent, transient and special population. These actions should include evacuation, shelter, respiratory protection, iodine prophylaxis, protecting supplies of food and water; restrictions on the immediate consumption of locally produced milk/crops; monitoring and decontaminating evacuees; care for evacuees; alerting special facilities; and the control of access to and restriction of traffic by air, water road and rail. Arrangements should be coordinated with all jurisdictions (including those beyond national borders) within any emergency zone.

Check how effective is the plan of iodine profilaxis at NPP site and EPP area.

Evaluate the protection of those on-site to include: instructions, notification systems, accountability; location of those unaccounted for; evacuation, decontamination, shelter, respiratory protection, iodine prophylaxis, first aid, suitable assembly points, safe escape routes clearly marked for all people in areas controlled by the operator (e.g. visitors, construction workers) and monitoring of the dose in the on-site assembly areas or shelters.

Check the arrangements:
- To promptly provide first aid;
- To prepare a contaminated patient for transport and transport them to an appropriate off-site facility for further treatment;
- To monitor and manage the contamination of evacuees from the site;
- To estimate the dose of those on site during the emergency and record sufficient information for their inclusion in a registry for medical follow-up if appropriate.

Look for communications that is secure and resistant to failure under emergency conditions (normal public landlines and public mobile telephone systems are not suitable). Check communications systems redundancy/back ups.

Providing information, issuing instructions and warnings to the public
Determine how well the arrangements provide for warning the public promptly of an emergency and informing them of the immediate action that they should take.

Check how well the arrangements address the following:
- Providing information, in advance, on response preparations and actions to the permanent, transient and special population groups and to special facilities within the emergency zones.
- Providing a warning to the permanent, transient, and special population groups within the emergency zones upon declaration of an emergency class along with instructions in the main languages spoken on the immediate actions to take. The warning should be provided within the precautionary action zone within minutes and within the urgent protective action-planning-zone within an hour of a decision to implement protective

actions. The system must be reliable, not vulnerable to normal power failures and routinely tested.

Check if and how the records of the warning broadcasts are prepared and who approves the broadcasts for using.

Protecting emergency workers
Determine how well the arrangements provide for protection of emergency workers.

Check how well the arrangements address the following:

- Identification as emergency workers those called upon to respond at a facility or within the emergency zones including: all essential on-site personnel, law enforcement, fire fighters, medical personnel, drivers of evacuation vehicles, monitoring/sample teams, traffic control, decision makers, those caring for special populations, and those assigned to maintain critical infrastructure elements (e.g. telephone systems) or special facilities;
- Providing information/training to allow emergency workers to make informed decisions concerning volunteering for tasks in high dose environments;
- Identification of hazardous conditions where emergency workers may be and provisions to allow for safe operations (e.g. shielding in advance) in these areas (consideration of radiation levels, heat, live steam, poor visibility, toxic gases, heights, and strenuous activities);
- Protection for emergency workers from the anticipated hazardous: managing and recording doses, operational turn back levels that are directly monitored, control of contamination, authorization of doses in excess of the operational emergency levels; and continuous communication and accountability for workers in very hazardous areas;
- Protective equipment and clothing, respiratory protection, high range survey instruments, and self-reading dosimeters in locations accessible during an emergency and in appropriate quantities for the range of anticipated hazardous and adequate supplies expendable items (e.g. air tanks, filters, and clothing);
- Training on protective equipment and conduct of drills wearing equipment. Ensuring workers are physically capable of working in the protective equipment under anticipated hazardous conditions (e.g. high temperatures).
- Once the emergency is over there will be application of the full system of detailed requirements for occupational exposure;
- Informing workers on doses received and health risks;
- On-site position responsible for ensuring the protection of workers.

Assessing the initial phase
Determine how well the arrangements provide for reliable assessment of facility conditions, exposures and releases; radiological conditions on-site and within the emergency zones for use in: classification (EALs), taking urgent protective actions on and off the site, and protection of workers.
Check how well the arrangements address the following:

- Response of instruments under abnormal conditions and warnings concerning misleading instrument response.
- Assessment of environmental levels and the contamination of people (e.g. evacuees) to include: trained teams, instrumentation, monitoring/decontamination supplies, monitoring locations/routes (confirm that locations where people stay are monitored first), secure communications, vehicles, default OILs, and provisions to revise of the OILs. The OILs used by on-site and off-site organization should be the same.

- Assessing releases (atmospheric and water) under emergency conditions and for estimating the radionuclide mixture of releases.
- Projection of off-site consequences based on estimated release and facility conditions (confirm that the great uncertainties of these methods are recognized).
- Monitoring of people to determine if decontamination or medical follow-up is warranted including criteria.
- Production of information useful for on-site and off-site decision making (confirm that facility monitoring results are incorporate with that from off-site organizations).
- Relevant information is recorded and retained.
- Information needed to identify individuals who may have been exposed.

Managing the medical response
Determine how well the arrangements provide medical assessment and treatment including provisions for first aid, the estimation of doses, medical transport, and initial treatment of contaminated or highly exposed individuals in local medical facilities.

Check how well the arrangements address the following:

- On-site first aid, contamination control and transport;
- A local medical facility to initially treat and decontaminate contaminated patients, identify exposures needing specialized treatment, and prepare patients for transport to a facility that can treat severe overexposures;
- Gathering information needed to reconstruct the dose promptly following a serious exposure to include: descriptions of circumstances, readings of dosimeters, onset early clinical symptoms (e.g. vomiting); and results of a general medical examination and analysis;
- A medical management for the emergency zones which includes operational criteria for performing triage and assigning any highly exposed members of public to appropriate medical facilities;
- Recording the identification information of those who may have received a dose sufficient to warrant long term medical follow-up to allow more effective treatment to radiation induced cancers or effects of exposure while pregnant.

Keeping the public informed
Determine how well the arrangements provide for the public receiving useful, timely, truthful, consistent and appropriate information, responding to incorrect information and rumours, and for responding to requests for information from the public and media.

Check how well the arrangements address the following:

- Sufficient personnel (professional and clerical) are assigned who are trained in public information practices;
- Sufficient facilities, equipment and resources that are properly maintained;
- Advance and continuing information to the media and public on subjects that would be discussed during an emergency, such as radiation levels, nuclear plant operation, emergency plans, protective measures and precautions;
- Understandable information for the public/media provided in advance (in co-operation with off-site officials) that address likely questions and concerns (in all local languages);

- Media inquires immediate upon declaration of an emergency;
- Coordination to ensure all information from national (regulatory body) officials, local officials, and the facility (site and corporate) are coordinated and provide a consistent an understandable message to the public. The initial release should be coordinated in advance for each emergency class;
- Establishment, as soon as possible, a single location, the Public Information Centre (PIC) that will be the only source of public information once established. The PIC should be at a pre-established location near the plant site but outside the emergency zones with security and a system for confirming the credentials of media personnel;
- Arranges for large numbers of the media near the facility to include information for the media on risks, restrictions, and precautions they should take for their protection;
- Instruction for those who will have direct contact with the public (e.g. monitoring teams) on how to interact with the public and media.

Taking agricultural and longer term protective action
Determine how well the arrangements provide for taking agricultural countermeasures and longer term protective actions and for managing radioactive waste and contamination.

Check how well the arrangements address the following:

- Restriction of the consumption, distribution and sale of potentially contaminated foods and agricultural produce following a release to include: default OILs consistent with international standards; means to revise the OILs; timely monitoring, sampling and analysis of food and water; and the means to enforce agricultural countermeasures;
- Promptly instructing the public, farmers and food production and distribution activities to take action to protect food (e.g. take animals off pasture), water supplies and cisterns; prevent immediate consumption of contaminated food (e.g. local milk or home grown garden vegetables); and protect the food and agricultural product system;
- Advanced information for farmers and the food and agricultural product industry;
- Implementation of temporary relocation including: OILs consistent with international standards; means to revise the OILs; timely monitoring of ground contamination; means for accomplishing relocation; and arrangements for assisting those people who have been relocated;
- Monitoring vehicles, people, and vital resources to include OILs compliant with international standards;
- Providing a single assessment based on all the available monitoring and analysis (facility and off site organizations);
- Management of radioactive waste to include: criteria for categorizing waste; criteria for use in assessing the effectiveness of decontamination efforts; testing decontamination methods before general use; minimizing the amount of material declared waste and avoiding unnecessary mixing of different waste types.

Conducting recovery operations
Determine how well the arrangements provide for the transition from the emergency phase to longer term recovery operations and that once recovery operations begin workers are subject to normal occupational exposure requirements.

Check how well the arrangements address the following:

- That workers undertaking recovery operations (non emergency actions) are subject to normal occupational exposure requirements;
- The transition from emergency phase operations to routine long term recovery operations to include the process for declaring an end to the emergency (co-ordained with off-site) and definition of the roles and responsibilities;
- Coordination with law enforcement (e.g. to preserver evidence) and other recovery workers (e.g., construction).

3.9.3. Emergency plans and organization

Expectations

Approved emergency plans should clearly allocate responsibilities and provide a basis for development of procedures, training and other arrangements that provide for a coordinated response by the operating organization and other authorities.

The emergency plans should include arrangements for emergencies involving a combination of non-nuclear and nuclear hazards and response of conventional response organizations such as law enforcement. These plans should be reviewed regularly taking into consideration the feedback from drills and exercises and to consider any revisions to facility operations, terrorist threat situation, or activities/conditions in the area that may impact on the potential emergencies to be addressed or the response.

Examples of documents to be available for review during the OSART mission:

- On-site emergency plan;
- Off-site emergency plan(s) to include those arrangements that may be implemented simultaneously such as for response to an earthquake or a terrorist event.

Evaluations

Common requirements for on-site and off-site emergency plans

Determine whether the plans contain sufficient information to allow other organizational elements (e.g. States, ministries, local governments facilities, teams) to develop an effective response capability and to ensure that the plans are compatible. Plans should have compatible:

- Terminology;
- Concepts of operations;
- Emergency operations management;
- Organization and functional descriptions;
- Co-ordination, activation and integration;
- Facilities, communications;
- Procedures, units, communication frequencies, and protocols, methods and equipment used for performing common or integrated tasks;
- Training and exercises.

Determine whether emergency plans have been developed and approved by:

- The operating organization (on-site and corporate levels);
- The responsible public authorities at local and national levels;
- Other bodies which may be a part of an emergency response.

Check whether the plans are consistent and coordinated.

