



INTERNATIONAL ATOMIC ENERGY AGENCY

NENS/OSART/92/58

July 1992

Distr.: Derestricted

Original: English

OPERATIONAL SAFETY OF NUCLEAR INSTALLATIONS

FRANCE

OSART MISSION

FESSENHEIM NUCLEAR POWER PLANT

9 – 27 March 1992

IAEA-NENS/OSART/92/58

OPERATIONAL SAFETY OF NUCLEAR INSTALLATIONS

FESSENHEIM NUCLEAR POWER PLANT

FRANCE

9 - 27 March 1992

REPORT TO THE GOVERNMENT OF FRANCE

PREAMBLE

This report presents the results of the IAEA operational Safety Review Team (OSART) review of Units 1 and 2 at the Fessenheim nuclear power station near Colmar, France. It includes recommendations for improvements affecting operational safety for consideration by the responsible French authorities and identifies good practices for consideration by other nuclear power stations.

Distribution of the OSART Report is left to the discretion of the Government of France; this includes the removal of any initial restriction. Until derestricted, the report will be made available by the IAEA to third parties only with the express permission of the Government of France. Any use of or reference to this report that may be made by the competent French organizations is solely their responsibility.

FOREWORD
by the
Director General

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

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

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

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

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

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

CONTENTS

	Page
INTRODUCTION	1
1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION....	4
2. TRAINING AND QUALIFICATION.....	14
3. OPERATIONS.....	25
4. MAINTENANCE.....	32
5. TECHNICAL SUPPORT.....	40
6. RADIATION PROTECTION.....	49
7. CHEMISTRY.....	54
8. EMERGENCY PLANNING AND PREPAREDNESS.....	59
ACKNOWLEDGEMENTS.....	66
ANNEX I: THE FESSENHEIM OSART TEAM.	67
ANNEX II: SCHEDULE OF ACTIVITIES.....	69

INTRODUCTION

At the request of the government of France, an international IAEA Operational Safety Review Team (OSART) of experts visited the Fessenhiem nuclear power plant (NPP) near Colmar, France, from 9 - 27 March 1992 to review operating practices at the power station and to exchange technical experience and knowledge between the experts and power station counterparts on how the common goal of excellence in operational safety could be further pursued. The Fessenheim OSART was the fourth mission to France.

The team (Annex I) was composed of experts from Belgium, Canada, Germany, Spain, Sweden, the United Kingdom and the United States of America and IAEA staff members with scientific visitors (observers) from Bulgaria, China and Yugoslavia.

Before visiting the power station, the team studied relevant information made available to them to familiarize themselves with the power station's main features, important programmes and procedures, and the operating record of recent years. At Fessenheim, the team of experts, using techniques derived from their collective nuclear experience of 260 years, reviewed records of the power station's operational safety indicators and other documentation, examined applicable procedures and instructions, observed work being carried out and held extensive discussions with power station personnel. Throughout the period of review, there was an open exchange of experience and opinions between the power station personnel and the OSART experts. The review was conducted in depth and the longer report is in keeping with the new Agency policy of presenting more technical details.

Plant description

The Fessenheim NPP has two 880 MW(e) pressurized water reactors (PWRs). The units achieved criticality and commercial operation as follows: Unit 1 - 7 March 1977 and 31 December 1977; Unit 2 - 27 June 1977 and 18 March 1978. The two units were the first of the CP-O pre-series of EDF 900 MW(e) reactors. EDF currently operates 34 900 MW(e) units.

Fessenheim NPP was built by Framatome and is approximately 30 km north-east of Mulhouse and 30 km south-east of Colmar, France. The condensers are cooled by water from the River Rhine.

Each reactor core consists of 157 fuel assemblies with 53 containing control rod clusters. Each fuel assembly consists of 264 fuel rods arranged in a square array. The fuel is 3.25% enriched UO₂ with a core thermal output of 2660 MW. The primary circuit pressure is maintained at 15.5° MPa with a coolant temperature on exit of 322°C. The primary circuit is served by three loops each having a vertically mounted steam generator and a coolant pump.

Safety systems to cope with design basis accidents are provided in addition to normal and auxiliary systems. These safety systems include the protection systems, emergency power system, emergency core cooling systems, emergency feedwater system and containment systems. The protective systems initiate a reactor scram or activate other safety functions whenever the limits of the safe operating range are approached. The emergency power system comprises two diesel generators and associated controls for providing power to the emergency core cooling systems, emergency feedwater system and containment systems. The emergency core cooling systems have enough capacity and redundancy to maintain core cooling until the reactor is in a safe cold shutdown condition within pressure boundary limits. Subsystems of the emergency core cooling systems include the three high head injection pumps, two low head injection pumps, two residual heat removal pumps and three core injection accumulators.

The emergency feedwater system for the supply of the steam generators is a three train system. The system consists of two motor driven pumps and one steam driven pump and a large auxiliary feedwater storage tank.

The nuclear steam supply system and its high pressure auxiliaries are contained within the reactor building which is made up of a prestressed concrete containment with a steel liner. The inner height is 60 m and it is of a pressure tight design to confine the effects of the most improbable severe reactor damage to the interior. The outer prestressed concrete wall is capable of withstanding external impacts including that of an aircraft.

Main conclusions

Eight areas were reviewed by the experts: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry and emergency planning and preparedness. The main conclusions can be summarized as follows:

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

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

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

- Management presence and monitoring in the plant should be increased to set higher standards of performance such as in the areas of material condition and housekeeping;
- A systematic process should be established to ensure the timely completion of action items and commitments;
- Greater attention should be given to the control and review of plant configuration changes such as temporary plant and procedure modifications;
- Wider use of objective internal evaluations through quality assurance should be used to evaluate and improve the implementation of various plant programmes;
- Increased emphasis is needed in the operator training programme on refresher training and on comprehensive skill and knowledge evaluations prior to authorization and for re-authorization;
- Improvements should be made in the analysis of events and in control of the operating experience programme, including in the definition of responsibilities, in the consistency and thoroughness of event analysis and in ensuring the timely completion of all recommended actions;

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

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

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

Within EDF, nuclear generating facilities are managed by the Nuclear Generating Capacity (SPT) which is part of the Generation and Transmission Group (DPT).

The SPT is an extensive centralized organization and sets policy nationally which is adapted locally by the individual plants. The SPT also provides technical assistance and support to all areas of operation.

A strategic plan establishes concrete objectives and medium term initiatives for all levels of the company. The implementation of this plan is accomplished through the effective utilization of negotiated management contracts between successive tiers of responsibility.

The plant management structure is well defined and is considered effective, but could be further enhanced by additional management tools in some areas and by increased management presence in the plant.

The industrial safety programme is well defined with appropriate oversight by the Safety and Radiological Protection Department.

The document control process is well structured, effectively controlled and efficiently implemented.

Plant management has instituted an initiative to create a strong safety culture which is soundly based on the application of quality assurance and personnel responsibility.

Improvement in a number of areas as a result of this effort has been evident. Further improvement could be realized by the expansion of some quality assurance activities and by the instillation of safety culture in a broader spectrum of operational activities.

1.1 Structure of Operating Organization, Responsibility and Administration

Size and structure of the operating organization

Within EDF, generating facilities are managed by the Direction de la Production et du Transport (DPT), the Generation and Transmission Group (DPT). Part of this group, Service de la Production Thermique (SPT), the Nuclear and Fossil Generation Division (SPT), manages all thermal power plants. SPT is an organization of about 2000 people with headquarters in Paris.

SPT is under the direction of the Manager of Nuclear Generating Capacity. Reporting to the Manager are two Deputies for nuclear matters, four Advisors in the nuclear inspectorate, and three Area Managers. One Area Manager is responsible for all two unit plants. The Fessenheim NPP Plant Manager reports to the Area Manager for two unit plants.

Policy making functions

The Management Committee of the SPT consists of the Manager, his two Deputies for nuclear matters, his four advisors, and the three Area Managers. Major policies are developed by the Management Committee, assisted by the corporate departments and the national units.

Based upon a management strategy that emphasizes decentralization and consistency, policy is defined nationally but adapted locally.

Management goals and objectives are clearly communicated through each given tier of the hierarchy by the utilization of strategic plans. The strategic plans are implemented locally by a process based upon negotiated contractual relations between each successive tier of management. This management scheme, by design, utilizes optimal dissemination of management choices supplemented by a frame of reference which clearly specifies the objectives and indicates the restraints.

A programme for monitoring the effective implementation of management policy and directives exists at each level of management. Various methods are utilized including, nuclear safety oversight committees, the Nuclear Inspectorate, checking of management contracts, financial audits and Management Committee inspections.

The Manager of DPT and his Deputy, the Manager of SPT, delegate their authority to the nuclear power plant Manager. As regards nuclear safety, the Plant Manager is thus the site representative of EDF.

Lateral communications and team work at the plant are also fostered by the establishment of the Management Committees. These committees work together to achieve the goals and objectives of the various management contracts.

Good practice: The Integrated Strategic Management Initiative of April 1988 resulted in the development of a company strategic plan prepared in 1989. This plan establishes concrete objectives and medium term (three year) initiatives for all levels of the company. The management system derived from this process is based on negotiated management contracts between successive tiers of responsibility. These contracts constitute the short term management plan, detailing the annual commitments of a given tier of the hierarchy having decision making authority, relative to the tier above. The commitments are clearly stated and are easily measured. Progress is monitored by performance indicators established at the time the contract is negotiated. Periodic monitoring of the contract is performed such that corrective actions may be taken if deviations from the desired objectives are forecast. At the end of the contract period, a report is submitted that analyses any differences between desired and actual results.

Operating functions

The corporate operating functions are provided by the National Units consisting of the Technical Support Department (UTO), the Central Laboratories Department (GDL), the General Technical Department (DTG), the Data Processing Department (DI), and the Overseas Support Department.

Collectively, the National Units total about 1400 engineers and technicians. These Departments do not have decision making power, either as concerns overall policy for SPT or for matters concerning the nuclear units themselves.

Supporting functions

The Nuclear Generating Capacity Co-ordination Team (GCP) was created to identify plant events that may potentially affect all nuclear operations. This is a cross-functional organization that deals with real-time management of SPT business. GCP collects all pertinent information on plant incidents and co-ordinates the response actions of departments, particularly in cases where the nature of the event crosses functional lines.

Supporting functions within SPT are provided primarily by the corporate departments. They perform the dual task of assisting the SPT Management Committee in the development of policy and assisting the units, particularly for expert examinations and analysis.

The operations Department (DEX) establishes the operating policy, manages experience feedback by analysing the technical and human performance aspects for operating incidents, drafts and manages the reference operating documents, handles management for the modifications and national files, and carries out core management for the plants.

The Maintenance Department (DM) establishes maintenance policy, manages experience feedback by analysing anomalies and equipment failures, drafts reports and reviews, and carries out anomaly studies and expert examinations for the plants.

The Nuclear Safety Department (DSN) establishes safety policy, manages cross-functional monitoring of safety matters and interfaces with the Safety Authorities in support of the technical departments.

The Industrial Safety, Radiological Protection and Environment Department (DSRE) establishes policy in the fields of radiation protection, environment, radioactive release, radioactive waste and safety while managing experience feedback in these areas.

The Interface Department (DI) takes part in designing units by providing the Engineering and Construction Group with experience feedback of units in operation which is incorporated into the original design.

The Administration Department (DA) establishes training policy, participates in defining national training resources and establishes human resources policy.

Reviewing functions

The corporate reviewing activities within SPT are intended to close the management system loop and cover three basic objectives:

- (1) ensuring a high level of management quality and consistency;
- (2) checking results against desired objectives;
- (3) detecting deviations so that appropriate corrective action can be initiated.

The internal monitoring system of the company is organized at a number of different levels and utilizes a variety of methods. Nuclear oversight committees have been established at each level of management to discuss and analyse questions relating to nuclear safety.

1.2. Plant Organization and Management

Plant Organization

The plant organization is well defined by organizational charts. Roles and responsibilities of key plant personnel are described in the Plant Organizational Manual along with policy documents that outline the functional responsibility of each department.

The management structure consists of the Plant Manager, the Deputy Plant Manager, four managers, each of whom is responsible for two specific areas, eight management consultants, each with a single area of expertise, and twelve department heads, each of whom is responsible for a department. The departments range in size from ten to 113 people.

The Plant Management Committee comprises the Plant Manager, the Deputy Plant Manager, the Maintenance and Budget Manager, the operations and Data Processing Manager, the Human Resources and Trade Union Relations Manager and the Nuclear Safety and Quality Assurance Manager.

Delegation of authority for members of the Plant Management Committee is defined in legal documents. Delegation of authority for Department Heads is defined in the Plant Organization Manual and the respective management contracts.

The Plant Management Committee members are also members of the Plant Operating Review Committee whose function is to review and analyse issues relating to quality and safety as well as to review the contents of the Quality Assurance Manual and to issue recommendations.

There is no particular bias toward the expertise of prospective members but rather an attempt to ensure that the members of a plant's Management Committee are well balanced and complement each other.

A fundamental principle of a sound safety perspective is a level of technical knowledge in the various areas of power plant management sufficient to be able to judge operational events that may be safety significant. This knowledge is also essential when reviewing issues relating to safety, to ensure that the right questions have been asked and resolved satisfactorily. Although the members of the Fessenheim Management Committee have balanced operating, safety and maintenance skills, formal position requirements for key management positions have not been established by the EDF Career Committee. For example the position of operations Department Head does not require operations training to the level of Operations Supervisor (i.e. shift supervisor).

- (1) **Recommendation:** Although the members of the Fessenheim management staff have balanced operating background and skill, the EDF Career Committee should review and formalize the practice of appointing members to the Management Committees to ensure strong operational expertise. Formal qualification and experience requirements should be established for key management positions. Supplemental technical training, particularly in the areas of operations and radiation protection, should be provided to management candidates for these areas if not previously acquired through training or actual experience.

Management objectives

Management goals and objectives are clearly defined by means of contractual agreements drawn up between successive tiers of management. These contracts are consistent with the strategic plan and in design support the contract of the next highest management level. The contract objectives are monitored, performance indicators are trended, and corrective actions are taken if the forecast results deviate from desired objectives.

Programmes have been established and approved for most plant activities with some notable exceptions. No programmes exist to monitor formally the status of experience feedback action items, to track recommendations of the Plant Operating Review Committee or to document and resolve lower level in-house operational experience.

It is essential for plant management to be able to ensure that effective corrective actions have been applied to important commitments and directives. The system currently in place to resolve these issues places a great deal of dependence upon the individual initiative and sense of responsibility of the managers and department heads to whom the tasks have been assigned. Managers at all levels need to have the tools at their disposal to be able to ensure that no important actions or commitments are overlooked.

- (2) **Recommendation:** A management task tracking system should be developed and implemented to document and track the status of corrective actions, Plant Operating Review Committee recommendations and important commitments. This system should clearly define the action required to be taken, the individual responsible for taking the action and the date by which the action must be completed. Routine reports should be generated and reviewed by plant management.

An essential element of a strong safety culture is the fostering of a questioning attitude on the part of all plant employees. The presence of deficiencies in material conditions in the plant indicates that not all plant employees feel obligated to investigate and report them.

Operational events occur within the plant that, although not meeting the criteria for a significant incident, could be precursors to a more serious incident or could be indicative of a programmatic or systematic weakness.

Investigations of these lower level incidents to determine root causes and corrective actions would enhance overall safety and reliability while at the same time promoting and encouraging a questioning attitude.

- (3) **Recommendation:** A programme for documenting and following up on lower level in-house operating experience should be developed and routinely reviewed by plant management.
- (4) **Recommendation:** The timely reporting of deficiencies in plant material conditions should be emphasized to all plant personnel as a fundamental job responsibility to which they are obligated.
- (5) **Suggestion:** A system of identifying previously reported deficiencies in the field, such as deficiency tags, would facilitate the process and also provide a visual reminder of the obligation to report deficiencies as plant personnel go about their routine.

Plant personnel will be more likely to believe that management values attention to detail and questioning attitudes if they see managers in the plant, making regular tours and observing work. The standards set by management will only be achieved if the managers check on them at first hand.

- (6) **Recommendation:** Making routine management tours of the plant and interfacing with workers first hand should be given a higher priority by the Management Committee.
- (7) **Suggestion:** A more formal programme of "Management by Walking Around" should be considered that would bring managers and Department Heads into the plant more frequently.

Administrative procedures

Procedures, rules and instructions are consistent for both nuclear units. The units are identical and the management and administration of the units are also identical.

The Plant Operating Review Committee and its associated subcommittees are described in administrative documents. The function, responsibility, membership and quorums are clearly defined.

The meeting frequency of the Plant operating Review Committee is defined by procedure to be quarterly. In a recent three month period, eight special meetings were held. Special meetings tend to be more ad hoc and do not always provide enough time for preparation and familiarization with the issues.

- (8) **Suggestion:** Consideration should be given to holding routine meetings of the Plant Operating Review Committee more often.

The procedure for the Plant operating Review Committee (PORC) allows for a regular member to delegate a subordinate to attend in his or her absence. It has been observed frequently in international practice that alternate members are designated in advance to ensure that the optimal degree of experience is available.

- (9) **Suggestion:** Consideration should be given to designating alternates for regular members of the PORC in advance, limited to subordinates only one management level lower than the regular member and approved by the Plant Manager.

1.3. Quality Assurance Programme

QA organization and responsibilities

Corporate QA policy is based upon the National Quality Assurance Manual. On the basis of the National QA Manual rules, each site has drawn up its own Quality Assurance Manual. The basic rules apply to all equipment, structures and systems which contribute to the safety and availability of nuclear units.

In order that the National Manual can be adopted specifically to each site, it contains a section describing the site organization and organizational documents defining the practical methods for implementing the requirements of the National QA Manual.

