



INTERNATIONAL ATOMIC ENERGY AGENCY

REPORT OF THE
OSART
(OPERATIONAL SAFETY REVIEW TEAM)

MISSION
TO THE
FLAMANVILLE
NUCLEAR POWER PLANT
FRANCE

30 January to 17 February 1995

AND

OSART FOLLOW-UP VISIT

3 to 7 June 1996

DIVISION OF NUCLEAR INSTALLATION SAFETY

OPERATIONAL SAFETY REVIEW MISSION

NSNI/OSART/96/78F

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Flamanville nuclear power plant, in the Manche Département in 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 plants. The findings of the IAEA's OSART Follow-up Visit, which took place from 3 to 7 June 1996, have been incorporated into the report. The purpose of the Follow-up Visit was to determine the status of all proposals for improvement, to comment on the appropriateness of the actions taken and make judgements on the degree of progress. The original report of the January-February 1995 mission has been revised to include the results of June 1996 Follow-up Visit.

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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. 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 methods involve not only the examination of documents and the interviewing of staff but also reviewing the quality of performance. It is recognized that different approaches are available to an operating organization for achieving its safety objectives. Proposals for further enhancement of operational safety may reflect good practices observed at other nuclear power plants.

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

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

The report that follows presents the conclusions of the OSART review, including good practices, good performances and proposals for enhanced operational safety, for consideration by the Member State and its competent authorities and the results of the Follow-up Visit, that was requested by the competent French authority to check the status of implementation of the OSART team's recommendations and suggestions. The text in normal type relates to the OSART mission of February 1995 and the text in italics relates to the Follow-up Visit of June 1996.

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INTRODUCTION

At the request of the Government of France, an IAEA Operational Safety Review Team (OSART) of experts visited the Flamanville nuclear power plant in Manche Département from 30 January to 17 February 1995. The purpose was to review operating practices and to exchange technical experience and knowledge between the experts and power plant counterparts on how the goal of excellence in operational safety could be further pursued. The Flamanville OSART review was the seventh mission to France.

The team (Annex 1) was composed of experts from Mexico, the Slovak Republic, Sweden, Switzerland, the United Kingdom and the United States of America and IAEA staff members with scientific visitors (observers) from Bulgaria and the Czech Republic.

Before visiting the power plant, 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 Flamanville nuclear power plant, the team, using techniques derived from their collective nuclear experience of over 250 years, reviewed documentation on the power plant's operational safety indicators, examined applicable procedures and instructions, observed work being carried out and held extensive discussions with power plant personnel. Throughout the period of review, there was an open exchange of experience and opinions between the power plant personnel and the OSART experts.

At the request of the Government of France, the IAEA carried out a follow-up to the Flamanville OSART mission from 3 to 7 June 1996. The team comprised three IAEA staff members, all of whom were members of the original OSART team. The purpose of the visit was to discuss the actions taken in response to the findings of the OSART mission conducted from 30 January to 17 February 1995.

During the five day visit, team members met with senior managers of Flamanville nuclear power plant and their staff to assess the effectiveness of the power plant's response to each recommendation and suggestion given in official report of the Flamanville OSART mission (IAEA-NENS/OSART/95/78). The team made technical comments supplemented by a broad categorization indicating whether an issue could be regarded as 'resolved', whether 'satisfactory progress' or 'insufficient progress' had been made in resolving an issue or whether a proposal should be withdrawn.

The results of the follow-up visit are summarized at the beginning of each of the sections and detailed comments can be found for each finding in the pages that follow thereafter. The results are presented quantitatively in Table 1.

Plant description

Flamanville nuclear power plant consists of identical pressurized water reactor units rated at 1345 MW net electrical output. The two units, designed by Electricité de France with Framatome nuclear steam supply system islands, entered commercial operation in December 1986 and March 1987 respectively. The plant is located 25 km from Cherbourg, 90 km from Caen and 340 km from Paris.

Each reactor core consists of 193 fuel assemblies, each having 264 fuel rods in a 17 x 17 square array. The reload fuel is 3.1 % enriched UO₂ with a total UO₂ weight of 117.8 tons and a thermal output of 4117 MW. Reactor power control is performed by grey control rod banks that minimize axial power distortion and permit operation in the load following mode. The primary coolant system consists of four cooling loops, each having a steam generator and a circulation pump.

Safety systems to cope with design basis accidents include the protection systems, emergency power supply, emergency core cooling systems and containment systems. The protection systems initiate a reactor trip or actuate other safety functions whenever the limits of the safe operating range are approached. The emergency power supply system comprises two diesel generators. The emergency core cooling system consists of four hydro-accumulators and two separate subsystems for safety injection and coolant recirculation. The subsystems are physically separated, in different zones of the plant, and with separate electric power supplies, ventilation and cooling systems.

The reactor containment is composed of an inner prestressed concrete shell meeting high leaktightness requirements, and an outer reinforced concrete shell to resist external impacts. The space between the shells is maintained slightly below ambient pressure. The containment could be cooled during accidents with a two-train spray system, and is fitted with a filtered venting system to enable mitigation of severe accident consequences.

Steam is supplied from the steam generators to the 1500 rpm turbines. Steam from the turbines is condensed in the main condenser. The condenser is cooled by sea water drawn by two circulation pumps.

Main conclusions

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

- a dedicated, motivated staff with strong team spirit who carry out their duties in a professional manner;

- an emphasis on the communication and achievement of plant safety goals and objectives through the effective use of management contracts and performance indicators;
- sound direction from the corporate organization in the form of strategies, policies and objectives and the use of extensive high quality support from corporate technical departments;
- successful programmes that have brought radiation doses, radioactive releases and volumes of waste well within international norms;
- the use of analysis techniques for operations and maintenance activities to identify and then selectively reduce to a minimum the risks of failures in equipment and in human performance ;
- effective cooperation between the three nuclear facilities in the Cherbourg area that has resulted in the adoption of a common radiation protection training programme for contractors for Flamanville, COGEMA and the naval shipyard (DCN).

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

- A regular programme of 'walk through' inspections of plant areas by managers should be established as a means of promoting quality and safety and demonstrating their commitment to high standards.
- Administrative control of temporary modifications to the plant should be strengthened. Permanent modifications affecting reactor performance should be carried out promptly.
- Approval of new and amended rules covering surveillance tests requirements should be expedited.
- The technical bases behind corporate policies and procedures, together with a greater awareness of international good practices, should be communicated to staff. This should be directed towards stimulating more technical creativity and initiative as well as a questioning approach in staff, thereby enhancing the decision making process.

The importance of nuclear safety has been communicated to the staff but the management team needs to continue its active promotion of safety culture. This could be achieved, for example, by clearly communication to staff the reasons for conservative

management decisions concerning nuclear safety and reinforcing safety culture expectations by direct contact with employees.

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

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

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

During the follow-up visit the IAEA team identified two issues whose satisfactory resolution by Flamanville NPP could be of interest of other utilities and plants. These were:

- *Plant-wide participation of staff in developing new strategies*
 - *development of plant's five year strategy plan [in connection with suggestion 1.2(3)]*
 - *operations alarm strategy [in connection with suggestion 3.5(1)]*
 - *field operators responsibilities [in connection with suggestion 3.5(2)]*
 - *training in infrequent operations [in connection with suggestion 2.3(1)]*
- The approach adopted by Flamanville has helped to engender a sense of ownership of the new strategy or solution and has motivated staff to achieve the objectives and goals.*

- *Significant improvements in international technical exchange [in connection with suggestion 1. 2 (1)].*

The Purpose of the OSART mission was to identify desirable improvements in operational nuclear safety, and thus assist in enhancing nuclear safety. The list of issues identified by the OSART team was not exhaustive given the limited time in which it carried out the review, but were those that were considered most useful to the Flamanville nuclear power plant. The OSART team did not attempt to assess the overall level of operational safety at the plant nor compare the plant's operational safety with other nuclear power plants. The eventual resolution of all the issues from the OSART mission, though significant, will be only a step towards the achievement of excellence. Attainment and maintenance of the highest standards of safety and plant performance requires that all personnel continually and actively seek and achieve improvement.

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

The nuclear organization of Electricité de France (EdF) is designed to capitalize on the advantages of standard plant designs while still giving power plant directors strong ownership and accountability. The power plants are provided with extensive high quality EdF corporate support. Recent corporate decentralization initiatives to provide power plant directors with more autonomy have been effective.

Three year corporate strategic plans are developed and serve as a basis for three year plant and corporate department plans. These plans include safety and quality objectives. The three year strategic plans are thorough and effective in setting and maintaining priorities. Annual objectives support the three year strategies. The objectives are formalized in signed management contracts at each management level. The contracts along with a monthly performance indicator process and routine feedback meetings are very effective in achieving annual objectives.

The plant management organization is clearly described in plant documentation. The management team is competent and well qualified. Management effectiveness could be enhanced by an increased presence in the field.

Plant staff is competent and morale appears to be high. Technical staff have a high level of competence and professionalism. Consideration should be given to improving the communication of technical principles and international good practice from EdF to Flamanville NPP to stimulate more creativity, initiative and technical questioning approach in plant staff.

The plant quality plan is documented and is being effectively implemented. Safety engineers are typically very experienced. They perform daily plant safety checks, which are independent and redundant from the shift manager's activities. Safety engineers also play a key role in internal inspections and audits. It is suggested that a formal departmental self-assessment system be implemented to enhance the quality programme. The quality manual and management manual are clearly written and provide the framework for administrative procedures. The documents that were reviewed were found to be well written. The Government of France and EdF have a proactive programme of having an OSART review of one of their NPPs each year. OSART recommendations and suggestions are being effectively implemented at the inspected plants; the OSART team believes that other French NPPs could benefit from an EdF programme to analyse and communicate to all plants the generic implications of OSART recommendations, suggestions and good practices.

The nuclear safety policy for EdF nuclear power plants is developed by the corporate safety department and approved by corporate management. This policy includes objectives and principles to guarantee safe and efficient design, construction and

operation of nuclear power plants. Flamanville has effectively implemented this safety policy and issued an excellent operational safety handbook to all employees. The continued promotion of the principles of a strong safety culture is encouraged.

The policy concerning alcohol consumption at EdF nuclear power plant sites should be progressively tightened. Although Flamanville has not experienced any problems with employee drug abuse, EdF is encouraged to adopt a formal drug policy.

The interface between regulatory authorities and the Flamanville NPP management is good. Interactions appear to be frank, open and professional. Currently a number of surveillance requirements have not been approved by the safety authority. Approval of these requirements should be expedited.

Flamanville NPP has a good industrial safety policy. Tours of the plant indicated the general plant housekeeping is very good. Fire fighting equipment is available and is in good condition. The plant industrial safety accident rate is improving and is better than the average of EdF nuclear power plants. The plant has a good practice of holding routine industrial safety meetings between management and all employees. EdF provides Flamanville with excellent experience feedback manuals on industrial safety and radiation protection.

Significant progress has been made in addressing the proposals for improvement made by the OSART team in February 1995. Continued effort is required, however, to complete the actions already planned so that the best results can be obtained.

The site initiatives for strengthening international technical exchange have involved different hierarchical levels of the plant and have resulted in significant improvements in several activities. In particular, operational self-assessment pilot studies are being conducted in the plant, that together with the normal quality assurance audit arrangements, should provide the plant with a stronger quality programme.

The plant-wide participation of staff in developing the site's five year strategic plan is commendable. Such involvement motivates staff to meet the objectives and requirements of the plan. One of the actions in the plan is the need for increased presence of managers in the field. This is an issue of the February 1995 OSART mission that up until now, has had insufficient progress.

The site management was deeply involved in the corporate initiative to develop a plan to prevent behavioural disorders in the work place, which was recently approved. The site management is committed to take immediate action to introduce a local policy that will include reference to drug and alcohol use.

The number of surveillance requirements awaiting approval by the safety authorities, DSIN, decreased from one third at the time of the OSART mission to one fifth at present. DSIN aims to have all pending requirements approved by the end of 1996.

Flamanville has continued to promote the principles of safety culture among the workforce. Training courses have been reinforced, new publications issued and well selected worldwide safety culture examples have been discussed in the different departments of the plant.

The corporate nuclear inspectorate has committed itself to be the co-ordinating body of experience feedback related to OSART issues in French NPPs.

1.1 Corporate Organization and Management

The EdF organization is designed to optimize the advantage of standard plant design while still retaining strong ownership and accountability by the power plant directors. The power plants are provided with extensive high quality support from the central resources group. Recently, there has been a corporate change to allow for more decentralized management of the individual power plants. Decentralization gives more authority to power plant management especially in the area of organization and management philosophy. The intention is to foster responsibility, implement optimal decisions and adapt to special situations.

The EdF and Flamanville management philosophy recognizes that a good nuclear power plant must be able to achieve the goals of high safety standards, high level of production and cost effectiveness simultaneously. The Flamanville managers clearly understand the importance of nuclear safety within this philosophy and decisions made by them indicates that nuclear safety is being given the appropriate priority. Several examples of the good approach to safety on-site are included in this evaluation. In the operations section, examples of good nuclear safety improvements include the new technical specifications with vital equipment unavailability decision trees, a comprehensive programme for mid-loop operations, and the administrative lockout system. The maintenance section discusses the excellent risk analysis performed before maintenance activities and the thorough outage safety committee reviews. A good operating experience feedback review programme is discussed in the technical support section. Managers also agree that it is very important that every NPP employee understands the importance of nuclear safety and its relationship to the goals of safety, production and cost. The Flamanville management is encouraged to continue the active promotion of a strong nuclear safety culture, communicate clear examples of conservative management decisions concerning nuclear safety to employees, and reinforce safety expectations through direct contact with employees.

Three year corporate strategic plans are developed and serve as the basis for three year plant and corporate department plans. These plans include safety and quality objectives. The three year strategic plans are very thorough and are effective in setting and maintaining priorities. Currently, these plans are produced every three years. A rolling three year plan could enhance the current system. The rolling three year plan would always include the current year and two future years and should provide added advantages to the present three year strategy.

Objectives supporting these strategic plans are developed for the power plants and the corporate departments. The plans and objectives are documented in comprehensive formal contracts which are signed by plant directors and corporate department managers.

In parallel with the development of the plant contract, supplemented contracts are developed and signed by the plant departments and sections. Objective implementation status is tracked by performance indicators which are updated monthly, and by formal reviews which take place three times a year. The contracts and subsequent follow-up on results provides for clear accountability.

- (a) **Good performance:** The use of formal management contracts and performance indicators and reviews of results are an excellent way to implement safety and quality throughout the organization. The management contracts are integrated and well structured such that the contract at each management level supports the next higher level. These plans serve as the basis for allocation of financial and human resources at both the corporate and plant level. The contracts provide clear communication of corporate and plant goals to all management levels of the organization. The management contracts along with monthly performance indicators and routine feedback meetings provide an effective way to motivate employees to improve performance and if necessary to take timely corrective action. This type of management contract and performance indicator system was previously identified as a good practice at Cattenom NPP.

The recently implemented operating experience system within EdF is based on sound principles and continued implementation should enhance the safety and reliability of EdF plants. Management should ensure that the programme is implemented as planned especially with regard to training, corrective action tracking and effectiveness reviews.

Level 1 probabilistic safety assessments have been completed for the generic 1300 MW and 900 MW units. The results of the probabilistic safety assessments are utilized by the corporate departments to evaluate modifications, operating techniques and maintenance programmes.

Flamanville does not have a written policy for maintaining a drug-free environment. Flamanville has a written policy which forbids any person working on-site from distributing or consuming, alcohol at the work place. However, consumption of

limited quantities of low alcohol content drinks such as wine, beer and cider is permitted during meals. Alcohol can only be brought on-site by the canteen manager. An informal programme is used by supervisors to detect and investigate changes in employee behaviour. To ensure nuclear power plant safety, employees must be alert at the work place. The undetected abuse of drugs or alcohol by employees could lead to significant problems in the areas of nuclear safety, industrial safety and work quality.

- (1) **Suggestion:** Consideration should be given to establishing a formal corporate policy relating to drug use. Consideration should also be given to progressively tightening the alcohol policy. This policy might include the formalization of the existing behaviour observation programme and the training of managers and supervisors to recognize the symptoms of employee drug or alcohol related problems, or it could result in the development of a new formal programme. The result of such actions would help ensure that all employees are fit for duty.

Plant response: (June 1996) The national 'think tank' dealing with the causes of 'uncontrolled individual behaviour' has rapidly developed towards the prevention of behavioural disorders in the workplace. This shows a clear determination to give priority to a humanistic approach which would involve taking a greater interest in these disorders, regardless of their cause, rather than dealing with the manifestation of the problem as such. This allows us to scan the full spectrum, beyond the mere causes, however important they may be, related to alcohol and drug addiction. Emphasis has clearly been placed on prevention, within the daily work routine of EdF employees and as part of work organization.

This national group, headed by the Flamanville plant director, comprised all types of unit management and corporate skills: management, human and social resources, occupational psychology and occupational medicine.

This group has submitted its recommendations to the EdF directorate for NPPs and occupational medicine general services. The NPP directorate has, in turn, submitted these recommendations in the form of a working document for enhancement by the various departments. This process was also designed to assess the practicalities of these recommendations.

Finalized at the end of 1995, validated by the EdF NPP management committee on 22 January 1996, this feedback will be used to formulate a summary and pedagogical document to be distributed to the various departments for approval and implementation. Due to its entirely humanistic nature a coherent grasp of this approach by all staff members and doctors in particular must be established before it can be implemented.

For Flamanville, the establishment in the autumn of 1995 of an authority encompassing management, the human resources team and occupational medicine, will be effective by,

the end of 1996, endowed with the mission of enforcing the implementation of these recommendations.

They are to be implemented gradually, starting at the end of 1996 as part of site project implementation.

As for alcohol abuse, a (re-)awareness meeting between supervisory and occupational medicine personnel was held in January 1996.

Close regulatory medical monitoring of employees and associated testing provide, here as in other departments, a precise knowledge about the employees' state of health, in a country where the consumption of alcohol is a cultural phenomena, whereas the use of drugs is seldom, if ever, associated with our region. As far as alcohol consumption on our plant is concerned:

- *the enforcement of Instruction 29 and its incorporation into internal regulations in accordance with Labour Law (limiting alcohol consumption - wine= 25 cl or beer=33 cl, exclusively during breaks and in recreational areas, forbidding the presence and consumption of alcohol in the work place and on the site in general), have considerably reduced alcohol-related problems among the staff: one of the two doctors monitoring half of the plant staff (300 employees) has only one problematic case, which is currently improving, while there were more than ten a few years ago.*

IAEA comment on status: *(June 1996) The report of the national working group, headed by the Flamanville plant director, has discussed the causes of 'uncontrolled individual behaviour'. This report includes how best to identify signs of personality and behavioural anomalies that might give early warning of alcohol or drug dependence. This report has recently been approved. The measures that derive from this national working group study go beyond the mere causes of alcohol and drug addiction. The site management intends to develop and introduce a comprehensive local policy for maintaining a drug-free environment. Occupational medicine measures currently in force at the plant site may be able to detect chronic abuse of alcohol and/or drugs. A counselling group (plant management, human resources department and medical service representatives) trained to assist, confidentially, any staff member in need of support due to any abnormal behaviour met twice in 1995. In the beginning of 1996 a training programme for all site supervisors was carried out, which includes discussion of how to recognize uncontrolled individual behaviour and how best to deal with such individuals. The reduced number of detected cases of alcohol dependence and no record of drug abuse at Flamanville NPP diminishes the possible impact that the lack of a comprehensive local policy.*

Conclusion: *Satisfactory progress to date.*

1.2 Plant Organization and Management

The Flamanville nuclear power plant has two 1300 MW nuclear units. The responsibility for the safety and operation of the plant is assigned to the Plant Director. The NPP senior managers are responsible for ensuring that the mission of Flamanville is fulfilled. The senior management or level 1 management consists of seven individuals, the plant director, the deputy director and five advisers. The advisers are given responsibilities by the plant director. The advisers do not have resources assigned to them. The plant resources are assigned to eight department managers, who report to the plant director and deputy plant director. The department managers and engineers make up level 2 management. The management team meets once a month under the chairmanship of the plant director. The management team consists of the plant director, deputy director, advisers, department managers and the internal auditor. The management organization is clearly described in plant documentation. Organization responsibilities are specified in job descriptions and by management contracts. The management team is competent and well qualified.

Topical committees are established on-site to avoid compartmentalization and to meet objectives common to several departments. There are eight topical committees including: the plant operating review committee; the safety technical committee; the industrial safety committee and the ALARA committee.

The management organization and topical committee functions appear to be well understood by plant staff. Communication among the plant director, deputy directors, advisers, department heads and topical committees is effective. Responsibilities are clear and although the potential for confusion exists given the additional non-executive layer of management none was identified. Overall the management structure appears to be functioning in a very effective manner.

The annual objectives for the plant director, deputy plant director, department heads and supervisors are specified in a signed management contract. Objectives for the advisers are included in the signed terms of reference. Annual appraisals are performed which consist of a written approval and a formal interview. The annual appraisal is supplemented each year by an individual training plan. Although after two weeks of in-depth review at Flamanville the team was able to confirm a high level of competence and professionalism of the technical staff, especially the counterparts for areas reviewed, it noticed that on a number of occasions some counterparts and technical staff were not able to provide prompt answers to questions related to his/her discipline and found it necessary to refer the question to the EdF corporate organization. This was particularly true in the areas of radiation safety and chemistry. Also, it was noted that in some cases the same responsible individuals were not very familiar with international approaches. See additional details in the chemistry and radiation protection section. Additional knowledge of the technical principles and international practices by plant technical staff could

improve the plant decision-making process and enhance the ability of the staff to have an effective technical questioning approach.

- **Suggestion:** Consideration should be given to improving the communication of technical principles and international good practices from the EdF corporate organization to Flamanville NPP, particularly in the areas of radiation safety and chemistry. This could be part of the decentralization programme of EdF, which has already proven effective in areas such as the engineering joint structure and the plant event analysis programmes. Providing the technical basis behind corporate policies and procedures along with different international approaches could stimulate more creativity, initiative and technical questioning approach in plant staff. This would provide additional motivation of plant professionals and provide more feedback of information from the plant to the corporate organization.

Plant response: (May 1996) *Expanding international awareness is an integral part of EdF's corporate development strategy. This implies involvement by all EdF departments. EdF personnel are in fact cognizant of good international practices in the field of nuclear safety as soon as these practices have been processed by EdF central management.*

As for the plant itself, the twinning agreement signed with Diablo Canyon NPP and its utility, Pacific Gas and Electric, in 1991 was resumed in May 1996, its effectiveness having proven mediocre in September 1995. The programme was incorporated into EdF NPP policy, following meetings between American power operators and EdF NPP management in November 1995 and after the previous deputy manager's trip to the USA in January and February. The first meeting held to draw up an action plan and exchange programme is scheduled for autumn 1996 (after outages).