Determine by reviewing existing plans whether they contain a planning basis that addresses:

- The range of emergencies postulated (to include those of very low probability) to include combinations of nuclear, radiological, technological (e.g. transport, fires, toxic gas), natural (e.g. earthquakes) events and deliberate acts (e.g. terrorist);
- The laws or acts assigning responsibility for co-ordination of conventional (natural and criminal) and radiological response;
- Local conditions such as transportation systems, population distribution, languages and available emergency services;
- The range of weather conditions under which response may be conducted.

Determine by reviewing existing plans whether they address:

- The basic concept of operation regarding how the relevant emergency response actions discussed in Section 3.9.2. will be conducted and co-ordained;
- The assignment of responsibilities and authority and chain of command and arrange for delegation and/or transfer of authority with arrangements for notifying all appropriate parties;
- Transition for normal to emergency operations;
- Sufficient qualified/trained personnel to perform the response tasks immediately (task to be performed promptly) and needed 24-hour emergency operations;
- Links between the operating procedures (especially the emergency operating procedures), the classification of events and the activation of the emergency organization;
- The criteria for classification of emergencies and the immediate coordinated actions to be taken each response organization;
- Communication between response organization;
- The tasks and actions required within the proper time frame;
- Harmonized radiological and protective action criteria that are consistent with international standards;
- Harmonized units, communication frequencies/system, monitoring methods, maps coordinates, criteria, and terminology are coordinated with off-site response;
- Simultaneous implementation of physical security/law enforcement or fire fighting and other conventional emergency plans;
- Describe the arrangements to develop and maintain the capability to respond to an emergency;
- The mechanism for periodical review and update, in particular considering internal and external experience feedback;
- Inventory, location and readiness of emergency supplies, equipment, communication systems and emergency facilities.

Check if the person responsible for clasification of the emergency situation in the begining phase (shift supervisor) is not overloaded until the emergency staff is called together.
Check if logistic support (transport, meal, changes of shifts) is prepared for personnel presumed for intervention at site.

On-site emergency plan
Review the on-site emergency plan and determine whether it adequately covers the following aspects:

- Emergency situation identification process and decision process to activate and terminate the emergency organisation;
- Responsibility and authority within the emergency organization including: location/assembly points of the key branches of the organization at plant and corporate level;
- Responsibility for notification and activation of the emergency response organization, including normal and alternate means of communication;
- Types, quantities, timing and pathway of the release (source term) and time frame to be considered in the various emergency situations;
- Emergency technical assessment and mitigating actions, including plant conditions, core damage, containment integrity, radiological protection;
- On-site protective actions, including accountability, monitoring and evacuation of plant personnel;
- Off-site notification and protective action recommendations to appropriate authorities and/or agencies on the basis of assessed and projected plant conditions;
- Agreement with external organizations and resources supporting the emergency plan and procedures, e.g. with hospitals in the vicinity specialized to receive potential contaminated casualties and fire brigade trained to operate in a nuclear environment;
- Keeping a record of the evolution of the emergency situation and actions taken;
- Provision of timely and accurate information to the proper off-site organizations;
- Organization, responsibility and authority for co-ordinating recovery actions and re-entry.

3.9.4. Emergency procedures

Expectations

Procedures and analytical tools should be available, validated and provide detailed guidance for the rapid and effective implementation of the response functions described in Section 3.9.2. On-site procedures should be linked with the plant document and records management system.

Examples of documents to be available for review during the OSART mission:

- Hierarchy of emergency documentation;
- Emergency procedures;
- Off-site organizations emergency procedures;
- Maps, drawings, software.

Evaluations

Determine whether emergency procedures to implement the emergency plans have been developed by:

- The operating organization (on-site and corporate levels);
- The public authorities involved in emergency response at local and national levels;
- Other bodies which may be a part of the emergency response infrastructure.

Determine, by spot-checking, that commendable practices are applied for document preparation and control in the emergency procedures development process. Especially check whether the procedures:

- Before use are coordinated with all appropriate organizations or departments; independently reviewed and integrated into the training programmes; field tested under conditions that maximize realism; and integrated into a QA programme to ensure that the procedures remain up to date;
- Cover the objectives intended and include the response levels, precautions and specific instructions;
- Have approval sheets, review plan, and data sheets to document that the actions described have been completed. Temporary modifications and deficiencies are addressed adequately;
- 'Action steps' are clearly displayed in a step-by-step sequential fashion (e.g. a checklist) and decision trees are clearly marked with pre-established criteria;
- Are distributed (including revisions) in a controlled manner;
- Are reviewed and updated periodically.

Determine the division of detailed elaboration between plans and procedures and the assignment of organizations in charge. Check the coherence and uniformity of the approach. Spot check to determine how well the emergency procedures deal with the performance of the response tasks described in Section 3.9.2, training and the maintenance of the response capability.

3.9.5. Emergency response facilities

Expectations

Facilities should be provided for adequate on-site and off-site emergency response with appropriate communications and equipment that can be brought into operation without delay in the event of an emergency. These should include centres from which the on-site and off-site emergency response can be managed, as well as means for assessment of the plant status and radiological conditions and for implementation of any necessary response actions or protective measures. In addition, special facilities for the protection of the personnel and the public, as e.g. gathering points and medical centres, should be available.

Examples of documents to be available for review during the OSART mission:
- Description and drawings of on-site and off-site emergency response facilities;
- Design specifications for the emergency response facilities;
- Equipment specifications for the emergency response facility.

Evaluations

Identification of emergency response facilities
Determine whether emergency response facilities exist at local and national levels for:
- The operating organization (on-site and corporate levels);
- The public authorities involved in emergency response;
- Other bodies which may be a part of the emergency response infrastructure.

Performing the response action discussed in Section 9.2 to include:
- Co-ordination on-site response actions and teams;
- Accident management and technical support of operations;
- Co-ordination with off-site response actions;
- Co-ordination of public information;

- Co-ordination of facility and off-site environmental monitoring and assessment;
- On-site medical treatment;
- Off-site medal facility for treatment of contained/ overexposed;
- Laboratories, located out side the emergency zones, for analyses of environmental and biological samples.

Evaluating emergency response facilities
Determine whether the emergency response facilities are adequate to support their assigned functions during the course of an emergency:

- Are of an adequate size and suitably located and identified;
- Are habitable under emergency conditions; facilities within emergency zones are suitably protected from radiation and other hazards (e.g. high temperatures, chlorine) and continuously monitor of radiological conditions and control of contamination.
- Are appropriately organized and equipped for carrying out the functions of the staff assigned to them;
- Have appropriate secure communications systems (including backups) to all required points as identified in the emergency plans;
- Have backup power supply;
- Have regularly updated copies of all emergency plans, procedures and engineering material (such as plant layouts, schematics and safety system drawings);
- Are adequately staffed with trained personnel;
- Have sufficient storage of food and water sanitary supplies to meet human needs;
- Have appropriate capability for data handling and processing and decision making support (maps, charts, status boards, safety parameter display system, etc.);
- Have record-keeping methods.
- Have appropriate security.

Gathering (assembly) points
Determine whether emergency gathering points exist for all people on-site (to include construction personal and visitors) not involved in the emergency response and incoming emergency support vehicles and personnel and they are:

- Well identified and adequately located;
- Sufficiently equipped and continuously monitored to ensure that they are habitable;
- Provided with communication and a means to direct the people on further actions.

3.9.6. Emergency equipment and resources

Expectations

Adequate emergency equipment and resources, communication systems, documentation (such as procedures, checklists, telephone numbers, and manuals) should be available where needed to properly initiate and support the emergency response actions described in Section 3.9.4. Necessary data transfer and communication should also be available.

Instruments, tools, equipment, documentation and communication systems to be used in emergencies are appropriate and are maintained in good operating condition, in such a manner

that they are unlikely to made unavailable by the postulated emergency and environmental conditions. Equipment, communications, vehicles etc. should be regularly checked and tested.

Examples of documents to be available for review during the OSART mission:

- Emergency equipment inventories, including storage places;
- Equipment operating manuals and maintenance records.

Evaluations

Review and evaluate the adequacy and appropriateness of emergency equipment and resources such as:

- Storage areas for emergency equipment are located where needed and accessible during an emergency;
- Communication systems are secure, resistant to loss under emergency conditions due to overloading or loss of power (normal public telephone systems, public mobile phone systems not appropriate for most response uses);
- Radiological monitoring, including high range survey instruments and dosimeters;
- Sampling equipment;
- Protective clothing and respiratory protection equipment;
- Mobile laboratory vehicles or other means for effective monitoring, sampling and analysis;
- Dedicated or designated vehicles (ambulances, fire fighting, monitoring);
- Accident assessment equipment or systems;
- Fire fighting equipment;
- First aid/medical support equipment;
- Stable iodine tablets;
- Specific equipment (on-site or elsewhere) to be used in case of an emergency;
- Surveillance and maintenance programme/procedures for the equipment and resources.

Confirm the arrangements to replace supplies of expendable/perishable items (e.g. batteries, air tanks, filters, clothing, sample containers, and clerical supplies) and to bypass normal procurement processes in order to obtain additional resources promptly.

Verify that checks of compatibility with equipment used by different response organizations: communication systems/frequencies, monitoring and sampling instruments and methods, power supplies, and transportation systems have been performed.

Confirm that the appropriateness of equipment was determined based on considerations of the user and possible conditions (light, temperature, moisture, weather, time in the field, workload and other conditions) during use.

Determine, by appropriate sampling of routine examination/maintenance records, tour of selected facilities, and/or demonstration, the availability and status of this equipment and these resources.

3.9.7. Training, drills and exercises

Expectations

A comprehensive, documented training programme should be provided for developing and maintaining the necessary knowledge, skills and physical ability required for all persons having duties under the emergency plans, to enable them to respond correctly and efficiently in the event of an emergency. A programme should also be provided for general employee training of on-site personnel. Similar training, or at a minimum, a well structured information briefing, should be provided to plant visitors.

A programme of periodic drills and exercises should be set up to reinforce the training and assess the effectiveness of the emergency response capability. The programme should include periodic, comprehensive and integrated on-site and off-site exercises aimed at assessing the coordinated response of all emergency response organizations and include evaluation of exercises for experience feedback.

Examples of documents to be available for review during the OSART mission:

- Emergency training procedures, schedules, lesson plans and records;
- Programme for emergency drills and exercises;
- Drill and exercises scenarios and reports.

Evaluations

Training and qualification will primarily be reviewed by the TQ reviewer. However, during interviews and observation of work activities, determine if the experience level and proficiency of the emergency planning and preparedness group, other plant staff, contractors and visitors are appropriate for their assignments. Check if personnel are knowledgeable of current work practices and plant procedures.