Within this frame of reference, Fessenheim NPP has in place a QA organization with organizational documents and procedures that clearly define the responsibilities and authority of the QA unit. Training emphasizing the importance to quality in a nuclear plant is given to all employees.

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

Written procedures for the activities affecting nuclear safety as defined by the QA manual are subject to the requirements of the programme. Temporary modifications (DPMs) that are made in conjunction with maintenance activities are subject to the requirements of a quality plan; however, the safety evaluation made in conjunction with these quality plans do not take into consideration some important aspects of nuclear safety.

- (1) **Recommendation:** The safety evaluation that is currently being made in conjunction with DPMs should be expanded to include specific consideration for impact on the design basis, safety analysis assumptions, disabling of safety alarms or functions and Technical Specifications.

Some procedure sets are defined as important to safety and receive a high degree of review by a corporate technical review committee (GERC). These sets include the Accident Procedures, Incident Procedures, Ultima Procedures and Procedures for events considered to be outside the design basis. The review by GERC takes into consideration the design basis, safety analysis and Technical Specifications. Normal operating procedures and other procedures that are included in the series E, F, G, S and fuel handling procedures, and changes made to them, receive a much less rigorous review. Changes to these procedures are made within the relevant department by an authorized person and are approved by another authorized person within that department.

- (2) **Recommendation:** Periodic review and changes made to some important procedures (Series E, F, G, S and fuel handling procedures) should receive a multidisciplinary review by technically qualified people with specific consideration of how the proposed change could unfavourably affect the design basis, safety analysis, critical setpoints and Technical Specifications. The procedures requiring this review should include all procedures that could have a direct impact on nuclear safety, including procedures controlling reactivity, vital electric power supplies, operating with reduced inventory and spent fuel handling.

- (3) **Suggestion:** Consideration should be given to having the multidisciplinary review performed by a subcommittee of the Plant operating Review Committee for approval by the Plant Manager.

QA Programme implementation

The QA Programme is implemented by the utilization of systematic checks during activities by the cognizant supervisors and by audits conducted by Quality Specialists within the Safety Department.

The QA checks and audits performed are primarily directed at activities. Audit reports are submitted and a tracking matrix maintained by QA is reviewed periodically by the Management Committee. Individual Managers and Department Heads do not have a formal system of tracking their QA audit commitments. Close-out of QA audit items does not require any formal root cause analysis.

While checks and audits on activities will reveal specific problems associated with that activity, they will not necessarily reveal programmatic weakness that could be causing similar problems in other areas.

- (4) **Recommendation:** The QA audit programme should be expanded to include audits of programme implementation, such as the Industrial Safety Programme, Operator Training Programme and Equipment Blocking Process.
- (5) **Recommendation:** QA audit findings should be classified by their relative significance. For findings of high significance root cause evaluations should be required as part of the close out.

Oversight of the QA programme

External review of plant QA programmes is performed at the corporate level by the Nuclear Inspectorate which reports directly to the Manager of SPT. The Nuclear Inspectorate consists of 17 inspectors and eight support engineers. The inspections are accomplished by several different methods, including:

- overall evaluation of operational quality;
- special evaluations on a theme to evaluate consistency between sites and generic implications and to provide an overall view of practices of a given theme;
- investigations at the request of plant management following significant events;
- VISUREX missions, team inspections by teams of operators from French and Belgian plants.

The VISUREX missions are similar in structure to peer evaluation missions used in other countries such as the U.S.A. and Canada. The evaluation teams are led by EDF plant managers. Each team is composed of about 20 evaluators from the operating staffs of various EDF plants assisted by 7 or 8 inspectors from the Nuclear Inspectorate. Each evaluation takes place over a two week period and is used primarily to promote the exchange of experience feedback between plants. About four VISUREX missions are conducted each year. Reports are prepared on the activities of the Nuclear Inspectorate and submitted to the manager of SPT.

The Quality Assurance Programme that has been put in place by EDF has all the elements necessary for a strong programme. However, the level of oversight may be too small. There are no formally established programmes for monitoring site QA programmes and no periodic in-depth reviews are performed. If continuous improvement is expected in the area of operational nuclear safety it is essential that the QA programmes are capable of providing continuous quality assessments. It is equally essential that corporate oversight of the QA programmes be capable of providing quality assessments.

Although the initiative to establish a strong safety culture is upon sound principles, the safety perspective that has evolved is too narrow. Examples that tend to indicate this include the following:

- the limited scope of procedures requiring in-depth review;
- the lack of attention to the design basis in making configuration changes with temporary modifications and procedural changes;
- the lack of formal tracking of significant event action items and important commitments;
- the failure of the QA programme to evaluate the effectiveness of programme implementation;
- the lack of periodic review in depth of the plant QA programme by corporate management.

- (6) **Recommendation:** The corporate support and oversight of plant QA programmes should be strengthened.
- (7) **Recommendation:** Consideration should be given to incorporating the sound principles of quality and safety that currently apply for safety related systems to other areas that could directly affect operational safety.

1.4. Regulatory and other Statutory Requirements

The regulation of the French nuclear industry is by the Ministry of Industry and the Ministry of Environment for matters of technical nuclear safety and from the Ministry of Labor and the Ministry of Health for radioprotection matters. The Nuclear Installations Safety Directorate (DSIN) directs field inspection activities mainly through Regional Divisions in DRIRES (Industry, Research, and Environment Regional Directorates).

The inspectors communicate directly with plant management and exit meetings are held following each inspection. Within two weeks following each inspection a preliminary report is forwarded to DSIN by the DRIRE inspectorate. At this time a letter is sent to plant management requesting formal responses to any inspection findings.

No copy of the inspection report is given to the plant or to EDF. Following the receipt of the responses, DRIRE only communicates with the plant if it considers a response inadequate.

In order to prepare satisfactory responses to inspection findings, it is necessary for plant management to have a complete understanding of the basis of such findings. Having access to the preliminary inspection reports submitted to DSIN would facilitate that understanding. Dialogue between the DRIRE and plant management concerning both acceptable and unacceptable responses would clarify all issues and enhance communications and understanding between both parties.

- (7) **Recommendation:** A copy of the DRIRE preliminary inspection reports should be given to plant management at the time of the request for responses to inspection findings.
- (8) **Recommendation:** A letter should be sent to plant management following the receipt by DRIRE of responses to inspection findings. This letter should acknowledge the Safety Authorities' understanding of acceptable responses and indicate the basis for rejecting responses not adequate.

Inspections by the DRIRE consist of announced inspections, which follow a six month inspection schedule, incident inspections following an operational incident, and unannounced inspections based on themes determined by DSIN. Eight inspections are required in every six month inspection period. Inspections generally are completed in one day by an inspector either alone or with one or more technical advisors.

Follow-up inspections are conducted periodically to check that commitments made are fulfilled satisfactorily.

Prior to each plant startup, for outages lasting more than 14 days, the Safety Authorities review outage work, modification packages and plant outage performance. Based on the results of these reviews, the Safety Authorities either grant authorization for restart or prohibit startup until problems are resolved.

1.5. Industrial Safety Programme

The EDF industrial safety programme is based on federal industrial safety law and is inspected periodically by the Regional Safety Authorities (DRIRE).

The industrial safety programme is monitored by the Committee for Health and Safe Work Conditions (CHSCT). This committee comprises members of the plant staff at all levels and has functional responsibility to improve work conditions, ensure application of work instructions, monitor safety training and recommend necessary changes. The CHSCT is authorized to stop work if working conditions are unsafe.

Industrial safety awareness is enhanced by an incentive programme for all employees that provides rewards for good industrial safety performance, including both extra time off and financial incentives. A surveillance procedure exists for testing safety equipment on a routine schedule, as well as a special procedure for diving operations.

Accidents that result in an absence of 24 hours or more are investigated and a report is submitted to the Safety Department. All treatable injuries are documented and reviewed by the Industrial Safety Department. Data from these reports is compiled and an injury trend report forwarded to CHSCT for consideration of corrective action.

Specific information on the types of injuries occurring and corrective measures taken is not communicated directly to all workers except in extreme cases, when they are sent an information notice.

- (1) **Recommendation:** Routine departmental or sectional safety meetings should be held for all workers within a department or section. These meetings should be conducted by the Department Head or Section Head. Injury reports should be reviewed, corrective measures discussed and worker input solicited. These safety meetings should also be used to reinforce basic expectations such as the use of hearing protection, hard hats, safety glasses, etc.
- (2) **Good Practice:** The personnel Safety Handbook and the safety training given to personnel are very comprehensive and indicative of management's sensitivity towards providing a safe workplace. Each job performed by a contractor is preceded by the signing of a pre-job summary agreement. This agreement covers job type, location, industrial safety considerations and expectations. It is signed by the site representative of the relevant department and the contractor's representative.

1.6. Document and Record Management

Procedures and instruction documents exist for the revision, verification and approval of procedures. Records management by the Document Control section is well defined and adequately maintained.

Writers' guides have been developed to ensure that procedures have a consistent format and a quality control procedure is used to ensure that standards are met when a procedure is rewritten or a new procedure is created.

Temporary procedures, when used, are the responsibility of the originating department and are intended for one time use, and as such are not distributed by document control.

Drawings are maintained in a master file, updated on site and distributed prior to startup for outage modifications. Regulatory requirements for retention are clearly reflected in procedures and are periodically inspected by DRIRE.

A computerized document control system in conjunction with detailed document identification cards makes documents easily retrievable.

All files are stored in specially designed vaults protected by carbon dioxide fire suppression and maintained, with an appropriate monitoring capability, within appropriate atmospheric tolerances for paper and film.

Revised procedures, instructions and drawings are distributed from the main distribution centre and through satellite centres that are conveniently located in areas where the documents are most likely to be used.

Out of date and invalid documents are stored, as required, on microfilm in the storage vault as specified by the retention regulations.

2. TRAINING AND QUALIFICATION

The plant manager is responsible for the qualification of the plant staff and the department head is responsible for the qualification of and definition of needs for and training given to his assigned personnel. Each department head has in his or her organization a deputy to help with the training activities of the department. This deputy, in addition to his or her normal job, co-ordinates training activities of the department staff.

The contents of the Fessenheim training programme reflect the concerns of management about safety aspects, quality assurance, risk prevention and awareness of responsibilities by the employee.

An important characteristic of the various training programmes is the technical competence of the instructors, the very high professionalism of personnel, and the quality and diversity of training facilities and equipment. Additionally, innovative training approaches are being applied to increase educational levels of personnel and to develop focused training programmes for important plant jobs.

There are however a number of areas where training could be improved. A deeper task analysis for each plant job should be carried out to focus the contents of the programme and training environment more accurately. Increased emphasis is needed in the operator training programmes on refresher training, including simulator and theoretical knowledge training, and comprehensive skill and knowledge evaluations prior to authorization and for re-authorization. Additionally the on-the-job training (OJT) programmes should be better structured and formalized to ensure the effectiveness of training and an objective trainee evaluation based on job performance.

The plant staff are making efforts to improve the initial and continuing training of personnel which, when completed, will strengthen the existing training programme.

2.1. Organization and Functions

Training organization

The corporate training centres (operating and maintenance) are dependent on the DPRS (Personnel and Staff Relations Group). These training centres provide, in general, the national training courses identified in the Guide Plan for Training document (PGF) which includes all generic courses related to nuclear safety for each job existing in the NPP.

Additionally, some training activities, plant specific courses and possibly national courses, are conducted on the site depending on the facilities and qualified human resources available for conducting them.

All departments at Fessenheim have an identical training structure except for the operation Department. Due to the amount of training within the Operation Department, a department deputy is assigned who only has training responsibilities.

Approach to training

The training requirements for a specific job in the plant are described in the Standard Training Plan (PTF), which is managed by each department training deputy. The PTF is structured in such a way that it defines four types of training:

- nuclear safety courses
- other compulsory courses
- courses common to sites
- other recommended courses.

The qualification criteria for each position are well established. To reach the nuclear safety qualification level, the employee must have received the required courses listed in the PTF or have equivalences granted by line management. Qualification and requalification certification are compulsory for all jobs according to the qualification level. This requalification is subject to re-evaluation by the hierarchy.

The requirements for each job related to safety are defined at the local level except for those of the operating team. These are defined at the national level by a Systematic Approach to Training (SAT) doctrine. However, the SAT doctrine used is based on a broad topical level task analysis requiring significant subject matter expertise to develop actual training programmes and adequate evaluations. This results in the developed training programmes and examinations not being clearly linked to the learning objectives.

Additionally, as indicated by the standards, there is no external entity to the plant or at the training centres which systematically supervises the application of the entire process of training to ensure that the plans, programmes and the qualification requirements are met.

Although SPT has developed a job and task analysis (JTA) method ("référentiel métier") and applies it to the operating team, the lack of depth in the task analysis for the control room operators results in training and examinations not being directly correlated to actual operator tasks. As a result, management judgement for the qualification of control room staff is often based on subjective factors rather than comprehensive performance factors.

- (1) **Recommendation:** Expand the current job and task analysis to analyse the tasks and to identify the corresponding learning objectives to ensure that training programmes are based on preparing control room staff to perform these tasks. Additionally, the JTA should be adapted for Fessenheim to account for any plant differences and continuously kept up to date for plant modifications procedure changes, etc. Job, tasks and derived skills and knowledge should be codified adequately to correlate easily the results of the JTA.

The purpose of an on-the-job training (OJT) programme is to train and evaluate job related skills and knowledge within the plant environment. On-the-job training provides realistic and hands-on experience for the trainee that is directly applicable to the job. Fessenheim NPP does not use formal OJT programmes to train personnel.

- (2) **Recommendation:** The OJT process should be formally developed using standard methods, to ensure adequate and consistent training on knowledge, skills and tasks required for job performance. The OJT programme should be formalized to ensure an objective evaluation of skills through performance, simulation or discussion of tasks required for job performance to grant the appropriate qualification. In addition, potential instructors should receive an instructional training course on how to conduct and evaluate OJT.

Owing to EDF policies, national standards for the plant training and authorization of operators are not formally established independently of the training and operation organizations. This fails to ensure the existence of a clear and consistent operator training and authorization process.

- (3) **Suggestion:** Consideration should be given to developing, independently of the training and operating organization, authorization and performance standards to ensure high standards in the training and authorization of operating personnel.

Standard Training Plans (PTFs) for each plant job may vary each year. Therefore it is necessary to check content of the PTF and the Individual Training Plan (PIF) of each individual prior to granting authorization by the department head.

- (4) **Suggestion:** Consideration should be given to developing a computerized cross-reference between the Standard Training Plan (PTF) and the Individual Training Plan (PIF) in order to help determine whether the individuals are missing any required training courses.
- (5) **Suggestion:** Consideration should be given to developing the PTF in a graphical format in order to ensure that the individuals are given the training courses in the appropriate sequence.

Good practice: The training courses conducted relating to quality and safety issues will increase the awareness of personnel about safe plant operation. An appropriate lesson in safety culture is being provided to the personnel.

Good practice: The station training committee created to co-ordinate general policies and programmes of the plant will increase homogeneity of training and help communications between departments about training matters.

Good practice: The local and national programmes to improve the educational levels of personnel (50% of BAC + 2 by the year 2000), given the necessary time and economic resources (training and qualification bonus), will increase motivation, improve qualifications and lead to safer plant operation. Additionally, the existing high number of training hours given to Fessenheim personnel during 1991 constitutes action to improve the technical level of personnel.

Good practice: The procedure for selecting a candidate for a vacant post, consisting of a written and oral examination, a functional simulator evaluation and an individual interview by the department head, is a very good practice to ensure success in subsequent training and leading to safer plant operation.

Good practice: Formalized personnel interviews at the beginning of the year to specify individual training needs is a good practice to promote improvement in the management of technical training of personnel.

Instructor qualifications

The Bugey training centre has two types of instructors: (1) simulator instructors and (2) theoretical instructors. Instructors originate from two sources, either directly from engineering school (BAC + 5) or from an NPP. Individuals who come from an engineering school follow the same training programme as for control room operators plus pedagogical skill courses for training to teach adults.

Retraining or refresher courses are not provided for instructors. During the instructor assignment at the training centre they also do not periodically return to the plants for refresher training. There is an appreciable turnover of instructors owing to the EDF policy of rotating instructors every 3 to 5 years.

Formal continuing training that maintains and improves instructional and technical skills is not provided for corporate instructors. Reliance instead is placed on instructors participating in working groups developing new training initiatives, managing additional training requests by the NPPs, and updating the content of the courses based on plant modifications and

operating experience. Formalized continuing development in technical skills training is normally required to maintain the knowledge and skills of instructors at or above the level necessary to provide effective training.

- (6) **Suggestion:** The corporate instructor retaining policy should be reviewed. A systematic means of providing instructors refresher training on advanced instructional and academic skills should be considered. In addition, a periodic assignment at a NPP is recommended to maintain current plant knowledge.
- (7) **Suggestion:** Some turnover of corporate instructors is recommended in order to get a fresh and motivated staff of instructors, but an excessive turnover may not be advisable. It would be desirable to determine the most appropriate rate of instructor turnover.

The training staff in the Fessenheim NPP training section have adequate technical qualifications and receive instructional skills training. They have the necessary qualifications to train line staff and skilled workers in technological and functional simulator courses.

Additionally, most personnel in all departments receive instructional skills courses and give training (lectures and shadow sessions) to their technicians when refresher courses or initial training courses are required.

2.2. Training Facilities, Equipment and Material

Corporate training facilities

Three 900 MW(e) and one 1300 MW(e) full scope simulators are installed at the Bugey training centre. The simulators are used for skill and knowledge based training.