Special efforts have been made since the OSART:

- *an assignment to Diablo Canyon and Calvert Cliffs NPPs (USA), to work on self-assessment in the field of nuclear safety and related good practices, before implementation in France (head of the safety quality team and safety engineer);*
- *an assignment to Farley NPP (USA), to work with laboratories on secondary chemistry (laboratory manager)*
- *an assignment to Trillo NPP (Spain), to present our good practices in the field of outage management (technical team leader)*
- *an assignment to Daya Bay NPP (China), to assist them in preparing for an OSART (safety, engineers)*

IAEA comment on status: (June 1996) *The initiatives taken by the plant management to improve the communication with other nuclear organizations is commendable.*

Professional staff of different hierarchical levels have benefitted by their participation in international technical exchanges, and other activities such as plant outage and operational self-assessment. The plant should continue this approach and use best known

performers in the nuclear industry to benchmark and continuously upgrade local standards.

Conclusion: *Issue resolved.*

Flamanville has distributed copies of an excellent new operational safety handbook to all employees. Time has clearly been devoted to designing a handbook that encourages people to read it. An employee chosen at random could produce his book, which, from its conditions had been well read.

- (a) **Good Performance:** A handbook, used as supporting material for induction training, entitled *Nuclear Power Plant Operating Safety Handbook* is distributed to all Flamanville employees. Effort had been made to produce material that encourages reading. Indications were that the staff at Flamanville were reading it.

The handbook is now in its second edition. Rather than just issue the new edition, the plant had carried out a survey to find out its employees' level of safety culture knowledge. The plant then combined the issue of the handbook with discussion based training. However, employee responses to OSART team members' questions indicate that there is not a consistent understanding of basic safety culture principles put forth in the power plant operating safety handbook or how safety culture tools can be incorporated into the conduct of work.

- (2) **Suggestion:** Consideration should be given to developing a formal programme to continue to emphasize the principles contained in the handbook to ensure that safety principles put forth in the operating safety handbook become part of the Flamanville culture. The formal programme could include additional training with emphasis on the fundamental principles of nuclear safety such as reactivity control, core heat removal and radioactive material containments; and on how the safety culture tools can be utilized on the job. The programme could also promote safety culture through direct management interaction with employees in the field and in small group meetings. Performance of additional safety culture surveys could also be considered. A strong safety culture will support the EdF corporate goal of maintaining an exemplary standard for safety.

Plant response: *(May 1996) Nuclear safety principles are dealt with and presented on various occasions and in various forums. In the field of training, several local training courses allot part of their programme to recalling the fundamental principles of nuclear safety described in the nuclear safety memo. For example:*

- *the risk prevention quality safety programme (SQPR) training course which provides an adapted programme for all employees (operations, maintenance, tertiary),*

- *the content of this training course is re-examined in order to deal more frequently with real cases stemming from nuclear safety-related events occurring at other plants or on-site,*
- *refresher training for work co-ordinators/technical inspectors.*

In the field of communication, the plant internal publications group plays a role in the development of nuclear safety culture. A 'nuclear safety' insert is planned for the site newspaper, 'Flam 'en Cause', distributed to all employees.

The site video circuit broadcasts nuclear safety information culled from various departments and related to technical problems encountered.

In the field of management, the presence of senior management questioning employees in the field is a way of ensuring that the notions of nuclear safety are imparted to all employees. Moreover, employee safety culture is assessed during the annual interviews between senior management and the employees.

Management has shown its desire to participate in the expansion of nuclear safety culture by organizing, in alternation with half days devoted to industrial safety, half days devoted to group reflection on nuclear safety by all personnel working in teams.

The first of these groups is scheduled at the end of the second outage in 1996. Its theme will be A Questioning Attitude During My Daily Tasks.

IAEA comment on status: *(June 1996) Several initiatives have been taken by plant management to reinforce the safety culture training at the site. Well selected examples of safety culture issues are included in initial and refresher training. The pilot group discussion on A Questioning Attitude During my Daily Tasks, scheduled for October 1996, has a well structured implementation plan. The site management is committed to follow up on this with a series of other safety culture issue work discussions. The requirements of the suggestion have been met and it is encouraging to see that further improvements are being sought.*

Conclusion: *Issue resolved.*

One of the stated Flamanville policies is that a management and supervisory presence in the field is necessary but several abnormalities were observed in the field, which indicate that department managers, advisers, and supervisors may not be making effective plant tours. The housekeeping and material condition of the plant in general is good, however, a number of plant deficiencies were identified such as the uncontrolled temporary installations, the unanalysed water on the floor in a part of the controlled area and the spent fuel pool foreign material control problem. More details on these issues are supplied in operation, radiation protection and technical support sections of this report.

- (3) **Suggestion:** Consideration should be given to establishing a programme of routine management tours. Since it is often difficult to find time for an effective tour, a routine programme could help schedule and carry out required tours. A routine programme could also provide guidance on how to perform effective safety or material condition tours. Effective tours will also assist in the achievement of the goals in the Flamanville policy related to presence in the field; make each person responsible, motivate each person to improve quality and efficiency and convince each person to meet objectives. A similar suggestion was previously made at the Gravelines NPP.

Plant response: (May 1996) Field meetings have been set up to establish a long term approach to site cleanliness. These meetings are held monthly and site conditions have improved as a result. These meetings do not address the actual question of presence on the site.

Making action meaningful is an important consideration for the future of EdF. The employees in the field are the most apt to assess and debate the meaning of any new developments. To this end, the unit project will comprise an internal communication policy designed to fuel these exchanges and debates by illustrating the communication strategy that a small, management-directed group has been working on since the end of 1995. The various aspects will be optimized.

As part of this effort, the diagnosis of conditions has been presented to some 180 persons. The NPP action plans defining how these objectives could be reached within 5 years will subsequently be drawn up in a participatory manner.

Moreover, such encounters will not be considered solely as a forum for debate. Exchanges will be conducted on professional experience, technical aspects, recognition and evaluation. The objectives of these exchanges is enhanced performance. An approach that seeks to make more time available to managers is currently being developed as part of corporate office-plant relations. It will subsequently be adapted to the site.

IAEA comment on status: (June 1996) The plant tour programme, oriented mainly towards housekeeping, has produced good results, and a follow-up of the actions required as a consequence of such field visits is maintained in the programme reports. However, a sample of one department showed that each manager took part in the plant tour programmes about twice a year. The electrical, I&C and software department implemented a formal programme of plant tours for its managers. It is a unique initiative on the site. A more comprehensive action plan is needed at the plant.

This could result from the site strategic plan for the next five years. The site strategic plan has been developed from extensive discussions among plant personnel, where plant strengths and shortcomings were identified and analyses, and objectives were established.

This plant-wide participation (50 people in the initial brain-storming sessions and 180 people in the subsequent plant development) reinforces staff's commitment to accomplishing the strategic plan. One of the topics indicated by plant staff and included in the strategic plan is the need for increased management presence in the field. The subsequent development of the detailed plan should address new opportunities for improvements in this area. Site management is aware of the importance of their being more visible in the field and are committed to pursue new solutions.

Conclusion: *Insufficient progress to date.*

1.3 Quality Assurance Programme

The policy concerning quality assurance (QA) is defined in the national quality management manual. It clearly expresses those principles of quality given in the IAEA code of practice 50-C-QA. Flamanville has its own quality manual which sets out the special local management systems for applying the provisions of the nuclear power plant operation quality manual. The plant quality manual is the backbone of the basis for the plant's quality system in that it specifies owners for the main plant activities.

The quality assurance programme is clearly described and appears to be effective. The QA programme is conducted by safety engineers. The safety engineers are well qualified. They have undertaken a comprehensive safety engineer training programme and many are past operations shift managers. On a daily basis, the safety engineers provide an in-depth review of plant safety that is independent, and redundant from that provided by the operations shift manager. The safety engineers also carry out a comprehensive review of the material condition of the plant which cover the whole plant in five weeks and is repeated on a continuous basis throughout the year. The nuclear and industrial safety department also conducts plant audits during the year. In the last two years Flamanville has conducted audits on spare parts, material used at NPPs, documentation, required records, radioactive sources and the four refuelling outages. In addition, a pre-OSART audit was conducted in 1994. The audits performed appear to be thorough and provided a good review of the audited area, but since formal audits of programmes and processes are fairly infrequent, developing concerns within these programmes and processes could go undetected and uncorrected between audits, particularly in areas not routinely reviewed by the safety engineers. EdF and Flamanville have been investigating the possible benefits of a self assessment programme.

- (1) **Suggestion:** Consideration should be given to performing a review of future Flamanville audit plans to determine whether all areas important to safety are audited on an appropriate frequency. Additional formal audits could be scheduled for safety-related areas that may need more frequent reviews. Consideration could also be given to the development of a formal self-assessment programme, performed by the departments on their own programmes. Such a system could

provide prompt identification of emerging concerns by the department which could then prioritize the concern and take appropriate corrective action. Additional audits by the nuclear and safety department and/or self-assessments by the line departments would provide a stronger quality programme.

Plant response: (May 1996) *The nuclear safety engineering group carries out a certain number of checks infields that are important for nuclear safety. These checks may take several forms: assessment of the daily nuclear safety level; nuclear safety roving inspections; and occasional or thematic checking activities grouped under the heading checking activities. In a similar vein, during outages, checking activities in operations and maintenance, from the preparation phase to the experience feedback phase are systematically carried out and written up in an outage audit report.*

All of these actions are used, in a cyclical manner, to verify the conformance to requirements of work done in all fields important for nuclear safety.

Additional formalized audits can be scheduled for specific themes based upon any perceived weaknesses or important axes of progress in certain fields. Such activities are scheduled during meetings of the technical specification group (GTS).

In 1995, in the field of nuclear safety, four of these actions were scheduled and carried out. These actions concerned the role and terms of reference of the work co-ordinator, updating documentation after modifications, fuel handling, and issuing operational assessments. In 1996, an action is currently underway involving the role of nuclear safety engineering consulting assistance. Other actions related to technical documentation, risk analysis and sub-contractor experience feedback during upcoming outages are planned. In addition, the test section of the environment technical department has developed a self evaluation programme, carried out on its own activities. During 1996, we plan to try the programme as well as carry out experience feedback on its content and presentation, with a view to generalizing this approach to all departments in the plant.

The self-evaluation approach sought by the plant is carried out in liaison with the nuclear inspectorate (IN) of the nuclear generation division (EPN). Common terms of reference between the plant and two American power plants in 1995 has provided us with knowledge about practices in the field of self-evaluation.

IAEA comment on status: (June 1996) *The plant audit plan covers areas important to safety in general. In addition, more specific and detailed audits are arranged based on the findings of planned audits or observations of day-by-day activities by safety engineers and other plant personnel. These additional audits cover complementary aspects related to safety, such as documentation related to design changes in safety systems.*

Some groups in the plant are developing self-assessment processes and pilot projects were carried out in 1995 and are planned for 1996. Feedback from the pilot studies should

help the plant to develop a more comprehensive self-assessment programme, which together with the normal audit plan, should provide the plant with a stronger quality programme. However, the plant should consider reinforcing the training programme for the preparation of the self-assessment process. It was noted that no specific training has been carried out for this purpose. This shortcoming should be addressed because the IAEA is aware that other plants have failed in successfully implementing self-assessment programmes due to underestimation of the required training.

Conclusion: *Satisfactory progress to date.*

EdF and the safety authority have a proactive programme of requesting an OSART review of one of their NPPs each year. OSART recommendations and suggestions are being effectively implemented at the inspected plants. In addition, recommendations and suggestions are communicated to plants expecting OSART evaluations in future years. There does not appear to be an EdF programme to analyse and communicate the generic implications of OSART comments to all EdF NPPs.

- (2) **Suggestion:** Consideration should be given to the development of a programme within EdF to analyse the generic implications and lessons learned from OSART recommendations, suggestions and good practices possibly, utilizing the experience feedback system. The applicable conclusions could then be communicated to EdF power plants as required. Such a programme could assist all EdF power plants in benefitting from OSART missions.

Plant response: *(May 1996) After the Flamanville OSART, the site sent a letter to corporate management as part of the effort to improve OSART experience feedback to the other sites.*

Beyond the overall analysis carried out on this type of evaluation, this feedback of experience identifies the good practices and good performances recognized within corporate resources or used in many other French NPPS, or to be taken up by other sites in order to progress, as well as the suggestions or recommendations for which the site will need the collaboration of corporate resources or which could indicate the road to progress for all French NPPs. Moreover, a feedback assessment on the Flamanville OSART was carried out by the corporate co-ordination department and transmitted to the sites.

In this same vein, an article about OSART organization and procedures was published in La Vie Électrique, an EdF internal newspaper.

Finally, and especially in the OSART Mission memorandum index 2, the nuclear inspectorate is very openly positioned as a motivating body of experience feedback related to OSART missions, by sending a cover letter signed by the corporate offices, the definitive reports of each mission, by asking each of the sites to take a stand after determining the relevance, to the site, of the recommendations and suggestions.

IAEA comment on status: (June 1996) *The actions taken by the plant management and at corporate level satisfy the requirements of the suggestion. Only by visiting other EdF sites could the response be verified.*

Conclusion: *Issue resolved.*

EdF has a strong and apparently very effective national experience feedback system for contractors.

1.4 Regulatory Interface

The regulatory control for nuclear safety at EdF nuclear power plants is organized into three areas: establishing and applying technical rules; an appraisal and licensing system; and systematic surveillance

The Ministry for the Environment and the Ministry for Industry are responsible for the technical safety of nuclear installations. The Nuclear Installations Safety Directorate (DSIN) is a department within the Ministry for Industry and acts for both ministries. The DSIN is supported at the regional level by specialized nuclear divisions (DIN) in nine regional departments for Industry, Research and Environment (DRIRE). The DSIN organizes plant inspections. The nuclear divisions of the DRIRE carry out inspections according to DSIN's programme, approve outage plans, interface with local authorities and check pressure vessels. The Institute for Nuclear Safety and Protection (IPSN), which is part of the Atomic Energy Commission of France (CEA) provides technical assessment expertise for DSIN and DRIRE/DINs.

The plant director is responsible for safety of Flamanville. The plant safety quality adviser is appointed by the plant director and is responsible for the plant's interface with the safety authorities. The safety quality adviser is present at the inspection meetings and has the authority to make commitments for the plant in the area of safety. An engineer from the nuclear safety department ensures that reply deadlines are met.

The inspectors of DSIN and DRIRE/DIN check that the plant is in compliance with the requirements of the regulatory documents. The plant is normally informed before an inspection takes place, however, some inspections are unannounced. After each inspection, the inspectors address an internal report to the DSIN director that contains their findings and remarks, and a letter to the plant director that contains their requirements. The plant must respond in writing within two months.

Four months before a refuelling outage the plant submits the outage work programme to DSIN. Two months before the start of the outage DRIRE/DIN approves the work programme and may request additional work or inspection to take place. At the end of the outage and before criticality DRIRE/DIN reviews the fuel record, the reload

safety evaluation and the startup test results. DRIRE/DIN gives advice to DSIN which issues the criticality license.

Proposed surveillance test requirements are developed by EdF's corporate organizations and sent to DSIN for approval. Proposed surveillance test requirements are also sent to NPPS. It is the policy of EdF to incorporate proposed surveillance test requirements into NPP surveillance programmes if the proposed surveillance requirements are more conservative than the DSIN approved surveillance test requirements. This policy along with a lengthy DSIN review has resulted in approximately one third of the active surveillance requirements at Flamanville NPP not being approved by DSIN. One revised surveillance requirement concerning venting and draining has been awaiting approval since 1989.

- (1) **Recommendation:** EdF and the regulatory authority DSIN should reach agreement on all active surveillance requirements as soon as possible. In addition, the surveillance approval and implementation process should be revised to prevent this problem from recurring. The safe operation and regulation of NPPs depends in part on clear mutual agreement on the basis for those requirements. This recommendation was previously made at the Cattenom NPP. A relaxed approach to this matter could erode the regulatory principles.

Plant response: (May 1996) As part of Flamanville unit start-up authorization, the periodic tests programme described in the general operating rules has been unanimously approved because of its exhaustiveness and its capacity to check all functional aspects of important for nuclear safety (IPS) systems.

As per the regulations, chapters III and IX of the general operating rules and their subsequent updating are also submitted to the regulatory authority DSIN for approval.

Since the Flamanville start-up, all or part of chapter IX has been updated several times so as to:

- *integrate experience feedback,*
- *increase the number of systems covered by formalized periodic tests*
- *take into account modifications on installations which partially affect already approved rules.*

Such updates are carried out in accordance with these needs. Some of these testing rules pertaining to the above mentioned categories remain to be sent to DSIN. These rules are currently being examined and approved by DSIN. For the 1300 MW P4 series, close to 80% of the (IPS) systems have already been approved. Others will be approved by summer 1996.

Nonetheless, it should be pointed out that due to the prime importance of operation in nuclear safety matters, the site carries out periodic tests to check the availability of

regardless of whether or not the corresponding test rules have been approved. After each outage, the site issues a formal report to DSIN.

EdF and DSIN seek to optimize the periodic test rule process so as to minimize the amount of time during which the site carries out periodic tests on IPS systems within the context of a not yet approved modification of the operating rules.

IAEA comment on status: *(June 1996) DSIN is currently giving priority to the examination and approval of the surveillance procedures submitted by EdF. At present one fifth of the rules for surveillance tests used by Flamanville are not yet approved by DSIN compared to one third at the time of the OSART mission. DSIN aim is to have all of the surveillance rules approved by the end of 1996.*

Conclusion: *Satisfactory progress to date.*

The Flamanville nuclear plant managers and DRIRE officials have established very open and effective communication. To help ensure effective relationships are maintained an annual informal meeting is held to review any difficulties between DRIRE and the plant during the previous year. Plant management also presents the plant results for the current year and the objectives for the year ahead.

DRIRE prepares site inspection schedules on a six month basis and submits them to DSIN for approval. The site management are informed approximately two weeks before an inspection. During the last two years, DRIRE and DSIN have conducted 23 inspections at Flamanville. Flamanville has completed 90% of the DRIRE 1993 audit commitments and 65 % of the 1994 audit commitments.

1.5 Industrial Safety

EdF management and the plant director are responsible for the safety of NPP workers. The department heads are responsible for the safety of individuals in their department. industrial safety training and the industrial safety of work carried out by contractors. Each individual is responsible for his/her own safety and that of those under them.

The Flamanville policy is contained in a policy brochure which has been distributed to all individuals. Detailed guidance on industrial safety is contained in plant regulations, personnel industrial safety handbooks, and industrial safety procedures. These documents contain guidance on topics such as tagging, protective clothing, use of hazardous chemicals and confined space entry.

Industrial safety goals are included in the three year strategic plan and the plant management contracts. EdF set a goal in 1993 to reduce the number of accidents per

million hours worked to below 5 by 1995. The average accident frequency rate of all EdF nuclear power plants has been 8.2 in 1993 and 5.5 in 1994. The Flamanville results have been 4.4 in 1993 and 4.3 in 1994. The 1995 Flamanville goal is still set at 5 but plant management has indicated that more challenging goals will be set in the future.

Team tours of plant indicated that general plant housekeeping is very good, with the nuclear auxiliary building, the fuel building and the electrical auxiliary buildings, all excellent, the demineralization station, pumping station and shops good and the turbine building satisfactory. Use of safety shoes and hard hats in the plant is very good. Use of safety glasses and hearing protection is satisfactory. Fire fighting equipment was available, stored properly and regularly inspected.

All new employees receive industrial safety training and are assigned to a mentor for the first three months. All employees then receive a one week course in industrial safety and radiation safety. Some employees also receive specialized, more comprehensive industrial safety training. Every three years all employees receive refresher training.

The industrial safety committee, which is chaired by the nuclear and industrial safety department manager, has members from management and the work force. The committee makes plant inspections, analyses experience feedback, ensures follow-up of industrial safety action items, and recommends necessary improvements.

Plant accidents and near misses are analysed. Lessons learned from industrial safety operating experience are used to update training. The corporate resource division provides the plant with excellent manuals containing EdF industrial safety experience feedback and ALARA experience feedback.

- (a) **Good practice:** The EdF corporate resource division provides NPPs with two excellent experience feedback manuals. One provides experience feedback on industrial safety. The other provides experience feedback on ALARA. The EdF NPP experience reports selected for inclusion in the manuals are thorough and contain valuable lessons which have been learned in the EdF nuclear programme. The presentation format for these manuals has recently been enhanced. The new format is clear and includes clarifying diagrams and pictures.

The plant holds half-day meetings three times a year with all employees to promote industrial safety and gets suggestions from employees on how to improve the industrial safety programme.

- (b) **Good practice:** Three times a year the Flamanville plant management holds industrial safety meetings for all employees. These half day meetings are held as a number of small group meetings in parallel. A member of the management team attends a portion of each group meeting. The meetings reinforce the importance

of industrial safety, review the status of current industrial safety action plans and promote employee feedback to management on how to improve industrial safety. These meetings are an excellent way for management to discuss the importance of industrial safety directly with employees in an open non threatening forum.

The plant also has a health and safety work place committee, CHSCT, which is required by French legislation. This committee is chaired by the deputy plant director. The CHSCT meets four times a year. It is a legal consulting organization, which consists of elected personnel and members of the NPP management team. It carries out site inspections and recommends actions which are tracked to completion.

1.6 Document and Record Management

Each department is responsible for managing its local reference documentation. The departments are responsible for keeping documents valid, complete and accessible. All documents are identified by title and code number. A procedure index is stored in a computer data base which includes procedure title, number, the latest issue date, and the procedure author. The document list is checked at least every two years. A spot check indicated that the system is effective.

The plant quality manual and management manual are well laid out and provide the framework for organizing site administrative procedures. Classification of documents as important for safety and/or subject to quality surveillance is done effectively. Documents reviewed were well written.

A corporate directive establishes criteria concerning which documents must be archived. Documents for the archives are put on two sets of microfilm. One set is used as a reference. The other set is stored in a fire proof area. Archived documents will be stored for 99 years.

2. TRAINING AND QUALIFICATION

EdF's policy of large scale nuclear development and replication gives Flamanville NPP staff access to good training programmes, well equipped and managed training centres and high quality training materials. Flamanville is able to rely on strong corporate support and its programme for improvements to the on-site programme is now showing results.