Basic training
Determine whether a programme exists and is regularly implemented for general employee training of on-site personnel other than those having emergency duties, to familiarize them with procedures for alerting and protecting personnel (gathering, sheltering, using protective equipment, evacuation) in case of an emergency. This training shall be provided before allowing site access and then periodically. This training programme should include contractors' staff working at the plant, continuously (e.g. housekeeping) or temporarily, especially during outages.

Check also whether clear and practical information is delivered to visitors or, for short term visitors, if a competent plant staff person continuously accompanies them.

Specific training
Determine whether a documented training programme exists for initial training and periodical retraining of all personnel assigned to various functional areas of emergency response. Review the effectiveness of the emergency training programme at various organizations having a role in the emergency response (including on-site and off-site emergency response organizations).

Check if:

- The training programme includes appropriate qualification criteria for individuals assigned to emergency response duties;
- The instructors have sufficient knowledge and experience in the field of training they are appointed to;
- The training programme is a proper combination of classroom instruction and hands-on use of all equipment and procedures which are expected to be used in emergency response;
- The training of support bodies entering the plant (fire, ambulance, rescue, police, technical support) includes all relevant information for their effective response and personnel protection;
- The training of personnel involved in technical advice to support the decision makers includes the relationship between plant conditions, environmental impact and protective measures and uncertainties;
- All the shift crews are properly trained in this subject and in the interfaces with on-site or off-site groups, if required.

Drills and exercises

Determine whether a programme (on-site/off-site) exists for conducting drills to develop skills in specific disciplines normally performed by teams such as:

- Coordination of the on and off-site response;
- Accident assessment (plant status, consequences);
- Communications;
- Public information;
- Radiation monitoring and sampling;
- Personnel monitoring and decontamination,
- Fire fighting (with off-site support);
- First aid/medical support;
- Implementation of specific equipment to be used in case of an emergency;
- Security response (with off-site support);
- Damage control.

Check that exercises are sometimes performed out of the normal working time, at night and in the week-end and that drills are conducted under simulated emergency conditions and actual adverse environmental conditions.

Check that this programme includes a periodical routine drills/exercises, to familiarize everybody on the site (plant staff involved and not involved in the emergency response and contractors) with procedures for alerting personnel of emergency conditions, activating emergency personnel, evacuating the affected area and moving to their (designated) emergency gathering points.

Determine whether a programme exists for conducting periodic comprehensive exercises involving on-site and off-site organizations. This programme should provide participation of media and in case the surrounding public, to test the effectiveness of the entire emergency response by review of:

- Scenarios (emergency condition, as much as possible, are realistically presented);
- Exercise critiques and records;
- Actions planned to improve plans.

Confirm that some of these exercises are systematically evaluated against established response objectives by the regulatory body or independent observers.

Review the completeness of the drills and exercises programme to ensure that all elements of the emergency plans are checked for effectiveness. Determine whether a feedback process is available to improve emergency plans and to update them taking into consideration the experience from drills and exercises.
Confirm that there is a system which ensures that all people having a role in the emergency plans are regularly participating in drills/exercises (no stand-ins for senior officials), and that it considers the special conditions of on-shift personnel. Records should demonstrate this participation.

Confirm that there are provisions on-site to ensure that people on-call are available at any time by regularly test calls. Check whether availability in a specified period of time of personnel is tested during non working hours, whether corrective measures from training are documented and implemented and whether NPP management is aware of deficiencies and their resolution. Check whether the drills are organized also without preparation. Check whether different types of emergencies (e.g. earthqake, terroristic attack, etc.) are trained.

Coordinate all findings with TQ and RP reviewers.

3.9.8 Quality assurance

Expectations

A quality assurance and maintenance programme that ensures a high degree of availability and reliability of all plans, procedures, supplies, equipment, communication systems and facilities necessary to perform specified functions in an emergency.

Evaluations

Determine whether a comprehensive QA programme covering all activities of the emergency response programme exists and that the programme includes:

- Review and updating of emergency plans, procedures, call lists, and other arrangements and incorporate lessons learned from research, operating experience (such as response to emergencies) and emergency drills and exercises.
- Inventories, re-supply, tests and calibrations, in order to ensure that needed items and facilities are continuously available and functional for use.
- Provisions to restock perishable items such as batteries, fuel, and food.
- Arrangements for prompt maintenance, repair and calibration of equipment during an emergency and for prompt inter-comparisons (field calibrations) during an emergency for the monitoring teams and equipment that may be added ad hoc to supplement the response.
- Ensure that the operator and the off-site response organizations arrange to review and evaluate responses in real events and in drills and exercises, to record the areas in which improvements are necessary, and to make the improvements.

3.10. COMMISSIONING

Commissioning is the process during which plant components, systems and structures having been constructed, are tested and placed in operation with the objective of verifying that these are in accordance with the design assumptions. This process continues until the plant is at full power and required testing at this power level has been conducted. In order to meet the expected performance criteria the plant is verified 'as built' and pre-operational plant adjustments are made. Commissioning also includes testing prior and subsequent to fuel loading. It is therefore essential to safety that the commissioning programme and individual system testing be designed in such a way that those design assumptions can be verified and quality can be assured throughout the commissioning process.

The commissioning process is the best scenario to prepare personnel and procedures for the normal operation of the plant. Operating personnel in all disciplines are involved as much as possible in commissioning activities and the operating procedures are validated to the practicable extent with the participation of future operating staff.

During commissioning an extensive amount of data is collected on structures, systems and equipment. This 'base line' data will be the reference for subsequent operational testing in order to prevent plant degradation.

The commissioning programme and results are an important part of the licensing process of the plant. Clear and well defined responsibilities and requirements for the operating, commissioning and regulatory organizations are essential to satisfy in a timely manner the licensing requirements for the plant.

The commissioning results greatly depend on the interfaces among construction, operations and designers. The boundaries of responsibility vary from site to site. The levels of cooperation between these groups will influence the quality of commissioning.

The responsibility for the plant is eventually transferred to the operating organization. This could be done gradually or in specified stages. Quality and comprehensiveness of this handover is necessary to ensure an adequate history and that the plant meets the design intent.

References: [6, 9, 11-12, 18 and 37]

3.10.1. Organization and functions

Expectations

Responsibility for commissioning may rest with a contractor, the construction organization or the operating organization. Nevertheless, since the time of fuel load the responsibility for nuclear safety should rests with the license holder, usually the operating organization. Whatever the arrangement, it is important that the organization or individual responsible for commissioning be accountable to the organization or to the individual responsible for compliance with the license for demonstrating that the plant behaves in accordance with the design assumptions and confirming that the plant is only tested in a fashion for which the design is satisfied.

The commissioning organization should adequately meet the standards of quality established within the plant organization. The functions and responsibilities for the commissioning

process should be clearly defined with well developed lines of authority for all persons involved.

Good coordinations between the commissioning organization and the operating organization at all levels should be evident. Clear lines of responsibility and authority for contractor organizations should be developed and understood by all those involved in commissioning.

A sufficient number of qualified personnel should be available during all stages of commissioning. Operating personnel and plant technical staff should be involved in the commissioning process to the extent necessary for ensuring proper preparation of the operational phase.

The responsibility of the regulatory authority in the commissioning programme should be clearly defined and well understood by the commissioning organization and operating organization.

Examples of documents to be available for review during the OSART mission:

- Organization charts for design, construction, commissioning and operating groups;
- Interfacing arrangements between these groups.
- Job descriptions for staff involved in commissioning;
- Commissioning administrative procedures;
- Terms of reference and minutes of any committees concerned with commissioning;
- Commissioning QA programme;
- Manual or procedures describing commissioning organization;
- License requirements with respect to commissioning;
- Safety Analysis report.

Evaluations

Overall organization and functions

Review the allocation of responsibilities for commissioning activities at different stages of the commissioning process in order to evaluate them for:

- Avoidance of ambiguity;
- Clarity of responsibility for compliance with license conditions;
- Clarity of delegation right down to the individuals testing or operating the plant;
- Compliance with the license.

Review the commissioning organization to confirm that is adequately staffed to carry out timely the assigned tasks. If contractors are used in the commissioning organization, confirm that their qualifications and standards are adequate to meet the quality requirements necessary to commission a nuclear power plant.

Confirm that all personnel involved in commissioning have a clear understanding of the overall organization, purpose of the commissioning programme and of their own specific authorities and responsibilities.

Confirm within the operating organization that the responsibilities for nuclear safety from initial fuel arrival to the site to fuel loaded into the reactor core are clearly documented and understood by all involved in commissioning.

Determine that adequate management goals and objectives exist to measure the effectiveness of the commissioning programme. Ensure that these encompass the schedule and milestones set up by the commissioning programme. Ensure that goals and objectives embrace operational, construction and design requirements.
Confirm that goals not directly related to programme schedule are being satisfactorily addressed, for example: industrial safety accidents, incidents and near misses, human errors, repetition of commissioning tests, validation of operating procedures, training of personnel etc.

Confirm that sufficient and adequate performance indicators exist to facilitate the tracking of established goals and objectives.

Management of safety
Confirm that the following specific are reflected in the safety management system for the commissioning phase:

- The interface and appropriate links to ensure that commissioning is in accordance with the requirements of the safety analysis report;
- The interface between the various organizations participating in the commissioning process;
- The transfer of the responsibility for safety from one participating organization to another;
- The discharge of responsibilities for safety owing to the gradual handover of commissioned systems and components of the plant.

Management of quality
Confirm that clear quality requirements exist within the organizations involved in commissioning that establish the level of responsibility for the following different activities:

- Scheduling;
- Approval of test procedures and test results;
- Clearance of hold points;
- Systems and equipment handover.

Check if these requirements embrace both quality control and quality assurance.

Review the scope of audits and surveillances and results. (More information in this area can be found in Section 3.1.)

Confirm that corrective actions resulting from audits and surveillances are timely and effectively acted upon.

Confirm that commissioning managers and supervisors conduct regular plant tours to observe on-going commissioning activities and status of the plant.