Functional simulators are used to train operators on the key plant systems. The expert system simulator (SEPIA) is used to train operators and shift supervisors on steam generator tube ruptures. Both types of simulators are available at the Bugey training centre.

The Bugey simulator is not a Fessenheim plant specific simulator. Training related to loss of AC power accidents cannot be given owing to limitations of the simulator's software model and it is not possible to execute multiple accident scenarios on the CP0 simulator. Owing to this simulator limitation it is necessary to use the CP1 simulator (at Gravelines) for advanced refresher courses.

A simulator is an especially valuable tool because it gives operating personnel "hands-on" experience. It is preferable that the simulator used for training have operating characteristics similar to those of the plant. Training on a non-plant specific simulator can detract from training.

- (1) **Recommendation:** It is recommended that the Fessenheim operating team be trained in a full scope plant specific simulator. This will prevent any abnormal responses by the teams and will help the operating personnel to a better understanding of the design of their own plant under normal, abnormal and accident situations. The project should be continued to as to have the Fessenheim specific simulator completed by 1995. Simulator model software of the CP0 simulator should be upgraded to simulate accidents or combinations of accidents on the basis of the Fessenheim plant.

There are three maintenance training centres in France, CF Mureaux, CF Gurcy and CF La Perollière, which give national courses for maintenance personnel on mechanical, electrical and electronic equipment. In addition some equipment vendor facilities are also used to train personnel on specific equipment, for example the telescopic crane, cooling systems, battery chargers, etc.

Site training facilities

At the Fessenheim training centre there are also three functional simulators and the SEPIA training tool already described. The Fessenheim training centre has various sizes of classrooms which can be used by any discipline. These classrooms have adequate supplies of visual aids such as video equipment, slide projectors, overhead projectors, tools, mock-ups, and models of plant system and components.

Other Computer Based Training (CBT) equipment is also installed in the training centre. However, the CBT applications related to the learning of the CP0 systems is not specific to Fessenheim and there are substantial differences.

- (2) **Suggestion:** Computer Based Training at the site training centre should be Fessenheim plant specific.

Good practice: The SEPIA system for the training of operators on Steam Generator Tube Rupture (SGTR) accidents is a very advanced tool for teaching the phenomena occurring during this postulated accident. Detailed methods to evaluate trainees on the functional simulators at the site training centre are a good tool for objectively evaluating trainee performance.

2.3. Control Room operators and Shift Supervisors

The training of operating department personnel is accomplished by training through a combination of national and local organizations. Different individual training plans exhaustively define the training courses an individual must complete. As part of the selection process for higher qualification in the operating structure, a candidate must complete a written and oral examination.

Once selected, the candidate starts training following the national and local courses (PLAP), some of which have associated evaluations to ensure that the qualification requirements are met. Trainees then begin shadow training in their future jobs. During this phase the trainees are evaluated by their tutors in an oral form and at the end of the training period they will be recommended to the department head for qualification.

The training is based on a broad topical level task analysis requiring significant expertise in the subject matter to develop actual training programmes and exams. The evaluation processes in national and local training courses are not well defined or formalized.

The evaluation processes in national training courses are not clearly linked to the job and task analysis. The exams are not objectively scored (i.e. no numerical score is assigned) and oral examinations are not documented. The written examination process is not kept separate from the oral evaluation and in many cases oral answers after a written examination can be substituted for a written response. In addition, the evaluation process for simulator training is not established for the module M1, M3 of the initial training simulator course and for refresher simulator courses.

- (1) **Recommendation:** The written and oral evaluation processes should be adequately documented and associated examination qualification procedures should be established. An evaluation grid similar to the session M2 of the initial training should also be developed for module M1, M3 and refresher simulator courses. The progress with the EVASION software programme for trainee evaluation in the simulator should be maintained.

The plant manager is responsible for plant personnel training through the department head. The training activities given by the centralized training centre to the department heads personnel should be monitored and the quality controlled to ensure that the aims are achieved. Plant management, however, does not systematically monitor operators during refresher training or audit the training programme.

- (2) **Recommendation:** More involvement of plant staff during the design of the refresher course in the simulator and during initial training is recommended. Checking of goals, training material, pedagogical files. progression of trainees, programme preparation, etc., will customize the retraining courses to each operating team and ensure the quality of training. Clarified goals or training objectives should be established for the simulator retraining courses. Additionally, plant management should periodically observe the operating crews in the simulator to ensure that desired performance levels are being achieved.

The full scope simulator is the proper environment to obtain practical experience in the use of accident procedures. Efforts to use accident procedures with the minor interference of using a non-specific simulator will increase the familiarity of operating personnel with their own procedures. Fessenheim personnel currently use Bugey Procedures in simulator training and their own procedures in lecture sessions.

- (3) **Recommendation:** The Fessenheim plant procedures should be used during the simulator refresher courses for the trainees to become familiar with the content and form and obtain practical experience in using them.

The annual required retraining to maintain operator competence is based on a one week course of fifteen hours of simulator training and twenty hours of classroom training, reviewing the simulator session. Once every two years, two advanced retraining courses with multiple accidents and one course of simple scenarios are scheduled, totalling 45 hours of simulator training over two years. In addition, annual operator evaluations of continued competence are not based on an objective examination process, but rather on the combined subjective judgement of the training instructors and shift supervisors.

Continuing training that maintains and improves technical skills and knowledge should correct operator weaknesses and develop the desired competences. This is done to ensure that the operators are able to operate the plant in a safe and reliable manner. The current amount, of knowledge based training and the frequency of operator simulator training, and the evaluations associated with refresher courses, appear insufficient.

- (4) **Recommendation:** The amount and frequency of refresher simulator training under normal operation and accident conditions should be increased. Systematic refresher training on the applied fundamentals and theory presented in initial training should also be provided. In addition, the training on plant modifications and procedure changes should be included and lessons learned from industry operating experience should be given greater emphasis.

The readiness of control room operator candidates for authorization is not evaluated in a comprehensive manner against established learning objectives and standards. In addition, periodic written and simulator examinations are not given for the reauthorization of control room operators.

- (5) **Recommendation:** A final comprehensive examination process (i.e. written, full scope simulator, oral and walk-through) should be developed for authorization as control room operator and other shift management/supervisory positions after completion of training. In addition, an objective evaluation based on required knowledge and skills should be part of the annual requalification process.

The training material given to the trainee during the national and local courses is not well developed. It could be improved and controlled by similar review requirements to those used for other plant documents. In addition some local courses identified in the PTF do not have associated pedagogical files, nor trainee material or detailed specific learning objectives. Consequently, the trainee and instructor (shift supervisor) could have some difficulty in fulfilling goals and the training could vary from one instructor to another.

- (6) **Recommendation:** Lesson plans should be developed to identify the learning objectives, instructor and trainee activities, training methods, training equipment and training material to be used. The effective use of lesson plans ensures consistent delivery of training from instructor to instructor and from course to course and ensures also that all required knowledge and skills are covered.

Good practice: Post-critiques of simulator training sessions in the classroom using a video filmed during simulator training improves communications and facilitates analysis of the scenarios.

Good practice: Development of the seminar on the loss of AC power is a good initiative to compensate for the gap caused by the limitations of the Bugey simulator.

Good practice: Creation of an instructional team, led by the Operating Supervisor, within the operating shifts to promote the improvement of skills and training of personnel assigned to the shift is a good initiative to motivate the personnel.

2.4. Field operators

There are three different categories of operating field staff in Fessenheim.

The initial training programme for field operators, which is defined by specific PTFs and corresponding qualifications, is composed of professional and common training which includes basic quality, basic techniques, electrical and mechanical safety, fire-fighting, industrial safety and radiological protection. The scope of the initial training programme is comprehensive; however, the training material and learning objectives are not well identified and formalized, which could result in differences in training between the candidates.

No plant specific and detailed task analysis (JTA) has been conducted. This is necessary to provide the appropriate framework for a training and qualification programme of field operators. The result of the JTA would provide the learning objectives for the initial and refresher training courses to ensure that training is performance based.

- (1) **Recommendation:** Recommendation 2.1 (1) applies.

The purpose of on-the-job training (OJT) programmes is to train and evaluate job related skills and knowledge within the plant environment. On-the-job training provides realistic and hands-on experience for the trainee that is directly applicable to the job. Fessenheim NPP does not use formal OJT programmes to train field personnel. Shadow training used in Fessenheim is not formalized.

- (2) **Recommendation:** Recommendation 2.1 (2) applies.

The refresher training only includes basic rules of the plant, basic quality, fire-fighting and risk prevention. There is no systematic and formalized refresher retraining on operational practices and operating experience. The normal practice is to provide retraining courses about these matters at least once every year.

- (3) **Recommendation:** Refresher training courses on professional skills and operating experience should be provided to ensure that the staff maintain and improve their knowledge and skills.

Good practice: The use of functional simulators for the initial training of field operating personnel is considered a good practice.

2.5. Maintenance and I & C Personnel

The maintenance and instrumentation and control (I & C) departments provide technical support in repairing rotating equipment, valves, tanks, lifting equipment, electrical generators, and switchboard instrumentation and controllers. Heads of department delegate training activities to engineers or section heads who are responsible for effecting general and specific training policies.

A new training plan developed at the corporate level for maintenance engineer qualification has been developed and is being applied in Fessenheim NPP.

The maintenance department holds weekly meeting to communicate to personnel the modifications completed or to be executed in the plant, the station's general status, industry experiences and concerns, etc. Meeting minutes are distributed to department personnel and appropriately filed.

A plant specific job and task analysis (JTA) has not been conducted and it is necessary to provide the appropriate framework for a training and qualification programme of maintenance and I & C personnel. The result of the JTA would provide the learning objectives for the initial and refresher training courses to ensure performance based training.

- (1) **Recommendation:** Recommendation 2.1 (1) applies.

The purpose of an on-the-job training (OJT) programmes is to train and evaluate job related skills and knowledge within the environment. On-the-job training provides realistic and hands-on experience for the trainee that is directly applicable to the job. Fessenheim NPP does not use formal OJT programmes to train maintenance and I & C personnel.

- (2) **Recommendation:** Recommendation 2.1 (2) applies.

Continuing training should maintain and improve the technical skills and knowledge of the maintenance and I & C staff and develop the desired level of competence. This would ensure that the staff are able to maintain the plant in a safe and reliable manner. The current programme of refresher courses (fire-fighting, security) appears insufficient to ensure these objectives.

- (3) **Recommendation:** Recommendation 2.4 (3) applies.

The training material given to the trainees during local courses is not well formalized. It should be improved and controlled with similar review requirements to those used for other plant documents.

- (4) **Recommendation:** Recommendation 2.3 (6) applies.

Good practice: Using mock-ups of motorized and air valves to train maintenance personnel is considered a good practice.

Good practice: The fuel handling machine used to train I & C technicians in the setting of electronic circuits and detecting common failures is considered a good practice.

Good practice: The centralized maintenance training facilities for electrical, mechanical and I & C personnel are considered as a good practice. Additionally, the scale mock-ups of some important components facilitate maintenance training and promote the availability and safety of the plant. Incorporation of I & C technicians in the operating shift team for 3 weeks during their initial training is also a good practice.

2.6. Technical Support and Chemistry personnel

The Technical Support Department provides technical services in various plant areas such as fuel management and handling, spent fuel transport, radwaste effluent, reactor engineering (core monitoring), containment building monitoring, primary coolant monitoring, environmental monitoring, maintenance of the hydrogen recombiner and chemistry activities.

The Technical Support Department is divided into four sections: testing, laboratory, general services and buildings services.

Some important training is done by corporate entities, for example by CETIC for fuel handling, but in general, a great part of the specific training of personnel is done at the site using the shadow training method.

However, no plant specific job and task analysis (JTA) has been conducted and it is necessary to provide the appropriate framework for a training and qualification programme of radiation protection personnel. The result of the JTA would provide the learning objectives for the initial and refresher training courses to ensure that training is performance based.

(1) Recommendation: Recommendation 2.1 (1) applies.

The purpose of an on-the-job training (OJT) programmes is to train and evaluate job related skills and knowledge within the environment. On-the-job training provides realistic and hands-on experience for the trainee that is directly applicable to the job. Fessenheim NPP does not use formal OJT programmes to train maintenance and I & C personnel.

(2) Recommendation: Recommendation 2.1 (2) applies.

Continuing training should maintain and improve the technical skills and knowledge of the technical support staff and develop the desired level of competence. This would ensure their ability to maintain the plant in a safe and reliable manner. The current programme of refresher courses (fire-fighting, security, fuel handling) appears insufficient to ensure these objectives.

(3) Recommendation: Recommendation 2.4 (3) applies.

The training material given to the trainees during local courses is not well formalized. It should be improved and controlled with similar review requirements to those used for other plant documents.

(4) Recommendation: Recommendation 2.3 (6) applies.

Good practice: Use of a full-scale fuel handling machine in a simulated vessel and core in the CETIC facilities is an excellent environment to train the appropriate skills.

Good practice: Computer based training on the fuel handling machine with the simulations of some accidents is a good practice for personnel training.

2.7. Radiation Protection Personnel

The industrial safety and radiological protection service has three main aims: (1) technical assistance to others; (2) control of the release of material and equipment from the plant to the outside; (3) training of plant personnel in radiological protection. The initial training of radiation protection personnel is well defined by job descriptions and pedagogical material. The training includes basic quality, safety of maintenance, fire-fighting, the plant emergency plan, industrial safety, radiological protection and pedagogical courses.

The training material is well controlled and the initial training activities are given to the trainee at the regional level. A great deal of emphasis is placed on risk prevention. The continuing training programme for radiation protection personnel is well defined by pedagogical material and includes fire-fighting and first aid refresher courses. Training progress and qualification is assessed effectively by oral and written tests.

However, a plant specific job and task analysis (JTA) has not been conducted and it is necessary to provide the appropriate framework for a training and qualification programme of radiation protection personnel. The result of the JTA would provide the learning objectives for the initial and refresher training courses to ensure performance based training.

(1) Recommendation: Recommendation 2.1 (1) applies.

The purpose of an on-the-job training (OJT) programmes is to train and evaluate job related skills and knowledge within the environment. On-the-job training provides realistic and hands-on experience for the trainee that is directly applicable to the job. Fessenheim NPP does not use formal OJT programmes to train maintenance and I & C personnel.

(2) Recommendation: Recommendation 2.1 (2) applies.

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

2.8. Managers and Supervisors

The management development programme is defined for each position of management in the PTF. Training programmes are conducted for all levels of management and include such courses as individual interviews, evaluation techniques, trade union negotiations, chairing meetings, etc. and are normally scheduled every year.

Some management training is obligatory: safety, quality, risk prevention, etc. However some training courses are not well identified and codified in the PTF.

(1) Suggestion: Consideration should be given to identifying the management training course codes, duration and trainee material in the PTF.

There are not any compulsory refresher training courses, but Fessenheim staff management is continuously improving its management knowledge by conducting new training courses each year.

2.9. General Employee Training

The initial general employee training, fire-fighting training, safety, quality and emergency plan training are given to all employees as obligatory training. Industrial safety training and plant radiological

protection training are also given to all technical employees as obligatory training. Additionally, a one week basic technical training course is given to all employees.

However, the plant emergency plan training (2 days) is not recorded in the PIF of the employees. Retraining on plant emergency plan is accomplished by participating in the yearly drills.

- (1) **Suggestion:** Consideration should be given to including the plant emergency plan training in the PIF.

Regarding of reception subcontractors, a well structured and organized training programme is provided that includes radiological protection, basic quality, risk prevention, industrial safety and plant general policies.

Good practice: The orientation training provided to subcontractors is considered a good practice.

3. OPERATIONS

In the area of operations the OSART team reviewed eight aspects in the Operations Department. They included daily operating activities, procedures, organizational structure and fire and accident management, and housekeeping. Together, these measure the utility management's support for the quality of operating personnel and their procedures, activities and ability to function effectively within the site organization.

The team's observations and evaluations indicate that the Fessenheim Operations Department has strong and knowledgeable leadership. The operating personnel are dedicated and support the goals of the Department. Overall the Operations Department is effective and maintains the barriers for safety required in a nuclear facility.

The experts recognize that the Fessenheim plant is a mature installation operating at its expected capacity and the major focus for improvement is the performance of the personnel. This is reflected in the recommendations for improvement in the area of plant operations.

The principle recommendations concern the level of refresher training, uncontrolled operator information and the quality of plant labelling and tags.

Improvements in these areas should assist Fessenheim management's continuing efforts to improve plant performance and safety.

3.1. Organization and Function

The operations Department is responsible for the safe operation of the Fessenheim nuclear plant. The department is managed by the Operations Department Head. The organization is divided into two sections: six shift teams and an operating engineering structure.

The various functions and responsibilities are clearly defined. The control room operator positions are divided into primary and secondary plant operations. Thus, integrated plant operation requires co-ordinated team work and communications between the two operators.

The organization is fully manned with vacancies being filled from the pool of qualified personnel within the national nuclear programme. There are five positions above the minimum manning requirements. This allows for the training and authorization of new operators entering or advancing in the organization.

The Fessenheim Operations Department is supported by a corporate off-site Generating Capacity Department. Its function is to provide strategic planning, experience feedback and technical support to the nuclear power plants.

Goals for the operating Department are conveyed by a Management Contract process. The operations Department Head has a clear set of goals (contract) with the Plant Management Committee and conversely with those reporting directly to him.

Shift scheduling is well controlled. There is a minimum of intershift personnel rotation and the normal number of hours to be worked per week is 35, unless otherwise approved by senior management. In 1991, the average number of hours worked per week was 37.

The training of operating department personnel is accomplished by a combination of national and local training organizations. These training resources are fully focused and dedicated to the training function.

Observations indicate significant issues the utility should address in relation to operator training. These issues are addressed in Section 2, Training and Qualification.