The plant managers are pursuing a policy of encouraging their staff to accept greater personal responsibility. One approach allows departments to pursue individual training initiatives in areas which are important to them. This is probably the best approach at the moment. The effect of individual department initiatives together with the state of change means that, at the moment, the conduct and quality of training differs from one department to another. It follows, therefore, that there are obvious benefits to the plant if, at an appropriate time, a strong focal point for training is provided to ensure that best practices are shared and to give the plant director an assurance that a Flamanville approach exists across the plant.

The plant managers have given visible support to training activities, firstly, by their personal involvement in attending courses and, secondly, by their encouragement and provision of resources to enable their staff to pursue training initiatives.

Each member of staff at the plant has a personal training plan which is updated annually as a result of an appraisal and discussion with his supervisor. Agreements are in place between operations and other departments to allow short term secondment to encourage team working and communication.

Whilst work remains to be done in the on-site training areas, the general impression created was that the staff were implementing and improving the plant's training programme in a well motivated and enthusiastic manner.

Since the February 1995 OSART, there have been improvements in the management of training in the plant to achieve a more consistent approach across the plant. The training assistance group, a transverse organization at the plant, plays an important role in sharing best practices across plant departments. Its role could be enhanced so that a greater degree of harmonization to the highest level could be achieved more quickly.

The plant has qualified shadow trainers in each department, and aims to increase the number of these qualified trainers in 1997. This is a significant improvement in the number of shadow trainers trained in instructional techniques.

Considerable improvements were noted in on-the-job training and continuous training records. The procedure to grant waivers for certain training has been improved. The best examples of granted waivers on-site should be used to further improve this procedure.

2.1 Organization and Functions

EdF is a large company with a policy of replication. This gives Flamanville NPP access to extensive corporate training resources and to materials and information that are produced to a high standard with the economies of scale. The plant director has ultimate responsibility for the training and qualification of his staff. This is in accordance with international practice. The plant director has five advisers one of whom covers the human resources area. The human resources adviser concentrates on policy and medium to long term strategy. On behalf of the plant director he monitors the 'health' of the training activities. Responsibility for the training of their staff is vested in the heads of each department. This has led to a degree of compartmentalization. The plant, for sound reasons, is pursuing a policy of encouraging staff to accept greater responsibility and consequently the on-site training activities are undergoing rapid development. Observations confirm that the content and quality of training differs from department to department. This could lead to inconsistencies in the training approach and results.

- (1) **Suggestion:** Consideration should be given to providing a strong focal point for training activities at the plant. This could be achieved by strengthening the position of the training section head. There are obvious future benefits if such a strong focal point for training is provided to ensure that best practices are shared across departments and that the plant director is given assurance that a consistent approach exists across the plant.

Plant response: *(May 1996) For several years, the Flamanville NPP has had centralized management based on a contractual approach. Giving more authority to the training section manager would be tantamount to challenging this type of management, which has already proven its worth. Moreover, the Flamanville site has chosen to second the training section manager in the roles of consultant, expert, experience feedback moderator and training inspector.*

Exchanging the best training practices is the responsibility of the training assistance section. Although this organization, created in 1994, was not able to have a significant effect on the OSART, today we can say that its work is beginning to pay off. It must be given credit for two actions which stand out:

- *extension to all departments that use shadow trainers, an action initiated by operations.*
- *the on-going efforts concerning the quality control of actions.*

As concerns the second item, the training section manager is now responsible for checking the list of specifications for all locally initiated training.

Moreover, the role of the training assistance section (CAF) has been clarified within the implementation process of transverse training where it plays a dominant role.

More recently, as part of a national directive, a methodology has been defined at the site level to address in a uniform, rational and pragmatic way the acquisition and maintenance of the skills necessary for performing IPS equipment activities and their assessment. The future implementation of this methodology should ensure an identical approach in the field

Finally, as part of this implementation, Flamanville will call upon the professional training department for assistance in developing the professional and training references for the various jobs. Calling upon a training specialist consultant within EdF should provide an identical approach for the content.

IAEA comment on status: *(June 1996) Before the OSART mission in 1995, the training assistance group (CAF) a transverse organization in the plant, had carried out five meetings. From then until now five more meetings were carried out. After the OSART mission, the training section head was appointed as the chairman of the CAF. Before, there was no specific chairman. This raised the importance of the CAF. In reviewing some of the reports of these meetings, the recommendations made by the CAF were found to be of good quality. However, there is no formal follow-up of the proposed actions, although the CAF has been in existence since 1994.*

The local implementation (beginning of 1995) of the national directive, DI70, Nuclear Safety Qualification, sought to harmonize the quality of training and to improve professional skills. As a consequence, a training specialist from the corporate level will spend one year at the site to develop higher standard training requirements for the maintenance department. Some progress can be seen in that a consistent approach across departments is beginning to develop. Nevertheless, improvement could be achieved faster if the CAF was requested to review all plant department programmes, waivers and procedures related to training with a view to proposing means of achieving harmonization to the best standards.

Conclusion: *Satisfactory progress to date.*

- (a) **Good performance:** Managers at Flamanville are giving visible support to training. The plant director has attended all of the last four induction courses and has spoken to new employees for two hours each time. Shift operations managers have a 100% attendance rate at the assessment of their employees on the Paluel simulator assessment against the national average of 67 %. A member of the management team attends each site course introduction and feedback session.

Flamanville NPP has representatives on the national training committees for field operators, control room operators and shift operations managers/technical managers, thus giving the plant a voice at this level in all three areas.

The operations department has instigated an excellent system for seconding their staff into other departments and vice versa for short periods. This assists in staff's understanding of each other and their roles. Early exchanges gave problems due to unclear objectives and lack of preparation. To overcome this, exchanges are now formalized between the department heads concerned and the secondee. The secondee is given clear objectives. During the secondment, a tutor is appointed who takes the secondee through his training plan. For example, a mechanic might take a field operator through maintenance of the valves that the field operator operates. The system appears to be working well and could be copied by departments other than operations.

The plant has a well documented standard training plan (PTF) for each post which is based on EdF's training plan guide (PGF) and the site professional adaptation programme (PLAP). The PTF is adapted for the individual employees to produce the individual training plan (PIF). The individual training plan is reviewed annually and agreed by the employee and the supervisor in joint discussion. The individual training plan is held within a personal file (CIF). The combining of various training requirements into an individual training plan for each employee is commendable.

The company has instituted a good system for instructor recruitment to the training centre at Paluel and to the operations department at Flamanville. A genuine sense of pride and enthusiasm was apparent amongst the instructors at Paluel and the two operations instructors at Flamanville.

(b) Good performance: EdF has a good policy for recruiting instructors for the training centre at Paluel and for the operations department at Flamanville NPP. Instructors are recruited for a five year period at Paluel and for four years to the operations department at Flamanville NPP. They are recruited from experienced plant staff. A promotion incentive together with a firm commitment regarding the location and work area to which the instructor will return ensures that the most suitable staff can be recruited. The timescale ensures that the instructor has sufficient time to be given a thorough training in instructional techniques and not too long that the instructor becomes divorced from the plant situation, especially as instructors at Paluel return to their plants for a period each year. The recruitment pattern at Paluel is arranged so that a 20% turnover of staff occurs each year.

Not all staff who are required to carry out significant instruction in the course of their duties have received appropriate instructional techniques training. To do so should improve their ability to impart information. The need has been recognized by the operations department who are arranging a suitable course and by the chemistry, section

who have arranged a course for some of their shadow trainers but not all shadow trainers have received training in instructional techniques.

- (2) **Suggestion:** Consideration should be given to ensuring that all staff who act as shadow trainers are trained in instructional techniques. This might be achieved by utilizing the one week course mentioned in section 2.8 or the course in instructional techniques being arranged by the operations department. The provision of such training would give confidence in shadow trainers' abilities as instructors.

Plant response: (May 1996) *The solution chosen by the Flamanville NPP involved reworking the training project developed by the operations department and expanding it to the maintenance departments. A list of specifications was drawn up jointly with a specialist company. These specifications take account of the necessity to mix the populations of various departments and to provide hands-on training in the field. At the end of the training course, the shadow trainers will be able to:*

- *understand the importance of establishing positive relations with beginners,*
- *extract, from their own experience and practical skills, those points which should be imparted to a beginner,*
- *question their pedagogical approach,*
- *transfer, to a beginner, a body of knowledge in a gradual and structured manner,*
- *evaluate quantitatively and qualitatively the information acquired by the beginner.*

For various reasons, the first experimental session could not take place before February 1996. Two other sessions are scheduled for 1996 (1 to 5 April and the second half of 1996) and two in 1997.

Moreover, an action plan has been developed subsequent to an audit concerning the integration of newly hired employees. This action plan seeks to promote this training, to develop the necessary prerequisites for participation therein and to examine how the shadow training managers can be associated with the plan.

IAEA comment on status: (June 1996) *By the time of the OSART follow-up visit, the departments have, on average, four to six shadow trainers trained in instructional techniques. An extended training programme is planned for 1997 to increase the number of qualified shadow trainers in each department.*

Conclusion: Satisfactory progress to date.

2.2 Training Facilities, Equipment and Material .

Flamanville has access to a number of EdF training centres. The centre at Paluel,

which carries out operator training was found to be well constructed and maintained in a clean, tidy and professional manner.

- (a) **Good performance:** The Paluel training centre has excellent classroom facilities. The number of staff being trained together with the company's standardization policy has allowed Paluel to analyse the training to be delivered in each room. Each room is, therefore, custom-designed to offer the optimum facilities for the training to be delivered. Each training room combines good classroom facilities (desks, boards, overhead projectors etc.) together with an extensive range of demonstration and practical facilities (models, laboratory equipment, working items of equipment from the plants etc.). This ability to reinforce theoretical training with practical understanding in the best manner is commended.

A number of facilities are available at Flamanville for training. The plant has recently refurbished an existing building on the site to a very high standard. At the time of the review the centre was still being equipped. The centre should be visited on the follow-up review to ascertain whether the excellent start has been followed through. Additionally the plant has two good worksite schools partially representing a full-scale primary circulating pump and steam generator water box. They are used for training in carrying out maintenance operations.

By the time of the OSART follow-up visit, the training centre at the plant site was seen to have some well equipped classrooms with two computer rooms for SYGMA and micro-computer training courses, a basic electricity and physics work room, and a library. There are plans to install work rooms for training activities such as thermodynamics and hydrostatics, chemistry and valve construction, operation and maintenance.

Flamanville has an interactive multifunction simulator but not an on-site control room replica simulator. Control room personnel are trained on a full scale simulator at the Paluel training centre, which replicates Paluel Unit 1. Due to EdF's strict replication strategy the layout is in fidelity with Flamanville. Except for two details, the simulation model and operating methodology also replicate Flamanville. These differences, which are explained to the trainees before training commences, have no significant influence on the effectiveness of the training. The simulator has the capability to interactively model a breach of up to 100 mm diameter in the primary circuit. Breaches above this can be demonstrated in a non-interactive mode. This is considered to be satisfactory.

Following an event, analysis takes place at the plant and then at the corporate level. When the causes of the event include human performance, the results are sent to the training centre. A nominated instructor is responsible for incorporating the lessons learned into the lesson plan. A 'fast-track' system ensures that instructors are quickly made aware of the event and its causes. This system of learning from operational experience is effective.

Modifications to the plant are incorporated into the simulator by carrying out the modification at Paluel Unit 1 and then using this unit to obtain simulator data. The EdF replication strategy ensures a thorough and controlled approach to modifications but the phasing of the installation of modifications at different plants means that the simulator may not always be a faithful replica of the Flamanville units as, for example the low steam generator level alarm, which has been fitted to all 1300 MW units except Flamanville.

Training programmes at Paluel are well documented, aims and objectives are clear and lesson plans including 'handouts' for the students are available. Further material is available for students wishing to study a topic in a greater depth. Simulator training requirements are documented. Operating instructions are available. The instructors work from a separate viewing area through 'one-way' glass. The simulator is equipped with freeze, back-track and operator action recording. Emphasis is placed on team skills and human behaviour in control room operations and to facilitate this the simulator is equipped with video cameras and recorders. The use of psychologists could be investigated to enhance understanding of the feedback to the operators.

2.3 Control Room Operators, Technical Supervisors and Shift Operations Managers

To give a clear responsibility for safety to the operations staff, Flamanville have deleted the shift supervisor role and created a shift operations manager position. The shift operations manager has a clear accountability for safety and is now involved in the management of the departments. The shift operations managers undergo a ten month training programme. Prospective shift operations managers may be recruited from technical supervisors who have long experience as control room operators or who were direct entry university graduates. They are required to pass a National Selection Board, that assesses their suitability, before commencing a 10 month training programme which covers, amongst other topics, management skills and safety issues. Technical supervisors also follow a thorough training programme having first been assessed by a site board for suitability. Their training has a high safety course content. Direct entry graduates are trained and authorized as field and control room operators as part of their training. This also increases respect from other team members.

Control room operators are recruited from operating technicians or directly from college with Baccalaureate plus two years as junior qualified technicians (JTS). A JTS entrant undertakes a comprehensive preliminary training programme of practical and theoretical training followed by 'shadow' field operations training. The JTS entrant must be authorized as a field operator before starting the well structured and comprehensive control room operator training course. The course consists of periods of theory and simulator training which is controlled from Paluel. Assessments, carried out after each module, use a systematic approach of awarding points for meeting a particular objective.

Objectives with clear safety implication carry double points. If a trainee misses one safety point he will pass provided everything else is correct. This is a good system though the centre should consider whether a pass should be allowed if any of the key safety points are missed. The trainee is required to correct weaknesses by further study during the following period at the plant. The trainee is allowed a maximum of two attempts to correct a specific weakness. Only one trainee has had to carry out a repeat.

The training programme appears to be thorough and is sufficiently long (18 months). EdF have clearly put a lot of effort into identifying the tasks to be covered and producing the training programme and training materials. Although a detailed systematic task analysis was not carried out, the objectives have been determined by working groups which include operating staff.

Six weeks after completing the second simulator module (procedure training) the trainee returns to the simulator for a one day assessment session. The trainee is required to carry out assessed simulator exercises which check retention of the training given. In particular, the trainee is assessed for knowledge retention concerning the correct use of procedures, attitude and the methodology to resolve incidents. The concept of ensuring lessons learned have been retained after a period of time is commended. Although it is not mandatory for a member of the trainee's management to be present, the records at Paluel show that shift operations managers from Flamanville have attended 100% of their trainees' assessments (against an average of 67% for all locations). This support and ownership attitude towards their trainees is highly commended.

The use of real timescales obtained from plant measurements for field operator manoeuvres (recorded as a good practice at the Cattenom NPP OSART) has also, sensibly, been included in the training of Flamanville NPP staff.

At Flamanville, a 'training representative' position together with two operations instructors has been created in the operations department to provide a service to all six shifts. The role of the operations training representative has been combined with that of operations feedback engineer, which gives a closer control of feedback initiated training. Each instructor has special areas of responsibility. The training plan for these instructors includes development in operations aspects. Plans to maintain and improve their instructional skills are still under consideration. A trainee feedback sheet has been introduced to assist them in evaluating the effectiveness of training.

Flamanville is developing continuing training in a structured way. A programme allocating four weeks of training to the shifts is to be introduced in 1995. Emergency plan training lesson material demonstrated by one of the operations instructors was a sound example of training material. The follow-up visit may wish to check progress in implementing this programme of continuing training.

The operations department's local training programme is complementary to national training. In 1995 the average training time per qualified operator was 190 hours with a standard deviation of 13 hours. The low standard deviation was due to a concerted effort to train operators in the new state oriented emergency operating procedures.

Control room operators return to the Paluel simulator for two weeks continuing training. One week of this is, commendably, spent on team training aspects, the other on technical aspects. However, the period of time at Paluel is considered by the operators to be too short to allow refresher training of infrequently carried out normal plant manoeuvres. This concern is shared by the OSART team. For example, the continuing training on the Paluel simulator does not normally include a full start-up. The length of simulator time that is required to achieve this and the fact that operators experience startups and shutdowns at the plant is quoted as a reason. A good example from international practice is that staff are trained on normal but infrequently used tasks. This example should be copied particularly as the plant is not able to demonstrate that it has not had any human error faults on the units during start-ups in the recent past.

- (1) **Suggestion:** Consideration should be given to instituting a system which objectively ensures that operators are given continuing training on infrequently used normal operating procedures. The system should take into account whether operators have carried out the procedure on the plant without error in the recent past. This additional training will ensure that operators are well trained in normal operations and will assist in detecting any weakness at an early stage. Although training needs are determined during an employee's annual appraisal, they are not assessed against objective guidelines.

Plant response: (May 1996) *Each year, the operations department develops a local training programme, as a complement to national training. This local training is based on:*

- *the operator professional system of reference, explained in the training system of reference,*
- *mandatory training sessions after procedural or organizational changes,*
- *specific requests from the teams or the management,*
- *experience feedback.*

Training in 1995 was carried out according to the planned programme. The average training time per qualified operator was 190 hours with a low standard deviation of 13 hours. Training during the first half of 1996 also took place according to the planned timetable and themes.

IAEA comment on status: (June 1996) By the time of the OSART follow-up visit, the enhanced control room operators continuing training had been applied twice.

Conclusion: *Issue resolved.*

2.4 Field Operators

Field operators are recruited against an appropriate personal profile. Suitably experienced operators are promoted to technician grade. Initial training is given over a period of one year through a series of ten courses at the training centre interspersed with periods at the plant. Assessments are carried out as the trainee progresses through the course. The policy is good in that its first objective is to help the trainee to succeed. No trainee has yet failed the training course; the policy in that case would be to divert the employee to another role.

The trainee is allocated a tutor from amongst experienced field operations staff of his shift. The tutor is responsible for the trainees 'shadow' training. A tutor has only one trainee at a time. Tutors, who are selected from volunteers, are given a well documented job description for that task. On-the-job training follows a training schedule.

The plant has not yet documented the plant-specific on-the-job training but Flamanville is aware of the problem and has a defined plan to produce these documents. The follow-up OSART visit should review progress in implementation.

A shadow training guide of good quality has been in use since December 1995.

For each on-the-job training module, it defines:

- *the programme and key points in accordance with the preceding theoretical module*
- *the practical objectives of field training*
- *preparation for the next theoretical mode*
- *the criteria for assessment.*

It also provides comprehensive training records.

Continuing training for the mandatory elements of authorization takes place at the training centres. Continuing training on the plant is also taking place, but is currently less well defined and structured. For example, a walk through of simulated actions on the plant for abnormal operating conditions sometimes takes place but is without structure or documentation. Assessments are made at the end of the plant and emergency plan training with a follow-up assessment six months later to check that the knowledge has been retained. Currently the records show that, although about four weeks of continuing training per employee is being carried out, the lack of systematic approach means that this is an average figure and not a figure for each employee. This situation would give rise to a recommendation were it not for the fact that the plant is aware of the situation and is taking action to correct it. The training plan for 1995 shows that all field operations staff

will receive four weeks systematic continuing training spread through the year. The plant is approaching the improvement of its continuing training scheme with enthusiasm and a check on the implementation would merit inclusion in the follow-up OSART visit.

A well developed field operators' continuing training programme was implemented in December 1995. The average training time per qualified field operator was 178 hours with a standard deviation of 27 hours. The training programme includes:

- *field operator professional requirements*
- *mandatory training with respect to changes in instruction and organization*
- *specific requests from managers, supervisors and staff*
- *experience feedback.*

2.5 Maintenance Personnel

Recruitment is normally at an educational level of Bacculaureate plus two years JTS. The trainee follows a training plan based on the corporate and site training requirements as detailed in section 2. 1.

The department training representative is able to grant 'waivers' from certain initial training. The grade of the training representative (equivalent to deputy department head) is appropriate for carrying out this function. The decision to grant a waiver follows an interview and work place assessment but does not require successful completion of the assessment of competency set at the end of training. The current method may not ensure that a member of staff meets all objectives of initial training. Commendably, the department uses a formal waiver certificate to record the decision.

- (1) **Suggestion:** Consideration should be given to instigating a system of 'waiver by assessment' whereby a trainee demonstrates that he can meet the objectives of a course by satisfactorily passing the assessment. This would give improved confidence in the trainee's ability.

Plant response: *(May 1996) Even though this practice remains the exception, professional experience and previous training can be taken into account as waiver by assessment for certain training actions in an employee's individual training plan. This exempts the employee in question from following these actions. This waiver means that the employee has acquired the abilities corresponding to the objectives of training action under consideration.*

A more rigorous waiver issuance procedure has been implemented. Such a waiver is given by management, after an objective analysis has been carried out concerning:

- *the ability objectives to be attained during the course for which the waiver is sought,*

- *the possession of these abilities evaluated after the employee has participated in other training actions;*
- *the possession of these abilities demonstrated by the employee as he/she carries out assigned activities, and confirmed by the supervisor.*

However, if the acquisition of skills cannot be confirmed by the employee as assigned activities are carried out, a written individual assessment is made by the employee's supervisor based on a questionnaire corresponding to the training objectives. If a discrepancy is detected between the assessed level and the expected level, the supervisor triggers implementation of the appropriate corrective action.

The waiver notice which formalizes the granting of the waiver is kept in the employee's individual training folder. The waiver is also noted on the employee's individual training plan.

IAEA comment on status: *(June 1996) Although the procedure that regulates the grant of waivers for certain initial training has been improved, criteria for assessment is not adequately specified. The use of interviews, observations and written examinations as well as a minimum pass level for the assessment should be considered. Some good examples were noted in the operations department.*

Conclusion: *Satisfactory progress to date.*

The training programme consists of a series of modules interspersed with on-the-job shadow training. The plant has recently produced a shadow training guide, that contains a list and a record of the tasks that each employee is required to carry out. This was demonstrated to be in use with current trainees. On completion of each module the trainee is given practical work related to the module as quickly as possible to reinforce the training. The modules are delivered at the company's training centres, at manufacturers' works and on-site.

The training appears to be comprehensive and the plant is developing a sound, logical system for initial maintenance training. The training carried out on courses and by shadow training, is brought together in an 'assessment grid' document, which is used as the basis for granting authorizations. Initially, the authorization does not allow staff to work on items of special safety significance such as reactor protection and control rods. For these items, further training is carried out following which the scope of the authorization is progressively increased.

Continuing training covers refresher, feedback and proficiency development. Refresher training consists of a safety, quality and risk prevention course (SQPR) every three years and first aid training for first aiders. Training which is a result of event feedback is given in recorded training courses or disseminated as information depending

on the significance. Proficiency training is given to increase the employees skill base when required by the department.