Functions and responsibilities of the commissioning group
Confirm that the functions and responsibilities of the commissioning group include the following:

- To plan in advance the commissioning programme with detailed test sequences, time schedules and staffing requirements;
- To update the commissioning programme in the light of experience in commissioning and as a result of design modifications;
- To establish a procedure for the preparation, review and approval of test procedures and other procedures;
- To ensure that operational flow sheets, operating and maintenance instructions, commissioning procedures, formats for commissioning reports and test reports, plant handover documents and submissions to the regulatory body are available;
- To establish a procedure for the systematic recording of plant data for future use;
- To establish a procedure for ensuring that incidents in commissioning are analyzed so that the experience gained can be fed back to the designers or the operating group;
- To verify that the installation of structures, systems and components has been satisfactorily completed and codified for proper identification;
- To ensure that the prerequisites for the commissioning programme have been satisfied and that pre-operational tests such as functional checks, logic checks, interlock checks and system integrity checks have been completed;
- To ensure that the commissioning procedures comply with the appropriate rules and regulations for safety (including radiological protection and safety);
- To ensure that the systems are commissioned safely and to confirm that the written operating procedures are adequate;
- To implement all the tests in the commissioning programme, including repeat testing of the systems that have been commissioned initially as partially installed;
- To make suitable arrangements for testing and maintaining systems (particularly safety related items) for which responsibility has been accepted;
- To direct the operation of systems in the commissioning programme and to update operational flow sheets and operating and maintenance instructions, as well as procedures based on experience in commissioning;
- To issue commissioning reports on tests;
- To ensure that a procedure is in place to control the calibration of test and measurement equipment;
- To establish a procedure to ensure that all participants in the commissioning process are suitably qualified and experienced;
- To ensure the configuration management, maintaining consistency between ‘as built’ drawings and procedures and physical configuration and the design requirements;
- To ensure that design changes are requested, reviewed and implemented when design criteria are not met or when they fall short;
- To establish a procedure for controlling temporary changes to plant and equipment;
- To issue test certificates and stage completion certificates or their equivalent;
- To provide up to date baseline information to the operating group and the operating organization;
- To report to the operating organization any deficiency detected in commissioning tests in order that corrective actions can be taken;
- To maintain a record of limiting conditions in commissioning;
- To ensure that plant performance is in accordance with the design intent, including all aspects of radiological protection and safety;
- To certify that the commissioning programme has been satisfactorily completed;
- To transfer the responsibility for operation of the commissioned systems and/or plant to the operating group using a system of documents such as transfer certificates;

- To establish and implement procedures that ensure the orderly transfer of responsibilities for structures, systems and components from the construction group to the commissioning group and from the commissioning group to the operating group;
- To ensure that an opportunity is provided for operating personnel to gain plant experience, typically by utilizing the appropriate personnel, as necessary, for
- Commissioning activities;
- To establish procedures for analyzing the results of tests and for producing test reports and test certificates.

Interfaces with other plant groups
Review the interface arrangements in order to determine if adequate communications are established and maintained between the groups involved.

Ensure the establishment and effectiveness of communication between commissioning and regulatory authority concerning:
- license requirements;
- hold paints;
- documentation to be reviewed or/and approved;
- deviation incidents.

Confirm that the responsibility of the regulatory authority in the commissioning programme/process is clear and well understood. After fuel load these requirements will be covered by Section 3.1. of these guidelines.

Review existing committees and confirm the adequacy of their purpose, scope, responsibilities and composition. Review the minutes of all safety and commissioning committees in order to determine if they are adequately addressing their objectives.

Confirm that good communication is maintained between shifts of different organizations/areas when performing commissioning work or testing. This communication should ensure complete understanding of previous activities and subsequent actions to be carried out.

Confirm that operating staff are effectively involved in the commissioning process. This is further investigated in the topic 3.10.8, interface with operations.

Confirm that good technical and human communication resources exist at the organization; Example of technical communications are: paging system, faxes, phones, computer networks, beepers, etc.

Qualification of personnel
Training and qualification programmes and processes will be primarily reviewed by the reviewer evaluating training and qualification. However, during interviews and observation of work activities, determine if the experience level and proficiency of the commissioning group, other plant staff, contractors and visitors are appropriate for their assignments. Check if personnel are knowledgeable of current work practices and plant procedures.

Review the number of staff involved in the commissioning process and assess if it is sufficient to carry out the task within the programme schedule.

Review the qualifications, training and experience of all key staff, and some individuals at more junior levels in particular, in the commissioning process, in order to determine their adequacy (coordinate with the Training and Qualification (TQ) reviewer). Determine that the functions and experience of system engineers is commensurate with their assigned responsibilities.

Confirm that special emphasis is placed on training commissioning personnel in safety culture aspects and general operating rules. Ensure that the training is conducted at an appropriate stage in the commissioning process and that personnel attend regularly scheduled training.

For more detail on this subject refer to Section 3.2. of these guidelines.

3.10.2. Commissioning programme

Expectations

The commissioning programme should be a management tool which allows those responsible to satisfy themselves that the scope and sequence of the commissioning process is adequate for the purpose and against which it may be controlled. It should also provide a reference against which the regulator may monitor and approve the process and allocation of safety responsibilities at different stages during the commissioning process from fuel arrival at the plant to full power operation.

A good commissioning programme should be structured to ensure that the following objectives are met:

- All the tests necessary to demonstrate that the installed plant satisfy the design intent are conducted;
- The tests are performed in a logical sequence;
- The programme provides a means of identifying hold points in the commissioning process;
- Operation personnel trained and procedures validated.

Commissioning activities should be scheduled to align them with critical path activities and take into consideration all organizations involved. The schedule will ensure that tests are performed in a logical sequence.

A good commissioning programme should be continuously improved. This is not possible to achieve without a good incident reporting and analysis system. The information obtained from this analysis is not only fundamental for the commissioning programme but also for subsequent operations of the plant.

Examples of documents to be available for review during the OSART mission:

- Commissioning programme showing sequence of all tests and regulatory hold points.
- Commissioning manual;
- Papers establishing the principles for the various stages of commissioning;
- Operational limits and conditions (Technical specifications) during commissioning.

Evaluations

Basis and scope of the programme
Review the overall scope of the testing programme proposed and confirm that it is comprehensive and will ensure that the plant will perform in accordance with the design intent stated in the safety analysis report and complies with safety requirements.

Confirm that the commissioning programme has been previously analysed and approved by the regulatory authority. Confirm also that initial fuel loading, reactor criticality and power raising shall not be authorized unless all tests deemed necessary by the operating organization and the regulatory body have been performed and the results obtained are acceptable to both parties.

Review the logic behind the sequence of tests and evaluate how well this process is used to determine the sequence (prioritization). Check that there are adequate controls for ensuring that all the prerequisites of any test (e.g. tests of support systems) are performed and evaluated before the test commences. Check that the limits and conditions for operation during commissioning define what systems are required to be operable to allow plant operation in any mode.

Confirm that there are adequate provisions established for allocation of safety responsibilities at different stages of the commissioning programme and that those embrace the new fuel since its arrival to the site.

Confirm that the arrival of new fuel to the site is covered by adequate documentation. This documentation should include:
- responsibilities for handling and storage of new fuel;
- storage conditions;
- security measures;
- supporting systems such as: electrical, fire protection, lighting etc.;
- regular surveillance.

Scheduling and provisions for changes
Check the qualification and experience of scheduling personnel and their awareness on safety and quality matters.

Ensure that a common schedule is used by construction, commissioning and operations. The schedule should be negotiated between all parties involved and be aligned with critical path activities.

Confirm that tests are carried out in a logical order and that there are provisions for regular review of the schedule based on results obtained and availability of human and material resources.

Confirm that the scheduling practices cover the following topics:
- anticipation of activities in all areas affecting commissioning;
- regular meetings between all organizations involved to draft the schedule and analyze the past sequences;
- shorter schedule of 1 or 2 weeks duration;
- daily meetings to control ongoing activities once major testing commence or deemed necessary.

Review scheduling priorities and confirm that systems and equipment related to industrial safety, e.g. lighting, fire protection, communications equipment identification etc. are given adequate priority.

Review the process for varying the sequence of tests from the intended programme and determine what checks are in place to confirm that all prerequisites have been satisfied for a test that is performed out of sequence.

Evaluate whether the test sequence has been unreasonably distorted for commercial reasons.

Hold points
Check whether appropriate hold points have been established in the programme, in particular prior to the following key steps:

- Fuel load;
- Initial criticality;
- Gradual power increase;
- Plant acceptance.

Determine what review process is in place to confirm that all the requirements of previous tests and the design intent have been adequately satisfied before a hold point is released. Evaluate this process and, where possible, check the records of an example.

Ensure that responsibilities for the clearance of hold points are clearly established for the commissioning and operation groups, depending of the stage of the commissioning process. Determine the involvement of the regulatory authority in the scope, number and clearance of hold points.

Experience feedback from commissioning (coordinate with TS reviewer)
Confirm that a system is established and understood to report and analyze incidents, human errors and near misses regarding commissioning and operating aspects. Confirm that the system in place permits drawing generic conclusions in specific aspects by grouping the information received in such a way that can be properly managed.

Confirm that there is good training and information in reporting abnormalities and errors and that no punishment is exercised when those are reported.

Ensure that the experiences are timely included in training for commissioning and/or operations and in documentation.

More information on this subject could be found in the chapter 3.5. of these guidelines.

3.10.3. Training in commissioning

Expectations

The commissioning of a NPP is a relatively quick transition from construction to operation. Throughout this process, significant changes in methods and disciplines occur. For this reason training and assessment of the commissioning personnel should be well established, understood and conducted in adequate time in order to meet the quality requirements of the commissioning programme at any time.

Training should be well staffed with experienced personnel in all subjects and the training programme should contain specific commissioning aspects. Designers, vendors, main contractors and operations should be encouraged to participate in the training programme because of the close interaction during this phase.

Given the plurality and different backgrounds of the personnel involved in commissioning, a safety and quality spirit should be established at all levels from the early stages of commissioning. The importance of their work in attaining the quality and safety objectives expected should be highlighted in the training programme.

Examples of documents to be available for review during the OSART mission:

- Organization chart of the training in commissioning;
- Training schedule;
- Training programme;
- Organization of the staff;
- Job descriptions and qualifications of trainers;
- Schedules of training;
- Assessment documentation.

Evaluations

This topic should be reviewed in coordination with the TQ reviewer.

Functions and responsibilities
Confirm that the organization for training during commissioning is adequately described and documented and the scope of responsibilities are well understood by all parties involved. Ensure that training is conducted at the appropriate time in the commissioning programme.

Review the training programme and check if the number of trainers and their qualifications are adequate to support the training programme.

Confirm that the training programme and trainees are subject to periodic assessment by responsible personnel and that the results are timely addressed to the commissioning manager and responsible supervisors.

Determine whether major commissioning incidents are systematically fedback to training and whether these experiences are adequately incorporated in the training material. Ensure that quality and safety objectives are emphasized.

Training programme
Confirm that nuclear safety, industrial safety, fire protection, radiation protection (if required) and design criteria, are incorporated in the training programme. Check if commissioning methods and techniques are adequately explained during training.

Confirm that safety culture and concern for quality are established at all levels among the personnel involved from the early stages of commissioning.