3.2. Operations Facilities and Operator Aids

The control room is clean, quiet and well designed. The working spaces for drawings are well lit with ample working surfaces.

Operating procedures and alarm response procedures are located outside the immediate control board area. Thus, the operators must leave the control board area while referencing or obtaining operating and alarm response procedure.

- (1) **Recommendation:** Relocate alarm response procedures adjacent to the control room operators' desk.
- (2) **Suggestion:** Consider relocating frequently used operating procedures adjacent to the control room operators' desk.

All necessary documents are available to the on-shift operators; however, some control room information is not issued via the document control process. Examples include the book of tables and graphs located on the control room drawing table and overlays on the pressurizer and turbine temperature recorders. This information could result in operating decisions being made on the basis of incorrect information.

The alarm system is designed with four different colours of alarms that assist the operator in alarm analysis. Important alarms during outage condition are uniquely coloured for easy identification from the many alarms lit during outage conditions.

Control boards are logically designed with identical panel orientation between Units 1 and 2.

However, not all control room panel switches and controllers are labelled. Thus the operator cannot verify whether he is manipulating the proper switch or controller.

- (3) **Recommendation:** Label all control room panel instruments, controllers and switches.

The facilities and equipment needed by the operating staff outside the control room are adequate to support safe and reliable operation.

There is one emergency shutdown panel for each unit located outside the control room. It is properly labelled, procedures are provided and periodic exercises are conducted. It is tested once per year by cooling down the reactor from hot to cold shutdown conditions.

The waste treatment, water treatment and fuel handling areas are equipped with necessary tools and procedures.

The procedures that are used in the field are not updated when a control room operating procedure is temporarily modified. Only emergency shutdown panel procedures are updated but this is not based on a procedure request.

- (4) **Recommendation:** Field panel operating procedures should be updated when temporary changes of the control room procedures are applicable to them. This should be defined by a station procedure.

Communications at the plant are well organized and multiple systems are used. Communication systems are reliable, but loudspeaker announcements in some places and in particular inside the containment were noted to be difficult to understand.

- (5) **Suggestion:** Consideration should be given to conducting a survey of loudspeakers in the containment and making improvements where necessary.

3.3. Operating Rules and Procedures

The document control system in EDF is well developed. There are a number of general manuals and instructions that maintain the consistency of the documents at all EDF's NPPs at a certain revision level, which assists staff at the power plants in developing plant specific manuals, instructions and procedures.

The plant's basic technical document is the Technical Specifications document. It consists mainly of very comprehensive and well structured operating limits and conditions. The latest revision of the document (approved by the regulatory authorities) was issued in 1990. New limits and conditions based on the results of a probabilistic safety analysis (PSA) of the plant were included. This document is the basis for developing all other technical documentation. It is strictly adhered to during power plant operation. The management and operating policy is conservative regarding interpretations of Technical Specifications.

Normal operating procedures

Normal operating procedures are well structured, clear and cover all phases of plant operation. The responsibility for procedure development, revision and review is well defined. A writer's guide is provided for procedures.

A review of the procedure modification process indicated that the experience feedback from operating incidents and events is not timely and can take up to 6 months or more to be issued from the Paris Office. The review process for temporary modifications to procedures is limited to the Operations Supervisor level. The lack of multiple reviews may not provide some perspectives needed to control plant safety systems. Any one of these factors could compromise the ability to use procedures to maintain proper configuration control of plant systems.

- (1) **Recommendation:** Reduce the backlog of operational incidents awaiting analysis and maintain a timely schedule for the revision of procedures.
- (2) **Recommendation:** Modify the review process for temporary procedures to increase the depth of review and to increase the number of disciplines required to conduct the review.

Emergency operating procedures

The emergency operating procedures are developed, revised and controlled by the corporate safety group and the Fessenheim operations Department. The set of procedures includes incident procedures, accident procedures, beyond design base procedures and ultimate procedures. The procedures are well structured and clear and appear to be well received by the operators. Flow charts and graphics are used extensively.

Good practice: Emergency Operating Procedures are well designed and controlled by the corporate organization. They appear to be well received by the operators.

3.4. Operating History

Recent and general operating history

Unit 1 was Commissioned in 1977 and Unit 2 in 1978. The units were the first in a series of 34 900 MW nuclear power plants in France. The average plant availability is 70.9% for 12 years of operation. In the last few years it has dropped to approximately 60%, mainly because of the 10-year outages of the units in 1989 and 1990.

There was only one scram in the last three years on Unit 1 and five on Unit 2. Three of these scrams were caused by faults in the secondary side equipment.

All operating data including steam cycle efficiency, equipment downtime, etc, are analysed and programmes exist for follow-up and improvement of performance. A comprehensive system of management by objectives has been developed in the operating department based on operating data performance indicators. This programme is well implemented and includes all shift and non-shift personnel.

Evaluation of plant events

All reportable events are analysed. A comprehensive report is produced for each event with root cause analysis. Human factor analysis and man-machine interface deficiencies are reviewed by specialists at the EDF headquarters in Paris. The results are included in the reports that are sent to the safety authorities. Regulations require that these reports be submitted to the authorities within two months. However, they are frequently delayed by up to six months. All delayed reports are completed prior to plant restart following refuelling outages.

- (1) **Recommendation:** The time taken to prepare and submit event reports to the safety authorities should be reduced. More expedient analysis and report preparation methods should be developed. Work and co-ordination between different groups should be improved and, if necessary, a longer time schedule should be agreed upon.

Each scram is analysed by the plant Operation Department. Before each restart of the unit, a meeting is held of the on-site Safety Committee and a comprehensive report is produced to ensure that the appropriate personnel have been contacted and adequate safety reviews have been completed.

3.5. Conduct of Operations

Plant status control, logs, procedures and shift turnover practices are a strength of the operating organization. Information required to control operating activities is captured as part of the operating procedures, logs and round sheets. Plant limiting conditions for operation are identified in these processes.

Control room routines are conducted in a professional manner. The two control room operators work as a team, keeping one another informed as required.

Field operations were followed during the startup of the unit after an outage and during normal operation. The operators were found to be well trained and doing their work in a professional manner.

Regular equipment checks were made for noise, high temperature, vibration, leakage, etc., and appropriate remarks were entered in the log book that each operator carries on rounds. These log books include forms indicating round requirements as well as all instrument readings and set points. However, these data are not used for systematic analysis of the equipment. The station plans have a computer based data recording system in 1993. This system will collect data through portable hand held computers used by the operators. Abnormal readings, missing readings and trends will be available from this system.

Visits to the turbine, reactor and service building areas were made on several occasions. Equipment labels were observed to be inconsistent and some were handwritten. Numerous labels were missing, broken or painted over. There were no labels on some plant components or major vessels.

Piping does not have a colour coding system nor an adequate labelling system. Adequate plant labelling is important to ensure that procedures and administrative instructions are carried out on the proper equipment. Room identification was found to be correct.

The quality of housekeeping was not consistent throughout the plant. Large areas even in difficult or remote locations were clean. However, some areas were noted to be dirty. Deficiencies noted include, for example:

- (1) Technical graffiti were noted on many components, e.g. information relating to equipment identification, assembly or operating values. This information is uncontrolled and could mislead operations and maintenance personnel.
- (2) Debris from maintenance activities was not always cleaned up.
- (3) Most equipment and its base structures and catch basins were dirty. consequently, the equipment instrumentation, their surroundings and indicators were dirty, which makes it difficult to identify minor leaks and causes safety hazards to personnel.
- (4) Water and steam leaks on floors were not cleaned up or barricaded. This could result in a safety hazard to plant personnel.
- (5) There was boric acid on the floor and on equipment where it is prepared for use. Not enough attention is paid to the cleanness of the equipment and surrounding area.

It was observed that the Operations Department was timely in responding to some OSART comments. Housekeeping improvements were observed and some work orders were issued promptly.

- (1) **Recommendation:** Housekeeping standards should be established by a plant management programme established to upgrade housekeeping to higher levels. Management should make frequent tours of the plant and set higher standards for housekeeping.
- (2) **Recommendation:** A review of the status of labels in the plant should be conducted in order to identify the total scope of label deficiencies. An action plan should be developed and implemented to correct label deficiencies identified by this review.
- (3) **Recommendation:** A review of operator information aids and operational flowsheets located throughout the plant should be conducted to identify the magnitude of the problem. The items identified should be either removed or controlled and updated as required to maintain accuracy.

3.6. Work Authorization and Planning

The work planning and authorization process is well controlled by the operations Department. Operating personnel are responsible for checking the state of the plant and the availability and redundancy of backup systems, and approving each work request before issuing a work order. Industrial safety rules and radiological checks are strictly implemented.

Work requests are initiated by the maintenance computer programme for regular preventive and predictive maintenance. Operations field operators identify and initiate most of the work requests for corrective maintenance. Every employee could initiate work requests to improve plant conditions but no such requests were noted on the list for the last few weeks.

The processing of work orders and isolation tags is computerized, however, the control room tags are prepared manually. There were tags in the control room without an equipment label number or a note of the intended position of the device. The correct positioning of control room tags therefore cannot be easily checked. Lockout of electrical supplies, tagging of equipment and positioning of locks were found to be correct.

The same system is also used for the administrative isolations. Control room tags are produced in a different colour (white), but the same deficiencies apply as with the isolation tags. Administrative tags on the equipment are the same colour as the normal isolation tags.

- (1) **Recommendation:** The control room tags should all be identified with the work order number, equipment label number and desired position of component.
- (2) **Suggestion:** Consideration should be given to upgrading the computerized work order and tag issuing programme for the issuing of control room tags.
- (3) **Suggestion:** Consideration should be given to making administrative tags easily distinguishable from the normal isolation tags.

Equipment post maintenance testing is the responsibility of the job foreman. System testing is the responsibility of the operations Supervisor.

In the last two years there has not been a QA audit of the work processing and authorization process.

3.7. Accident Management

Operating accident management procedures, roles and responsibilities are well defined. The task of initial accident evaluation is the responsibility of the Operations Supervisor until relieved by the on-call Safety Engineer. The Operations Supervisor then assumes the role of Local Emergency Centre Leader.

The on-shift Technical Manager is responsible for co-ordinating the control room and auxiliary plant operators in accident response procedures.

Control room operators receive training in the use of accident response procedures annually during simulator training. Exercises to train the site emergency team are held on an annual basis. This level of training would appear to be insufficient to develop and maintain an effective emergency response team.

- (1) **Recommendation:** The Emergency Preparedness organization should increase the number of emergency response drills, and provide mini drills for Operations Supervisors.

3.8 Fire Protection

The Fessenheim NPP fire protection systems were constructed following the EDF design criteria that were valid during initial plant construction. Subsequently the design criteria were upgraded as nuclear power was developed in France and by feedback of information collected from the operating plants. Modifications to the plant fire protection systems were designed and implemented in the 1980s.

The operating philosophy for fire protection is based on comprehensive alarm and automatic fire-fighting systems in the areas with high calorimetric burden (over 400 MJ/m²) and capabilities for rapid response by personnel to each alarm to isolate and fight the fire. Basic fire-fighting is provided by the operating shifts (five persons per shift) with backup from teams of on-call personnel (five persons) and by a professional fire-fighting brigade from Mulhouse. Adequate individual and team training is performed as well as drills and exercises.

A considerable amount of mobile fire-fighting equipment and personnel protective equipment for fire-fighting is available at many places in the plant. it is regularly checked and maintained.

The control room is equipped with a central alarming system and the control room operators respond to the alarms. The plant is divided into fire areas and zones which also have panels for fire alarms.

4. MAINTENANCE

The plant maintenance departments and their matrix functions for operations and outages are appropriately organized. The personnel display a professional attitude. Scheduling and executing work in matrix functions were found to be effective. The EDF corporate departments give the site excellent maintenance support when requested to do so. Clear and well implemented policies exist for providing direction to the site and for returning appropriate maintenance experience feedback to EDF.

Site maintenance management and programmes provide a strong focus on plant safety. The tasks and responsibilities for the two departments, sections and individuals were found to be strictly defined and understood by the personnel.

Indicators for the maintenance departments have been set up to monitor objectives, which encourage them to improve both safety and quality. Consideration should be given to developing some additional performance indicators to measure the improvement in the overall condition of the plant and the effectiveness of the maintenance programme.

A policy for subcontracting has been defined and criteria established to guide the decision making process. This concept is well structured and ensures good control of work performed by contractors.

QA reviews and audits are conducted in accordance with an annual programme. The results of the internal audits found the maintenance area to be professional, performing in accordance with existing procedures, and the staff to have a positive attitude towards solving the problems raised by audit reports.

The safety culture and awareness of maintenance personnel during maintenance activities were found to be consistent with established policy. Observed activities and documentation, such as contractors' reception, outage handbook, work requests, work procedures, work orders, work files, quality plans, etc., are good examples that strengthen the safety culture.

The overall condition of plant equipment and systems is generally good, but water and steam leaks, boric acid residue, oil leaks, loose cables and overloaded cable trays were observed during tours. More frequent plant tours should be carried out by management and technical staff to verify that the overall status of the plant is attaining the level required by the Management Committee.

It is recommended that a policy to control the calibration and condition of installed local instrumentation and devices be developed.

The use of computer based maintenance management systems gives good control of maintenance work during the whole process from the initiation of a work request to the filing of completed maintenance actions in material history.

During the work process different meetings are held to co-ordinate and discuss work performance. The "kick-off" meetings were found to be an excellent way to initiate work.

The facilities and equipment storage rooms were found to have adequate space, and to be clean and well organized. The use of bar code systems was found to be very effective to track and control inventory.

Outage management was found to be well structured, organized and supported by a computer based scheduling system. A standard outage plan ensures that the requirements in the Technical Specifications are considered during outages.

4.1. Organization and Functions

Generally the EDF corporate organization Provides support and performs maintenance when (1) a problem or modification applies to a whole series of units or several units (2) permanent site expertises or resources are not sufficient or (3) changes in the design basis of equipment important for safety are involved. Typical applications include primary system welding, steam generator tube plugging, main turbine overhauls or repairs. 10 year surveillances generic modifications, etc. The central organizations also provide assistance to plants as requested.

UTO (Unité Technique Operationnelle) controls the overall planning of outages at the different plants. Every month it checks the plan and compares it with the needs of the national grid. There is a practical limit that specifies that the outage date should be fixed at least two months before the outage is scheduled to start. They are also in charge of the control and management at the national level of resources that are limited, such as special NDT inspectors for steam generators. UTO performs evaluations of contractors and certifies their qualifications at the national level. They also procure special tools, robots and some of the in-service inspection equipment. The EDF/Framatome scale model training centre (CETEC) near Lyon can be used to qualify the special tools and personnel that operate them.

Another corporate maintenance function is the performance of root cause analysis of equipment related events that occur at the various sites. Generally significant events are reported in summarized form by telex within 24 hours. Following the review of these events, corporate maintenance provides the event information to other sites, to new plants under construction and to nuclear component manufacturers and contractors.

The Decree of 1974 regulates in-service inspection (ISI), repairs, boundaries, hydrostatic tests, transients, leaktightness, etc. The decree was developed for the reactor primary Coolant systems when the authorities found that earlier legislation was insufficient for nuclear power plants. This decree provides the basis to determine to what standard maintenance activities should be performed at both the national and local level. The Decree of 1974 stipulates that the most up to date revisions must be used in the case of repair, welding or procurement of spare parts.

The plant maintenance organization consists of two departments, one for mechanical maintenance and one for I & C. The departments are supported by three specialist engineers within the areas of static machinery, rotating machinery and I & C maintenance. Each department has engineering support within specified areas and work groups for the preparation and performance of work. In the maintenance organization there is a technical secretariat which prepares work files and updates the computerized maintenance management system. The tasks and the responsibilities for the different departments, groups and individuals were found to be well defined and understood by the personnel.

Matrix organizations have been established to handle the scheduling and execution of work during the phases Of operation and outages. They are called the Operation Structure and the Outage Structure. Special engineers, technicians and workers are assigned to work in the different structures for the preparation and execution of work. The departments are responsible for personnel and budget management as well as for long term planning, work techniques, quality and safety.

Indicators for the maintenance departments have been set up to monitor objectives. The indicators are monitored monthly and some of the indicators encourage maintenance personnel to improve both safety and quality.

Observations during tours in the plant indicated that housekeeping, labelling, maintenance and the overall material conditions could be improved. The performance indicators used by the plant do not adequately measure the effectiveness of the plant maintenance programme.

- (1) **Suggestion:** Consideration should be given to developing additional indicators to measure the improvement in the overall condition of the plant and the effectiveness of the maintenance programme, such as the backlog of work requests, the amount of rework, or the time spent on leak repairs or fastening cables.

An industrial maintenance policy for subcontracting in the areas of mechanical, boilermaking, valves and I & C has been defined and criteria have been established to guide the decision making process. A programme has been established for the training of Fessenheim personnel in the proper supervision and quality control of work performed by subcontractors. The quality plan is the managing document for work which requires several related operations. On the quality plans, the supervision, technical inspections and checking are signed off in accordance with defined responsibilities. This concept is well structured and secures good control of work done by subcontractors.

Good practice: Qualification of contractors is a good method to ensure that the contractors have adequate knowledge to perform their tasks in the plant.

The Safety Department is responsible for QA reviews and audits in the maintenance area and is also responsible for conducting QA audits in all the other operating areas of the plant. The Safety Department reports directly to the plant manager and is independent from the maintenance departments.

An annual audit schedule is followed and detailed audit reports are prepared. The National Nuclear Safety Inspectorate has also performed an audit of the maintenance area during 1991. The results of the internal audit found the maintenance personnel to be professional, performing in accordance with existing procedures, and the staff to have a positive attitude towards solving the problems raised by audit reports.