2.6 Technical Support Personnel

Training of staff in the technical and environmental department follows the standard Flamanville pattern of collating training requirements to produce an individual training plan (PIF). Although the department head has responsibility for the training of his staff, the management of the process has been delegated to the deputy department head who ensures that training and authorization matters are handled in a consistent way across the department.

The testing section has a thorough method of appraisal and assessment. Authorizations automatically lapse after a time period; positive results must be achieved from the appraisal system for the authorization to be renewed. This gives an assurance that the continuing appraisal of an employee's competence is taking place rather than automatic renewal.

2.7 Radiation Protection Personnel

Initial training follows the standard pattern of combining national and site requirements into a personal training plan. Courses and shadow training are then combined to prepare the trainee for his nuclear safety authorization. Emphasis is placed on instructional technique courses since part of the group's role is to teach radiological and industrial safety to the rest of the plant personnel. The initial training programmes appear to be satisfactory. The obligatory continuing training is the course on safety, quality and risk prevention (SQPR). To this is added training identified during the employees' annual appraisal.

2.8 Chemistry Personnel

Initial training follows the standard plant pattern and appears to be satisfactory. The chemistry section have established a good terms of reference document for shadow trainers that details what training they are required to give and by when. Other departments on site are encouraged to examine it. Some chemistry section shadow trainers had been sent on a one week 'instructional techniques' course (3758) though not all. Staff who have a key part to play in the plant's training system should be trained in instructional techniques. Shadow trainers have such a role and should receive appropriate training. This has already been commented on in section 2.1. Continuing training follows the standard pattern of the safety, quality and risk prevention refresher course (SQPR) on a three yearly basis together with training identified at the annual appraisal.

2.9 Management Personnel

EdF use their standardization policy to good effect when training and developing their management personnel. Staff are able to move from one location to another especially within the same plant series, without the time consuming need to familiarize themselves with new plant and corporate systems. EdF expects mobility of both function and geographical location from their more senior grades of staff since this is regarded as a training medium. The plant has in place a good system to develop their managerial staff. This is based on the company's corporate system and the Flamanville appraisal system. The system is steered by the central career path committee in Paris.

A feature of the annual staff appraisal system is that after discussion between the appraiser and appraisee the next career path/development post which the employee is expected to hold is detailed. This gives the employee a medium term view of his/her development (several years) as well as the short term (next 12 months). The appraisal records that were reviewed indicated that the appraisal had been carried out in a thorough manner. When managers are appraised, their attitude towards, and knowledge of, safety, risk awareness and quality is taken into account.

2.10 General Employee Training

The arrangements for induction training of new employees arriving at Flamanville appear to be good. All employees arriving on site are taken through a syllabus in a systematic and consistent manner which covers the necessary topics including a welcome by senior management. It is commendable that for at least the last four of these courses run during 1994, the plant director has shown his personal commitment by undertaking this role.

Following these general induction topics the new arrival undertakes three days of safety quality training (basic safety quality, FBSQ). This is designed to impart safety culture. The lesson material covering IAEA Safety Series No. 75-INSAG-4 and the international nuclear event scale was chosen as the sample to be reviewed further. The lesson material covered both subjects in some detail and contained a number of case studies designed to take the trainee from what INSAG-4 says to its practical application to work situations but the lesson material did not contain examples of instances in France or abroad where safety culture was lacking. Opportunities appear to be missed to sensitize new staff to the importance of developing a good approach to safety.

- (1) **Suggestion:** Consideration should be given to include well thought-out examples of good and poor safety culture in the lesson material of the safety culture course. To do so will assist in reinforcing the importance of a good safety culture for new employees by tangible and practical examples.

Plant response: (May 1996) *A file of examples has been established: it is fed mainly from significant event reports (CRIS) from other 1300 MW site, significant event report events and Flamanville incident reports (CRI). It is designed around a system of data sheets such as: acts; consequences; analyse; and corrective actions, which enables the instructor to opt for a general approach or a step by step approach with the trainees reflecting on actual occurrences. A summary table of the various events enables the instructor to select the examples to be used, according to the 'target populations' and the 'points to be taken up'.*

These files will be tested in the first quarter of 1996. They will be enriched by the experience feedback of the instructors and will be used as additional course supports in the new SPQR modules which are currently being developed. The development and renewal of these examples are the responsibility of a NS supervisor.

IAEA comment on status: (June 1996) *By the time of the OSART follow-up visit, the list of examples of safety culture issues had been completed and used during two safety culture training courses. Both trainees and instructors reacted positively to the inclusion of such examples in the training. The list of examples currently includes sixteen issues, of which six are classified as level 1 in the INES scale. The examples have been carefully selected, and the important aspects to be discussed during the training are well indicated to the instructors.*

Conclusion: *Issue resolved.*

The course, together with the refresher course (SQPR) based on it, is a key one and should, in common with other courses, have a means of ensuring it is updated to take into account new approaches and events. There was no systematic method in place to ensure that updates take place. Topicality is introduced by the operational feedback engineer who sometimes gives instruction during the course. However, this is not done in a systematic manner.

An agreement has recently been signed by Flamanville NPP, COGEMA and DCN-Cherbourg to move to a common radiological protection course for contractors.

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

3. OPERATIONS

The current organizational structure of the operations department at Flamanville was set up three years ago with the intention of flattening the management structure and improving off-shift support. Shift operations are supported by groups that provide training, experience feedback, surveillance trend analysis and preparedness for abnormal conditions including emergencies. Not all new programmes in the department have been implemented; the full benefit of the new structure will only come after full implementation.

Some of the more significant documents that were recently implemented, or are in the process of implementation, are the new technical specifications (including unit fallback time with respect to accumulation of unavailability of safety related equipment), and the mid-loop operation procedure and training file. The administrative lockout system for safety related systems provides an important tool to ensure correct line-up of nuclear safety functions. These are important examples that provide evidence that safety has priority in the operational process.

The support available to operations during emergency conditions is commendable. A strong network of teams and centres on-site and at national level are able to develop complementary procedures for severe operational conditions, and to supply equipment for faults that were not considered in the original design. The shift staffing is flexible enough to cope with the emergency conditions, together with the other site support teams. The emergency operating procedures are event based, however, symptom based procedures are to be implemented in 1996, and initial training has started already. These new emergency operating procedures should be able to provide the operations shift crew with a more comprehensive set of instructions to cope with emergency conditions.

Good standards of cleanliness and housekeeping were evident. However, some deficiencies were observed that indicated a lack of attention to details such as unauthorized handwritten notices, leaks that had not been reported, missing equipment labels and some uncontrolled temporary installations. The administrative procedures for temporary modifications should be reviewed. This review should determine the need for authorization by specific persons, such as safety engineers, when nuclear safety might be affected. In addition, the review should evaluate the approval and control by the operations department and the keeping of records in the control room that can readily provide a clear status of all temporary installations in the plant. More attentiveness by field personnel and improvements in their training could provide significant improvement to the standards in the field. Increased, effective supervision and coaching by managers and direct supervisors in the field would assist in this improvement.

The plant operational history was found to be good, with several indicators giving evidence that even better performance may be achieved. Nevertheless, there were six

reactor trips of Unit 2 in 1994 that affected plant performance. Three of these reactor trips were related to long standing design request changes at corporate level but not yet installed at Flamanville NPP. A strategy to review groups of events as a step towards reducing the number of reactor trips should be developed and implemented to minimize challenges of the plant safety functions.

Overall, nuclear safety was seen to be embedded in the aims, performance and results of the operations department as well as in the strong support provided by the corporate organizations. A constant enhancement of safety culture is needed to avoid complacency in the day-by-day activities. With regard to this enhancement, more attention should be paid to accomplishing the department's proposed goals and objectives and programmes and, through a questioning attitude, to continuously improve them.

Several actions have been taken in the operations department which have significantly enhanced the department's role. Examples of these actions are:

- *the improved interface with other plant departments - notably with maintenance;*
- *the implementation of the administrative lockout system for safety related systems;*
- *the completion of the operators training on the new state-oriented emergency procedures (planned to be implemented in June 1996);*
- *the improved procedure for approving, implementing and controlling temporary installations in the plant.*

The measures that have been taken at plant level to understand and prevent a recurrence of unit trips from the same causes are appropriate and should continue to be pursued.

The involvement of shift staff in reviewing operators' responsibilities and practices is leading to improvements in the sense of ownership and thereby to improvements in performance. Experience in using recently-improved procedures for activities such as the tracking of panel alarms, identifying plant defects and approval and control of temporary installations should be fed back into the procedure improvement programme so that it can be further strengthened.

More effective coaching by managers and supervisors in the field has still to be achieved.

3.1 Organization and Function

The operations department is common to both Unit 1 and Unit 2 and comprises six shifts together with a supporting organization. This organization works on day staff hours and consists of operations engineering and training. Each shift team comprises: one operations shift manager, who is responsible for nuclear safety, industrial safety, unit

availability, environmental protection and shift human resources; two technical supervisors, one of whom supports both control room operators in the day-by-day operation and monitoring, and another who is involved in planning, analysis and developing short- and mid-term plans and objectives for shift activities (these two technical supervisors switch positions weekly); three control room operators per unit (one of whom is also responsible for tagging); four field operators per unit; and a field operator for systems common to both units such as water treatment and the auxiliary boiler. A safety engineer is on call 24 hours a day to support the shift during abnormal and emergency conditions. He is responsible for frequently touring the field, including weekends, mainly for aspects related to safety systems and equipment in accordance with a specific administrative procedure. This department structure, including changes to the shift posts was established three years ago. The changes were aimed at shortening the management line, improving off-shift support and the definition of the responsibilities of shift positions, thereby minimizing overlaps and improving supervision (inspection and checking).

The interfaces between operations department and other departments are based on meetings where short-, mid- and long-term actions are discussed and strategies determined, and on joint reports, where these actions are recorded and followed up. It seems that mutual understanding is generally accomplished. Nevertheless, there are signs of some lack of co-operation among operations, I&C and electrical and mechanical departments [see suggestions 1.2(1) and 3.5(2) and recommendation 3.6(1)]

Job descriptions that cover all shift posts state the minimum training requirements. Specific authorizations are required for some activities such as operation of electrical circuit breakers, equipment tagging, procedure approval and the control room panel operation. The training and qualification of some posts on shift, such as the control room operator responsible for tagging and field operators was found to consist mainly of unstructured on-the-job training. Despite this, they were found to have developed their responsibilities with competence. A new programme has been developed and is being implemented in 1995, that will give more consistency to their training and qualification.

As a consequence of the decentralization process at the corporate level, the department was able to create eight new posts which were staffed a year ago. This increase in the number of posts has improved the flexibility of the shift team during critical phases, such as outages. During normal operation this extra manpower is devoted to improving the operations department training activities, supporting planning and scheduling and supporting the shift team in surveillance tests and technical analysis.

Exchanges of team members from one unit to the other is not frequent, but occurs when necessary and is an important managerial tool to minimize staff overload, for example during outage and unexpected staff absence. Precautions are taken, such as informing the operators more than two weeks in advance and providing an overlap period,

but this criteria is not formalized, a step which might give more consistency to this process. There is no reported event involving this kind of exchange.

The operations department managers, including shift supervisors, do not routinely tour the field. Some deficiencies were observed in the turbine buildings of both units that indicate lack of attention to details by field operators. Such deficiencies should be identified by managers and supervisors during regular plant tours who should provide coaching and initiate corrective actions [see suggestion 1.2(1)].

3.2 Operations facilities and operator aids

There is a computerized operator aid (KIT) in each control room comprising four terminals and two keyboards. It provides control room staff with information about the status of equipment and systems and displays, parameters and special functions such as trends and calculations (boron concentration, xenon evolution). This system has no backup and thus its operation in emergencies is not assured. Improvements of the KIT system are being considered, which should increase its capability.

3.3 Operating rules and procedures.

Chapter 3 of the technical specifications, *Limiting Conditions for Operations*, will be replaced shortly by a revision that has been developed by EdF for all 1300 MW PWR plants. This revision includes the limiting conditions for operation for the accumulation of unavailabilities of vital equipment and has an improved, user-friendly format. Since Spring 1994, this new version of technical specifications has been the subject of comprehensive training for operations department staff, and such training is planned to be completed prior to the next outage in 1995, when the new technical specifications will be implemented.

- (a) **Good practice:** The revised technical specifications that will be in force prior to the next outage in 1995 include unit fallback times for combinations of unavailabilities of vital equipment. The fallback times are based on the results of probabilistic safety assessments. In the event of simultaneous unavailability of vital equipment a decision tree guides the operators to easily determine the unit fallback time that results from the combination of two or more items of equipment being unavailable. This approach maintains the defence in-depth principle by prescribing more conservative limits for multiple unavailabilities.

Flamanville's normal operating procedures are of good quality and are well maintained and controlled. The preparation, verification and approval is carried out by authorized personnel. An effective system of review and revision is in place to support any, correction or upgrading that may be necessary. The majority of the procedures are

common to both Unit 1 and Unit 2, with a few procedures that apply specifically to each unit, taking into account the design changes that were not implemented simultaneously in both units. The requirement to obtain the approval of the safety authority before carrying out mid-loop operations, the quality of training given to operations staff and the comprehensiveness of the operating procedure is seen as a strength.

- (b) **Good performance:** There is a strong safety policy on mid-loop operations. All mid-loop operations must be reviewed and approved in advance by DSIN. Mid-loop operations before refuelling are only approved for special situations. In Flamanville, comprehensive training in mid-loop operation has been established based on an excellent teaching file. Control room operators are regularly trained in understanding the physical background for potential risks, such as residual heat removal degradation during reactor drainage and reactor cold shutdown operations. The operating procedure for mid-loop operations also provides the control room operator with an explanation of instrumentation and controls used during this phase, particularly during a reactor drainage sequence. Such a practice improves the ability of control room operators to better carry out all actions with a full understanding of the background of the physical processes during this phase.

The emergency operating procedures in Flamanville are event based with the exception of an overall procedure that is followed by the operations shift manager (or by the safety engineer when he arrives) which is a state oriented procedure. State oriented procedures (a term adopted by EdF) are similar in concept, scope and purpose to symptom-based procedures used in several NPPs worldwide. These two styles of procedure seem to be well set up together. If a critical safety function is detected by the state oriented procedure to be in jeopardy, a procedure of high priority will be followed to return the critical safety function to within the acceptable limits. New emergency operating procedures are being produced at the corporate level with completion due in 13 months. These will be state oriented procedures, presented in the form of flow charts, with sets of procedures for specific posts in the operation shift. The operations staff are already being trained on these new state oriented procedures. The new emergency operating procedures should provide the operations shift crews with a more comprehensive set of instructions to better cope with emergency conditions.

The temporary procedures in the control room are well maintained and appropriately controlled. There are about ten temporary procedures per unit and the criteria required by the quality manual and operations department administrative procedure for temporary procedures were met. They were issued in accordance with the required sequence of authorizations. Their period of enforcement can be extended up to six months with re-examination every two months. A weekly inspection verifies their validity.

3.4 Operating history

The plant operational history was observed to be good, with several indicators giving evidence that even better performance may be achieved. Examination of the reactor trip history of the previous three calendar years showed that the rate had stabilized at about one trip per unit per year, a rate that is comparable to international performance. However, there was a sharp increase in the number of Unit 2 reactor trips during 1994 that substantially affected plant performance and challenged the control, protection and safety of the plant. Two reactor trips were probably caused by an error in the design change implemented in the main generator exciter during the 1994 outage (the root causes of the reactor trips are still under analysis at the corporate level). Two other reactor trips occurred during startup within two days of each other, when the four steam generators had their level control in manual mode and might be partly attributed to operator error. In any case, a design change request was raised in 1987 to warn the operator of the proximity of the reactor trip condition by installing a low-low steam generator level alarm. Although this has been installed at all other 1300 MWe plants, it is programmed to be installed in the Flamanville units in the next two outages. Another reactor trip was caused by a turbine trip. Even though, at Flamanville, there is a steam dump system capable of sustaining 85 % of reactor load, a turbine trip leads automatically to a reactor trip from the turbine trip. Since 1990 there has been a design change request to disconnect the reactor trip. At the corporate level it is planned to implement the change together with a batch of other design changes during the outages of 1996 [see suggestion 5.4(1)]. The number of trips is high and no strategy exists on-site to review the events as a group as a step towards reducing the number of trips. Such a review is due to be carried out at the corporate level but the above experience suggest that implementation of corrective measures would take a long time.

- (1) **Recommendation:** A strategy to carry out timely on-site reviews of groups of events should be developed as a step towards reducing the number of trips. Such reviews should include an analysis of reasons why some events happened more than once. The strategy could include actions such as: being proactive in ensuring that corporate organizations expedite the implementation of design changes that contribute to reactor performance and safety [see also recommendation 5.4(1)] and the need to include certain plant operations in the simulator training programme [see also suggestion 2.3(1)]. Prevention of reactor trips will minimize challenges of the plant safety functions.

Plant response: (May 1996) *The site is involved in a voluntary approach to reducing the number of reactor trips (AAR). A technical memorandum, which will be updated each year, has been written jointly by operations and maintenance departments. This memorandum:*

- *gives the numbers of trips occurring over the last five years: the causes of each trip, associated analysis and experience feedback documents,*

- *compares the number of on-site trips with number of trips at the other 1300 MW plants,*
- *classifies reactor trips by family,*
- *describes past strategies: follows-up implemented corrective or preventive actions,*
- *establishes a developmental perspective on the number of trips,*
- *offers a medium- and long-term strategy concerning experience feedback, modifications, actions taken and actions to be taken, in an effort to reduce the number of reactor trips.*

This strategy has been implemented through an action plan approved by the operations and maintenance departments, on the one hand, and the operations technical committee on the other. The target set for the year 2000 is one reactor trip per unit per year.

Whenever a reactor trip takes place, the operations engineering section checks to see if the trip is dealt with in this technical memorandum and covered by the action plan.

IAEA comment on status: *(June 1996) Although the plant took early action to meet the requirements of the suggestion, the number of unit trips increased significantly in 1996: Unit 1 had six trips, and Unit 2 had two trips. At the national level, the number of unit trips has also increased in 1996. Three of the six trips on Unit 1 were caused by a form of seaweed not previously experienced by EdF coastal plants that clogged the cooling water pump intake strainers.*

The plant should continue to pursue and reinforce its strategy because an improvement in performance will only come about as a consequence of a well implemented strategy to reduce reactor trips.

Conclusion: *Issue resolved.*

3.5 Conduct of operations

The layout of panels in the control room, and computer driven visual display units (VDUS) provides the operator with sufficient information in a logical manner to support safe and reliable operation. All the necessary documentation such as drawings, normal and emergency procedures are adequately stored, regularly updated, controlled and easily accessible. Emergency operating procedures are maintained in sealed plastic envelopes in order to ensure their completeness, and an extra copy for training purposes is also available at the control room. The emergency operating procedures are mainly implemented in response to alarms, that is, an event based approach. The layout of alarm windows using a colour coded hierarchy is appropriately designed and provides easy orientation for the operators to apply the appropriate emergency procedures.

Shift turnovers observed at the plant were carried out in a professional manner. Outgoing operators inform their respective counterparts of the incoming shift of the status of the unit and of all deviations that occurred during the previous shift using shift logbooks. Together they inspect all panels in the control room. Nevertheless, the active alarms were not recorded even in the control room logbook and the field operators' turnover was not performed in their room, nor in the field. Although the turnover procedure covers the most significant aspects, lack of tracking of important alarms and a failure to tour the field could lead the incoming shift to make decisions without being aware of a specific equipment history.

- (1) **Suggestion:** Consideration should be given to including in the shift turnover procedure the need to record and discuss the active alarms in the control room and to establish an exchange of information between field operators in the field where the deficiencies or abnormalities that could affect nuclear safety can be visited. This would provide the incoming shift with better information that should enable them to carry out their functions appropriately.

Plant response: (May 1996)

Control room alarms: The organizational memorandum dealing with shift turnover, stipulates that the operators must make a complete 'block inspection' together. In terms of operator professionalism, it is perfectly clear that an exchange of information on the alarms present and the important alarms that have disappeared during the shift, is an integral part of this block inspection. Nonetheless, actions will be carried out in order to reinforce this point..

- *A standard leaflet on the expected block inspection results will be integrated into the organizational document (beginning of May 1996).*
- *This leaflet will be explained to the operators (sometime in May) by the operations shift managers.*

Moreover, major consideration of control room alarms during normal operation, headed by a department operator will lead to:

- *Use of a real time system of sorting alarms by family (inadvertent due to poor design quality, actually anomaly related, planned due to maintenance actions, etc.), thus providing 'custom' processing for each alarm. This sorting system will be implemented on an experimental basis starting mid-May 1996; in both control rooms.*
- *Creation of a management system to facilitate information monitoring and transmission (with the operators responsible for management). After validation,*

this system will be implemented as soon as implementation of the organization has begun.

- *The technical supervisors will be responsible for inspecting the device (operational inspection) and inspecting the management systems. Operational inspection is part of the technical supervisors' professionalism. The management inspection will be seconded by a weekly inspection procedure (July 1996).*

Field Information: *An overall consideration of the terms of reference and the professionalism of the field operators has been carried out in the department since the end of 1995. This consideration takes into account shift turnover, analysis and transmission of information. Nonetheless, occasional actions may contribute to enhanced knowledge about malfunctions and anomalies in the field.*

- *Field shift logs have been kept since 1993 but the quality of required information is random and insufficient. Field operators are reminded on this point in an effort to give meaning to these logs and to instill the desired degree of accountability. In this regard, new logs, more complete and more accountability inducing have been used experimentally since the first half of April 1996.*
- *Implementation of an organization designed to describe (physically) any malfunction or anomalies locally [see 3.5 (2)] will serve to formalize and ensure a high level of information. After five months of debugging, this organization will be implemented at the end of April 1996.*

IAEA response: *(June 1996) A provisional procedure for shift turnover has been prepared, taking into consideration shift operators' suggestions and the results of a preliminary application of the draft document. It covers those aspects important to shift turnover. In addition, a strategy to reduce the alarms in the plant has been established, which includes design changes and temporary modifications. A computerized system, using the SYGMA system, has been developed which gives the status of the plant alarms to the operator. This information is used during the operators' shift turnover. Operations management should expedite the approval and implementation of the final version of procedures so that the above improvements can be implemented as soon as possible.*

Conclusion: *Satisfactory progress to date,*

The operations shift manager reviews both control rooms and operational status by, using the plant safety assessment sheet, a guide that lists safety functions and related equipment as well as limiting conditions for operations.