Confirm that the administrative aspects of commissioning are adequately addressed, such as:

- Conduct of testing and regulations;
- Procedural and design changes;

- Permanent and temporary modifications;
- Work control and equipment isolation;
- Interfaces of Construction, designer and Operations with commissioning;
- Test limitation boundaries in mechanical and electrical systems;
- Incident reporting criteria and its importance.

Check that introductory courses on NPP technology as well as explanations of systems and equipment are provided. Confirm that the programme contains requirements for the license e.g. technical specifications, safety analysis report requirements etc. Confirm that quality and safety aspects are emphasized.

Confirm that manufacturers and designers are involved in this area of training particularly in specific systems or equipment.

Determine to what extent the operating personnel benefitted from the commissioning training and if the operating personnel are being used in the commissioning training programme.

3.10.4. Preparation and approval of test procedures

Expectations

The test procedures should define in detail how each equipment or system will be commissioned and thus form the core of the commissioning process. Competent personnel and adequate controls should be in place to ensure high commissioning standards.

Commissioning test procedures should be produced in accordance with the commissioning schedule well before the test is conducted to allow sufficient review time and prevent delays in the programme.

The test procedures should be consistent with detailed guidance provided. Test controllers should have a clear understating of all instructions. Test should provide sufficient data to satisfy the design intent of the system or component being tested and meet the requirements of the plants final safety analysis report.

Tests that may place the plant in an unanalyzed condition shall not be performed. Changes to approved procedures should be authorized in advance and controlled.

The procedures should be subject to a thorough verification and approval process in which beyond commissioning, the regulatory authorities and the operating organization play an important role.

Examples of documents to be available for review during the OSART mission:

- Flow chart for preparation and approval of test procedures;
- Administrative procedure for review and approval of test procedures;
- List of commissioning test procedures;
- Test procedures writers guide;
- Administrative procedure for changes to approved test procedures;
- Examples of approved test procedures;
- Examples of changes to approved procedures made during the testing (where available).

Evaluations

Process for preparation of test procedures
Confirm that the test procedures define how each equipment and system is commissioned. Confirm completeness of necessary test procedures to satisfy the design intent of the plant.
Review the procedure writers' guide and check that it requires the inclusion of the following in all test procedures:

- Installation and removal of temporary modifications;
- A check that prerequisites have been satisfied;
- Specification of the initial plant condition;
- Reference to limits and conditions for the test;
- Any particular safety precautions; e.g. industrial, radiological, etc.
- Instrument and measuring equipment and calibration dates;
- Appropriate means of recording test results;
- Acceptance criteria and references of the safety analysis report;
- Tolerances in the acceptance values described in the procedure;
- Clear and unambiguous instructions for the conduct of the test;
- Clear instructions when the acceptance criteria is not met;
- Means of restoring plant to a normal condition at the end of the test;
- Identification of the cognizant person for the test.

Confirm that test procedures are developed in accordance with the commissioning programme and well before the test is conducted, in order to meet the quality requirements for approval established by the commissioning organization.

Check that test procedures comply with the procedure writers' guide and that they are ‘user friendly'.

Evaluate the process for preparation of test procedures and determine how the writer acquires knowledge of the design intent requirements in order to structure the test. Determine how the procedure writer ensures that all the conditions the plant will be placed in by the test are previously analysed according to the design.

Confirm after fuel loading that relevant test procedures contain analysis of risks prior to test performance.

Review the procedure for changes to approved test procedures and determine how it is ensured that the change does not lead to an unsafe plant condition. Determine what authority the test controller has to change the procedure during the test and check whether this had been exceeded in examples available.

Verification and approval process
Evaluate the process for review of the test procedures and check whether a specialist with knowledge of the design is involved in the review. Check records of the review of an approved procedure to see how reviewers' comments were handled.

Evaluate the procedure for approval and check that the sample test procedures have been correctly approved. Ensure that the quality requirements established within the operating/commissioning organization are implemented. Review the role of quality assurance in the development, verification and approval process.

Confirm that provisions exist to prevent the plant to be placed in a condition, which has not been analyzed.

Review the participation of the licensee and regulatory authority in the approval for use of pre-operational test procedures, in particular on those important to nuclear safety.

3.10.5. Control of test and measuring equipment

Expectations

Test results gathered during commissioning can only be as accurate as the instruments and calibration methods used. It is important to note that test results will be taken from permanently installed instrumentation as well as from special test equipment. Nevertheless, the criteria should be clearly established.

Test equipment should be available in advance to ensure that appropriate test equipment is used in every test.

Since several organizations are usually involved in commissioning, calibration responsibilities should be clearly assigned. The review should determine that the controls in place ensure that measurements are made and instruments are used in a manner, which can be traced back to a recognized standard.

Examples of documents to be available during the OSART mission:

- Procedure for control of calibration of special test and measuring equipment;
- Procedure for calibration of installed instrumentation.

Evaluations

Calibration programme
Determine the responsibilities of different organizations for the calibration programme and evaluate the existing criteria for using test and process instrumentation and the calibration criteria in either case.
Evaluate the procedures and determine how well the calibration of the following calibration and process equipment (instruments) is carried out and controlled, for example: electrical multimeters, pressure gauges, thermometers, flow meters, radiation instruments, torque devices and process/testing instruments (equipment).

Review the responsibilities for calibration of test and process instruments and measuring equipment, to ensure that instruments and equipment are calibrated before the test is carried out.

Review calibration in progress for both special test equipment and installed instrumentation. Evaluate the adequacy of the calibration laboratory/equipment available in terms of cleanliness, temperature, humidity etc. and the competence of the staff performing calibrations.

Verification process
Confirm that the calibration data is kept at least for the duration of the commissioning stage.

Check how readily a user can determine that an instrument has been calibrated within the required period, considering both installed instruments and special test equipment.

Check the arrangements for reviewing the results of tests, which have been taken with an instrument which is found to be inaccurate at its subsequent recalibration.

Check that adequate records are kept to establish an auditable trail from a test report, through the calibration results of the instruments used and back to recognized standards (consider both installed and temporary equipment).

3.10.6. Conduct of tests and approval of test results

Expectations

The organization, personnel, controls and procedures for conducting the tests should be effective in practice and the objectives for; collecting the necessary data to demonstrate that the plant performs in accordance with the design intent, providing base line data for the plant surveillance programme and ensuring adherence to procedures and administrative documentation should be satisfactorily met. Changes to test procedures should be properly authorized and controlled.

The review of the approval of test results should be structured to establish how the following objectives are satisfactorily achieved, with particular attention to the way in which ‘unexpected' results are handled:

- There is a comparison of plant performance with design assumptions;
- Sufficient data are provided for reassessment of the design assumptions when performance is found to differ from that expected;
- It can be established that the performance of the plant as tested is adequate to proceed with subsequent tests or to release commissioning hold points;
- Appropriate involvement of the regulatory authorities and the licensee.

A rigorous adherence to test and administrative procedures as well as to existing policies during the conduct of the test and approval of test results and a questioning attitude at all levels should be exercised for the safe operation of the NPP. An adequate storage process, facilities and safety and retrievability of commissioning records should be ensured.

Examples of documents to be available for review during the OSART mission:

- Approved procedure for a test which the reviewer will be able to witness;
- Procedure for evaluation and approval;
- Report of completed tests;
- Summary of test with unexpected results and documentation generated, at least of one case.

Evaluations

Conduct of testing

Review the adequacy of briefing all those involved immediately prior to commencement of the test and maintaining control and communication throughout the test as well as responsibility for bringing the plant to the required initial conditions.

Check to ensure adequate responsibility for complying with appropriate operational limits and conditions before, during and after the test. If this responsibility changes from one individual to another, the means of transferring both responsibility and knowledge of plant status should be reviewed.

Review and evaluate the performance of the tests in as much detail as practicable, with particular attention to the following points:

- Qualification, knowledge, experience and attitude to safety and quality of all staff involved;
- Responsibility for restoring the plant to a normal operating condition on completion of the test at different stages in the commissioning process;
- Changes to the test procedure;
- Special tools, test and measuring equipment (refer to item 9.5 of these guidelines);
- Temporary modifications to the plant, during the conduct of the test, including the necessary recording of these activities;
- Participation of operating personnel and the regulator in the conduct of commissioning testing.

Confirm that after core loading special attention is paid to nuclear safety and radiological precautions. Confirm also that testing is carried out in close cooperation with operations. Ensure that facilities and systems to host the new fuel are included in the commissioning programme and the same quality requirements are applied.

Confirm that base line data is collected for the plant surveillance programme.

Verification process

Check the following items:

- The potential for error in recording of test results;
- Whether instruments are of appropriate range;
- Whether plant and installed instruments are adequately identified to ensure that the correct values are being read;
- Communication from individual reading instrument to another recording results;
- Standard of handwriting, usage of pencils, alterations to record of results;
- The potential for mis-selection of channels for computer recorded results.

Check some test procedures in progress to confirm adherence to; in particular to pre-requisites, initial conditions and special safety precautions. Confirm attention to general industrial/radiological safety requirements by those involved in the test.

Confirm that computer printouts, recorder papers etc. are included in the test procedure as supportive information for the test results. Check the arrangements for reviewing the results of tests which have been taken with an instrument which is found to be inaccurate at its subsequent recalibration.

Review the extent of QA involvement during the preparations and performance of the test.

Approval of test results

Check whether the test report presents the results in a clear and unambiguous fashion.

Review the mechanism for comparing the results with the design intent assumptions. Confirm that clearly defined acceptance criteria are available for each test so that the results can be adequately evaluated in an objective manner. Check if there is a reasonable test of significance for any variation found and how the reviewer of results is made aware of all the relevant design intentions assumptions.

Evaluate the process for dealing with unexpected results and check if:

- Subsequent tests are allowed to proceed without question;
- Design specialists are available to consider the implications;
- The resolution is required before clearing the next commissioning hold point;
- The results are discussed at the safety committee;
- Test results vary frequently and sufficiently to require reconsideration of plant design.

Check if reports are produced in a timely fashion for review prior to approval or in great numbers just before a hold point, putting unnecessary pressure on reviewers. Review the date of issue of test reports with respect to the completion of the tests and the commissioning hold points.

Determine whether somebody who carries the necessary authority approves test reports in accordance with the appropriate procedure.

Confirm that the operating organization is involved in the approval process of test results,

Storage of test results
Check that adequate provision is made for lifetime storage of test results and reports and their retrievability. Check also the adequacy of the storage facility in terms of space, fire protection, flooding, cleanliness etc.

3.10.7. Maintenance during commissioning

Expectations
From construction to commissioning and finally to operation the plant should be adequately monitored and maintained in order to protect the equipment, support the testing phase and continue to satisfy the safety analysis report. For accomplishing that, the organization in charge should be well structured and staffed with sufficient and qualified staff. Further more, responsibilities for control and maintenance of spare parts should be clearly defined and executed.