4.2. Maintenance Programme

The overall EDF maintenance policy provides direction to the EDF National Maintenance Programme. The National Maintenance Department provides doctrines and programmes to all the nuclear power plants. These doctrines and programmes are converted into local maintenance programmes. Fessenheim NPP, as a part of the EDF system, uses system experience and feedback knowledge obtained by close liaison with the central organization.

The local and national maintenance programmes used at the plant cover the functions and tasks of plant maintenance to ensure the reliability of operation. The programmes address preventive, predictive and corrective maintenance, in-service inspection, modification of plant components, stores systems, feedback evaluation, lessons learned, quality assurance and control of maintenance.

Maintenance programmes for fire doors and cable penetrations used during outages have been implemented. These are good examples of maintaining high standards of fire protection barriers.

A programme for the qualification of personnel at all levels exists and training programmes for each individual for a period of three years have been implemented. Training records are stored in a computer based system.

The safety culture and awareness of maintenance personnel during maintenance activities were found to be consistent with established policy. Observed activities such as contractor reception, the outage handbook, work procedures and quality plans are good examples that enhance the concept of safety culture.

4.3. Material Conditions, Facilities and Equipment

The overall condition of the spaces and equipment was generally good in the controlled area with some notable exceptions. The areas close to the containment needed to be cleaned. The turbine area was found to be orderly, but the house keeping should be improved.

Plant system components and equipment are properly insulated, with some exceptions where there is damage to lagging. The condition of equipment and systems is good but boric acid residue was noted on many valves and Pipes. Water, steam and oil leaks in the turbine building should be rectified by the plant staff both for reliability as well as for worker safety. After maintenance some labels were not fastened to the components. Plant management, maintenance and technical staff appear to spend insufficient time in the plant.

- (1) **Recommendation:** Management, maintenance and technical staff should make more frequent plant tours and set higher standards for maintenance and plant material condition.

The instrumentation in the plant is calibrated and periodically checked at intervals stated in the PM programme. Calibration work is performed following procedures and is properly documented. However, local gauges are not calibrated and were found in some cases to be damaged and out of order.

- (2) **Recommendation:** A calibration programme should be established for local gauges used by operations staff for surveillances or other purposes.

Scaffolding was properly built and signs with access rules for using the scaffolding were clearly displayed. Special work sheets have been developed with photographs, showing the position of the scaffolding and the construction measures. This ensures that the scaffolding is built correctly and contributes to worker safety.

A main door to the auxiliary building in the controlled area was found not to be correctly closed, and the locking device was out of order. Open ends were found on cables that were in the process of being dismantled owing to modification.

- (3) **Recommendation:** A Programme for checking doors from the controlled area to the outside should be introduced.
- (4) **Recommendation:** The industrial safety programme for Fessenheim should include the isolation of cables in the process of being dismantled.

In the workshop, stainless steel and carbon steel were stored separately and special protection was in place to shield the stainless steel from carbon steel.

Mechanical, electrical and I & C tools and portable instruments were found to be properly calibrated and the calibrations documentation was in order. Calibration activities are performed annually.

The chemical control system was found to be well implemented. Chemicals have been analysed and a list of approved chemicals has been prepared. Analyses have been done for both corrosion effects and health effects.

4.4. Procedures, Records and Histories

A highly developed Work Request/Work Order system is used in Fessenheim NPP. All maintenance activities are prepared and executed following procedures. During 1991 a computerized maintenance management system (SYGMA) was introduced.

Work orders and attached work files were found to be very well prepared and present in the field during maintenance activities. After maintenance is performed the work files are evaluated by the preparator. The work order process is very well implemented and is a good example of comprehensive preparation for maintenance work.

Fessenheim NPP has a good system of administrative procedures which specify how technical documentation is to be handled. The storage of maintenance documentation is satisfactorily arranged. The documents, manufacturers' manuals, drawings, films, etc. are properly stored. Documents checked were found to be updated according to procedures both in the main archives and in the "satellite" archives.

The incorporation of experience feedback into maintenance history documentation was found to be good. The maintenance personnel working in the preparatory phase for maintenance activities make effective use of the historical information available.

The plant is provided with technical information from all other nuclear units of the same design, all other units in France and international units. The technical staff use the feedback appropriately and strive for improvement.

4.5. Conduct and Control of Maintenance Activities

The work request/work order system is very well controlled and the responsibilities and functions are well defined.

The submission of a Work Request provides the initial identification of work to be done in the plant. After review of both technical and economic aspects, the Work Request is given a priority and after final authorization by the management a Work Order is prepared. The Work order formulation stage leads to the preparation of a work file that includes all documents necessary to perform the work, such as work procedures, spare parts lists, quality plan, dosimetry requirements, etc. Blocking requirements and work permits are prepared using a computerized system which has been integrated into the work management system SYGMA.

Every morning during the Work Request meeting the new Work Requests are discussed between the Operations and, Maintenance departments. The information from SYGMA is displayed on the wall by a video-projector and the audience can clearly follow the discussion. Each Work Request is handed over to the preparator in charge who indicates the time for execution as well as accepting the work Request for the preparation of a Work Order. This meeting was found to be very effective for co-ordinating the work and for informing the different departments about the work to be done in the plant.

In the afternoon a Work Issuing meeting is held for distribution of work files and planning documents to the foremen. This meeting is split into two sessions, one for mechanical and one for electrical work, but held in the same conference room. This process provides effective communication for joint work. Later in the afternoon a summary meeting is held in order to reach agreement on equipment isolation and blocking for the issued work orders.

The OSART team observed a "kickoff" meeting that was held before starting repairs to change a control rod indicator coil. The "kickoff" meeting was found to be an excellent way to discuss and inform all the involved personnel about technical# radiation protection and industrial safety matters. The meeting was performed very effectively. About 15-20 kickoff meetings are held during a normal outage and about 50 during a ten year outage.

The Quality Decree of 1984 states that checking and supervision of maintenance activities on equipment important for safety (IFS) must be performed. Fessenheim has implemented a quality plan concept for IFS work which is intended to limit the human factors risk. A formalized risk analysis is performed. The quality plan specifies the necessary maintenance steps, verification hold Points, external and internal audits, work site reviews, etc, which result in an effective independent quality control system. Together with the development of work procedures, this concept will provide good control of the performance of maintenance in the plant. Fessenheim intends to extend this work control process to equipment other than IFS equipment.

Good practice: The Quality Plan concept and development of detailed work procedures minimize human factor risks and contribute to good control of performed work.

Good practice: The Work Request meeting and the Work Issuing meeting provide good co-ordination between the different maintenance departments and operations and are professionally conducted.

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

4.6. Preventive, Predictive and Corrective Maintenance

The preventive maintenance programme (PM) for Fessenheim was developed on the basis of the manufacturers, specifications, experience feedback and doctrines and programmes evaluated and developed at corporate level. Doctrines for CP1 and CP2 NPPs have also been evaluated and used where applicable. The departments for Mechanical Maintenance and I&C Maintenance have developed PM programmes for mechanical, I&C and electrical equipment according to the above corporate directions and local experience.

A Computerised management system (A22) is used to initiate and organise the PM work on a weekly basis, one week before the scheduled start of work. Work Orders are prepared after an evaluation of the listed PM activities on the list after the work is performed, the system is updated. Comments and observations made during work performance are recorded in SYGMA.

A system for monitoring the condition of about 116 pieces of rotating machinery has been implemented. Temperature, pressure and vibration parameters are routinely monitored. The results are stored in a database and evaluations are conducted periodically. Intervals for monitoring have been established and monitoring is also conducted before and after outages.

Corrective maintenance identified during back-shifts and weekends requiring short term attention is initiated and prioritized by the shift supervisor. An on-call staff of 44 people provides sufficient backup to the shift personnel for corrective maintenance needs.

After completion of corrective maintenance a report is written by the person in charge of the work which is then verified by the foreman. The complete work file then goes back to the preparer for analysis, the computerized system is then updated, the documentation is microfilmed and the original documents are archived.

4.7. In-service Inspection

Safety related components are classified in three safety classes depending on their level of importance to nuclear safety in the plant. The corporate maintenance department writes and updates the EDF National programmes based on the national regulations and experience feedback.

The local ISI programme at Fessenheim is based on these national programmes. The local ISI programme is managed by a local computerized system and will be incorporated later into SYGMA.

Inspections are performed by national contractors for the reactor pressure vessel and steam generator tubes. Other inspections may be performed by on-site personnel or contractors. Certification of contractors is performed and tracked by the Central Laboratories (GDL).

The ISI programme is included in the outage file sent to the authorities two months before the outage

Indications are evaluated and files generated to provide analysis, repair or monitoring. These files are reported to a national computerized system for managing anomalies and also to the safety authorities.

Final ISI programme results are documented and presented to safety authorities in an outage report. The results must be reviewed with the safety authorities prior to unit restart.

4.8. Stores and Warehouses

The EDF-UTO organization is responsible for the procurement of safety related spare parts, spare parts shared by PWR units and nationally managed spare parts with economic criteria. The procurement and control of quality are in accordance with EDF procedures.

The bar code system for controlling the issue of tools was found to be very good. The computerized system was a very effective method to track and control inventory in the stores. The stores area was also clean and well maintained.

The site stores function is well staffed with personnel with a professional attitude to their work. The facilities and equipment storage rooms were reviewed and found to have adequate space, to be clean and well organized. The warehouse has separate rooms for storage of rubber/packing material and electrical circuits. These are controlled for temperature and humidity.

Certificates and shelf documentation are stored together with the spare parts and also in the stores archives. The shelf life programme was found to be in order.

Preventive maintenance procedures exist for large equipment or components which are stored under special conditions.

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

4.9. Outage management

A long-term outage schedule is prepared, which includes all EDF nuclear power plants. This schedule is co-ordinated to control planned outage dates and duration, to plan for additional manpower, and to check the availability of special outage equipment, major suppliers and technical expertise to support the outages.

The Outage management and administration at Fessenheim NPP is organized in an "Outage Structure", which is a matrix function that is responsible for outage organization, technical administration, logistics and scheduling. The permanent staff ensure effective management, scheduling, implementation and control of maintenance activities and ensure a continuous development of outage performance.

Procedures have been developed for the overall Planning and Preparation of outages with deadline, for Preparatory activities, reports, meetings and meeting reports, which ensure an effective documentation of the outage. The tasks and responsibilities of different organizational departments and persons are clearly defined.

A Standard Outage Plan has been developed for each unit with break down into the seven main phases of an outage, from the shutdown phase of the plant to the startup phase.

All NPPs in France are obliged to write a report before outages of longer than two weeks with work on safety related system. All scheduled work on safety related systems must be described in this report as well as all work on pressure boundaries. Two months before the outage the report is sent to the safety authority for approval.

Two weeks before the startup the original report is complemented with inspection results and work performed on safety related systems as well as anomaly reports. This report is sent to the safety authorities for approval before startup.

A procedure for reporting observations of bad performance of work or behaviour in the plant during the outages has been developed. The observations are documented in a special form and evaluated by the outage manager. The performance of each outage is evaluated and experience feedback is fed back both locally and nationally. The lessons learned and recommendations for next Outage were found to be appropriately implemented.

The reception of contractors is organized and performed in an excellent way with good training aids such as video films. The contractors' qualification is checked by verifying authorization papers as well as their knowledge regarding radiological protection, safety and quality.

Good practice: The Outage Structure organization contributes to good co-ordination for both the preparation and the performance of the outage. The responsibilities for individuals are clearly defined and understood. The Procedures for preparation, scheduling and performance of the outage are structured in such a way as to provide for a high level of safety.

Good practice: The on-line updating of the Outage schedule is a good example of extensive conduct and control of work execution during the outage.

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

5. TECHNICAL SUPPORT

The technical support function at Fessenheim is provided by a number of plant departments which also receive considerable assistance and direction from the corporate organization. The combined efforts of these various groups have, in general, been successful, although the sharing of duties and responsibilities produces an environment in which communication and setting of priorities can often be difficult. In general, technical support functions are appropriate in scope, are well documented and are carried out by an enthusiastic and competent staff.

The overall plant surveillance test programme contains all the necessary key elements. It appropriately covers not only tests required by Technical Specifications but also a number of the tests required by vendors. The execution of tests was found to be acceptable; however, some improvements for increasing the effectiveness of surveillance programmes have been suggested.

In the area of modification control, the combined efforts of plant and corporate personnel have been particularly successful. The creation of a joint design and operations team at Fessenheim, combined with the use of modification project leaders, has played a key role in achieving performance comparable with that of the best nuclear plants. Effective computer support has also been an important factor.

The experience feedback programme contains many of the necessary features for success but analysis of events and control of the overall process require improvement. Corporate responsibility should be more clearly defined, event analysis should be more thorough and consistent, and provisions to ensure the timely completion of the various activities should be made.

The functions of reactor engineering, fuel handling and computer applications were all observed to be comprehensive in scope, well documented and well managed. More involvement of plant engineers in writing and reviewing of operating procedures was suggested.

5.1. Organization and Functions

Technical support at Fessenheim does not, generally, reside in the department identified as "Technical Support". This department's main involvement is only in reactor engineering# fuel handling and specialized aspects of testing. The balance of technical support is provided by a number of plant departments as well as various corporate departments in the Nuclear and Fossil Generation Division (SPT) and, to a lesser extent, the Engineering and Construction Division (DE).

There is some evidence to suggest that in the technical support area this fragmentation of responsibility is creating problems. The average unplanned extension of major outages at EDF is approximately 30%. Analysis of the causes of these outage extensions reveals that approximately 50% are the result of organizational problems. In addition, over 50% of all Significant Event Reports occur with the plant shut down, and of these about 70% are caused by human rather than equipment problems.

In addition to the "line" organization at the plant, there are special interdisciplinary organizations for outages and for operations. Technical support is a component part of these special organizations.

The Nuclear and Fossil Generation Group (SPT) and the Plant Engineering and Construction Group (DE) provide most of the corporate technical support to Fessenheim. They play a major role in experience feedback, modification control and reactor engineering. In these areas they provide in depth technical expertise, and they also manage all aspects that are common to more than one plant.

For Operational Feedback Experience, SPT has the responsibility for indepth analysis of selected specific events, for the specification of corrective actions for those events and for documenting and analysing generic lessons learned for the entire utility. Various SPT and DE departments are involved in assessing generic experience feedback, but responsibility for the entire process is not well defined. Within SPT, the Corporate Technical Support Group (UTO) is responsible for performing analysis of outage experience feedback that is of generic interest.

For plant modifications, implementation is managed effectively by a joint plant/DE organization named the Site Works Structure (STN) with a staff of 31. This appears to be a very effective arrangement.

Good practice: The organization of the Fessenheim New Site Work Structure Department combines the expertise and the manpower of EDF's Corporate Engineering Division and Fessenheim's plant technical and trades staff into one permanent department under a single department head. This arrangement is very effective in the management and implementation of modifications, and also results in an invaluable interchange of experience between Design and Operations, which is of mutual benefit to both divisions.

For surveillance testing, the following departments are involved as required: Operations Department, Technical Support Department, Instrumentation and Control Department, and the Precision and General Mechanics Department.

The Safety Department has overall responsibility for the operational feedback process at the plant level while the outage organization has the specific responsibility for plant feedback from outage experience.

The New Site Works Structure has full responsibility for implementation of plant modifications and also for design of local modifications.

The involvement of the Testing Section of the Technical Support Department in reactor engineering functions is limited to implementation of the startup tests and specific periodic tests.

In contrast, all fuel handling operations are under the full responsibility of the Testing Section, but physical handling and inspection of nuclear fuel for acceptance, dispatch and refuelling is carried out by the General Services Section.

The plant Data Processing Section is responsible for operating and maintaining all computer hardware and software at Fessenheim and for providing necessary services to plant staff.

The technical support function is performed by the Maintenance, Operations, Safety, and Radiation Safety Departments. These groups provide specialized technical support to prepare and review procedures, to troubleshoot plant problems, to review modifications, to provide input to event assessments and, where appropriate, to plan and direct work.

Adequate resources appear to be available for the technical support function. No serious backlog of important work was found, and appropriate qualifications and levels of training are specified for the various technical support groups. A proper regard for and knowledge of nuclear safety matters were observed.

Training is provided commensurate with the area of expertise and also in common safety related areas such as operating rules, station systems, safety philosophy and radiation safety. Structured training programmes are available to upgrade technicians to the equivalent of engineers and even to support University training to become professionally qualified.

Problems have been identified within the technical support function that relate to the co-ordination of work over a number of disciplines and departments. EDF has proposed the establishment of project engineers for managing large maintenance jobs, and has already implemented such an approach for field management of modifications.

- (1) **suggestion:** EDF should consider extending this approach to incorporate the use of system Engineers. This concept, which has been used successfully in a number of nuclear plants, is based on the rationale that the management of an individual plant system (or group of systems) is best carried out by one person who is responsible for all technical, operational and maintenance aspects of that system. This approach is very effective in reducing the difficulties in communication and responsibilities that are inherent in multidisciplinary tasks.

5.2. Surveillance Test Programme

A significant number of periodic tests are carried out at Fessenheim NPP to demonstrate, in a specified technical form, that safety systems and equipment are within acceptable limits to perform their tasks properly as established in relevant design and technical documents.

The overall surveillance test programme is clearly defined by an administrative document plus other documents from the quality series. A review of these programmes showed that they appropriately covered the tests required by the Technical Specifications but also a number of tests required by vendors' instructions for main equipment and components important for safety and availability.

The Safety Department plays a key role in the overall surveillance test programme from an administrative and formal point of view. The Safety Engineers from this department monitor implementation of the programme and act as overall co-ordinators.