The controlled area was found to be well maintained. The corridors and rooms were clean. The radiation levels were clearly displayed on signs posted throughout the area. Room and equipment labelling was clear and well identified, including colour

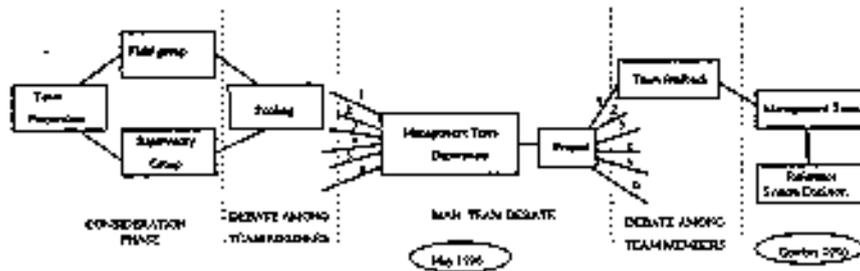
identification for each safeguard train. Particular attention had been paid to the suitable location of fire evacuation plans and fire extinguishers. In a few places leaks and unauthorized handwritten identification were observed that were not consistent with the overall controlled area status. Several anomalies were also found in the turbine buildings of both units indicating that operators did not always pay enough attention to detail and that managers and supervisors did not always take the time to observe activities. The latter issue is discussed in more detail in sections 1.2, 3.1 and 4.6. The shortcomings included: lubricating oil leaks that were not appropriately reported, isolated and identified (the oil in question was hazardous to health); several unauthorized handwritten mimic panel updates; unauthorized handwritten component identification applied for maintenance convenience by the use of tape, and other sorts of tags as well as writing on the equipment itself; labels missing from valves and equipment; a few uncontrolled temporary installations; equipment deficiencies that were not reported; and some areas where the cleanliness needed improvement.

- (2) **Suggestion:** Consideration should be given to eliminating the shortcomings in reporting plant defects, labelling, control of temporary installations and plant cleanliness. This could be achieved by better instructing operators to report deficiencies and follow up the required action in order to improve the field conditions such as industrial safety, plant equipment labelling and housekeeping, to eliminate the practice of unauthorized handwritten aids and the installation of unauthorized and uncontrolled temporary installations. Such measures would improve the operating status of the plant, reduce operator error and help to maintain good attitude towards housekeeping, among plant personnel while pursuing excellence in operations.

***Plant response:** (May, 1996) As part of the drive towards a general improvement in the quality of operations carried out by the operations department, an major approach involving a clarification of roles and terms of reference of operations department employees has been undertaken. This approach is put into practice through a complete, in-depth consideration of the field operator's job definition and all expected contributions. A sense of propriety, anomaly detection and analysis are key points explained in the list of specifications for this consideration phase, which will last 18 months before implementation.*

The profiles, skills and qualifications will be redefined during the approach, in addition to those actions required for skill acquisition and maintenance (training, evaluation, etc.)

Carried out in a very participatory manner, the study will take place according to the following timetable:



In order to prepare for this consideration phase, a research guide has been developed by the Management Team, the main data of which are as follows:

- *Which job in the field ?*
 - *Goals and objectives*
 - *Sense of propriety*
- *Fields of activity?*
 - *Role, responsibility, detection enhancement*
 - *Role, responsibility for troubleshooting (technique, detection, risk analysis)*
 - *Contribution to preparation, as assistance to the Preparation Technical Supervisor or as individual preparation*
 - *Role in Operations/Maintenance Relations*
 - *Role, responsibility in equipment surveillance*
 - *Relays of the Technical Supervisor and Engineering*
 - *Integration of the Operational Analysis system*
 - *Which new activities?*
- *A single job or several?*
 - *How many jobs?*
 - *If more than one, what is the job breakdown? advantages, disadvantages*
 - *Sequence of activities - Positioning.*
- *Management*
 - *Reconsideration of employees, perception*
 - *Required field of competence*

- *What are the objectives?*
 - *Evaluation by the operators, recognition, criteria*
 - *Degree of freedom, autonomy and delegation.*
- *Career path*
 - *Enhancement of performance, know-how and behaviour*
 - *Moving into the BLOCK*
 - *Follow-up and formalization.*

Without waiting for the results of this far-reaching action, three areas are benefiting from the implementation of specific organizations:

- *local identification (by affixing a label) of malfunctions and anomalies, in parallel with the detection and processing system, with final inspection after processing. Implementation by the end of April 1996.*
- *clarification of the current organization for processing deviations or failure to identify, thus making temporary identification more rigorous. Operational since autumn 1995.*
- *local identification of specific temporary devices and measures (DMP) and their traceability. Implementation by May 1996.*

IAEA comment on status: *(June 1996) The implementation of the above actions is scheduled to be completed before the end of 1996. It includes the issue of the final corresponding administrative procedures.*

Several of these actions have already been implemented, with good results in the plant, such as better records, better identification and control of plant defects and temporary installations. The implementation of these actions is contributing to the enhancement of the operators' sense of ownership and to improving the operational status of the plant.

Conclusion: *Satisfactory progress to date.*

Flamanville NPP has a policy on restarting the plant following a reactor trip. Authorization for startup is subject to identification of the cause of the trip and to the agreement of both operations shift manager and safety engineer. An independent procedure is implemented by the safety engineer in order to confirm the reactivity balance by using a different technique than that used by the shift team. Such an approach significantly reduces the potential risk of unexpected criticality during plant startup.

3.6 Work authorization

The plant work processing and authorization system in Flamanville is described well in administrative procedures and is controlled by the operations department. The work control (SYGMA) and tagging (AIC) computer systems are powerful tools used to support this control and to keep records of the process.

An administrative lockout system is implemented in Flamanville which ensures that safety related equipment is properly maintained in its designated position.

- (a) **Good performance:** The administrative lockout system for safety related equipment at Flamanville is an important tool in ensuring availability of safety related equipment under all operating conditions. Equipment is grouped according to coded safety functions and is identified by a system of padlocks and hard plastic orange tags, displaying the safety related code. The purpose is to keep the alignments that are required to fulfill the safety functions. The computerized tagging system (AIC) manages the administrative lockout system for safety equipment. Any work request that could affect the alignment of locked out safety related equipment is subject to specific authorization. In the tagging office, a special board displays the status of the above mentioned alignments including the equipment status sheet for each safety function. The system enables operators to quickly check that safety related components are correctly aligned in accordance with their safety functions. Periodic inspections of both documentation and equipment in the field are performed by control room staff and safety engineers.

There are three ways of processing temporary modifications at the plant and each process includes request, approval, implementation and control phases.

- Jumpers and lifted leads are regulated by an administrative procedure under the responsibility of the I&C and electrical department. These are only reported to the operations department if requested initially by operations.
- Mechanical and electrical cable temporary modifications (DMP) relating to nuclear safety, industrial safety and unit availability are managed by an administrative procedure which requires maintenance staff to perform risk analysis. The assistance of an operations safety engineer in this analysis is optional, and the installations will only be reported to the operations department if requested initially by operations.
- Other temporary installations are processed through the normal work control system.

No system is in force that identifies an installed temporary modification in the field, although a procedure has been developed but not yet applied. The review of the

documentation in the control room revealed that temporary modifications actually installed in the plant were not controlled by the operations department. Some temporary installations, although not affecting safety, were found to be neither controlled, identified nor approved by the operations department, such as electrical cables, drain hoses, and test equipment connected to a process system in service.

- (1) **Recommendation:** The administrative procedures for all types of temporary modifications (not only DMPS) in the plant should be reviewed to ensure that all proposed temporary installations are analysed by qualified people (such as safety engineers if affecting nuclear safety), that they are approved by the operations department, that they are clearly identified so that shift staff can easily identify all temporary installations and that control room staff have sufficient information to control and be aware of the status of all temporary modifications. Consideration should be given to limiting the time for such installation and to performing periodic audits. This should ensure that temporary installations do not erode the operating safety margins and that the control room staff are able to control and assess these installations at all times.

Plant response: (May 1996) *A multi-speciality working group initiator, installer, operator has been assembled to redefine each person's responsibility in the field of temporary modifications (MTI) on an installation. The work of this group has led to the definition of a number of additions to the current organization of work, based on a prior risk analysis and the definition of measures so that the identified risks can be taken into account. These additions to way of processing modifications concern:*

- *the validation of risk analyses*
- *their approval by the operator*
- *operator information on the MTIs currently on an operating installation,*
- *the duration limitation and periodic checking of how well founded the existence of MTIs is.*

The memorandum concerning provisions and specific resources has been modified so as to include these additions.

This improvement in the way modifications are processed was implemented through a training programme which comprised:

- *hierarchical information in the various departments*
 - *accompanying training through refresher courses for maintenance department work*
- co-ordinators and technical inspectors, given before outages.*
- *specific training to the operations teams based on the revised memorandum.*

IAEA comment on status: (June 1996) *The new procedure that regulates the analysis, implementation and control of temporary modifications in the plant is still provisional: some aspects should be reconsidered. This review could include:*

- *the length of time a temporary modification can remain in force should be subject to a limit. Extension beyond this limit should be subject to a re-analysis of the modification the scope of which should be similar to the original analysis that allowed the modification to be installed,*
- *the periodic review of all temporary modifications installed in the plant should be formalized. At present, the operations department informally carries out a weekly review of such installations.*

Conclusion: *Satisfactory progress to date.*

All plant staff are expected to report equipment defects found in the plant, using the SYGMA system that manages the work authorization. In a multi-disciplinary meeting held every morning, priority is given to each work request which is then conveyed to the planning group.

The post maintenance testing is determined by operations engineering personnel and agreed upon with the maintenance representatives at the daily afternoon meeting where planned work is discussed. Following work on safety related equipment, components are tested. After successful component testing, a system test is performed. To determine what system criteria must be verified by testing and to select the proper test procedure, a set of requalification criteria sheets has been developed. Excellent requalification criteria sheets have been developed for half of the safety related equipment at Flamenville. The remaining safety related criteria sheets are expected to be completed by the end of 1995.

- (b) **Good practice:** The development and use of requalification criteria for post maintenance testing of safety related equipment is very effective in ensuring that the correct safety characteristics are identified and verified in accordance with the appropriate procedures. Requalification criteria sheets have been prepared for more than 30 types of equipment. The sheets contain information on:
- acceptance criteria;
 - outage conditions, that are required for the test;
 - reference to the commissioning start-up procedure that was used to test the equipment in question;
 - reference to the post maintenance test procedure; and
 - department in charge of the test.

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

3.7 Accident Management

In the event of an emergency in one unit, the local operations emergency centre (PCL) is in the control room of the affected unit. If the emergency is common to both Units 1 and 2, the control room of Unit 1 is the PCL. Immediately after the implementation of the emergency plan, the head of the PCL (PCL 1) is the action technical supervisor; the planning technical supervisor becomes the acting technical supervisor for the unit under normal operation. The operations shift manager follows the operational emergency procedures until the safety engineer arrives to take over these procedures, and the operations shift manager then takes over the PCL 1 function. The shift team and the safety engineer report to the head of the PCL (the operations shift manager). The shift team is sufficiently staffed to allow enough flexibility to manage one unit in operation and one unit under emergency. Moreover PCL 1 is supported by five people. The means available for the shift crew are well maintained and accessible, but it was observed that no dosimeters were available in the control room (see section 8.3).

Strong local and national technical and logistic support systems have been set up to assist the plant in coping with emergency situations.

- (a) **Good performance:** The support provided to the operational shift during emergencies is well structured. At national level, the corporate structure and the vendors have built up a strong capacity for carrying out calculations, simulations and assessments as well as providing technical and logistic support. On-site, multi-disciplinary centres are set up to provide assistance in all matters relating to incidents. This support is organized by a network of teams and centres connected by an effective multichannel communication system.

Equipment such as pumps, piping and instruments are available at Flamanville or on other sites to cope with beyond accident conditions.

- (b) **Good performance:** Several facilities are available at Flamanville to cope with accidents that were not considered in the initial design of the plant, such as alternative safety injection pump, piping and valves. At the national level, several other facilities are located at different sites in the country. They are not required to be used in the first stages of an emergency and the plant can wait until the facilities arrive. Such facilities include hydrogen recombiners. The equipment is subject to periodic surveillance, inspection and testing. Its use is prescribed in the operational emergency procedures followed by the local operations emergency centre (PCL), and it would be installed by technical support teams made available during an emergency. All equipment, installation tools, manpower, responsibilities and related surveillance and installation procedures are described in an administrative procedure.

The content of initial and continuous training programme for emergency planning and preparedness in the operations department is comprehensive, but the length and frequency of refresher courses (two hours every three years) does not seem to be sufficient. Several drills are performed each year that help operations staff to maintain their skills. Periodic drills and exercises are performed at national and site level. An operations shift team uses the Paluel full-scope simulator for each national level exercise. The team performs the planned scenarios on the simulator or in the site control room. This makes the exercise more realistic and does not disturb operation at the site.

3.8 Fire Protection Programme

EdF has developed and implemented a fire protection programme for all NPPs based on the national fire protection policy. This programme has established three main objectives: to protect personnel; to guarantee operability of safety functions; and to limit equipment damage that might result in a lengthy outage. These objectives are implemented in the plant design and policy. The fire protection programme is currently being revised.

A well established fire protection programme was found to exist at Flamanville NPP. A fire supervisor has the overall responsibility for its implementation, verification and training of fire fighting teams on site. Because the plant does not have its own fire brigade on site (a local fire brigade comes to Flamanville), on-site fire fighting teams are formed from among the shift teams. The teams are well equipped with fire protective gear including self contained breathing apparatus. Every month a fire fighting drill is carried out at the plant and once a year another fire fighting drill is carried out together with the assistance of the local fire brigade.

The control room is the centre of the fire alarm response. A control panel of the automatic fire survey system monitors electrical cabinets, rooms and corridors in the plant. A comprehensive set of fire action plans that provides the operators with all necessary information on fire zones is available at the control room and in each fire zone. In the event of fire, the operator applies the procedure, calls the local fire brigade and sends the shift fire fighting team to the affected site.

The fire action plans were found to be complete and well located. Extinguishers are labelled with the date of the last inspection and are easily accessible in corridors and electrical cabinets. The emergency exits are properly indicated on the walls. However, there were no arrows on the floors to help orientation of personnel in an emergency.

The OSART team reviewed one of the regular site fire fighting drill at Unit 1. The time response of the team to the fire alarm was appropriate and its performance was excellent.

4. MAINTENANCE

The maintenance activities at Flamanville NPP are performed by several departments in the plant: the instrumentation and control, electrical and data processing department (AEI); the mechanical department (TX); the joint structure; and the corporate groups of EdF. These activities are based on a team effort between the staff of the two units and the corporate organizations.

The maintenance programme covers the functions and tasks of plant maintenance with respect to checks, tests, inspections and overhauls with the object of achieving an economic and optimized level of safety and availability. The maintenance programme has the objectives for implementation during operation and outage. The responsibilities of the different groups and the maintenance staff are clearly defined in written procedures. Plant operation and management policies are a good contribution to plant safety and availability. In this respect the Quality Safety Plan applied by maintenance personnel during work coordination meetings, detailed work procedures, job file preparation and work implementation for each activity is a good example of safety culture.

The overall condition of plant equipment and systems is generally good, but some suggestions for improvement were offered during plant tours. Storage areas, workshops and document archives were found to be in order. Corrective, preventive and predictive maintenance programmes are well defined and established by the use of a computerized maintenance management system.

All maintenance activities were found to be well controlled. Maintenance managers systematically check reports, outage summaries, maintenance indicators and event reports to verify that the maintenance programme is applied in an efficient manner.

The outage planning process, outage programme implementation and outage follow-up are very well defined. The in-service inspection (ISI) programme is very well supported and organized and all inspections are performed by qualified personnel.

The effort of the staff is evident and reflected by the equipment and plant availability and working conditions. These in turn reflect a well managed maintenance operation and a strong safety culture but a challenge to plant staff exists for devising an effective system for defect tagging of leaks.

The maintenance department continues to develop its activities in an efficient and well controlled manner.

The improved interface with the operations department is noted. Development of better performance indicators in the topics of preventive maintenance and maintenance

performance is on track and takes into consideration the experience from other nuclear installations.

Since February 1995, Flamanville has committed itself to the reliability centred maintenance approach which is being introduced system by system.

4.1 Organization and Functions

Maintenance responsibilities are shared at the corporate level between departments within the corporate resources division (MCP). The division of responsibilities is well defined and organized. Most of the corporate support is provided during outages or when there is a persistent problem. Specific corporate staff are assigned to Flamanville to assist in resolving problems in accordance with an established system of equipment priorities; this system appears to function adequately.

The corporate nuclear maintenance department (DM) reports to the senior vice-president of MCP for the development of policies and the basic preventive maintenance programme. DM proposes a maintenance strategy that, in compliance with technical specifications, aims to minimize corrective maintenance during normal operation while at all times ensuring that safety margins and availability targets are met. DM prepares the preventive maintenance programme for the plant's main systems taking into account information from manufacturers, experience feedback, regulations and costs.

The corporate chemical and metallurgical laboratories group (GDL), which is a group within MCP, provides assistance for maintenance activities including non-destructive examinations (NDE) and metallurgical analyses. Life time extension studies, up to 40 years, have been started for EdF NPPS, mainly steam generators. As yet, this is not a critical project since the oldest plants are about 20 years old.

The maintenance activities at Flamanville NPP are performed by several departments in the plant: the I&C electrical and data processing, the mechanical department, the joint structure and in the corporate group of EdF. These activities are based on a team effort between the staff of the two units and the corporate organization.

The site maintenance group comprising TX and AEI follows the maintenance policy for the equipment, which determines what should be done and when. It is the 'owner' of the equipment who makes the decision to undertake the maintenance work. It is the plant director's responsibility to delegate ownership between the operations and the maintenance departments. The 'owner' is responsible for the safety of the equipment under its control.

The interface between maintenance and operations is based on the plant policy of responsibility and professionalism. In accordance with this policy, operations staff

maintain a high level of confidence in actions of maintenance staff. In carrying out work requests, the maintenance departments routinely follow the priorities assigned by the operations department and so keeping as close to the weekly work schedule as possible.

Maintenance personnel at Flamanville NPP are well qualified. Each group within the maintenance departments has technical support engineers, some of whom have operating experience and others who have experience in the corporate organization. Workers have a good level of qualification and several years of experience at Flamanville. In addition, the training programme for maintenance personnel has helped instill a homogenous understanding between all maintenance staff with respect to the importance of a disciplined approach, including adherence to procedures.

4.2 Maintenance Facilities and Equipment

The cold and hot workshops are well organized, clean and have sufficient space. Both are properly equipped and prepared to host the contractors who, during outages, represent a significant workforce. There are good arrangements in the mechanical hot workshop for tool storage. The system is maintained by a contractor and this has resulted in good tool control in the radiation area as well as reduction of excessive tool decontamination work. Tool control in the cold and hot areas is maintained by a computerized bar code system, integrated with the personal badge. The system allows a plant worker or contractor to withdraw a tool easily while maintaining good tool control. Measurement and test equipments are controlled following the same principle. An additional feature of this system is that the calibration date is also controlled, which helps to avoid instruments being used out of their calibration periods. This system at Flamanville is reliable and commendable.

Flamanville NPP has installed an excellent computer network in all offices, workshops and control rooms. The computerized maintenance programme is available to all maintenance and operations personnel. The system is also connected to the corporate organization of EdF. This equipment is useful for planning, scheduling and optimizing human resources and feedback application.

Many support devices and tools are available to reduce individual and collective radiation exposure. Examples of such special equipment are the steam generator manhole stud tensioner, the reactor pressure vessel stud tensioner and the full sized lower part steam generator mock-up training facility. The corporate technical support group (UTO) is responsible for design and development of special tools required to support plant activities.

- (a) **Good performance:** The support given by the corporate technical support group, UTO, in the design and procurement of special tools is effective in facilitating maintenance activities, reducing the duration of work and reducing personnel

radiation doses. The efficient manner in which requests are responded to and the quality of the tools provided encourage maintenance staff to seek better ways of carrying out their work. Requests from plants are studied by UTO for feasibility and application bearing in mind dose reduction, cost benefit, etc., because it represents a combined effort to optimize maintenance in terms of safety, dose reduction and cost effectiveness.

4.3 Maintenance Programmes

The Flamanville preventive maintenance programme is developed by the corporate maintenance department based on information from manufacturers, material specifications, maintenance doctrines, probabilistic safety assessment (PSA) and experience feedback from the performance of similar equipment in other French NPPs. The preventive maintenance programme is based on two principles: planned maintenance, which is carried out in accordance with an established timescale (hours, weeks, outages); and condition based maintenance, which is carried out when a given threshold of significant degradation has occurred (bearing temperature, vibration condition and oil analysis). The preventive maintenance programme includes planned refurbishment or eventual replacement. At Flamanville NPP the preventive maintenance policy of the equipment is applied to main components (safety or availability related) and is established by equipment family or by a single piece of equipment. The policy contains justification of the maintenance work to be done taking into account possible failure modes induced by operating regimes, failure consequences (nuclear safety and availability), analysis of maintenance costs, cost of failures and the requirements for in-service inspection. Risk analysis is also included in this policy. The preventive maintenance programme is computerized and is part of the maintenance management (SYGMA) system. The Flamanville TX and AEI departments are responsible for planning, scheduling and implementation of the preventive maintenance programme during normal operation. During outages, contractors carry out programmed activities.

A review of the maintenance performance indicators used at Flamanville NPP indicated that more should be tracked. An assessment of the preventive maintenance programme indicators, such as maintenance performance, scrams and equipment incidents does not provide enough information to confirm the effectiveness of the programme. The indicators used to monitor maintenance performance were insufficient to see clearly the projection of the present maintenance policy into the near future, or for example, that a higher proportion of corrective actions arises in I&C. The OSART follow-up visit should investigate what improvements will have been made with respect to maintenance performance indicators.

As per the commitments made by all French NPPs, Flamanville has committed itself to the reliability, centred maintenance approach by, carrying out an initial study on the boron recycle system (TEP) on the 1300 MW series, and primary, effluent processing.

This study began on 9 November 1995 and finished in March 1996. A 16 member multi-speciality team participated in this study. A second study will take place as of November 1996 and will deal with the feedwater flow control system (ARE) of the 1300 MW series.