Maintenance applied during commissioning should be up to the same standards applied during operations. Operations and maintenance historical records should be kept from the initial energization and operation of each plant system, and provisions should be made to eventually hand them over to operations.

Construction and operations scope of responsibilities regarding maintenance during commissioning should be clearly identified. The organization established should ensure that the maintenance group of operations, either participates or becomes actively involved in the commissioning maintenance organization at all levels including validation of documentation.

The involvement of personnel from the instrumentation and control section should be especially ensured.

Examples of documents to be available for review during the OSART mission:

- Commissioning and project organization;
- Commissioning Manual;
- Preventive, predictive and corrective maintenance programme;
- Maintenance records.

Evaluations

This topic should be reviewed in coordination with the reviewer of 4.0 Maintenance of these guidelines.

Functions and responsibilities

Confirm that the organization for maintenance during commissioning is adequately documented and the scope of responsibilities is well understood by all parties involved. Review the participation of construction and operations in the commissioning maintenance group and the mechanisms in place to ensure good coordination.

Confirm that corrective, predictive and preventive maintenance programmes are well implemented. Check if adequate computerized means are available to support these programmes and that the programmes are effectively executed. Review the instruments calibration programme. Check if these programmes will continue during operations. Ensure that in-service inspection activities are carried out as per review area 4 of this document.

Determine that the responsibilities over the warehouses and control and maintenance of spare parts are clearly defined among all parties involved. Confirm that storage conditions are adequate. Check if audits or QA surveillance is routinely carried out.

Interfaces with other groups

Check the involvement of operations maintenance personnel in maintenance of commissioning mainly in the area of instrumentation and control, surveillance procedures of the primary protection systems and control systems. Check that operations maintenance personnel are systematically attending vendors presentations. Check whether the plant maintenance procedures are being used as much as possible during commissioning for validation purposes.

Determine the responsibilities for overhauling and maintenance of heavy equipment. Confirm, that operations maintenance personnel participate in these activities.

Confirm that operations and maintenance historical records are being kept from the initial energization and operation of each plant system, and provisions are made to eventually hand them over to operations.

Effectiveness of maintenance

Observe maintenance work in progress and confirm that the standards being applied are the same QA standards applied during normal operation. Confirm the adequacy of procedures and how well they are being adhered to.

Check that maintenance records are properly maintained and provisions are made for the final handover to operations. Some examples of the records included should be:

- Maintenance backlog;
- Preventive, predictive and corrective maintenance historical records;
- Material condition of energized equipment;
- Incorporation of lessons learned.

Review the material conditions of some plant equipment, which has been energized for some time. Check records of routine and corrective maintenance on this equipment. Evaluate whether this is indicative of a well managed programme.

Confirm that a list of incompatible materials exist, is available to appropriate commissioning personnel and being used.

Evaluate how well the backlog is controlled for routine and corrective maintenance work for each organization, which carries responsibility for these activities.

3.10.8. Interface with operations

Expectations

Confirm that the responsibilities of the operating personnel at the plant in relation to commissioning are as follows:

- To satisfy themselves that the systems which are transferred comply with specified performance requirements, the design intent and safety requirements;
- To accept responsibility for the transferred systems;
- To participate in the commissioning activities;
- To become competent in the methods of operation of the plan
- To carry out operation and maintenance with competent staff using approved techniques to meet the needs of the commissioning programme.

The plant should have plans to incorporate operating personnel in commissioning activities at all levels, thus providing the operating staff with an opportunity to become familiar with, and gain experience on their own plant. Operation personnel should be fully and timely informed of commissioning activities.

Responsibilities for nuclear safety should be well defined and understood from the arrival of new fuel and core load.

Operating procedures should be used as much as the conditions of the plant will allow during the commissioning phase, so as to validate them prior to the initial core load. Inter organizational arrangements should be made to schedule this activity to ensure that operating, maintenance, surveillance and chemistry procedures are adequately validated.

Personnel should adhere to normal operating rules, such as access to the control room, control of I&C cabinets and switch boards, communications to the control room for abnormalities and changes in plant configuration. This adherence should be emphasized after the core is loaded.

Examples of documents to be available for review during the OSART mission:

- Description of responsibilities in training of the operating staff and validation of the operating procedures;
- Scope of participation of the operating organization in commissioning;
- Procedure for validation of operating instructions.

Evaluations

This topic should be coordinated with the reviewer of Section 3.0 Operations of these guidelines.

Responsibilities and interfaces during commissioning

Confirm that there is a clear commitment in all organizations to use operating personnel and procedures in the commissioning activities. Check if a detailed programme exists, specifying dates and relevant commissioning activities and where the operating personnel will participate. The existence of programmes establishing this participation and the adequate number of operation personnel integrated in the commissioning organization would prove this commitment.

Confirm that the operating personnel are closely involved in the following activities:

- Preparation and operation of systems and equipment in particular those which are nuclear safety related;
- Work control process and equipment isolation;
- Integrated tests such as: primary and secondary cold hydraulic tests (PWRs), integrated containment leak rate tests, emergency safety systems actuations or hot functional tests;
- Surveillance of equipment performance;
- Control of chemical parameters.

Determine to what extent the operating group is supporting the commissioning phase, and if this support is established by a well developed programme authorized by all parties involved in the construction, commissioning and operation of the plant.

Confirm that a well developed system exists to generate and approve temporary changes to procedures/instructions to be used during commissioning. Ensure that the system is being applied and temporary changes to procedures/instructions are minimized.

Ensure that responsibilities for industrial safety and discharges of hazardous effluents are clearly established.

Confirm that the changes of responsibility after the core is loaded are clear and understood by all parties as well as the responsibilities for the new fuel reception and storage.

Preparedness for operations

Confirm that there is a well-controlled programme for validation of operating procedures and that the procedures to be used during the commissioning phase are well written in advance. Check that the validation process includes:

- Identification of weaknesses in the man-machine interface and ergonomics such as; lighting, room temperature, noises, equipment accessibility and operability;
- Identification of construction and design weaknesses;
- Confirmation of good labeling in the control room and in the plant;

- Participation of the operating personnel in the validation process;
- Validation of operation and surveillance procedures, including the validation of the EOPs to the extent possible.

Confirm that the operations personnel are satisfied with the standard of procedures. Determine what proportion of the operating procedures will be validated during the commissioning process.

Determine if well developed operating type environment is established as soon as possible in the commissioning process but not later than primary/secondary hydrotests. Check:

- That operation personnel adhere to procedures and established operating rules;
- That the access to the main and emergency control room, switch boards, controls cabinets, motor control centers etc. is established;
- Communications with the control room for abnormal incidents, changes in plant configurations and changes in equipment isolation;
- That alarms in the main control room and auxiliary panels are controlled and minimized.

Determine how well operations and special CR operators are informed about system handover. Confirm that after core loading the operations group have total control of the control rooms and equipment related to safety, and that operations personnel report incidents, near misses, field deficiencies and non-conformances regularly.

3.10.9. Interface with construction

Expectations

Confirm that the responsibilities of the construction group in relation to the commissioning process include the following:

- To ensure that the installation of structures, systems and components has been completed in accordance with design requirements and specifications;
- To make suitable arrangements for surveillance and maintenance to prevent deterioration after the completion of installation and before the handover;
- To issue certificates of completion of installation giving the necessary assurances to the commissioning group;
- To provide, for use as baseline data, as-built documentation of installation and test certificates, highlighting design changes and concessions;
- To transfer the installed systems to the commissioning group using a system of documents such as transfer certificates;
- To correct deficiencies in installation detected in commissioning.

Clear and well-understood authorization and communication lines should be established and documented between construction and commissioning to manage a rigorous work prioritization policy established by commissioning. These communications should support the commissioning schedule and the agreement on the scope of activities in both organizations, in particular at the interfaces.

The responsibilities of construction in the testing programme should be well defined in advance to commencement of this programme in order to prevent misunderstandings. This participation should be properly scheduled to meet construction and commissioning requirements.

The quality of maintenance activities should follow operation QA standards during commissioning but especially from core loading where the license holder would be responsible to ensure this. During the commissioning phase special attention should be paid to ensure that the equipment is adequately tested after construction interventions.

Examples of documents to be available for review during the OSART mission:

- Commissioning manual;
- Memorandum of agreements defining responsibilities between construction and commissioning;
- Testing programme and long term schedule.

Evaluations

Responsibilities and interfaces during commissioning

Confirm that responsibilities for the following topics are clearly defined and understood by all parties involved in the commissioning activities:

- Hydrotesting and flushing;
- Design change implementation and testing;
- Pending construction items;
- Clearing of deficiencies;
- Request for construction interventions;
- Work prioritization policy used by commissioning;
- Qualification of suppliers.

Check that the involvement of construction in the testing programme is clearly established and documented in advance to enable the scheduling group to allocate the required manpower. Check to what extent the vendors are implicated in construction and hence in commissioning. Evaluate carefully the participation of construction (vendors) in the review process for the following tests:

- Thermal expansion programme during the hot functional test and power raising;
- Structural tests and analysis;
- Commissioning of heavy equipment, turbine, reactor coolant pumps, etc.

Review the activities of construction during the commissioning stage to confirm that adequate standards are being used. Confirm also that these activities are under control of commissioning mainly in the systems already turned over. In these systems special attention should be given to post construction intervention testing, in particular on systems where the prenuclear procedures were carried out and approved.

Determine the scope of the quality assurance and quality control activities in this interface. Check that the responsibilities are properly assigned and understood by both groups.

Effectiveness of the interface

Confirm that there is prompt construction response to commissioning requests to support the commissioning programme.

Confirm participation of construction in commissioning committees and vice versa, to ensure a continuous awareness in both groups of the current and scheduled plant activities. Check whether specific committees are held to control the progress of this interface.

Confirm that testing carried out by construction complies with commissioning requirements. Confirm that documentation requested by commissioning is supplied comprehensively and in a timely manner.

3.10.10. Interface with engineering (designer)

Expectations

During the commissioning process a thorough validation of the design of the plant should be carried out. As a result, a comprehensive programme to identify weaknesses in design and equipment deficiencies should be established. The effective prioritization and resolution of these deficiencies will be closely associated to the quality and effectiveness of the process, documentation, and communications established between commissioning and the design organization.