In general, the review of the surveillance test procedures showed compliance with administrative documents regarding the format and presentation of content and with Technical Specifications. Some weaknesses were found in the procedures related to the return of the tested equipment or systems to the required configuration after the tests.

- (1) **Recommendation:** The identification of detailed steps concerning the proper return of the tested equipment or systems, to the required configuration after testing should be improved in test procedures. For example, making a clear statement and/or providing a checklist for proper verification of system lineup, especially for complicated cases when a number of valves or switches are involved.

Scheduling and monitoring of the surveillance tests are usually done by computer on a weekly basis. Proper interpretation of test intervals from Technical Specifications and acceptable limits were found for all examples reviewed. The full set of test procedures and the implementation plan are carefully prepared two weeks in advance.

The conduct of three periodic tests was observed by the team. All tests witnessed were carried out in a professional manner and appropriate tools and instruments were available.

Despite some examples given, the reviewers found that the overall review of the test results carried out at the plant, such as trend analysis and objective assessment of the effectiveness of surveillance programmes, were not systematically conducted.

- (2) **Suggestion:** Consideration should be given to conducting systematic reviews and trend analysis of surveillance test results.

5.3. Experience Feedback

Plant staff are provided with criteria for initiating a significant event report (SER) in a station directive. Similarly, criteria for the less serious safety related events and anomalies are also provided in directives.

SER initiation and initial event analysis are normally carried out by the Safety Engineer on shift in conjunction with the Shift Supervisor. A meeting is held at which initial recommendations are made. After review by the Manager of Safety, the event is formally recognized and necessary notifications are made. The target for notification to the safety authority of a significant event is one working day after the event.

All events are entered into a computer based event file which is accessible to the plant, headquarters and DSIN staff. This forms a statistical database which can be used for utility wide trending and analysis.

Only a very small number of safety related events receive individual analysis and this practice diminishes the capability of EDF to draw lessons from the many precursor and near-miss events that fall into this category.

During outages, experience feedback reporting also occurs, and although this analysis concentrates on causes for outage extensions, it does provide additional safety related information.

For SER's an in-depth site analysis is carried out by a committee of relevant persons, chaired by a Safety Engineer, and recommended follow-up actions are developed. The persons involved in the initial actions and in this follow-up meeting generally have no training in interviewing skills, human factors or event analysis, and formal event analysis is not performed. This problem has been recognized and a training programme has been initiated with the intent that all Safety Engineers will eventually be familiar with event analysis and the skills necessary to perform this analysis. The plant deliberations culminate in a review by the Plant Operating Review Committee and issue of the SER. The time limit for issue of the SER is two months after the incident.

For outage feedback, the Outage Structure reviews plant-wide lessons using input from relevant plant departments and evaluates and initiates follow-up actions. Generic follow-ups are addressed by UTO.

The SER includes follow-up actions, including responsibility and target dates. The SER is sent to safety authority and the SPT Operations Department who perform indepth analysis of selected events, assess and initiate actions, and update the database. Procedures and methods for the corporate SPT activities are not well developed. SPT does-not routinely use formal event analysis. Completion targets for the SPT analysis process are set by the chairman of the SPT Review Committee but it is not apparent that adherence to these targets is monitored. The corporate review includes personnel with operating or safety engineer experience.

The plant wide follow-up actions from outages are reviewed by the outage structure at least three months prior to the next outage and UTO reviews follow a similar approach.

Periodically, SPT sends summary leaflets and "good practice" guides to the plants, which describe major events that have occurred in other nuclear power plants. These guides are in an easy to read format and are effective communication tools.

The ability of Fessenheim and EDF to learn from experience and to reduce the future occurrence or recurrence of incidents is hampered by what appears to be an inadequately managed and insufficiently rigorous programme. Effective corporate responsibility for the overall experience feedback programme is not apparent and senior plant management are not normally involved in event analysis.

- (1) **Recommendation:** A senior corporate manager should be made responsible for the overall Experience Feedback programme, who should ensure that the programme is effective in meeting EDF's stated goals.
- (2) **Suggestion:** Consideration should be given to including one or more members of the management committee in the plant review and analysis of SERs and Safety Related Events. This would raise the profile of the process and also ensure that the necessary broader view of safety provided by senior management is incorporated.

Monitoring of the implementation of recommended follow-up actions is the responsibility of each plant, and at Fessenheim this is the responsibility of the Safety Department and the department responsible for the action. There is no effective mechanism for monitoring and controlling the status of follow-ups.

The Plant Operating Review Committee meets periodically and reviews general safety matters, including SERs. At a more senior level, a corporate committee, the In-Service Nuclear Safety Committee, reviews events of special significance, while various other corporate departments and senior committees also have a mandate to review and assess the most important Significant Events.

There appears to be no system in place to allow management at the plant or at SPT to monitor the effectiveness of the event reporting, analysis and follow-up process. Significant event data prior to 1988 for Fessenheim are not available in the computer database and therefore cannot be used for analysis, nor can the status of follow-ups for this period be easily assessed.

- (3) **Recommendation:** Means of tracking the timeliness of SER submission to DSIN, of corporate SPT event analysis and of the implementation of event follow-up actions should be formalized. Appropriate reports should be generated for the plant and for SPT and targets should be set and monitored.
- (4) **Suggestion:** Details of Fessenheim significant events prior to 1988 should be transferred to the computer database to allow better analysis and follow-up of recommended actions.

The process documented in the various plant procedures appears to be adhered to except that the implied role of the Safety Department in managing the status of follow-up actions does not seem to occur in an effective way. No regular review of SER follow-ups takes place.

Event analysis using a formalized system does not occur at the plant nor routinely at the corporate level, although human factors specialists are involved in the corporate review group. Without a formal process defined by procedure to analyse events, effective root cause identification may not occur.

SERs are available in the plant record system and were available for examination. The computer based significant event database contains all significant events since 1988 and the computerized event file contains summary information on all important events since startup.

- (5) **Recommendation:** A more formal and consistent approach to event analysis should be developed and documented. Training should be given as appropriate to ensure that the chosen approach is adopted. This applies particularly at the plant but also at SPT.
- (6) **Suggestion:** The existing treatment of safety related events should be reviewed to determine if more rigorous analysis of these events is necessary.

5.4. Plant Modifications

Plant modifications are managed in four phases: (1) initiation of a request for modification; (2) assessment of the request; (3) design; and (4) implementation of the modification. Three principal groups are involved: the plant, the SPT corporate departments and the DE division via its Lyon Engineering department (CLI). The Plant Manager approves all modifications that are carried out at the plant.

All activities associated with the modification process at both the corporate and the plant level are well described in formal documentation and the process is controlled by computer programmes.

Initiation of plant modifications is usually from the plants. A universal system for requesting modifications is used, with a standard request form and a well documented procedure.

For national modifications, initial assessment is by a corporate Modification Management Committee, which comprises senior managers from each SPT Technical Department (approximately 18 in total), two managers from DE and one plant manager. This first stage assessment is at the conceptual level and is to seek approval for a detailed feasibility study, normally carried out by DE's CLI Department. A project leader is also designated.

Once a feasibility study has been completed, the technical solutions are brought back to the Modification Management Committee for them to select the appropriate solution or to reject the proposed modification. A target is established for completion of each modification. A similar approach is used for local modifications, but assessment is by a plant Modifications Committee.

Prior regulatory approval of modifications is not required as such, but DSIN receives summary statements of all modifications and also chairs a joint DSIN/EDF senior managers group at which it identifies those modifications it wishes to review. DSIN is also closely involved in the plant annual outage when it takes a particular interest in modifications. DSIN approval is required before plant startup following the outage.

The designated project leader sets up the Modification File, which contains all the necessary information to fully implement the change, including documentation affected by the modification, training required and test requirements. At this point, the modification is entered into the computer database which tracks and controls it until it is completed.

Scheduling the implementation of national modifications is managed by the UTO scheduling section. In addition to the overall monitoring provided by UTO, the plant Modification Committee meets at least four times a year to review the progress of modifications at the plant.

STN, via an appointed project leader, manages the field implementation of modifications. This responsibility includes the technical aspects of the work, scheduling and coordination of other work groups, quality control, worker safety and site cleanliness.

Prior to starting work on each modification, a "Kick-Off" meeting is held with all involved parties at which all aspects of the job are covered. The work proceeds with the project leader controlling and monitoring the work.

On completion of the field installation and testing, all departments responsible for updating documentation are informed and the new or revised documentation is issued. Most modifications are carried out during a planned outage and the modification progress is periodically reviewed by the outage Structure Unit before being presented to DSIN for their approval to restart the plant. At this stage, the modification file will show evidence that the proper installation, testing and documentation have been completed, with any non-conformances identified and dispositioned.

Although the modification management programme tracks and controls the update of documentation and requires key documents to be ready prior to unit startup, there is no documented requirement to monitor completion of those documentation updates that are not mandatory for startup, nor the upgrading of temporary changes to permanent ones.

- (1) **Suggestion:** Although STN has departmental controls on its documentation update commitments, consideration should be given to modifying the existing computer database so that it can provide routine reports to plant management on the plant wide status of documentation update.

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

5.5. Reactor Engineering

Reactor engineering tasks at Fessenheim NPP are clearly divided between the plant staff and external organizations.

A national, well validated and benchmarked three dimensional computer code (APOLLO) is widely used for reload calculations. All reload calculations and reload safety evaluations are independently checked by the fuel supplier. They are sent to the Safety Authority.

The set of working documents for startup tests is prepared by an engineer from the Technical Support Department who is properly qualified in core physics. The implementation of the startup tests is usually carried out under joint supervision of both NPP and corporate representatives.

The fuel integrity management policy which allows the reload of the leaking fuel assemblies is based on a large volume of experimental data and successful long operating experience.

The monitoring and testing of the core physics instrumentation (neutron detectors, thermocouples) are adequately controlled by the I & C department

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

- (1) **Suggestion:** Consideration should be given to more involvement of the engineers from the Technical Support Department in the writing and review of the operating procedures relating to core physics.

5.6. Fuel Handling

All fuel handling activities starting from receipt of fuel to the dispatch from site are under the responsibility of and are carried out by the Technical Support Department. One of the departmental engineers supervises the team of fuel handling personnel from the General Services Section which is responsible for acceptance, dispatch and refuelling of nuclear fuel.

Planning for forthcoming activities is appropriately co-ordinated with other outage activities in the Reactor Hall and Fuel Building, with account taken of the limits on the number of personnel participating.

New fuel inspection is carried out by qualified technicians. All important elements are checked in accordance with stipulated acceptance standards and requirements. Records reviewed were accurately filled in and carefully kept.

New fuel assemblies are usually stored in the spent fuel pool or in dry storage. Access to the dry storage is under strict key control and material conditions were found to be satisfactory.

During fuel loading and unloading, criticality and radiological protection are strictly controlled by checking boron concentration, water level and neutron flux.

The EDF policy for storing spent fuel is fully followed at Fessenheim NPP. The number of spent fuel elements in the pool is limited and sufficient new elements are kept only for the case when a new core configuration may be required as a result of sipping tests.

Material and environmental conditions in the vicinity of spent fuel pool are good and are properly monitored.

5.7. Computer Capabilities

The plant Data Processing Section is responsible for control of all plant computer hardware and software (excluding custom made microprocessors which are a Maintenance Section responsibility). The staff of 20 appears adequate to carry out its tasks.

Design, modification and purchasing of software and hardware for all national non-process plant applications is the responsibility of the Corporate Data Processing Department of SPT. The responsibility for process applications is shared between SPT and DE although the specific software is produced to EDF's specifications by the manufacturer of the products. This overall corporate control results in maximum benefit from standardized design and equipment at all EDF nuclear plants.

Adequate documentation exists to manage all aspects of computer usage at the plant and at the corporate level. Quality control procedures are a requirement of the manufacturer and are reviewed for acceptability by DE. UTO observes and approves the testing of software at the factory.

The process for initiating and reviewing modifications is well documented. For process applications the regular plant modification procedures are used, and for business applications, a separate initiation and review process is used, which includes an appropriate breadth and level of review.

All process software is classified according to its safety significance and receives a level of quality control consistent with its classification. This approach ensures that the software is assessed for its possible impact on nuclear and personnel safety.

Computer usage at Fessenheim is extensive. Process computers provide support for the control Room staff under normal and accident conditions. Business computers provide a large number of important services, including work order processing and work assessment, work protection and modification management. Personal computers are considered essential tools in a modern industrial environment, and Fessenheim has approximately 400.

6. RADIATION PROTECTION

The radiation protection programme at Fessenheim is implemented by a small professional staff with excellent performance results.

The training in radiation protection for the workers is well developed, in accordance with the radiation protection (RP) policy based on all workers being responsible for determining the RP risks and for taking their own protective measures. The RP staff assists the workers when the need arises and control the quality of radiological protection.

An ALARA policy has been implemented for doses as well as for radioactive releases and solid wastes.

A good practice was found in the creation of the ALARA Committee to examine the work on the reactor pressure vessel head and the on-line study of radiation protection means during the work.

Improvements were recommended in the following areas: to conduct more frequent and systematic contamination surveys outside the controlled area; to improve the calibration and test programmes for radiological instrumentation; and to update the calculation models for doses received following an internal contamination according to the new models being used in other countries.

The following suggestions were also made: to use individual neutron dosimeters in order to have confirmation of calculated neutron doses; to use bags of different colours in order to facilitate solid waste separation on work sites; to place a poster on the controlled area exit doors that specifies the end of the controlled area and the exit instructions for removing equipment; to organize more frequent emergency drills; and to instal a dose rate or air contamination monitor in the security building.

Overall the plant has achieved excellent results in the radiological protection area and is striving to further improve its performance. The radiation protection staff are very professional and experienced and provide excellent support to the station staff in RP matters.

6.1. Organization and Administration

The radiation protection activities in Fessenheim are based on the French national regulations. The radiation protection policy for EDF nuclear power plants is defined by the central department DSRE (Département Sécurité Radioprotection Environment), taking into account the regulations, operating experience and evolution of the techniques.

The radiation protection policy is based on all workers being responsible for determining the RP risks and for taking their own protective measures. Consequently:

- Each station department is responsible for implementing the radiological protection measures for its own field of activity;
- Each worker must know the instructions and actions to be carried out to protect himself or herself; depending on job function and in accordance with the given instructions, the worker assumes responsibility for the actions he or she carries out and their impact on radiological protection.
- The Radiation Protection and Industrial Safety Department assists the other departments when the need arises, controls the quality of radiological protection and provides training.

The qualification level of the RP staff is good. Pedagogical training is also given to the RP staff to enable them to train the station workers in radiological protection.

An ALARA policy has been implemented and there is a strong commitment by line management to dose reduction.

Good practice: The creation of the ALARA Committee to examine the work on the reactor pressure vessel head and the on-line study of radiation protection means during the work is a good example of the ALARA policy.

6.2. Radiation Exposure/Radiation Work Permits

Workers (plant and contractor staff) are required to receive training in radiation protection. After training, two kinds of authorization are provided, RP1 for workers executing work in the controlled area and RP2 for people in charge of work sites in the controlled area (who must be able to define the means for radiation protection). Authorization is given after a written examination.

The controlled area is divided into four "colour zones" according to national regulations. Workers needing to perform tasks in the "green zone" (0.0075 mSv/h to 0.025 mSv/h) or to the "yellow zone" (0.025 mSv/h to 2 mSv/h) have free access to these zones. Access to the "orange zone" (2 mSv/h to 100 mSv/h) is subject to written authorization. This authorization indicates the instructions for radiological protection; it is completed by the department requesting the job and signed by the Radiological Protection and Industrial Safety Department. Access to the "red zone" (more than 100 mSv/h) is submitted to the plant manager for signature.

All radiological hazards (dose rates, air contamination, surface contamination) and industrial safety hazards are taken into account during the writing of the access authorization.

In the case of high dose rate work sites, workers are specially trained to reduce the dose. For example, a mock-up of the lower part of a steam generator is available on site and the workers may be trained by an external firm (CETIC). A mobile shielding system is also used to reduce the dose rates during outages.

Radiation surveys are carried out on a weekly basis for the most significant places in the controlled area (measurement of dose rates, air and surface contamination). In case of intervention in a particular place or on a particular piece of equipment, the work chief may use the existing data or ask for a new survey.

Procedure for intervention on potentially high dose rate equipment require a measurement of the radiological conditions before work begins. Dose rates and contamination values are indicated on a sign at the entrance to each area. Hot spots are indicated locally by a sign indicating the dose rate.

Outside the controlled area, there is no systematic programme to survey for potential contamination, in particular at the exits from the controlled area and in the counting room of the chemistry laboratory. Controls are performed only after the outage or if a contamination problem is suspected. Industry experience shows that contamination outside of the controlled area may not be excluded, especially at the equipment exits.

- (1) **Recommendation:** A systematic programme for contamination surveys outside of the controlled area should be developed.

6.3. Internal Radiation Exposure

Protection of staff against internal contamination is achieved through collective (cleaning, ventilation, etc.) or individual (protective clothing, with ventilation if needed) protection means.

Potential internal contamination of EDF staff is monitored by whole body counting every six months. Contractor staff are submitted to whole body counting on initial arrival at the site and on leaving when their work is completed.

Cleaning and decontamination of various areas are carried out systematically. Air contamination is permanently monitored on some work-sites (spent fuel pool and reactor building Pool) during outages. Air contamination is reduced on worksites, if necessary, by using dynamic confinement (aspiration near the contaminated pieces and filtration of the aspirated air).