The predictive maintenance programme at Flamanville NPP is similar to good international practice and appears to be working satisfactorily. The programme is designed to avoid safety related equipment failure by first predicting its occurrence in the absence of maintenance and then carrying out preventive maintenance prior to failure hence minimizing equipment unavailability for safety related equipment. The predictive maintenance programme at Flamanville NPP basically consists of analysis of information of the condition of equipment that is revealed during maintenance and by analysing the results of surveillance tests, preventive maintenance, in-service inspection and by thermography.

Flamanville NPP is moving towards reliability centred maintenance (OEM). It is normally the practice that an intention to reduce preventive maintenance is supported by a strengthening of predictive maintenance. Flamanville NPP is trying to implement this policy in accordance with the OEM process. However, additional emphasis will be necessary to meet this intent. The OSART follow-up visit may care to check the progress.

The maintenance indicators have been completely reworked. The improvements concerned the following points:

- *SYGMA computer applications..*
 - *creation of a list of specifications for the indicators and of the associated performance indicators;*
 - *utilization of data culled from the work requests (DI) and work orders (OI);*
 - *automatic extraction of data and performance indicators.*
- *Organization*
 - *utilization of indicators by the instrumentation control electrical data processing department, technical environmental department and the mechanical department;*
 - *designation, in each department, of a counterpart responsible for distributing and monitoring indicators;*
 - *re-organization and limitation of the number of portfolios in the instrumentation, control, electrical data processing department, technical environmental department and the mechanical department;*
 - *definition of qualitative and quantitative criteria associated with the indicators.*

Corrective maintenance activities at Flamanville NPP are initiated by a work request using the SYGMA system. Work to be carried out is discussed at the daily,

morning meeting attended by representatives from the operations and maintenance departments as well as radiological protection and chemistry. Diagnosis is carried out and the priority for each task is decided by the operations department. The whole process is well structured and systematic, and permits a good control and follow-up.

Corrective maintenance work is performed using a well organized job file, which is fed back to the planners whenever there is a need for in-depth analysis and root causes. If so, the corporate maintenance department searches for similar events at other French NPPs using the SAPHIR computer system. This SAPHIR system is continually updated, with maintenance history and plant events and so provides a good feedback of experience.

4.4 Procedures, Records and Histories

Flamanville NPP has a comprehensive computerized maintenance management system (SYGMA), which is used in all maintenance activities from defect reporting and work request to work completion. SYGMA relies on three databases: the equipment database; the spare parts technical file; and the procedures database (BMO), which contains standard work sheets, standard work orders and standard tagging requests. The possibility to create standard work orders enables rapid and reliable definition of resources needed for the job. This system is very effective and therefore well accepted by all personnel. Maintenance procedures can be developed and updated by editors, who have been accredited by a department manager. The procedure is checked by the editors' supervisor before it is approved by the department manager.

Maintenance records are generated when a job file is opened with a work request or a work order. Job files for safety related equipment are treated most carefully at Flamanville NPP. All records are maintained in a comprehensive file which describes all the activities that are required to meet high standards.

- (a) **Good performance:** The control of maintenance records is effectively organized. Files of maintenance records meet the safety standards according to French regulations. Paper files and microfilms in the archives are referenced in the computer system SYGMA, which is connected to the corporate organization. The paper records contain all information such as: general data related to the work request; fault analyses, records, special qualification of parts or materials, operating problem summaries, monitoring and modification.

4.5 Conduct and Control of Maintenance Activities

Maintenance activities at Flamanville NPP are executed to high standards of quality. A thorough risk analysis is carried out before troubleshooting and before carrying out corrective maintenance. Qualified maintenance personnel carry out their

work in a professional manner according to approved work procedures. Foremen maintain effective assistance and supervision.

- (a) **Good practice:** An exhaustive risk analysis is carried out before starting corrective maintenance. This requirement is considered to be a good practice, particularly as it includes the need for a risk analysis before commencing trouble-shooting activities. The quality plan (PDQ) requires:

Analysis of the work conditions: Unit status, equipment status, equipment required, technical specification application, duration.

Technical risk due to the activity: Foreign material exclusion, use of specific tools, risk of spare parts errors, source of electrical supply, safeguard protection, loss of equipment protection regulation, control rod dropping, cable snapping, other risks.

Analysis of external risks: Protection against rain or frost, start and stop of redundant equipment, jumpers and lifted leads, dilution, containment rupture, other risks.

Analysis of interfaces risks: Change of tagging (wrong alignment), workers co-ordination, incomplete maintenance test.

Analysis of the reconfiguration after post-maintenance test: Precaution when placing the equipment back in service, such as, jumper and lifted leads, alignment, sensors, check list.

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

The maintenance work control system at the plant is computerized and all maintenance activities are controlled by the SYGMA system. When a deficiency is observed, any member of the plant staff can issue a work request, which, after being approved by the supervisor, is proposed and discussed at the daily morning meeting and operations assign priorities. After the meeting the TX and AEI foremen ensure that the work order is checked. After preparation, inspection and analysis, a job file is prepared which includes all the documents necessary to carry out the work such as work procedures, work sheets, spares parts lists, equipment isolation requirements, drawings and radiological protection measures.

Once the job file is completed, the work order is scheduled. The same activities are carried out on preventive maintenance work orders and during outage preparation so that all job files are complete to ensure quality and efficient work.

4.6 Material Condition

The material condition and plant housekeeping are generally good. However, there were leaks from some pipe systems and there were other equipment deficiencies some of which were not reported via the SYGMA system. This issue has been discussed already in sections 1.2 and 3.5.

During the review a wiring anomaly was discovered in a KRT back panel in the control room of Unit 1. Leads were seen to be disconnected and a long lead having the appearance of a jumper was in place without any indication as to why or when it was applied. The expert and the counterparts were convinced that it was a case of *uncontrolled* lifted leads and jumper, which was 'confirmed' when no records could be found. Further investigation, however, showed the 'lifted leads' to have been leads that had not been correctly terminated since construction and that the 'jumper' should have been a short lead joining two adjacent terminals. Staff failed to identify a long standing wiring anomaly that had all the appearance of a case of uncontrolled lifted leads and jumper. When coupled to suggestion 3.5(2) with respect to reporting deficiencies and to recommendation 3.6(1) with respect to temporary modifications, it is of concern that staff were unaware of the long standing wiring anomaly in the panel; it should be a natural part of everyone's work to be observant, to identify anomalies and to report them so that they can be followed up.

- (1) **Suggestion:** Consideration should be given to setting up a programme to ensure that staff, in particular operations and maintenance staff, understand their responsibilities to be observant, to identify and report anomalies that they encounter. Training should be given as necessary. This measure would help prevent potential risks of inhibition of a safety function that might occur after maintenance work or after temporary modifications installation and removal by the timely detection of any abnormalities.

Plant response: (May 1996) Site organization was developed around the considerations of a transverse working group comprising representatives from the operations department, and the various maintenance departments and formalized in a memorandum. This memorandum defines the responsibilities of each employee during the phases of observation, detection, identification and signalling of anomalies as well as the procedures implemented. Identification of apparent discrepancies is done by additional specific labelling which provides a link to the work request. The implementation of this organizational improvement, based on the practices of Diablo Canyon NPP (USA), is dealt with in a training programme that comprises:

- *hierarchical information in the various departments*
- *continuing training through refresher courses for maintenance department work co-ordinators*

- *specific training in the operations teams based on the organizational memorandum.*

IAEA comment on status: (June 1996) *The following have contributed to the accomplishment of the requirements of the suggestion:*

- *revision of the procedures for identification of defective plant and temporary installations, including the corresponding tagging systems,*
- *improvements of the maintenance training programme,*
- *improvements of interfaces between departments, particularly between the maintenance and operations departments.*

Conclusion: *Issue resolved.*

4.7 In-service Inspection

The basis for in-service inspection (ISI) at Flamanville NPP is a set of rules for monitoring mechanical equipment during operation of the nuclear steam supply system (RSEM). This document was issued by EDF-UTO-GDL in 1990. The components are classified in accordance with these rules and monitored by non-destructive (NDE) methods, at periods in accordance with the safety class of the equipment. The programme calls for a ten year period to complete all inspections of all components in the programme. In addition, before and during commissioning, the equipment baseline measurements (pre-service inspection), were recorded and stored in order to compare them with results from subsequent inspections. The areas to be inspected, the type of inspection and periodicity are defined and presented by EDF-GDL for negotiation to the safety authorities. GDL is the mechanical maintenance contractor for these activities, but the Flamanville plant is responsible for the execution of the programme. Test acceptance criteria are approved by the safety authority. The system is well established without weaknesses.

- (a) **Good performance:** Special emphasis is given to the in-service inspection programme. This is strongly supported by the corporate laboratories group (GDL) which provides support to all French NPPs. Based on the wide experience accumulated, GDL has developed this programme with high quality standards.

The testing methods used for the ISI programme at Flamanville NPP are well established by GDL and compare favourably with international practice. GDL has shown itself to be highly qualified in this field and it was observed that ISI work is given appropriate attention. Measurement and test equipment, the tools and material laboratory at the site are of a high standard and well organized. ISI documentation and records are well stored and structured in an easily retrievable manner. A computer support program exists and is useful in quickly identifying all the indications that had been found and the reference to the file number showing the type of test carried out. There is a practical and professional level of visibility for using records. The on-site ISI archives containing

original radiographs are stored in a room equipped with a fire detection system. Any indication shown during the NDE is analysed and the documentation is updated so that behaviour of each indication can be followed.

4.8 Spares and Warehouses

The corporate organization, UTO, has established the material and spare parts procurement organization for Flamanville NPP. UTO procures all the equipment and parts subject to specifications (technical requirements and quality assurance). UTO is responsible for parts managed nationally, especially category 1 parts (specification and control of manufacture by EdF). At Flamanville NPP, planning staff are responsible for technical control and for defining safety stock levels. The purchasing section place orders and ensures they are obtained on time. Warehouse personnel are responsible for storage, packing, preservation, monitoring shelf life, documentation and maintaining stock levels. Material not subject to specification is purchased by the plant based on UTO general procedures and instructions.

- (a) **Good performance:** All the steps involved in the procurement and supply of spare parts are very well defined and structured to give this service not only to the Flamanville NPP but also to the other French NPPs. This gives Flamanville NPP good availability of spare parts, because of an interlink between all warehouses of other French sites. When a spare part is not available in the local warehouse, the national warehouse database is available to search for it. This interlink of all spare parts and material gives maximum flexibility and support to Flamanville NPP.

The storage of spare parts in the warehouse is well organized and adequately controlled. The area is very clean and there is generous space between the shelves to allow lifting equipment (e.g. fork lift truck) to be moved without the danger of hitting adjacent shelves. A lot of wood is used to protect the spare parts. At first sight this appears to significantly increase the fire risk but the team was assured by plant staff that most of the wood was treated to reduce its flammability and calorific value and that the overall fire burden of the materials in the warehouse was within specified limits.

In Unit 1, prior to the diesel generator monthly test surveillance, maintenance was scheduled to replace the manual isolation valve of 89 mm diameter flange, between the bulk fuel oil storage tank and the day tank. During checks before work was started, as required by the quality plan, it was noticed that the new valve brought from the warehouse was 100 mm diameter flange, so the valve could not be replaced. A subsequent review by plant staff revealed that the spare part number was correct, in accordance with the warehouse records. The mechanical maintenance manager has initiated an investigation of the problem with a view to identifying root causes so that

effective corrective measures may be instituted. The OSART follow-up visit may wish to check the outcome of the investigation.

The corporate technical support department (UTO), which is responsible for spare parts specification and control for all nuclear plants, was informed of the above mismatch, and, after research for the root cause informed the site that it was caused by an error with the UTO valve reference numbers. It was considered to be a unique problem. The UTO and plant files were updated, and the compatible valve made available to the plant. During the following plant outage the valve was repaired (valve seats were replaced).

4.9 Outage Management

The generic outage schedule is defined by UTO for all French nuclear plants. Flamanville NPP takes UTO reference length and feeds in programme site constraints (such as work, modifications, organization). The site target length is then negotiated at national level with the Outage Monitoring Committee (CSA). The objectives of all outages are defined one year in advance by the site management contract. The main objectives take into account nuclear safety, industrial safety, radiation protection, liquid and solid waste, planning and cost.

Preparation of outage planning and scheduling starts sixteen weeks prior to shutdown. At the same time, as a regulatory requirement, the plant must send the outage programme to the safety authority. This programme defines all site statutory maintenance and is drawn up by the departments. Eight weeks before the start-up date a meeting is held with the safety authority to discuss the outage programme following which the safety authority sends a response letter; from this moment further modifications to the programme are not allowed.

Flamanville NPP has a permanent outage group (CPAT). This group is composed of seven people: one outage manager, one safety engineer (attached to nuclear and industrial safety), one scheduler, two foremen and two scheduling technicians. Once the outage starts the outage group increases to approximately twenty people who work as a project team and includes work co-ordinators and outage activity co-ordinators of several specializations. The outage organization works very satisfactorily.

National and local experience feedback (REX) is used during the outage programme to help with the dose reduction programme during outages. National experience feedback, managed by UTO, is applied to the programme. The use of tools like the steam generator manhole stud tensioner, the reactor vessel stud tensioner and the full sized lower part steam generator mock-up training facility developed for that purpose have helped in reducing doses.

The outage scheduling method uses a computer system called PRO which uses SYGMA (maintenance management), AIC (equipment tagging system) and EXCEL (outage visualization/display) for optimizing the duration while respecting technical specifications.

The changes in plant operational states are managed very effectively during the outages by the outage safety committee (COMSAT)

- (a) **Good performance:** During the outage there are several plant operational state changes and care is taken to ensure that the required plant systems are available at every state change. Responsibility for approving each change of state is vested in the outage safety committee (COMSAT). It is the responsibility of this committee to ensure compliance with operating rules, to check that the required functions are available and to propose alternatives on discrepancies. To achieve these objectives, documents are prepared 24 hours before the change of state, to facilitate a check, by discipline, that all required maintenance and modifications have been completed, circuits aligned, sensors aligned, temporary measuring equipment removed, anomaly or non-conformance sheets completed, quality safety plan requirements have been met, documents updated, fire sectors established and all post-maintenance tests completed. All these documents are made available to the safety authorities. COMSAT activities are commendable in that they ensure that all activities have been finished before state changes can be made and that the new operational state can be entered without restriction.

The follow-up to an outage is very effective. The outage group is responsible for writing an outage report which includes the technical, financial and administrative aspects. This is submitted to the plant director.

5. TECHNICAL SUPPORT

Technical support functions are performed by different technical departments, sections and groups at Flamanville power plant. The groups receive considerable assistance and sometimes direction from the corporate organization. Plant staff expressed their satisfaction with the help and support from corporate groups. This help and support may be two edged because the staff may be too ready to accept the situation and status as it stands and so fail to fully develop a questioning approach.

Personnel involved in technical support activities are formally qualified and well experienced. The qualification and experience requirements stated in administrative documents are satisfactory and strictly met.

The surveillance test programme for the plant consists of all necessary key elements. The programme is well tracked by the SYGMA computer system. A parallel programme operated by maintenance staff includes extensive use of vibration analysis techniques; this programme will become even more comprehensive when computer-based trending developed at corporate level encompasses all surveillance tests.

The operational experience feedback programmes have been found to be very well structured, effective and well implemented at the site and corporate level; particularly effective is outage experience feedback, which has resulted in reduced length of outages.

The plant modification programme is strongly centralized and controlled at the corporate level from initiation of the modification to the necessary changes on the relevant documents. There was a spate of reactor trips in 1994, some of which might have been avoided if implementation of approved modifications had not been delayed. The more prompt implementation of modifications, especially those having a bearing on safe and continuing reactor performance is suggested.

The functions of reactor engineering, fuel handling and safety-related computer applications were found to be comprehensive in scope, well documented and well managed. In connection with fuel handling, a comprehensive unified procedure for a foreign material exclusion programme for all activities at the site is suggested to be developed. It should replace the existing rules which are to be found in different documents.

In addition to the proposals of the February 1995 OSART team, there were two issues already being addressed by the plant, that the OSART team suggested should be followed up.

An acceptable unified foreign material exclusion programme has been introduced that awaits its first use during an outage. The OSART team was concerned that the plant

modification in EdF was so protracted that modifications that might result in safety benefits were being delayed. Two examples were given in the OSART report where reactor trips might have been prevented had plant modifications, already in train, been implemented more expeditiously. EdF studied the possibilities for expediting the modifications. One has been implemented the other, due to safety reasons, not yet been implemented.

The issues already being addressed by the plant at the time of the mission, namely a comprehensive trend analysis programme of surveillance test results and the tracking of corrective actions to completion have been successfully introduced.

5.1 Organization and Function

The functions and responsibilities for providing technical support at Flamanville nuclear power plant are distributed between a number of departments, including some corporate groups. Some functions are carried out by committees, such as the safety follow up committee, experience feedback committee, plant operation review committee and safety technical committee. These lateral committees are chaired by the plant's advisers or a designated member of the plant management team. Strong support is given by corporate organizations, but implementation is a site responsibility. Individual duties, obligations, goals and accountabilities are contained in personal contracts. The commitments are clearly stated and quantified to make it possible to monitor progress by established indicators, which are agreed when the contract is negotiated. Performance against contract requirements is carried out regularly on a monthly or three monthly basis. Corrective actions are proposed as necessary. At the end of the contract period a report is prepared that includes an analysis of the causes of differences between commitments and achievements. Compliance with contract conditions affects remuneration. The system is effective in ensuring that staff understand the organization and their own duties and tasks.

It is the plant's policy that individuals are responsible for all aspects of the work they are doing. In the technical support area activities are largely conducted by groups, formed of personnel from a number of departments, including operation and maintenance. This contributes to the effective establishment of links among all plant personnel as a result of being jointly engaged in such activities. Communication links with corporate support groups are well established and well utilized by the personnel.

Personnel involved in technical support activities are formally qualified and well experienced. The qualification and experience requirements stated in administrative documents are satisfactory and are strictly met. There are some ten trainees in the plant shadowing other engineers. The trainees do not have formal responsibilities and do not carry out tasks except under the direct supervision of qualified staff. Personnel demonstrated a good attitude to safety. Whenever necessary a safety analysis or a risk

analysis is done as required by the quality plan (PDQ); the quality of the analyses was found to be good.

Safety culture is well developed at Flamanville and its employees understand its importance. The strong support given by corporate divisions to Flamanville is a significant contribution to its good operational status. However, the need for staff to conform to and to follow the requirements of systems set up by corporate organizations may result in staff failing to develop and maintain a healthy curiosity of activities outside the immediate scope of the work assigned to them, may deter people from pursuing initiatives and might stifle the full development of a questioning approach.

5.2 Surveillance Programme

The surveillance programme includes surveillance testing, maintenance and repair and data evaluation. The programme includes actions to be taken when failures and deficiencies are detected. Test procedures are well structured, having a step-by-step format, and include prerequisites, such as alarms that should not be present and which equipment should not be unavailable before a test may begin. Procedures include warnings, at the appropriate place, that improper execution may cause a reactor trip. This excellent practice could be strengthened by giving such procedures a distinctive colour. The Flamanville procedures include the measures to be taken to return the plant to the normal state.

The surveillance test procedures are based on rules developed at the corporate level, which are required to be approved by the safety authority, DSIN. However, about one third of the surveillance test procedures are covered by rules (new and amended) that have not been approved by DSIN. This issue is discussed further in section 1.4. Test intervals are set with a tolerance of plus or minus 25 % of the interval. The scheduling of tests during normal operation and for outages is well controlled using the SYGMA computer system.

Two tests were observed by the reviewers. The persons performing the tests made suitable preparations by reading the objectives, hazards and criteria for acceptance of the tests contained in the procedures. All procedures were followed in an appropriate professional manner and all data collected. Both tests were satisfactory. One of them was a diesel startup and load run test. For each diesel, preventive maintenance precedes five out of the six surveillance tests per year. This is arranged to avoid post-maintenance test starts that would otherwise aggravate wear caused by additional starts and to minimize the unavailability of the system. The extent of the preventive maintenance is minor and unlikely to artificially boost the starting performance of the diesels.

Surveillance tests on rotating machines are scheduled and performed during week days so that the maintenance staff are available to carry out vibration tests in parallel to

surveillance testing. The results of vibration measurements are trended and used for preventive maintenance planning. Some surveillance test results are subject to trend analysis particularly where problems have arisen such as when a test fails. A computer based comprehensive trend analysis is being developed at the corporate level that will encompass all surveillance tests. Introduction of the system is planned for 1996. The plant is encouraged to seek its implementation as soon as possible. The progress made should be checked during the OSART follow-up visit.

Bi-monthly reports have been issued jointly by the operations and mechanical departments since 1 January 1996. These include:

- *trends in parameters of surveillance tests results of some safety related pumps (analysis back dated to 1993/94);*
- *comments on any noticeable draft in parameters between successive periodic tests;*
- *a table showing actions taken or on-going following joint analysis.*

Vibration data recorded by the maintenance department will be correlated with the above before the end of 1996. No major repair has been found to be necessary based on trend analyses carried out to date.

Special tests are rarely carried out at the plant. The last two were carried out in 1987 and 1989. A request for a special test can be initiated by the corporate or the site organization. The requirements of the quality plan (PDQ) must now be met before conducting a special test or infrequent operation (evolution). This appears to be an effective way of ensuring that adequate safety margins are maintained during special tests and evolutions.

5.3 Operational Experience Feedback System

The operating experience feedback programme (OEF), known in EdF by the acronym, REX, is well developed. The corporate organization has set ten criteria, which apply to all EdF's NPPs, for those events which must be reported to the corporate REX department. These events are first analysed on-site. The corporate department is responsible for further analysis of the events and the identification of trends and emergent generic problems. In 1994, 970 Flamanville events were reported in accordance with the ten criteria. Of these, 55 were classified as equipment failures and were analysed according to a prescribed methodology. This classical reliability analysis is aimed at identifying the frequencies and causes of equipment failure.

Significant events are determined by criteria set by the safety authority, DSIN. Eleven of the 970 events met the DSIN's criteria and besides being reported, were analysed in-depth to identify root causes. All eleven events were classified against the INES scale as level 0. Human factor analyses were carried out whenever human

performance was judged to be contributory to the event. Approximately 30 persons on-site are trained in root cause and human performance analysis techniques.

- (a) **Good performance:** Responsibilities for the operating experience feedback (OEF) is now devolved more to the nuclear power plants. Flamanville staff now conduct all root cause and human performance analysis. Adequately trained personnel in all departments support the human performance analysts who co-ordinate the whole OEF site programme. The threshold of the reported events is very low, as shown by the fact that 970 events were reported in the year 1994. Fifteen other events were analysed using the same methodology and depth of analysis as the significant events. The analysis reports are well structured and show that the depth of analysis is satisfactory.