Mechanisms should exist at the plant to confirm that all design changes are approved and conform to the design intent. This will be achieved by thoroughly evaluating the proposed design changes prior to their implementation by all organizations involved and by testing the system or equipment after implementation of the changes. In addition, commissioning should have the adequate level of authority to set priorities for evaluation, and implementation of changes proposed.
All documentation affected by design changes should be timely updated and relevant personnel informed. Close adherence to these rules should ensure that plant configuration is maintained at all times and therefore that nuclear safety is not jeopardized during the operation of the plant.

Examples of documents to be available for review during the OSART mission:
- Description of how design changes are managed during commissioning.
- Procedures governing field changes;
- Procedures governing design changes;
- Description of the functions of the Design Change Approval Committee.

Evaluations

Responsibilities and interfaces during commissioning
Review the commissioning organization chart and ensure that the responsibilities assigned to both groups (commissioning and design) are clear, well understood and work well.

Confirm the effectiveness of meetings/committees to discuss design changes, composition and duration. Review the thoroughness of meeting minutes and its distribution.

Determine the involvement of the designer in the approval process of test procedures, in particular, reviewing the validity of the acceptance criteria.

Confirm, that there is an established and approved process for managing changes involving all the organizations concerned and that this process is clear and well understood by all parties.

Management of changes
Confirm that before a ‘design field change proposal’ is originated at the plant as a consequence of identifying a potential weakness or deficiency, the issue is analysed in depth

by the system engineers responsible for commissioning and discussed with the responsible designer. Confirm also that suggested solutions to resolve the weaknesses or deficiencies found are included in the field change reports addressed to designer.

Confirm that a clear differentiation exist between the 'design changes' originated by plant weaknesses and deficiencies found during commissioning and 'design changes' originated by design upgrades.

In cases that the changes are proposed by the plant, determine if there are links between the 'design changes' coming from the designer and the 'design field changes' requested by the plant.

Check if there is a good mechanism in place to keep the originator of the ' design field change proposal' informed of the resolution taken on the proposal, regardless of the result of the response.

Confirm that there is a field change form to administer the process of managing identified weaknesses and deficiencies. This form should include the following topics:

- Originator and supervisor signatures, reference numbers;
- Suggested modification;
- Detail explanation and attachments of complementary information and drawings;
- Nuclear or non nuclear related;
- Priority and basis.

Confirm that special precautions and means are allocated to control changes to software. These precautions should be emphasized if the software is used to control the reactor and/or safety systems. For further information see Section 5.7 of these guidelines.

Effectiveness of interfaces with designer

Determine the quality of communications and support of the designer by investigating:

- The response time to request changes and information;
- The adequacy and quality of the information received from the designer;
- The effectiveness of representatives of the designer on site if applicable;
- The effectiveness of meetings held between both organizations;
- Participation of designer in regular training for commissioning and operations staff.

Investigate how many field changes have been issued during construction and commissioning and what percentage have been disregarded, ignored or resolved.

Determine the average time interval for the resolution of issued field changes. These observations may give an indication of the attitude towards nuclear safety and the effectiveness of all parties involved in the field change process.

Incorporation of changes to documentation and training

Confirm that when a design change proposal is accepted and implemented there is a system established to systematically update the affected documentation; i.e.:

- Operational limits and conditions;
- Operation, maintenance and surveillance procedures, alarm books, etc.

- Drawings, electrical, I&C and flow diagrams;
- System descriptions and set point books;
- Commissioning test procedures.

Evaluate how the commissioning, construction and operation procedures, already developed and approved, are affected by the change.

Confirm also that a comparable system is in force to keep the plant personnel informed of design changes and that these are incorporated into the training programmes on timely basis.

3.10.11. Initial fuel loading

Expectations

Initial fuel load is of great significance because it is the first time that the fuel is brought into a potential critical configuration. This potential for criticality carries with it the potential for radiation hazards, contamination and even nuclear emergencies. The procedure for fuel load should limit the risk of criticality as far as practicable and that measures to control all these hazards should be in place before fuel load commences.
When the first fuel assembly is inserted into the reactor core, the responsibility for nuclear safety at the plant should rests with the license holder or his designee, usually the plant manager. Although, responsibilities for nuclear safety commence since the arrival of the fuel to the site. Responsibilities prior, during and subsequent to this holdpoint should be well defined and understood by the construction, commissioning and operations organizations.

In order to confirm that the plant is prepared for the initial core loading, prerequisites regarding testing, systems, equipment, documentation and personnel should be established well in advance. These prerequisites should be clearly described and documented based on the safety analysis report and the existing regulatory requirements. These prerequisites should be also satisfied well in advance of the initiation of the fuel load.

Prior to this holdpoint the plant personnel should be qualified and trained to a sufficient level to be able to operate the plant in safe conditions.

Examples of documents to be available for review during the OSART mission:

- Organizational charts of all the organizations involved in the initial fuel loading;
- Core loading organization;
- Commissioning initial fuel load procedures;
- Core design report for first change.

Evaluations

Responsibilities during organizational changes
Investigate the change of responsibilities at this holdpoint according to the existing documentation. The commissioning manual might be one source. Investigate the function of the regulatory authority during the whole process.

Confirm that when the first fuel assembly is inserted into the reactor core, the responsibility for nuclear safety at the plant rests with the plant manager. Confirm, that this is clearly understood by all parties involved in the commissioning of the plant by reviewing:

- Who own the systems;
- Who is responsible for the maintenance and surveillance programmes;
- Who has the responsibility to report to the regulatory authority;
- Who is setting priorities in the organization.

Confirm that initial fuel loading shall not be authorized unless, all pre-operational tests deemed necessary by the operating organization and the regulatory body have been performed and the results obtained are acceptable to both parties.

Pre-requisites for fuel loading

Confirm that provisions are made to accomplish the following topics prior to the initial fuel load:

- Operations staff trained as per Section 2.0 of this guidelines and on shift;
- Pre-nuclear testing completed;
- Normal and emergency operating procedures approved;
- Hold points cleared by the regulator;
- Emergency planning and preparedness provisions in place and equipment tested;
- Radiation and contamination control personnel, equipment and procedures in place, equipment tested; For additional information see Section 6.0 of these guidelines;
- New fuel properly stored on site;
- Maintenance and surveillance programmes in place;
- Access control arrangement established;
- List of systems established by hold point arrangements, tested, operational and in control of operations.

Confirm that access responsibilities to computer software/hardware are clearly defined and understood.

Determine if the initial fuel loading procedure is sufficiently comprehensive to conduct this stage safely. Confirm, that pre-requisites are clearly established, that these pre-requisites satisfy the safe initial loading of the core and that provisions are made to execute these pre-requisites step by step. Check if the following pre-requisites are included:

- Surveillance programme in place for this mode of operation;
- Adherence to the Operating Limits and Conditions (OLCs);
- Safety systems operable as specified by OLCs;
- Plant status monitoring system in operation;
- Communications established between the reactor cavity, spent fuel pit and the main control room;
- Systems filled with borated water in the case of PWRs;
- Permanent and temporary nuclear instrumentation system calibrated, installed and tested;
- Audible and visible count rate indication in the control room, initial fuel load centre and reactor cavity.

Determine by observing the accomplishment of these prerequisites and that a safety culture atmosphere exists in the organizations involved in this process.

In PWR's evaluate how the entire process of draining and filling of systems with borated water and subsequent recirculation and sampling is carried out and the commissioning or operating procedures to manage this operation. Determine if there are precautions to avoid an inadvertent dilution or actions to be taken if this occurs.

Ensure that there are requirements and procedures to test the fuel transfer machine and any other tool or system necessary, before commencement of fuel loading.

Check the qualifications and training of the fuel loading personnel. Determine if licensed operators are required to handle the fuel. Confirm that proper training will be carried out on the fuel transfer machine in the reactor cavity and with the spent fuel pit fuel tools, using a dummy fuel assembly.

Ensure that special procedures exist and are used when manual operations are needed.

Determine how well fuel assemblies are inspected prior to fuel load and that every fuel assembly carries its assigned insert, such as a control rod, burnable poison rod, neutron source or flow mixer (as applicable). Procedures should be in place to record all of this information. Confirm that the initial loading sequence is described, and that there are appropriate procedures to manage this fuel loading sequence.

Confirm that licensed engineers supervise the initial fuel loading process and that control room personnel are timely informed of any changes occurring in the reactor. Ensure that shift supervisors and operating personnel are well informed of the actions to be taken during unexpected increases in count rates.

Special precautions during and after the fuel loading
Since the fuel is placed into the core special safety precautions should be exercised by both the commissioning and the operating organizations, Confirm that:

- The operating organization authorize any test to be carried out;
- Testing is carried out just when sufficient safety evaluation is conducted by all organizations involved but mainly by operations;
- Scheduling of test is done well in advance to permit operations awareness, preparations and safety assessment;
- Commissioning personnel is trained and briefed on the analysis of safety risks in accordance with their activities;
- Locking of valves and equipment is implemented to ensure availability of safety systems or to prevent undesired actions.

3.10.12. Plant handover

Expectations

Plant handover is the transfer of responsibilities for the plant. This transfer should be comprehensive and will include systems, equipment, structures and documentation and may include personnel. According to the plant organization and within the handover framework two separate types of transfers may be found, one from construction to operations directly and

the other from construction to commissioning and finally to operations. All these responsibilities and authorities should be clearly established documented and understood.

Systems should be transferred gradually to the operating organization as soon as the pre-nuclear tests are performed and approved. In this way the operating organization can carry out the inspection in a thorough manner prior to acceptance. Systems should also be transferred before the pre-nuclear tests are performed or approved, with exclusive operating responsibilities. Systems and equipment handover should be well controlled and differentiated from ongoing commissioning activities and operations should be timely informed.

The transfer of documentation is a key feature in the handover process. This should be done in system packages and take place over a reasonable period of time in order for the plant to be able to make a comprehensive review of every package. These transfers will also depend on how the responsibilities for the post fuel load, low power and power escalation testing are assigned.

Examples of documents to be available for review during the OSART mission:

- Policy, requirements or arrangements for the handover;
- Commissioning manual;
- Manuals for hand over from construction to commissioning and from commissioning to operations.

Evaluations

Programme for handover

Confirm that a comprehensive procedure or instruction for handover exist that clearly describes responsibilities, requirements and steps in the handover process.

Evaluate whether the persons responsible for Operations or Commissioning are authorized to accept or refuse documentation, systems or the plant if they consider that the construction or commissioning is inadequate and/or incomplete. Check whether there are provisions and procedures for accepting structures, systems or equipment with pending items (deficiencies, documentation, testing etc.).

Determine whether the period for acceptance is adequate to carry out an extensive and detailed inspection of all the documents and equipment transferred.