6.4. Radiation Protection Instrumentation, Equipment and Facilities

The calibration of the fixed radiation monitoring system is carried out on an yearly basis. Between two successive calibrations, every 5 weeks, a test with a source functionally checks the operation of the instrumentation and of the associated actions to be verified. However, this is done without measuring the accuracy of detector response. (Expert for the instrumentation measuring noble gases in the chimney, which is tested by injecting a known quantity of Krypton-85.) Moreover, it appears that during the annual calibration of some detectors the sensitivity has changed by a factor up to four; thus indicating significant detector drift since the calibration of the preceeding year that was not detected during the 5 week tests. The calibration Procedure contains no criteria defining the actions to be taken by the instrumentation technician during calibration.

The portable radiological instruments are calibrated yearly in the plant or by certified firms. Instruments are marked with the expiration of their calibrations. During the review, a test was made to check the calibration of a contamination meter calibrated by a certified firm one month earlier. The instrument exceeded the 20% tolerance level prescribed by the plant.

- (1) **Recommendation:** Acceptance criteria should be added to the procedures for the yearly calibration of fixed radiological monitoring instrumentation.
- (2) **Recommendation:** A monthly test including the measurement of the response of fixed instrumentation to a known radioactive source (check source) should be performed to detect drift of its calibration. Working criteria should be defined.
- (3) **Recommendation:** The quality of the calibration procedures for portable radiological instrumentation should be examined and improved.

A calibration facility is available on site for the yearly calibration of dose rate meters and electronic dosimeter's. However this calibration facility does not provide a security system that would protect a worker who enters the beam from exposure. A modification of the regulation has been announced which will require that all future calibrations be performed by certified firms only.

- (4) **Recommendation:** If the use of the calibration facility is still planned, security system(s) should be added to protect the workers from exposure to calibration sources.

A medical department is located on the site. The facilities for staff decontamination, the procedures and decontamination products are adequate. However, the current organization of the decontamination facility does not include a permanently installed device for contamination monitoring at the exit of the decontamination room.

- (5) **Recommendation:** A permanent contamination monitor should be installed at the exit of the medical decontamination facility.

6.5. Personnel Dosimetry

External exposure is monitored by means of electronic dosimeters and film dosimeters (official dosimeters).

Film dosimetry is read on a monthly basis. Electronic dosimetry is read on a daily basis on exiting the controlled area (one dosimeter is given to each worker, EDF or contractor, at the entrance of the control area).

Film doses are taken into account in the recording programme when they are known, one month after the film period. A monthly systematic comparison is made, for each worker, between the film dosimetry and the electronic dosimetry. An investigation is held if the difference is greater than 20%.

Neutron exposure is calculated, notably for people entering the reactor building during operation, or for people working on the transfer of exposed fuel assemblies. Neutron exposures are based on calculations taking into account the measured dose rates, times of exposure, and the relationship between gamma and neutron dose rates. However, individual variations from the calculated values are possible.

- (1) **Suggestion:** Consideration should be given to using individual neutron dosimeters, even if their accuracy is still low, in order to have confirmation of calculated neutron doses.

Four whole body counters are available on the site, three for routine staff monitoring and one to be used in the event of a contamination incident involving a worker. The minimum time for a measurement is ten minutes.

Equipment and measurement analysis programmes are imposed by SCPRI. These programmes are still based on the ICRP 2 Recommendation models.

Bioassays are systematically carried out every sixth month, and when internal contamination has been detected.

- (2) **Recommendation:** Calculation models for doses received following an internal contamination should take into account more recent ICRP Recommendations (currently ICRP 26 and 30).
- (3) **Suggestion:** Consideration should be given to purchasing an internal contamination measuring device allowing quicker measurements.

6.6 Radioactive Wastes, Control and Monitoring of Effluents and Environmental Surveillance

Efforts are made to limit the volume of solid radioactive waste, notably by limitation of packaging materials, entering the controlled area and by strict management of the treatment system for the liquid effluents (use of the filters or demineralizers). Annual goals are set to reduce the volume of the different wastes and progress in meeting these goals is reported, to management.

Procedures for the treatment of different wastes are available and they have been accepted by ANDRA (National Agency for Radioactive Waste Management) and approved by the Safety Authority (DSIN). The management of the wastes is done by DRA, a computerized radioactive waste management system.

In the plant, the separation of different types of waste is carried out on the work site, under the responsibility of the work chief. Good separation of solid wastes facilitates the treatment and could further reduce the doses and waste volumes.

- (1) **Suggestion:** Consideration should be given to using bags of different colours to facilitate solid waste separation on work sites.

There are no exit indications or instructions for removing equipment from the controlled areas on the exit doors.

- (2) **Suggestion:** Consideration should be given to having a poster on the controlled area exit doors that specifies the end of the controlled area and the exit instructions for removing equipment.

The authorized release limits are defined in the plant license and conform to the national regulations (in particular, there is a combined limit for iodine and aerosols in the gaseous releases, as well as for nobles gases and tritium). Annual goals are set and are substantially less than the limits (except for tritium in the liquid releases). These goals are being decreased every year to achieve ALARA goals.

Recording of releases is performed in accordance with the directives of SCPRI and conform with the national regulations. The record keeping does not require the periodic measurement and recording of Strontium-90 in the liquid releases.

- (3) **Suggestion:** Consideration should be given to periodically measuring Strontium-90 in liquid releases (for example, a composite sample.)

A special study of the radioecological impact of the plant was carried out in 1989, after 12 years of operation. Only some aquatic plants contained measurable amounts of radioactive isotopes coming from the liquid releases, without any human health impact. An annual survey of the radioecological impact of the plant is now foreseen.

6.7. Radiation Protection Support During Emergencies

Radiation protection emergency procedures are a part of the emergency planning manual. Every person on the RP staff has instructions depending on their task in an emergency situation. Two measuring vehicles can be sent out to assess the dose rates and air or ground contamination, on and off the site.

Information concerning emergency planning is provided and specific training is provided to the RP staff in relation to their tasks. Emergency drills are organized about once a year. These are necessary for staff to become familiar with procedures and to ensure that they react correctly in the event of an emergency.

A security building is situated at the entrance to the site where RP staff and plant management gather to assess the situation during an emergency. The air is filtered. However, neither a dose rate monitor nor an air contamination (noble gases) monitor is installed in the building.

A well equipped building is also provided in the village of Fessenhiem for personnel decontamination

- (1) **Suggestion:** Consideration should be given to installing dose rate and/or air contamination monitors in the security building.

7. CHEMISTRY

The chemistry of the Fessenheim Nuclear Power Station follows up-to-date specifications taking into account plant design and materials used in the circuits.

Plant chemistry is based on guidelines and procedures prepared by EDF headquarters. The guidelines give valuable advice for chemistry equipment and instrumentation for reliable chemical treatment of the circuits.

The Laboratory Section, which is responsible for the chemical and radiochemical surveillance, is staffed with an adequate number of well educated, well trained and highly experienced personnel.

The laboratories are modern and are equipped with well maintained instruments of the latest design. A comprehensive system of on-line monitors for checking main chemical parameters together with carefully performed analytical surveillance of the circuits ensures that chemical conditioning is kept close to the required values.

Industrial safety facilities in the laboratories generally meet the normal standards; however, further precautions should be taken to prevent the spread of contamination and to improve safe storage and handling of chemicals.

The results of chemistry surveillance are adequately evaluated and reported and form the basis of a good experience feedback system. The co-operation of the Laboratory Section with corporate and plant sections, especially with the plant operational staff, is exemplary.

7.1. Organization and Functions

The Laboratory Section is part of the Technical Support Department and has a well defined organizational structure. Various levels of foremen, technicians and skilled workers are placed under the Laboratory Section head.

The Laboratory Section is responsible for the performance of chemical and radiochemical surveillance of all plant circuits and of liquid and gaseous effluents, the performance of environmental measurements, the monitoring of fuel integrity, and the operation and surveillance of the demineralized water plant.

Qualified members of the Laboratory Section are on call around the clock to ensure short term availability in case of any event.

Chemistry surveillances are based on comprehensive chemical and radiochemical national guidelines for the circuits and systems of PWRs. They are prepared on the basis of existing up-to-date knowledge by the EDF headquarters' Central Laboratories (GDL) and Industrial, Safety Department (DSRE). Headquarters departments provide expert advice for normal and abnormal situations to the Laboratory Section of the plant. Considerable aid is also given in the improvement of on-line monitoring systems and the qualification of laboratory instrumentation.

The members of the Laboratory Section were found to have an appropriate education and were well trained and experienced. Periodic refresher courses and job rotations ensure that all personnel are adequately trained in the event that they are required to perform special duties when on-call.

7.2. Chemical Treatment, Material Concept, Activity Buildup and Corrosion

The chemical treatment of the circuits has changed over a period of time to take into account new knowledge concerning the design and the materials present in the plant.

The systems which are available for chemical treatment of the primary and secondary coolant, such as purification systems and chemical addition equipment, are used in an exemplary manner.

Good Practice: Automatic injection of hydrazine into the secondary coolant controlled by on-line monitoring ensures optimal conditioning e.g. in cases of load following operation.

The plant uses a comprehensive system of on-line monitors for monitoring important chemical parameters in the primary circuit and secondary circuit. Administrative instructions for the operating staff ensure that corrective measures are performed in adequate time if limiting values are exceeded. Thus specifications for chemical treatment are kept close to the required values.

Limiting values of chemical parameters are not marked on control room recorders.

- (1) **Suggestion:** Consideration should be given to marking limiting values of chemical parameters on the scales of recorders in the control room.

Primary coolant chemistry follows boron/lithium co-ordinated chemistry in strict accordance with the EDF guidelines to maintain a pH value of 6.9 under operationing conditions. The activity in the primary system has thus been kept approximately constant up to now in Unit 1 but is slightly decreasing in Unit 2. The activity levels are comparable with those for plants of similar design. The pH value is at the lower level to minimize corrosion product transport and activity buildup of radioactive materials in the primary circuit.

- (2) **Suggestion:** Consideration should be given to reviewing the Li/B co-ordinated specification together with GDL.

The levels of corrosion products and corrosive agents were found to be low in the primary coolant, thus showing the effectiveness of the carefully performed chemical treatment.

Precautions are taken to keep hydrogen in the appropriate range during normal operation, shutdown and startup periods in order to protect steam generator tubing from stress corrosion cracking.

Secondary coolant chemistry had to be optimized with the aim of minimizing corrosion of copper alloys in condensers and preheaters, erosion corrosion of steam swept areas, and intergranular attack of Inconel 600 of the steam generator tubing. This is achieved by all volatile treatment with morpholine and hydrazine to maintain a pH value of 9.1 to 9.3 (at 25°C) in the feedwater. The extraction areas of the condensers are retubed with stainless steel and titanium in order to prevent ammonia corrosion. Further improvements were made by retubing areas affected by drop impact erosion in the condensers and retubing of a feedwater heater in Unit 1 with stainless steel tubes.

Chemical treatment of the secondary cycle during plant operation is performed closely following the given specifications. Many precautions are taken during outages to protect the components of the secondary cycle from corrosion by carefully controlled dry and wet layup. Thus good results are achieved in minimizing corrosion in all parts of the circuit.

Optimization of chemical treatment to minimize transport of corrosion products to the steam generators could be further improved by eliminating the presence of copper alloys in the secondary circuit.

- (3) **Suggestion:** Consideration should be given to developing a long term programme for the replacement of copper alloys in the secondary circuit.

7.3. Chemical Surveillance Programme and Procedures

Based on the Chemistry and Radiochemistry Specifications prepared by GDL and DSRE, detailed surveillance programmes were established containing parameters, frequencies for analysis, and expected and limiting values for systems and circuits, and for normal and abnormal operation.

The data bank used for trends and graphs of main chemical parameters by EDF/GDL and for internal evaluation of analytical results is an excellent tool for comparison with other plants and for the follow-up of short and long term chemical parameter transients during plant operation.

Procedures for the calibration of laboratory equipment and on-line monitors to evaluate chemical and radiochemical parameters are available in an up-to-date format. The on-line monitors are regularly calibrated and crosschecked by comparison with analytical results. The record keeping of analytical results and calibrations in the laboratories are performed on a regular basis.

Fuel integrity is controlled by on-line monitoring of total activity and by periodically performing measurements of fission product isotopes in the primary coolant during normal operation and during transients.

Defective fuel elements are identified by sipping during unloading. The fission product release is then measured in a detailed sipping test. Sipping test results are used to calculate the criteria for determining whether the defective fuel element can be reloaded.

7.4. Operational History and Recording of Results

Responsibilities for the preparation, maintenance, review and release by senior staff members and distribution of reports are defined in administrative procedures. The content and distribution of relevant reports were found to be adequate for the information of all persons concerned.

The results of daily analytical work stored in the data bank are available on terminals throughout the plant.

The Laboratory Section records the results of chemical and radiochemical surveillances in monthly, annual and outage reports and in reports on radioactive releases and fuel integrity. Special reports are issued for abnormal situations and chemistry related incidents.

Performance indicators are given for chemical parameters of importance.

Information on incidents at other plants related to chemistry are provided by EDF/GM and are incorporated into the procedures of the laboratory handbook.

Internal reports on abnormal situations, such as steam generator tube leakage, condenser air in leakage and abnormal values during unit startup, are detailed and used for appropriate experience feedback.

7.5. Laboratories, Equipment and Instruments

A hot laboratory in the controlled area, a cold laboratory and a counting room are available in a centralized area in the plant. The sampling room for nuclear circuits and systems is adjacent to the hot laboratory. Liquid and gaseous samples are taken in glove boxes or ventilation hoods to prevent the spread of contamination. The general laboratory equipment is up to date.

Laboratories for the low level monitoring of liquid and gaseous effluents and of environmental samples are available in the administration building.

Maintenance and calibration of the instruments are carried out and controlled in an exemplary manner utilizing comprehensive instructions.

The laboratories are kept in very clean conditions by the chemistry staff thus providing precise low level measurements.

Eye wash stations, showers, fire extinguishers protective clothing and safety instructions are available at suitable locations and meet normal safety standards.

The counting room is outside the controlled area. There is a door between the hot and cold laboratories which, bypassing the radiation the radiation monitors, is only closed by a special key kept in the foreman's desk.

- (1) **Recommendation:** Complementary measures should be taken to prevent the unauthorized use of the door between the hot and cold laboratories. This should be done to prevent the Potential spread of contamination and unauthorized transport of radioactive materials outside the hot laboratory.

A Post accident sampling system (PASS) has been developed by GDL and DSRE to take samples from the coolant circuits and containment atmosphere. Backfitting of on-site equipment such as sampling lines and shielded sampling systems with glove boxes is nearly completed. Devices for handling and dilution of samples are partly available and will be completed in the near future. The dilution of highly radioactive samples poses a risk of both dose and contamination.

- (2) **Suggestion:** Consideration should be given to use training exercises to improve the handling procedures with the PASS in order to minimize personnel exposure and contamination.

7.6. Quality Control Of Operational Chemicals

There are detailed specifications available for the purity of operational chemicals and other Products used in the primary circuit and in the controlled area. Some of the delivered chemicals and ion exchange resins are certified and quality checks are performed on acids and bases.

A QA procedure developed by corporate authorities to ensure that only qualified and certified chemicals are used will be applied in the near future.

Concentrated hydrazine solution is stored in the turbine hall and filled from open containers.

- (1) **Suggestion:** Consideration should be given to improving the industrial safety practices for the storage and handling of concentrated hydrazine solutions.

The amount of inflammable chemicals in the laboratory exceeds the demands of normal use. The storage of the chemicals does not meet the requirements.

- (2) **Suggestion:** Consideration should be given to improving the safe storage of hazardous and inflammable chemicals and labelling of chemicals and storage areas to acceptable industrial safety standards.

7.7. Radiochemical Measurements in Environmental Samples

Environmental samples are taken and measurements are performed according to a programme prepared by SCPRI. The procedures for sampling, measurements Of beta activity and tritium in the samples, instrument calibration, and reporting are available and strictly follow the SCPRI guidelines. Sampling and measurements are performed by skilled staff. Equipment and instrumentation are well maintained.

The results of environmental measurements are trended and reported periodically, e.g. in monthly and annual reports, and used for public information.

8. EMERGENCY PLANNING AND PREPAREDNESS

The overall good quality of the emergency preparedness, plans, equipment and procedures of Fessenheim nuclear power plant is derived in part from sharing a common approach with other nuclear power plants of Electricité de France (EDF). This common approach has also benefited the off-site organizations of EDF, the Nuclear Installations Safety Authority and the Institute for Nuclear Protection and Safety. They have been able to concentrate their resources by not having to deal with many different approaches by different nuclear power plants to emergency preparedness. The inherent hazard of a common method, of being subject to common mode failure, has been addressed by the provision of diversity and redundancy in equipment and procedures.

The many good features seen during the mission give considerable confidence that Fessenheim nuclear power plant has the capability to respond to a wide range of accidents and cope with those beyond what is foreseen as possible. Many of the recommendations and suggestions made in this section are based on different experiences in emergency planning and preparedness. They do not imply fundamental weaknesses in the existing emergency plans; rather they suggest that some aspects could be enhanced as a result of experience in other countries.

The principal recommendations relate to the enhancement of training and exercising, notably in exercising with local off-site organizations. In addition, a recommendation is made about the potential problems of the media coming into contact with the nuclear power plant staff.

8.1. Emergency Planning and Preparedness Organization (Site/Utility)

A common approach to emergency planning has been adopted by EDF for its NPPs. EDF has a corporate organization which provides guidance on emergency planning and they have produced a "model" on-site emergency plan as a guide for each NPP. Fessenheim NPP has used this model to produce an on-site Internal Emergency Plan (PUI).

At Fessenheim NPP, the responsibility for emergency preparedness is placed with the Deputy Plant Manager. The Deputy Plant Manager is supported by one management Consultant whose duties are solely concerned with the internal emergency plan and fire protection. Responsibility for the provision of services identified within the PUI rests within the 12 departments of the Fessenheim NPP organization.