The OEF programme at the corporate level is well developed; it receives reports from EDF's NPPs as well as worldwide nuclear industry experience. Of the events reported, approximately 10,000 events from French plants and 1500 events from other countries are analysed for application in France. The performance and co-operation of the corporate OEF department is considered by the Flamanville personnel to be effective.

At the corporate level, tracking of corrective actions is being extended. At present, the corporate OEF programme considers an action to be completed once the actions are passed to a responsible person at the corporate or site level. The success of the actions is not yet followed-up. There are plans to extend tracking beyond the present scope. The corporate group is encouraged to complete the implementation of these plans as soon as possible. The follow-up visit should check on the progress of this plan.

The corporate level nuclear power plant operations (EPN) management now checks that:

- *all objectives and success criteria associated with the implemented action have been met;*
- *sufficient publicity has been made concerning developments in the existing system;*
- *any deviations identified during the execution phase have been processed.*

These requirements are set out in a comprehensive procedure introduced in June 1995.

The REX system also includes outage experience. The co-ordination between sites and the corporate groups has been most beneficial and the analysis of outage experience has resulted in the reduced length of outages by up to five days per unit.

- (b) **Good performance:** Operating experience feedback programme (OEF) for following the outage experience has been developed by EDF for the site and the corporate level. It contributes to the management of the outages. The experience feedback process ensures a standard classification for outage evaluations and validation of the experience feedback reports. The outage experience feedback

programme had substantially contributed to improving the outage organization and shortening the outage length, when it was initiated, by approximately ten days for each unit outage. It is still useful and has resulted in Flamanville in reducing the length of outages by an additional five days per unit.

The corporate OEF department publishes a compendium of events, *C'est Arrivé dans les Centrales*, on a monthly basis informing staff of events in the power plants. The well illustrated publication, which is professionally laid out, is interesting to read and is popular among the staff and contributes to safety and to improving the OEF programme.

5.4 Plant Modification System

Plant modifications are managed by the EdF's generation and transmission division (DEPT) as the owner, and the engineering and construction division (DE) as the contractor. A contract between the two divisions signed two years ago, governs their relationship. The corporate engineering department (IPE), formed by both organizations, DEPT and DE, takes the lead in modification management. The modification control system forms part of the guidelines for IPE (first edition published in 1994) where all policies, plans, responsibilities and authorities at corporate and site levels are well explained. The guidelines include the main policy principles such as: only worthwhile modifications to be carried out; the validity of choice to be confirmed; consistency in the physical and documentation aspects of the units to be maintained; pilot modification to be carried out and feedback from it to be obtained before applying it to the rest of the series; and the impact on the length of outage time to be minimized. A joint organizational structure is formed from the personnel of two divisions for each modification and support is given by the engineering support centres.

The processing of modifications is the same for small and large modifications as well as for the modification of documents including the development of symptom based procedures. After a request for a modification is received, usually initiated by the NPP an evaluation report is produced, together with safety risk analysis and Lie total package is presented to the corporate operating review committee (CTE). When a modification receives formal approval, implementation studies are produced and a preliminary work file prepared. The work file defines the objectives and the means needed to carry out the modifications on the specified unit including the requalification test and states the consequences of the modification on operation, maintenance, and spare parts inventory. All the sites with similar units are informed. Information is then given to the safety authority. Modifications are collected in packages for implementation during an outage. The packages for Flamanville's 1996 outages consist of 128 modifications. Each modification has been assigned to a co-ordinator who is responsible for all sites where it will be implemented. Good control and the transfer of experience is thereby achieved.

The modification process from request to implementation is complicated but well structured and effectively controlled. A procedure governs how the process for emergency safety related modifications can be shortened. It is rarely used.

On reviewing a modification in the course of installation it was noted that completed work was in order and the work places had been cleaned and were tidy. However, in the area where work was in progress, it was found that tools and materials were scattered about. This suggests that the control of materials was not strict and this might lead to some materials inadvertently entering an open system. All necessary documentation and drawings were in place.

When reviewing operational history the team found that some of the reactor trips that occurred in 1994 might have been avoided had approved modifications been implemented without delay. More details of the modifications and the effect their delay has had, are given in section 3.4. Avoidable delays at the corporate level in committing resources to implement some plant modifications may have been a contributory factor to an increase in reactor trips and a consequent reduction in plant performance. A design change request was raised in 1987 to install an alarm on a low-low steam generator level, which would give warning of the imminence of a reactor trip due to low steam generator level. A design change request was raised in 1990 to disconnect the reactor trip signal from the turbine trip signal, Liking into consideration the 85% steam dump capability. Three out of six Unit 2 reactor trips in 1994 were related to the above design change requests. These changes were planned by the corporate level for implementation at Flamanville in 1995 and 1996. A plant request to implement them earlier was denied, even though, the OSART team learned, no complex resources would be needed to implement these design changes. These long standing design change requests have contributed to the significant number of reactor trips of the Unit 2.

- (1) **Recommendation:** The corporate level of EdF should expedite the implementation of plant modifications, especially those likely to have a beneficial influence on reactor performance. The more timely implementation of the low-low steam generator alarms and the disconnection of the reactor trip from turbine trip, both approved modifications of long standing, may have prevented three reactor trips in 1994. This would contribute to a strategy of reducing the number of reactor trips and consequently to a reduction in challenges of reactor protection systems.

Plant response: (May 1996) Subsequent to the recommendation, as of today, the steam generator alarm modification was carried out during the two unit outages in 1995.

As for expediting the 'turbine trip without reactor trip' modification the site sent a letter (D5330/DRN/DGT/RN 4012 dated 2 May 1995) to corporate management, who decided to maintain the integration of this modification, (which contributes to a reduction in the number of trips) with the 1993 batch of modifications, during the ten-year inspection,

i.e., 1997 for Flamanville 1 and 1998 for Flamanville 2 [letter GO/HS/95238 signed by the technical delegate of nuclear power plant operations (EPN)]. This decision was taken by the corporate office after a feasibility study was made by the UNIPE (Corporate Engineering for Modifications). The conclusions of this study were presented during a meeting of the CSNE (Corporate Nuclear Safety Committee). These conclusions point to major difficulties and nuclear safety risks which would emerge if a modification were to be installed disassociated from its batch (letter GO/HS/95238+ answer from the CSAE dated 5 April 1995).

This decision corresponds to EdF's adoption of the policy to standardize all French NPPs, with respect to design as well as operation. This gives the advantage of being able to share experience feedback and enhanced nuclear safety. To this end, this modification will be installed on Paluel 1 in 1996 during the integration of the 1993 batch. (This unit is first off of the P4b series). After one year's satisfactory experience with the modifications made, the 1993 batch will be extended to all units within the series during their ten year inspection.

It should be pointed out that this modification affects the following systems: reactor protection system (RPR), turbine bypass system (GCT) and generator and power transmission system (GPA) as well as SPIN software and that it requires several years of study. EdFs concern for quality as well as the enhancement of French NPP's performance dictates the need for caution to guard against the modification failing to meet its target objective.

In conclusion, the highly operational nature of this modification and its interconnections with the 1993 batch are such that there is no point in separating this modification from this batch, regardless of the deadlines.

IAEA comment on status: *(June 1996) The expediting of the two modifications has been considered in-depth by EdF. In one case it was possible to accede to the OSART team's recommendation but for safety reasons it proved impossible to bring forward the implementation of the second modification.*

Conclusion: *Issue resolved.*

5.5 Reactor Engineering

Reactor engineering activities are performed by the technical and environmental department (STE) and the nuclear fuels group (GCN) of the corporate resources department. GCN is responsible for long term fuel management. Generic studies are carried out, such as fuel management schemes and safety analyses to determine the overall strategy. GCN is also responsible for tactical studies such as determining the reloading pattern, safety evaluation of a reload, and parameters for plant operation.

The site is responsible for refuelling, management of fuel on-site and core monitoring. The analysis of the next cycle's core is calculated by the GCN and verified by the fuel supplier. Different computer programs are used by GCN and the fuel supplier ensuring that an independent check is carried out. The regulatory authority is required to approve the safety evaluations and to receive the results of the core physics tests such as the zero power test, the neutron flux mapping, the reactor protection system calibration, determining the power levels and power increase, if necessary. The safety authority also partly inspects the periodic tests during core monitoring.

The results of analyses of the next cycle's core, such as reloading pattern and theoretical parameters for plant operation, are supplied to STE approximately one month before the Flamanville needs it. In order to make this analysis, GCN follows up on the necessary on-line data.

The computerized refuelling orders are drawn up by the test section of STE in accordance with a safety requirement and are checked step-by-step. The refuelling procedures are drawn up by the general section of STE. The core physics test and the periodic tests for core monitoring are performed by the test section in accordance with the procedures and are partly helped by GCN. Some procedures were reviewed; they were found to be clear and understandable and consistent with the requirements of the technical operating specifications, the FSAR and vendor recommendations. The conclusions of the tests are reported to the plant manager in a timely manner along with sufficient core performance data. The computerized fuel assembly history data include all necessary data for fuel management and are kept up to date. The test section is provided with adequate human resources who have accumulated sufficient training and experience; their relationship with GCN is good.

The chemistry section of STE monitors the integrity of fuel by taking radiochemical measurements. The criteria for maximum activity are specified in technical specifications. The criteria to carry out sipping analysis are specified in directives from the corporate organization. Although, EDF does not have a zero fuel leakage policy, it has strict requirements with low limits for reloading fuel with small leaks.

5.6 Fuel Handling

Fuel inspections and manipulations are the responsibility of the testing section and fuel group of the general section of the technical and environmental department. A number of other site departments and sections are included as necessary, such as: security, section, mechanical department and radiation protection section. The co-ordination among them is well defined. There are well developed administrative procedures, which control all manipulations with the fuel at the site from arrival of fresh fuel on-site and the departure of spent fuel from the site. All changes of fuel positions at site have to be authorized and witnessed by the testing section.

There were no activities with fuel at site during the mission. The procedures for manipulating the fuel are comprehensive. The fuel and transport containers are carefully inspected upon arrival on-site, acceptance standards and non-conformity procedures exist.

Fuel loading and unloading procedures are comprehensive. Identification of fuel to be loaded or repositioned in the core and spent fuel pool is checked by two different persons using two different documents to avoid errors. The procedures require the control room supervisor to authorize the programme before the fuel handling in the reactor starts. Radiation protection provisions are included in procedures or they are covered separately in the quality plan risk analysis for maintenance work, if some such work is necessary. The number of qualified personnel involved in the fuel handling activities is adequate.

When visiting the fuel storage building of Unit 1 the team found some extraneous items in the spent fuel building. The following day the spent fuel pool area of Unit 2 was found to be clean and properly maintained. Environmental conditions in the spent fuel buildings were found to be satisfactory and properly monitored. Discussions with staff revealed a perception that a foreign materials exclusion programme was the control of tools in the vicinity of open reactor coolant and other systems. Although a foreign materials exclusion policy exists at Flamanville, including provisions in the quality plan and risk analyses for maintenance work, it does not appear to extend to the exclusion of foreign materials from the spent fuel pools. In the fuel storage building of Unit 1 the team found three loose bolts (about 5cm long), several nuts and washers in the vicinity of dry storage fuel racks and part of a broken metal tool (about 16 cm long) and a few spare parts within 1 metre of the spent fuel pool. The presence of debris in the fuel pools can have a deleterious effect on cladding and can interfere with cooling arrangements.

- (1) **Suggestion:** Consideration should be given to developing a unified procedure for a foreign material exclusion programme for the site. Staff members and contractor personnel involved in maintenance, other work on open systems and in fuel storage buildings, should be trained in the requirements for foreign material exclusion. Such a procedure will contribute to safety and availability of the systems.

Plant response: (May 1996) *As a complement to the general cleanliness provisions that are part of the QC method, a general memorandum was issued that defines the service areas judged to be a high risk and the procedures established for carrying out service operations in these areas. This memorandum defines the following major principles:*

- *counting and management of tools, measuring instruments, spare parts brought into the service area,*
- *product management,*
- *cleanliness report once the work site is finished,*
- *interdiction of certain objects. (tools in poor condition, breakable items, etc.).*

The principles of this memorandum were presented to the technical inspectors and work co-ordinators during the day of training prior to the outages. The technical inspectors and work co-ordinators are responsible for passing this training on to the sub-contractors participating in the pre-service operation meetings (kick-off meeting, lifting of prerequisites, etc.). These principles are permanently posted at the access points of these high risk service areas.

IAEA comment on status: *(June 1996) The plant has introduced a procedure that provides a unified foreign material exclusion programme. The procedure identifies the critical areas and defines the measures to be taken. The principal activities are posted on all entrances to the controlled zone. The procedure, implemented in 1996, has been effective in normal operation. No modifications to the procedure are foreseen for its use during outage periods.*

Conclusion: *Issue resolved.*

Procedures prescribe the storage configuration of spent fuel to ensure compliance with criticality requirements. Spent fuel pools are well equipped for carrying out fuel handling operations including packing spent fuel into casks for transportation.

5.7 Safety Related Computer Applications

A programme for utilization of computer capabilities and applications is managed by the corporate computer applications management committee. The functions and responsibilities of each EdF organization for computer utilization are well defined and clearly stated for the plant and the corporate level. A decision to develop new large applications can be taken only at the corporate level. Two excellent large computer networks have been installed at Flamanville NPP, which are a technical management network and a resources management network. Each network has more than ten computer applications. There are no safety related computers at the plant. There is a process monitoring computer system (KIT) to support the operators' work but the plant can continue to operate even if the KIT stops working.

The computer quality assurance programme includes well developed secure password systems at plant and corporate level to protect data and programs. The information system management group (GSI) at the plant is responsible for the operation of networks, analysis of users' applications, user assistance and ensuring the integrity of data. Maintenance of the corporate level software is the responsibility of the corporate technical support department (UTO). Data maintenance is performed by the plant, whenever possible, and managed by UTO. Both groups are successful in working together and end users that were interviewed expressed satisfaction with the services.

The process computers, including the process monitoring computer system (KIT), monitor radioactive releases to the environment and meteorological data. They are connected to an interplant monitoring systems network. Real time data from the system can be obtained at the corporate level and by some other external organization, such as emergency centres. The KIT system, although designed almost 30 years ago, is still very helpful and is in constant use as a tool for the operators. There is adequate redundancy in the circuits from the plant to other organizations, computers and in databases in case of failure. The integrity of the network is confirmed twice a day.

Information system implementation and follow-up control information strategy of the plant is well controlled by an information officer, supported by experts in functional, technical and resources groups and by the corporate organization. The personnel are knowledgeable and adequately qualified and trained.

The most significant national applications are the SYGMA system for work order processing and work assessment and SAPHIR for collection of local, national and worldwide operational experience. The SYGMA system was extended in 1992 to include the collection of preventive maintenance related data. The SAPHIR system has been operating since 1994; it is able to access SYGMA. They are well designed and helpful to the users.

There are about 450 personal computers at Flamanville which are also terminals to the networks. The end users of the computer systems, including control room operators are satisfied with the systems and the applications that are available.

6. RADIATION PROTECTION

It is EdF's policy that plant departments and personnel are responsible for their own radiation protection. Staff are given sufficient knowledge through training to achieve the objectives of this policy. As a result the main tasks of the industrial safety and radiological protection section are to provide advice, carry out checks and deliver training. These tasks are carried out competently.

Flamanville's approach to radiation protection is based on the recommendations given in ICRP-26 published by the International Commission on Radiation Protection (ICRP). Over the past two or three years the whole plant has striven to fully implement the ALARA principles. These efforts have been fruitful and, at present, the plant is approaching it in a structured way. The ICRP-60 recommendations are to be fully implemented by the year 2000. Since 1990, the collective dose has stabilized at a relatively low value about 1 Sv per unit. The individual doses for the group of workers with the highest radiation exposures have continued to decrease considerably.

A consequence of the policy that every individual is responsible for his/her own radiation protection is that radiation protection work permits are not used. However, the policy encourages individuals to request assistance and advice from the industrial safety and radiological protection section whenever required.

The unit of radioactivity used at the plant has been changed from the old units, Curie (Ci), to the Système International (SI) units, Becquerel (Bq). However, both old (rem) and new (Sievert) units of dose can be found in use around the plant. This could be a source of confusion.

The walls, floors, equipment and instrumentation in the controlled areas of both units are in the condition required for radiological work and give evidence of good housekeeping with respect to these matters. However, consideration should be given to correcting the deficiencies found in the coating of the floor in the site decontamination workshop, in addition to the work planned to repair the coating of the walls.

The radiation survey programme is sufficiently comprehensive. There are sufficient fixed and portable monitors; their calibration and status control are adequate. Internal contamination is determined by whole body counting on a routine basis. The plant has a spacious and fully equipped facility for the treatment of contaminated persons, which is seen as a good performance.

Since 1990, Flamanville has succeeded in considerably reducing the volume of solid radioactive waste and plans further reductions. This reduction can be accredited to the awareness of the personnel of their responsibilities for the waste reduction. The solid waste treatment seems to be well under control.

Except for tritium, the amount of activity of gaseous releases is currently less than 1 % of the regulatory limits. Since 1988 the NPP has succeeded in considerably reducing the activity of liquid releases to less than 1 % of the regulatory limits, except for tritium.

The plant has good facilities and is very well equipped to give radiation protection support during emergencies. This is a clear commitment by the plant staff to support emergencies.

Good progress has been made in resolving the radiation protection items identified for improvement by the OSART team. Three items are resolved and three are progressing satisfactorily.

Good progress has been made in the checking and clearing of equipment before it is removed from controlled area. Monitoring of the corrective measures is still necessary to ensure that the aims of the corrective measures are achieved. A programme for the change over from old radiation units to Système International (SI) units has been developed and will be completed on 1 January 1999. EdF is now committed to the monitoring of extremity doses but more work is required before it is introduced at Flamanville.

The remaining issues namely the introduction of predetermined locations in loose surface contamination surveys, the repair or the protective coating on the walls and the floor of the decontamination workshop and a procedure for dealing with unusual leaks have all been resolved.

6.1 Organization and Function

The position of the radiation protection manager (head of the radiation protection section, SRP) in the organization is such that he can readily advise management as to the effectiveness of the radiation protection programme. He has access to the levels of management that have the authority to establish and to enforce safe radiation protection procedures. SRP staff have the authority to stop work, if radiation protection practices are judged to be unsafe.

Written policy statements on radiation protection and the application of ALARA principle have been issued at both the corporate and plant levels. It is EdF's policy that the departments and their personnel be responsible for their own radiation protection. As a result, the main tasks of the SRP to give advice, make checks and train other staff. However, jobs involving significant doses have to be authorized by SRP. The number of staff in SRP is sufficient (16 persons).

The whole plant has worked hard in the past two to three years to fully implement ALARA principles, as set out in ICRP-60. Some of the procedures concerning the

subject have been introduced only recently and others are still in development. The effectiveness of the procedures could not be checked because of lack of experience in this matter.

The qualification of SRP staff is sufficient for them to fulfil their tasks adequately. Since the middle of 1994 a formalized training plan has been set up for every individual. It is intended that the plan will be updated every year according to the needs of the section and the individual. Radiation protection training constitutes an essential part of that training. Special attention is given to the understanding of the ALARA principle. At the time of the OSART mission SRP staff appeared to be well qualified and working effectively.

The training and qualification of radiological workers (both for EdF and contractors) is defined by EdF. Training consists of basic initial training with refresher courses held every three years. For both types, validation of the level of knowledge is assessed at the end of training. SRP staff carry out independent checks of the level of contractors knowledge and if not satisfied can require individuals to retake the refresher course even if they have passed the assessment. In addition, radiation protection training is given by SRP staff to both EdF and contractors' supervisors in preparation for the annual outage. The training is a necessary supplement to the three yearly retraining.

6.2 Radiation Work Control

The policy that workers are responsible for their own radiation protection has resulted in there being no need for radiation protection work permits. This places a greater importance to radiation protection training to ensure that all radiation workers have sufficient knowledge to avoid the dangers. The training defined by EdF together with the annual training given by the SRP staff before the outage is considered to be sufficient for this purpose. Although all radiation workers are responsible for their own safety, they are encouraged to request assistance and advice from the SRP. However, there are no criteria in procedures and work descriptions requiring special precautions and SRP assistance with respect to higher levels dose rate, but a procedure is being developed covering work carried out in areas with dose rates exceeding 0.02 mSv/h. The procedure requires that SRP must be consulted and special radiation protection measures applied, if advised.

A system of zone-categorization according to the dose rate is applied. The workers have free access to the green and yellow zones (dose rate less than 0.025 mSv/h and from 0.025 to 2 mSv/h respectively). Work in orange zones (dose rates between 2 and 100 mSv/h) has to be approved by the SRP. Work in red zones (dose rate may exceed 100 mSv/h) needs the approval of the plant director.

Maps at the entrance of the controlled area show the most recent dose rates and the hot spots. Special rooms and individual work sites (e.g. shelters in the hot work shop) are marked with respect to dose rates and, if applicable, with the contamination level.

The walls, floors, equipment and instrumentation in the controlled area are in a good condition as required for radiological work and give evidence of good housekeeping with respect to these matters. However, the radiation protection measures taken to deal with puddles of water in the controlled area were not commensurate with the problems that might have existed. In several places, for example at the joints between building units, there were puddles of water. The puddles had appeared in the middle of the week previous to the OSART mission and were thought by plant staff to have been caused by recent heavy rainfall. There were no signs to indicate whether and to what degree the water was contaminated and no measures could be seen that would limit the spread or remove the water such as channelling towards drains thereby minimizing the chances of it becoming contaminated where it lay. Although the manager of SRP section declared that it was not contaminated, the plant's approach did not seem to be adequate for the following reasons:

- documented contamination surveys started the day after the expert raised the issue;
 - smears were only performed for one puddle;
 - contamination surveys were done once a week up to the moment of observation
 - the absence of signs to show whether and the degree to which the water was contaminated;
 - the absence of arrangements to minimize the chances of the puddles becoming contaminated.
- (1) **Suggestion:** Consideration should be given to developing arrangements to deal with unusual leaks and sources of contamination (especially sources of a persistent origin). These arrangements should include instructions about the frequency of the contamination surveys to be carried out and the way to mark leaks. Adoption of such arrangements would prevent any misunderstanding of the status of contamination and would also reduce prevent the risk of its being spread. Appropriate instructions will provide guidance to the radiation protection section on how potential contamination sources in the controlled area should be identified, surveyed and reported in a timely manner.