Confirm that the following topics are covered in the review carried out by the organization receiving the handover package, usually associated with one system:

- Instrument status (control room and plant);
- Status of switchboards, motor control centres and control cabinets, regarding cleanliness, lifted leads, jumpers and unidentified cables;
- The transfer of original and copies of keys for panels, equipment, motor control centres, switchboards, cages and restricted areas; and passwords for accessing equipment or software.
- Identification and labelling of equipment, rooms, piping and instruments;
- Accessibility of equipment for operation and maintenance;
- Environmental conditions, painting, cleanliness, leaks, tidiness, weather protection, scaffolding;
- Status of the thermal insulation, snubbers, hangers;
- Status of the fire protection and fire detection associated with the system.

This review is generally performed by responsible engineers from the organizations involved. Meetings and plant walkdowns by representatives of both organizations should be carried out as part of the review.

Confirm that provisions are made to carry out the handover prior to the system engineer's departure.

Effectiveness of handover
Check if the systems already handed over, are properly identified and are differentiated from other systems. Ensure that personnel understand that the system or equipment cannot be operated without the authorization of the organization responsible. Confirm that system identification is clear and includes instruments and equipment especially, valves, breakers, cables, switches etc.

Confirm by reviewing the handover process that there is not excessive pressure on the organization receiving the systems or documentation packages to accept them.

As part of the handover process determine how well the status of housekeeping, cleanliness, material conditions, lightning, communication etc. on systems in the process to be transferred is being maintained. Sumps should also be included, in particular the containment recirculation sumps.

Evaluate the adequacy of the manufacturing, construction and commissioning records. Confirm that in the acceptance package, the following documentation applicable to a specific handover is included:

- General correspondence and systems records;
- Load tests, hydraulic tests and flushing and cleaning records.;
- Acceptance packages from construction (including welding control films);
- As-built diagrams, electrical, I&C, flow diagrams;
- Pre-nuclear test procedures and report data sheets;
- Failure and incident reports;
- Temporary modifications, lifted leads and jumpers, software modifications records etc.;
- Equipment isolation and work permit records;
- Preventive, predictive and corrective maintenance records;
- Surveillance records;
- Field and design changes records;
- Pending item lists including defects, omissions and weaknesses carried forward from the previous handover;
- Vendors' manuals and setpoint books.

Preparation for operations
Confirm that operations group and especially control room personnel are timely informed about systems handover to operations.

Determine how well the handover pending items lists are controlled. Ensure that the items are subject to appropriate evaluation to determine if any item included in this list could jeopardize nuclear safety after fuel loading.

Ensure that the master strainer log book indicates that all the temporary strainers have been removed. If this book does not exit, a rigorous inspection should be made to locations of temporary strainers (especially in suction of pumps) to identify misplaced strainers.

Also confirm that the handover is performed without weaknesses during the transition period e.g. lack of preventive maintenance, poor instrument calibration or inadequate surveillance.

3.10.13. Work control and equipment isolation

Expectations

During the commissioning of the plant there is a large amount of work that must be done in parallel with the commissioning activities. Responsibilities and authorities to carry out this work should be clearly established, documented and understood by all organizations involved.

This work should be adequately managed to ensure that the testing programme is not impaired and ensures that the equipment tested after interventions is in accordance with established safety standards. The fulfillment of these objectives is closely associated with the effectiveness of communications, coordination and authorities established

During construction, equipment may be worked on without any potential hazard arising from energy (electricity, heat, fluid pressure) contained therein. However after initial energization, a set of rules with appropriate training of personnel in these rules should be required to ensure that workers are protected from these hazards during the work.

Examples of documents to be available for review during the OSART mission:

- Flow chart for work control and equipment isolation;
- Work authorization procedure;
- Equipment isolation procedure;
- Initial energization process.

Evaluations

This topic should be coordinated with the reviewer of Section 3.0, Operations of these guidelines.

Responsibilities for work control
Ensure that responsibilities have been clearly assigned and documented of all organizations involved. Confirm that these responsibilities are understood and determine the authority of the commissioning group in releasing systems/equipment for work, especially in those systems under the cognizance of commissioning.

Determine how well work authorizations are assessed before being released in order to avoid interferences with the commissioning programme. Check the existence of work orders and work authorizations and their links.

Determine if sufficient qualified personnel are available to carry out this work. Determine how many persons have operating and/or maintenance experience.

Work control process

Determine how well the work control process in place coordinates the activities of all the groups involved in commissioning and cover all the major work activities including e.g.: operations, maintenance, quality control, industrial safety, fire protection and commissioning. Confirm proper channeling of the work to the system engineer and awareness in the control room of all the work in progress.

Determine how well the following topics are covered in the work authorization process:

- Identification of the originator and his supervisor;
- Clear description of the work to be done;
- Envisaged completion dates and work extension;
- Equipment isolation system;
- Post-intervention tests;
- Awareness of the commissioning and/or operating personnel;
- Disconnection of cables and jumpers;
- Awareness of the operating and commissioning groups, represented by the shift supervisor or shift coordinator and system engineer and the QA responsible.
- Post-intervention testing should be authorized and approved by the system engineer during the commissioning phase.

Equipment isolation system

Determine if there is a comprehensive process, procedure or system to indicate if a system, subsystem or equipment is prepared to be isolated from boundary systems. If there is, evaluate how well it is followed and investigate which are involved. Investigate if written notice to all concerned parties is provided prior to initial energization.

Review how well the equipment isolation process and procedures address the following:

- Safety recommendations, gloves, glasses, protective clothing;
- Initial and final line up of equipment and identification of individuals performing the work;
- Dissipation of stored energy (drawing, venting, cooling, draining, application of electrical grounds);
- Participation of the persons responsible for the work in the isolation of the equipment;
- Periodic surveillance of the isolation boundaries during the performance of the work.

Evaluate the adequacy of the tagging system in place and determine if tags are placed locally on the equipment, switchboards and motor control centres, and control rooms or control centres. Check how many kinds of tags are found such as; stop tags, caution tags, test tags etc. Evaluate how well the tags are controlled in coordination with the equipment isolation procedure.

Confirm that there is a well understood administrative system to ensure the inoperability of the equipment beyond industrial safety reasons. This system should embrace valves, electrical equipment, doors, panels, cubicles etc.

Determine how well personnel involved in the equipment isolation process are qualified and have been specifically trained for this work. Also determine the scope of involvement of operations in this area.

3.10.14. Control of temporary modifications

Expectations

Inevitably, the process of commissioning requires some temporary modifications (e.g. jumpers, lifted cables, temporary blank flanges, safety valve gags, interlock defeats, non-standard software). Since temporary modifications interfere with the design configuration, they should be properly assessed and controlled.

The process to control temporary modifications in place should satisfy the following objectives:

- When the design configuration of the plant is modified the safety implications are properly considered;
- Modifications are properly documented and marked for easy identification and all groups affected are timely informed;
- The design configuration is restored following temporary modifications.

The safety of the plant strongly depends on the control and management of temporary modifications. Therefore, the responsibilities before and after core load should be well defined, documented and understood and that the whole process of implementation, control and removal of temporary modifications be conducted rigorously and carefully.

Examples of documents to be available for review during the OSART mission:

- Flow chart to control TMs during commissioning;
- Procedure for control of temporary modifications;
- Schedule and records of currently implemented temporary modifications.

Evaluations

This topic should be reviewed in coordination with the reviewer of Section 3.0, Operations of these guidelines.

Process to control temporary modifications

Check if there is a comprehensive programme and/or procedure to control temporary modifications. The programme should clearly identify responsibilities and authorities for the whole process. Ensure that everyone understands what a temporary modification means.

The system engineer may have final responsible for authorizing the implementation of a temporary modification before core loading and the shift supervisor afterwards. In any case, confirm that clear provisions are taken in the procedures to keep the shift supervisor or the shift supervisor informed of the status of the temporary modifications at any step of the process.

Confirm that relevant topics are incorporated into the temporary modification request form such as:

- Time limitation (less than 6 months);
- Extension of the initial period requested;
- Nuclear safety or industrial safety implications;
- Identification and signatures of the originator, person responsible, QA;
- Information and purpose of the temporary modification;
- Restoration requirements and responsibilities.

Determine that there is a comprehensive arrangement for lifted leads and jumpers in the existing documentation.

Ensure that there are well established provisions for systematically assessing the impact of temporary modifications on testing and operations procedures

Confirm that there is a good communication system to keep all groups affected informed of the status of the temporary modifications. Determine if the process considers safety implications of temporary modifications and if those persons responsible are aware of the impact on the design.

Ensure that there is a comprehensive control programme for temporary changes to control and process computer hardware and software are managed. For further information see Section 5.7 of these guidelines.

Periodic assessment
Confirm that a continuous assessment is made of the authorized temporary modifications in order to minimize their number. Ensure that there is an effective mechanism to evaluate temporary modifications that have been extended several times to replace them by permanent changes to the design. Determine how well the root cause is investigated when a large amount of temporary modifications is found.

Check the records of previous and present temporary modifications for adequacy. Confirm that temporary modification documentation is filed in such a way that audits can be carried out.

Check how the implementation and restoration of temporary modifications is supervised and investigate the quality assurance role in this process. Determine if a good system exists to track them and to confirm that they are within the authorized period.

Review how well the temporary modifications in progress are visually identified in the control room and in the plant.

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CONTRIBUTORS TO DRAFTING AND REVIEW

Cook, J.	International Atomic Energy Agency
Dubois D.	International Atomic Energy Agency
Diaz Francisco, J.	International Atomic Energy Agency
Hezoucky, F.	International Atomic Energy Agency
Lange, D.	International Atomic Energy Agency
Lipar, M.	International Atomic Energy Agency
Massera, G.	International Atomic Energy Agency
Mckenna, T.	International Atomic Energy Agency
Nichols, R.	International Atomic Energy Agency
Perramon, F.	International Atomic Energy Agency
Ranguelova V.	International Atomic Energy Agency
Renev, A.	International Atomic Energy Agency
Sengoku, K.	International Atomic Energy Agency
Song, S.	International Atomic Energy Agency
Toth, A.	International Atomic Energy Agency
Vaisnys, P.	International Atomic Energy Agency
Werdine, H.	International Atomic Energy Agency

Consultants Meetings

Vienna, Austria: 16–22 September 1997, 4–11 June 1999

Bull, P.	Nuclear Electric Ltd, United Kingdom
Cordoba, I.	Consejo De Seguridad Nuclear, Spain
Durand, C.	Edf – Gravelines Npp, France
Frick, U.	Leibstadt Npp, Switzerland
Gierich, T.	Byron NPP, United States of America
Lange, D.	Consultant, United States of America
Lipar, M.	Bohunice Npp, Slovakia
Vamos, G.	International Atomic Energy Agency