The adequacy of a revision to the PUI is subject to on-site assessment based upon the NPPs Quality Assurance (QA) procedures. Copies of the revised PUI are supplied to the EDF corporate organization although they do not have any review function. A copy of the revision is submitted to the Nuclear Installations Safety Authority (DSIN), but it is not approved by them. (DSIN did approve the original version of the PUI prior to loading the core, but even if it does not approve formally any revision, DSIN formulates observations when necessary.) DSIN has carried out an assessment of EDF's model PUI and the results of this assessment were discussed with EDF corporate staff and representatives of some NPPs, but not Fessenheim NPP. EDF produced a schedule for the implementation of the model PUI by all NPPs which was agreed to by DSIN. DSIN then monitored the implementation of the model PUI by all NPPs through its inspection procedures. The QA procedures require the PUI to be reviewed every 2 years. There is no formal system for off-site organizations to participate in the review process of the PUI.

There is a good relationship with the local off-site organizations. Copies of the PUI and the emergency plan of the local off-site organization have been exchanged. The relationship involves both Fessenheim NPP contributing towards the provision of equipment for off-site organizations and making use of off-site facilities for training.

- (1) **Suggestion:** Consideration should be given to formalizing a system to ensure that all relevant off-site organizations, including those in the EDF corporate organization, have the opportunity to comment on any revision to the PUI before it is implemented.

The organizational structure of the PUI is based upon a Management Control Centre (PCD) team, which co-ordinates the response of four on-site control centres. The PCD team is responsible for executive decision making and provides the primary communication link to other off-site organizations. The Local Control Centre (PCL) team is responsible for undertaking operational procedures to bring the NPP to a safe state. The Logistics Control Centre (PCM) team is responsible for caring for persons on the site who are not involved in the response to the emergency and for the provision of additional support to those responding to the emergency. The Health Physics Control Centre (PCC) team is responsible for estimating the consequences off the site. The Local Emergency Team (ELC) is responsible for evaluating the nature of the emergency in conjunction with off-site organizations, and makes suggestions for enhancing the response to bring the NPP to a safe state.

The on-site response to an emergency at any of EDF's NPPs is supported by EDF's corporate staff. In addition, other NPPs of EDF supply additional resources to the NPP at which the emergency is located. The fact that the major part of the off-site response refers to a national frame constrains the on-site structure to the national approach.

8.2. Emergency Plans (Site/Utility)

The PUI is organized in two parts. The first part is divided into eight chapters. The chapters follow the 'model' PUI but also have three additional chapters and an additional section to one of the other chapters.

The first chapter provides a description of the on-site emergency response organization.

The second chapter is subdivided into six sections. Each section covers the teams' functions, location, personnel structure and the detailed checklists and forms for use by team members.

The subsequent chapters cover supporting material for the emergency plan, including planning basis, maintenance arrangements, additional resources and documentation control.

The second part of the PUI consists of one chapter and covers general instructions to persons who do not have emergency response duties.

Various design basis accidents have been identified, together with three extreme, beyond design basis accident scenarios. The planning basis for off-site responses is based upon a beyond design basis accident scenario, called S3. The S3 scenario assumes core meltdown with pressure vessel rupture. The resultant pressure rise within the containment building requires the depressurization of the building via sand filters to the atmosphere one day at the earliest after the start of the emergency. There are three classes of emergencies: (1) where there is no radiological consequence but a conventional accident has occurred, (2) a radiological consequence confined to the site and (3) a accident with off-site consequences. The PUI and EDF's corporate emergency plan cover the response to each level of emergency.

However the PUI does not provide for a system of consultation with off-site organizations before terminating a state of emergency. There is value in having an agreed system of consultation before terminating an emergency. This should ensure that all aspects of the response to the emergency, both on and off the site, have been considered.

- (1) **Suggestion:** Consideration should be given to providing for a system of consultation with Off-site organizations before terminating a state of emergency. Such a system should not necessarily require all organizations to terminate at the same time.

8.3. Emergency Procedures (Site/Utility)

There are a wide range of procedures covering all aspects of the emergency response. Procedures exist for staff on the site who have specified roles in the PUI.

Depending upon the level of the emergency, most if not all persons within the system receive the alert by an automatic call system. Those on call come to the site and take up their specified positions. Up to 190 other staff who have also received the alert are required to come to the NPP entrance. They are thus available for additional tasks which may be identified by the on-site teams. Due to an extension of the reception building the Plant staff is temporarily assembling at the Centre for Public Information, which is also used to receive the media in the event of an accident.

- (1) **Suggestion:** Until the reception building is extended, alerted staff should be quickly processed and, if necessary, transferred to another location so as to minimize the Potential for interaction between staff and media.

8.4. Emergency Response Facilities, Equipment and Resources (Site/Utility)

All PCs were found well set up and ready for operation. The on-site emergency response centres, called command posts (PC), are located in the security building (BDS) and at the control room. A centre is provided at Fessenheim, known as the retreat house, for the monitoring of all Persons who may be evacuated from on-site.

Good practice: The retreat house is well equipped to cope with the total on-site Population. It provides monitoring and decontamination facilities and is equipped with considerable stocks of clothes to replace any found to be contaminated.

A substantial range of equipment and resources were found to be dedicated for use in an emergency. Of some note was the telephone system which made use of five different communications networks and provided for switching telephones between each network.

There are only four on-site fixed radiological monitoring points and three French Off-site radiological monitoring points. There is also one German off-site radiological monitoring point; but this does not automatically feed data to Fessenheim NPP. There are also a number of German based monitoring points controlled by the German authorities. Fessenheim NPP also has two new dedicated radiological monitoring vehicles.

The use of these monitoring resources to provide information on the consequences of the release is secondary to that derived from an assessment of the source term. (See also Section 8.7.) There are no derived intervention levels for members of the public in either the PUI or the off-site

authorities emergency plan (the PPI) . This reflects the approach of EDF which is accepted by SCPRI and DSIN. Emphasis has been given in training and provided in documentation of the value of the implementation of precautionary countermeasures when one or more of the three containment barriers is believed to have been breached.

- (1) **Suggestion:** Consideration should be given to improving the systems for using the monitoring data in decision making procedures on off-site counter measures, such as providing derived intervention levels.

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

8.5. Off-Site Emergency Planning and Preparedness organization

The local off-site organization is organized under the Prefect of the Departement within which the NPP is located. The off-site Authorities' Emergency Plan (PPI) is based upon a model plan provided by the central government.

The Prefect directs the off-site response. The Prefect has a fixed control centre (PC fixe) from which the off-site response is managed. Local representatives from the relevant government ministries attend the PC fixe, together with other interested bodies such as that controlling the navigation along the Rhine. In addition, representatives from DSIN, IPSN and SCPRI attend the PC fixe to provide technical and radiological advice. The decisions of the PC fixe are implemented by an Operational Control Centre (PCO).

Co-ordination of central government is provided by the Interministerial Committee for Nuclear Safety (ICNS). DSIN and SCPRI also brief central government via ICNS. By this route, the Ministry of Foreign Affairs obtains information to brief other countries to comply with its international agreements.

Fessenheim NPP is situated on the French/German border and a convention between the two countries on early notification of an accident has existed from before the start of operation. Another agreement also exists between France and Switzerland. The Prefect is responsible for making these notifications and providing subsequent information.

8.6. Off-Site Emergency Plans

The PPI covers the Prefect's procedures and provides for the integration of the emergency plans of other off-site organizations. The German authorities also have a similar emergency plan. DSIN has an emergency plan, whilst IPSN has a range of documentation covering their response.

The planning basis of the Prefect and other off-site organizations is identical to Fessenheim NPP's basis. The emergency plans of the German authorities are stated to be effectively identical to those of the Prefect. The PPI is comprehensive and exists in two parts. The first part provides a range of information and is written without sensitive information such as communications details. It is available to members of the public. The second part contains additional detailed plans and communications information.

Both Germany and Switzerland have mutual assistance agreements with France which provide for the deployment of resources in each other's country.

8.7. Off-Site Emergency Procedures

Detailed procedures exist for the response of the Prefect's organization. Procedures also exist for the control of access to the effected area, warning the public, implementation of countermeasures, monitoring and decontamination and for the housing of evacuees. The procedures for monitoring of foodstuffs is under review.

8.8. Off-Site Emergency Response Facilities, Equipment and Resources

The PC fixe and the PCO are dedicated facilities. DSIN and IPSN also have dedicated facilities. All have dedicated communications facilities and those of DSIN and IPSN also have computer links to Fessenheim NPP.

The CMIR has adequate equipment for contamination monitoring and decontamination of a number of persons and small areas. Additional equipment and resources would be brought in to the area for dealing with a large number of potentially contaminated members of the population.

IPSN has a large array of computer based resources for predicting the course of the emergency and the radiological consequence based upon a given source term.

SCPRI can provide a range of whole body monitoring equipment within 24 hours. These are mounted in vehicles and also in a railway carriage. They have a total capacity to deal with over 5000 persons per day. This equipment can also measure the level of contamination in samples of food, water and other materials.

Good practice: The mobile whole body monitoring equipment of SCPRI provides for considerable reassurance to members of the public and is a significant asset in the follow up monitoring campaign.

8.9. Training, Drills and Exercises

The training of Fessenheim NPP staff is under revision. The system is not clear on prior qualifications and mandatory and recommended initial training requirements. More work has been done on retraining requirements but this exists in isolation from initial training.

- (1) **Recommendation:** The revision of emergency preparedness training should be continued, with particular attention to ensuring that an integrated training programme is achieved which allows for the easy monitoring of compliance with the requirements and uses existing training procedures and systems.

An annual schedule of exercises required under the PUI is produced. This only covers drills of PCs, mobilization exercises, and technical exercises. Neither the PUI nor the schedule covers drills of each function which would be required in the event of an emergency. Other information indicates that a range of such drills, for example fire-fighting and use of the radiological monitoring vehicle, do or will occur under the authority of the relevant department head.

Each operational shift team takes part in a drill during their annual training on the Bugey simulator. This drill reflects most of the control room tasks but does not incorporate the roles of PCL1, PCL2 and PCL3.

Each PC is only required to be drilled once per year. The objective of the drill is to ensure that persons are familiar with roles within the PC. The schedule identifies that only two operational shift teams will be drilled. The schedule does not show that all staff involved in other roles will be drilled on an annual basis.

Two mobilization exercises of the PCs are scheduled to take place during the year though the requirement is for only one such exercise. Their objective is only to demonstrate the assembly of staff and that the PC is in full working order. A mobilization exercise is also scheduled to demonstrate the effectiveness of the assembly procedures for all persons on the site who do not have duties in responding to the emergency.

Two technical exercises are scheduled to be carried out during the year, though only one is required. Their objective is to put the PCs into realistic situations so as to ensure that the systems function correctly.

Once every two years, Fessenheim NPP exercises in conjunction with the EDF national crisis team and part of the EDF headquarters PCD. However, the corporate organization exercises seven or eight times per year with a range of EDF NPPs. It is estimated that once every ten years, Fessenheim NPP will exercise with both EDF corporate, DSIN and the Prefect (DSIN and EDF exercise twice per year with a NPP and its associated Prefect).

Once every three years, there is a national exercise involving a NPP, EDF corporate, DSIN, a Prefect, SCPRI and ICNS.

There has not been an exercise between the Prefect and Fessenheim NPP since 1984. There are two exercises with local off-site organizations every two years. One is with the Emergency Medical Assistance department (SAMU) and the other is with the off-site fire brigade (CSP).

The schedule does not reflect the whole range of drills and exercises which take place. Neither does it demonstrate that all persons who have roles in responding to an emergency are drilled or exercised. The frequency of on-site exercises is only acceptable if the simulation of the work loads from non-participating PCs and other teams is adequate. The examples considered (radiological monitoring vehicle to PCC, PCD to Prefect, ELC to EDF national crisis team and DSIN crisis team) do not suggest that the simulation is acceptable. The frequency of exercises with SAMU and CSP do not match those of many other countries. As an example, in the United Kingdom, the fire and ambulance services participate in one full scale on-site emergency exercise per year.

- (2) **Recommendation:** The exercise schedule should be revised to show all drills and exercises and also cover future years to show the involvement in exercises with other organizations.
- (3) **Recommendation:** Negotiations with the Prefect should be undertaken so as to obtain an exercise programme which will provide sufficient experience of the likely demands which the Prefect's emergency organization will make on Fessenheim NPP.
- (4) **Recommendation:** Negotiations with SAMU and CSP should be undertaken so as to obtain a more frequent exercise programme.
- (5) **Suggestion:** Consideration should be given to improving the simulation of workloads on PCs which would arise from non-participating PCs or teams.

The site procedures call for a report on each use of an emergency plan procedure, both for real and in exercises. The Management Consultant with responsibility for Emergency Preparedness has the duty to monitor the implementation of recommendations included in these reports.

8.10. Liaison with Public and Media

EDF procedures for liaison with the media in an emergency use on-call staff, both from Fessenheim NPP and the corporate organization, who normally deal with the media.

A procedure provides for the distribution of a leaflet to the Population within an area in France up to approximately 12 km from Fessenheim NPP once every four years. The leaflet covers not only advice to the public but also advice to farmers. Local medical doctors have also received a pamphlet.

The frequency of distribution of the leaflet to the local population does not reflect that adopted by operators in other countries and could leave persons new to the locality uninformed for several years. The frequencies in other countries vary, the most frequent known being every six months. A common frequency is every year.

- (1) **Suggestion:** Consideration should be given to increasing the frequency of distribution of the leaflet to the local population.

Procedures exist within the PUI and PPI for dealing with media which include the prior clearance of press releases. A Center for Public Information is used to receive the media in the event of an accident. The center does have a useful range of displays and exhibits which are of value in briefing the media. Two other media briefing centers are available at the PC fixe and EDF corporate management.

ACKNOWLEDGEMENTS

The Government of France, the Nuclear Installations Safety Directorate, Electricité de France and Fessenheim NPP personnel provided valuable support to the OSART team.

The close co-operation between France and the IAEA in all nuclear safety activities, including the hosting of three previous OSART Missions, had already established many personnel contacts and a common basis for efficient work.

Throughout the whole mission, Fessenheim NPP management, EDF corporate office staff and counterparts were open minded, co-operative and supportive in creating a productive working atmosphere. Personal contacts occasionally extended beyond working hours and will not end with the submission of the report. The efforts of the station counterparts, liaison officers, interpreters and secretaries were outstanding. This enabled the OSART mission to complete the review in a fruitful manner. The IAEA, the Division of Nuclear Safety and its Nuclear Power Plant Operational Safety Services Section wish to thank all those concerned for the excellent working conditions during the Fessenheim NPP review.

Annex I

THE FESSENHEIM OSART TEAM

Experts

BLACKMORE, Robert - UNITED STATES OF AMERICA

Maine Yankee Atomic Co.

21 years of nuclear experience

Review area: Management, Organization and Administration

CARDOSO, Alain - SPAIN

Training Innovation Section Manager

Technatom SA

15 years of nuclear experience

Review area: Training and Qualification

DRYMAEL, Henri - BELGIUM

AIB Vincotte Nucléaire

Nuclear Safety Inspector

13 years of nuclear experience

Review area: Radiation Protection

DULAR, Janez - IAEA

Division of Nuclear Safety

Senior Operational Safety Officer

24 years of nuclear experience

Review area: Operations

ERWIN, Ashley - IAEA

Division Of Nuclear Safety

Senior Operational Safety Officer

26 years of nuclear experience

Team Leader

HANSSON, Bertil - SWEDEN

Managery Mechanical Maintenance

Barsebäck NPP

25 years of nuclear experience

Review area: Maintenance

JOHNSON, Rex, A. - CANADA

Station manager

Point Lepreau NPP

New Brunswick Electric Power Commission

28 years of nuclear experience

Review area: Technical Support

MEHEW, Robert D. - UNITED KINGDOM

Principal Inspector

Nuclear Installations Inspectorate

16 years of nuclear experience

Review area: Emergency Planning and Preparedness

MOORE, Brian - IAEA

Division Of Nuclear Safety

Senior Operational Safety Officer

27 Years of nuclear experience

Assistant Team Leader

REEDER, John L. - UNITED STATES OF AMERICA

Manager, Nuclear Training Division
Southern California Edison, San Onofre
25 years of nuclear experience
Review area: Operations

SOLYANY, Vitaly - IAEA

Division of Nuclear Safety
Operational Safety Officer
20 years of nuclear experience
Review area: Technical support

WALTER, Karl - GERMANY

Gemeinschaftskernkraftwerk Neckar GmbH
26 years of nuclear experience
Review area: Chemistry

Observers:

MOORE, Clarence Edward - UNITED STATES OF AMERICA

Director, Corporate Support Division
Institute of Nuclear Power Operations

OVTCHAROV, Roumen - BULGARIA

Committee on Use of Atomic Energy
for Peaceful Purposes

SIROLA, Predrag - YUGOSLAVIA

Deputy Operations Superintendant
Krsko NPP

ZHU, Zhiming - CHINA

China National Nuclear corporation
Bureau of Safety, Protection and Health

Annex II

SCHEDULE OF ACTIVITIES

- | | | |
|----|--|-------------------|
| 1. | Request for Operational Safety Review
of Fessenheim NPP | 29 June 1989 |
| 2. | Preparatory meeting at Fessenheim NPP | 30 May 1991 |
| 3. | Approval of the mission by IAEA
Nuclear Safety Division | 11 September 1989 |
| 4. | Recruitment of team members | Oct/November 1991 |
| 5. | Operational Safety Review of Fessenheim NPP | 9 - 27 March 1992 |
| 6. | Submission of OSART Report | July 1992 |