***Plant response:** (May 1996) Written instructions have been drawn up to specify the actions that radiation protection section employees must follow whenever a leak is discovered within the controlled area. These instructions are designed to avoid any risk of dispersion, in the first phase and to repair the leak in the second phase.*

These instructions involve:

- *measuring the surface contamination,*
- *installing markers to avoid the risks of:*
 - *slipping,*
 - *dispersion, if the water is contaminated. In such a case, the level of contamination is specified on the marking.*
 - *seeking the origin of the leak,*
- *issuing a work request (DI).*

Work request processing triggers the following actions:

- *additional radiation protection measures and their frequency of application,*
- *catchment of the leak if it flows into a passageway,*
- *decontamination of the room if surface contamination is greater than 8 Bq. cm⁻², servicing the faulty equipment.*

IAEA comment on status: (June 1996) *The comprehensive procedure was put to good use in one event when a floor drain became blocked and a puddle formed on the floor. The procedure proved to be effective: no modifications were necessary.*

Conclusion: *Issue resolved.*

Dose rate and loose surface contamination surveys are carried out by SRP in the controlled area by the SRP. The cold changing rooms are also checked for loose surface contamination. However, the regular surveys of loose surface contamination do not include strategically predetermined points, only points chosen arbitrarily. This practice means that the ability to and benefits of analysing trends is lost.

- (2) **Suggestion:** Consideration should be given to including strategically predetermined points in the current survey programmes in addition to the practice of using arbitrarily chosen points. This would permit representative trend analyses of loose surface contamination surveys to be carried out which should greatly improve the usefulness of the information of contamination conditions.

Plant response: (May 1996) *The work procedures of the radiation protection section have been modified to take into account this suggestion. 34 strategic points have been determined based on the analysis of last year's results and risk analysis. The exact location of these points was positioned on room plans enclosed with the procedures thus guaranteeing repeatability of the measurements at the same places. The measurement results are given in the expert report of the procedure and in a table for the analysis of trends over time.*

IAEA comment on status: (June 1996) *The 34 additional strategically chosen fixed survey points were introduced in February 1996. Analysis of results is carried out using*

a computer program. Plant staff believe the inclusion of fixed points in the survey programmes to be a valuable improvement.

Conclusion: *Issue resolved.*

The official individual radiation dose is determined by film dosimeters. The operational dose is measured with electronic dosimeters. The operational dose records are stored in a computer. The computer system is slow and the records are only made available the next day. Therefore a system of daily dose limitation is not possible.

Equipment leaving the controlled area has to be checked for contamination by the work supervisor. If the equipment is not contaminated (total $\hat{\alpha}$ -count and $\hat{\alpha}$ -dose rate less than the prescribed criteria) each package has a green label. If the equipment is contaminated each package is labelled with a yellow label. Although the system is satisfactory, the requirements are not being fulfilled consistently. Based on the evaluation of the documents provided, there is a high proportion (about 10%) of errors in the way that the equipment is being cleared before it is removed from the controlled area (equipment not inspected, labels incorrect or missing) so that there is a risk of a spread of contamination. This problem has been identified already by the plant and measures are in preparation to improve the situation.

- (3) **Suggestion:** Consideration should be given to identifying the root causes of problems in clearing equipment before it is removed from the controlled area. Corrective actions should be implemented based on this analysis and may include revision of procedures/instructions, training of personnel and enforcement of requirements. This should make the system more professional and would reduce the risk of a spread of contamination.

Plant response: *(May 1996) In 1994, anomalies encountered on equipment exited from the controlled area were divided as follows:*

- *5% label incorrectly filled in,*
- *5% equipment incorrectly checked, or not checked at all.*

In 1995, the site implemented corrective actions designed to improve the professionalism of its employees:

- *information from the EdF work supervisors, technical inspectors and work coordinators,*
- *information from the work site managers of the sub-contractors,*
- *clarification of controlled area exit procedures and accompanying employees responsible for opening the equipment air-lock,*
- *reinforcement of checking actions performed by the radiation protection section.*

In 1995, checking actions were increased two-fold. The results of these checks show:

- *a significant reduction in the amount of unchecked or poorly checked equipment a drop from 5 % to 1.5 %;*
- *mixed results concerning label information when compared to 1994: increase from 5% to 12% in Unit 1 and decrease to 3% in Unit 2.*

Actions undertaken to eliminate unchecked or poorly checked equipment have given satisfactory results. Provisions, especially in terms of information, will be carried out once again in 1996. In an effort to solve the problem of incorrectly filled in labels, a new, more ergonomic model has been designed and implemented on the site. The programme of reinforced checking is maintained to guarantee the effectiveness of the corrective measurements taken.

IAEA comment on status: *(June 1996) Flamanville NPP has implemented measures to meet the requirements of the suggestion and has monitored their effectiveness. As a result more improvements were introduced in May 1996. Monitoring of the corrective measures will continue to be carried out, and until the measures have been shown to be effective, the suggestion cannot be considered to be fully resolved.*

Conclusion: *Satisfactory progress to date.*

6.3 Internal Radiation Exposure

The plant pursues a clean plant concept, striving constantly for a surface contamination of $< 8\text{Bq/cm}^2$ in the controlled area, which is seen as a restrictive level. Suitable equipment is available to prevent the development and spread of airborne contamination. There are sufficient fixed monitors as part of the plant monitoring system (KRT) as well as portable monitors to measure airborne contamination. The monitors of the KRT system are provided with alarms in the main control room and satisfy the present plant needs. The SRP is responsible for this part of the KRT.

External contamination is checked by sensitive personnel monitors (portal monitors) in two stages at the exit of the controlled area. Internal contamination is determined by whole body counting on a routine basis. This monitoring is done every six months for EdF workers. For contractors the whole body counting is performed on the site at the beginning and end of the work period. Urine measurements are taken if the whole body count gives rise to additional investigations. Should there be a case of internal contamination, the resulting dose would be calculated according to ICRP-54. The plant has a spacious and fully equipped facility for the treatment of contaminated persons, which is considered to be a good performance.

- (a) **Good performance:** The medical centre has spacious and fully equipped facilities for the decontamination and simple medical treatment of any person on the site. Persons contaminated in the controlled area can be transported to the medical

centre. By timely administration of appropriate treatment the intake of radioactive material in the body can be decreased.

The plant has a contract with a military hospital in Cherbourg for the treatment of contaminated and/or irradiated persons who need full time treatment off-site. This hospital has the required facilities.

6.4 Instrumentation, Equipment and Facilities

The plant has sufficient fixed and portable radiation protection instrumentation for normal operation, outages and emergency situations. Instrumentation covering the full range of ionizing radiation, and all categories of contamination present in a nuclear power plant, are available. The instrumentation is readily accessible during operation as well as outages. The instruments are calibrated annually by an outside contractor, who is accredited by the Bureau National de Metrology. The fixed instruments (portal monitors) are checked by the SRP every month in accordance with procedures. All instruments are labelled with the date of calibration. The status of the instrumentation is well controlled. Although the unit of radioactivity used at the plant has changed over from the old units, Curie (Ci), to the Système International (SI), Becquerel (Bq), both old (rem) and new (Sievert) units of dose (equivalent) are in use. During the review it was found that both old and new units were used for dose (equivalent) and dose (equivalent) rate on instrumentation, bags of waste and stickers, and in procedures and instructions. This could be confusing for the plant personnel and can give rise to mistakes.

- (1) **Recommendation:** The plant should establish a mid-term plan to change over from the old unit (rem) to the Système International unit (Sievert) for the dose (equivalent) and dose (equivalent) rate, so that within two to three years the new unit for dose is used throughout the plant. This would prevent misunderstanding and eliminate a possible source of a mistake that might lead to an increased irradiation risk.

Plant response: (May 1996) Flamanville has defined a strategy for changing equipment units, taking into account the following criteria:

- *changing units at the same time to avoid having old models and new models of equipment simultaneously present. This eliminates a major source of errors.*
- *changing units after the two ten year inspections (Unit 1 in 97 and Unit 2 in 98) in an effort to avoid additional inconvenience to the workers during these special periods within the life cycle of the NPP.*

The action plan chosen by the site is as follows:

Maintaining the present provisions:

- *label showing the equivalency between Sievert and Rem affixed to each unit,*
- *utilization of Sieverts in documents (procedures, expert report)*

1996: Technical study on the modifications to be made on the units.

1996/97: Purchase of 20 radiation meters in SI units reserved exclusively for use by radiation protection section employees.

November 1998: Information to Flamanville sub-contractors.

December 1998: Modification of units: Removal of units which have not been modified.

As of 1 January 1999: The only units used will be the Gray and the Sievert

1999: Training Flamanville sub-contractors.

IAEA comment on status: (June 1996) A well structured programme for the mid-term has been developed although completion within two to three years as envisaged by the OSART team will not be achieved. Once all the steps in the programme as outlined above have been completed, the issue can be considered to be fully resolved.

Conclusion: *Satisfactory progress to date.*

There is sufficient protective clothing and equipment available in the controlled areas. Workers have ready access to protective clothes and equipment during normal operation as well as during outages. The plant has a spacious laundry with sufficient equipment, situated in the site hot workshop building. The decontamination workshop is to be found in the same building. The equipment in the workshop is sufficient for all decontamination activities. However, the state of the coating of the floor and walls of the decontamination workshop is in need of some remedial work. At several points in the decontamination workshop the coatings of the walls and floor have deteriorated, making decontamination at these points difficult or impossible. It is recognized, however, that recoating of the walls is planned. This work was scheduled prior to the commencement of the mission.

- (2) **Suggestion:** Consideration should be given to correcting the deficiencies found in the coating on the walls and floors in the site decontamination workshop, so that decontamination activities can be performed thoroughly.

Plant response: *(May 1996) Restoration work on the paint coatings in the decontamination workshop and the hot workshop was carded out in March 1995 for the 'rises' on the walls and in December 1995 for the floors.*

IAEA comment on status: *(June 1996) The decontamination workshop was visited by the follow-up team and the coatings on walls and floor were found to be free of deficiencies.*

No decontamination activities have taken place since the coatings were repaired so there is, as yet, no experience of the effectiveness of the repairs.

Conclusion: *Issue resolved.*

6.5 Personnel Dosimetry

French regulations prescribe film dosimeters for the measuring of external exposure. For EdF employees the supply and the interpretation of the results are undertaken by the radiological protection and environmental department (DSRE) of EdF on the authority of the central Office for Protection against Ionizing Radiation (OPRI). The supply and evaluation of the dosimeters for contractors is also provided by the OPRI. Contractors have to bring their dosimeters with them to the plant.

The dose limits given in regulatory requirements are consistent with the ICRP-26 recommendations. The dose limits recommended by the ICRP-60 (published in 1990) are planned to be fully implemented by the year 2000. The minimum detection level for film dosimeters is set by the regulator at 0.5 mSv. This minimum detection level seems high compared to ICRP-60 recommendations with respect to dose limits. However, the present practice is that the minimum level of recording doses read on films is set to 0.2 mSv for EdF and contractor workers.

EdF has introduced an electronic dosimeter system (SAPHYMO/DOT 80) for operational dosimetry of EdF and contractor personnel. This system overcomes the inevitable delay in receiving dose history from the film badge system and, more importantly, allows job related doses to be determined. In 1992 EdF introduced a computerized program in all plants that makes computerized monitoring of the dosimetry of everyone entering the controlled areas in EdF sites possible. This enables each site to consult the records of all EdF and contractor workers.

It was observed that extremity dosimeters are not used and that individual neutron dosimeters are not used for persons who have to enter the reactor building during operation. In these cases, doses are calculated on the basis of data measured during the startup of the reactor. During the removal of spent fuel from the plant, individual neutron dosimeters (known as 'bubble' dosimeters) are used. The neutron dosimetry is considered to be sufficient. The justification for the lack of extremity dosimetry is less acceptable, because for special jobs the extremity dose can be considerable and may reach or even exceed the dose limit for extremities before the whole body dose is reached. The absence of extremity dosimetry was previously identified as an issue at Gravelines NPP in 1993. That same year, experiments were carried out at Flamanville to monitor doses during work on the secondary side of steam generators. The main result from these experiments showed that the extremity dose is only a problem in the case of televisual inspection. Meanwhile, Gravelines NPP has instituted a study to determine the feasibility

of monitoring extremity doses using finger rings on extremities during high radiation tasks (status November 1994).

- (1) **Suggestion:** Consideration should be given by the Flamanville NPP to reviewing the results of the studies being carried out at Gravelines NPP to determine the feasibility of monitoring extremity doses. If the review of these studies gives rise to Gravelines NPP taking measures, then Flamanville NPP should also consider taking measures to implement extremity dosimetry. The assessment of the studies should provide the SRP with a realistic impression of the current approach in this subject.

Plant response: (May 1996) *In 1993, EdF carried out a study on the 900 MW sites in order to study the relevance of implementing extremity dosimetry surveillance. The results of this study have shown that:*

- *the major improvements made to tools, since 1990, have lead to a reduction in extremity exposure time, therefore the dose equivalents;*
- *no overshoot beyond the regulatory limits of 300 mSv/quarter was observed,*
- *hand extremity dosimetry must be monitored during certain operations given that the dose rate equivalent of the extremity dose is sometimes greater than 10 times the equivalent dose rate for the entire body.*

In June 1994, EdF initiated a survey, through the WANO network, among operators in Belgium, Germany, Canada, Sweden, the United States and Japan. The purpose of this survey was to know if these countries took extremity dose rate equivalent measurements for operations in which the dose rate equivalent is greater than the ambient dose rate equivalent. As of 31 December 1995, ten operators have answered this survey.

Response analysis is used to confirm the orientations chosen for writing the recommendations concerning the methods and equipment. By the end of June 1996, the industrial safety, radiological protection and environment department (DSRE) will establish for the policy for:

- *maintenance activities concerned by extremity doses,*
- *the rule to apply for dosimetry monitoring,*
- *the monitoring and counting method,*
- *the equipment available.*

As soon as this policy is released, the site will implement the required provisions for extremity dosimetry monitoring whenever the nature of the service operation so requires..

IAEA comment on status: (June 1996) *The results of studies at Gravelines NPP will be the basis of the recommendations to be issued by DSRE by the end of June 1996. Flamanville NPP staff have prepared a programme that they, expect will be implemented before the end of 1996.*

Conclusion: *Satisfactory, progress to date.*

Since 1990, the collective dose has stabilized at a relatively low value of about 1 Sv per unit. The individual doses for the group of workers with the highest radiation exposures (more than 10 mSv/yr) have decreased considerably.

6.6 Radioactive Waste, Storage and Discharges

On the national level it is the responsibility of the National Radioactive Waste Management Agency (ANDRA) to ensure that the storage of the solid radioactive waste complies with the fundamental safety rules issued by the Nuclear Installations Safety Directorate (DSIN). ANDRA has converted these rules into specifications for the different stages of waste management. To comply with these ANDRA specifications, the DSRE has established guidelines for the packaging process and the package characterization (results of tests required).

The general section (SGX) of the technical and environmental department (STE) of Flamanville is responsible for the production of a package conforming to ANDRA specifications. Packages are managed and tracked by the power plant using the national radioactive waste management software (DRA), whereby the characteristics of the packages to be stored are entered and transmitted to ANDRA.

Solid waste treatment at Flamanville nuclear power plant seems to be well controlled. Since 1990, Flamanville NPP has succeeded in considerably reducing the volume of solid radioactive waste and plans further reductions. Notwithstanding extensive maintenance work to be done in 1995 (repair of the reactor vessel head of unit 1), the objective for 1995, with respect to radioactive waste, is the same as for 1994. Personnel at the power plant are well aware of their responsibility for the reduction of the amount of radioactive waste.

Experience feedback in the field of radioactive waste management takes place in solid waste treatment system (TES) seminars organized by the DSRE twice a year. Representatives from all 900 and 1300 MW EdF sites take part in these seminars.

The responsibilities for operation and control of effluents are well defined between the operations department and the technical and environmental department respectively. The effluents are monitored before release into the environment and are recorded in a statutory register. The registers are sent to the OPRI at the end of each month after the plant director has signed them. The Flamanville plant has established an effluents committee to give technical support to the NPP management. This committee has representatives from several departments who make plans, define actions and make proposals.

Flamanville NPP's authorizations to release liquid radioactive waste forbid the release of α emitters into the environment. Each liquid effluent release is monitored for

the absence of α emitters. OPRI must be informed if any α emitter is found in the samples. In such a case, it would define the additional measurements to be taken and the release conditions for the effluent. Except for tritium, the activity of the gaseous releases is currently less than 1 % of the regulatory limits. Since 1988, Flamanville NPP has succeeded in considerably reducing the activity of all liquid releases, except for tritium. The present objective is to keep the activity of all releases, except tritium below 1 % of the regulatory limits. For tritium, the objective is to keep it on a constant level at about 40% of the regulatory limit. Notwithstanding the present status of low releases of liquid effluents, the plant has identified that there is room for improvement. The production of wastes especially of liquid waste during normal operation can be decreased and a working group has recently started a study of this aspect.

Fuel integrity is checked three times a week. If a fault is present, the technical specifications prescribe the course of action to be taken (increased monitoring and shutdown within six hours). As a result of these precautions, uncontrolled fuel leakage and release of fission products into the primary circuit is almost excluded. However, it is noted that OPRI does not require monitoring of the presence of Sr-89 and Sr-90 in the liquid, as well as in the gaseous releases which is normal practice in many nuclear power plants.

Monitoring of the environment with respect to radioactivity is performed in line with the interministerial orders on discharges of radioactive liquids and gases from the nuclear power plant. These orders prescribe, amongst other requirements, the inspection procedures by OPRI which govern the frequencies, sample analysis and counting, as well as the inspection of measuring instruments.

Flamanville NPP has an environmental laboratory located at Les Pieux outside the site boundary for the analysis and counting of the samples. The routine monitoring of the environment is done by the measurement of tritium and total α activity in the different samples that are collected periodically. At the request of the plant and in accordance with French regulations, the Atomic Energy Agency (CEA) carries out more specific studies on the levels of natural and artificial radioactivity in the land and water ecosystems around the plant site 4 to 5 times per year. Together, both programmes form a comprehensive monitoring of the radioactive environmental impact caused by the plant. It covers all the potential impacts that the operation of the plant may have the environment.

6.7 Radiation Protection Support During Emergencies

During an emergency, the local logistics emergency centre (PCM) and the local assessment emergency centre (PCC) are responsible for the protection of everyone on-site and the estimation of the quantity of radioactivity to be released and the radiological

effects on-site and in the environment, respectively. The responsibilities of the PCM and PCC members are well defined.

The PCC has manual and computerized means for the assessments mentioned above. For a rapid determination of the accident envelope (upper bound accident) and the potential maximum doses and radiological consequences, the PCC has a user friendly procedure based on the diagnosis of the state of the three barriers (fuel cladding, primary circuit and containment). A computer is available with user friendly and fast software for the diagnosis of the releases and the radiological consequences in the environment (whole body and thyroid dose as well as ambient radiation are calculated in parallel). There is on line input of the meteorological and dose monitoring data into the computer. The final version of the software will be installed in 1995/96. This will permit the on-line input of stack flow, activity released from the stack and the monitoring of parameters to check the functioning of the safety systems in an accident situation. As a result hand calculations of the source term will become superfluous and thereby make the assessments more reliable.

- (a) **Good performance:** In the event of an emergency, Flamanville nuclear power plant has well equipped facilities to give the desired radiation protection support. They are user friendly and include the capability to rapidly assess releases and the radiological consequences to the environment, good facilities for monitoring the plant and the environment as well as facilities for the reception and decontamination of affected personnel.

Radiation protection personnel form part of the PCC and PCM. Most actions requested during an emergency situation are part of their job during normal operation. They take part in the training of their respective local emergency centre.

The on-site emergency plan (PUI) technical training is carried out within the departments and in the specific local PUI training. Based on the professional knowledge and skill exhibited during the demonstrations of the different radiation protection activities in case of an emergency, the training seems to be sufficient.

7. CHEMISTRY

The chemistry section of Flamanville NPP has a well qualified and highly motivated team. All tasks, duties and responsibilities are clearly defined. Additional assignments are agreed in contracts. The staff have demonstrated that they are fully aware of their responsibilities and very familiar with the plant by the care they take to ensure safe operation. The formation of follow-up study groups has been an effective means of involving personnel in long term technical work and in improving their understanding of safety culture. The training of staff is conducted in an organized manner and effectively leads to the chemistry staff gaining sufficient knowledge and skills to be authorized. This is another contribution to nuclear safety.

The corporate organization of EdF defines the plant chemistry policy. Corporate departments such as GDL and DSRE give considerable and valuable support. Guidelines, specifications and many procedures have been created by these departments. All improvements require the permission of the corporate level. A liaison engineer from GDL is responsible to support the plant chemists. The policy and performance of plant chemistry correspond to the international level; performance can be compared easily using the WANO index. A modern sampling system in both units enables the analysis of all specified chemical parameters to be well managed. The specifications are in agreement with the international standard.

The laboratories are well equipped; instrumentation is well cared for. It is also true of the extensive number of on-line monitors. The organization and documentation of maintenance, calibration and checks of laboratory equipment and on-line monitors is managed in an excellent manner. All data and test results are recorded and reported. Computer applications make the evaluation of data easier.

In addition to their surveillance tests, the chemistry staff are responsible for the conditioning of the circuits and the production of demineralized water. These activities are also well managed. Various means are used by the chemistry section to assure quality and these contribute to a good chemistry performance.

A number of recommendations and suggestions are made. These include chemistry performance indicators, long term evaluation of plant chemistry, measurement of total organic carbon and international experience feedback and the post-accident sampling system. These are offered as a means of improving on the present good performance.

Implementation of improvements proposed by the OSART team in the chemistry area have progressed well. Five of the seven issues identified by the February, 1995 OSART have been fully resolved. A better range of chemistry indicators have been introduced, plant chemistry evaluations are included in annual reports and activity, build

up is included in the ALARA work. The question of measurements of total organic carbon is resolved; the follow-up team accepts EdF's arguments. The taking of representative samples of corrosion products is covered by a new procedure, which has proved to be effective.

The remaining two issues are progressing satisfactorily. The proposal that a limit for suspended corrosion products at startup should be set, will be resolved albeit in an alternative manner, once a mobile secondary circuit purification system has been acquired by Flamanville NPP. The issue of post accident sampling has been given significant attention by EdF and a number of studies have been carried out. Discussions are ongoing to confirm a new strategy. Automatic hydrogen meters in the containment have yet to be installed.

7.1 Organization and Functions

The chemistry section together with the test section and the general section is part of the technical and environmental department. This has a common resource of two engineers and an environment supervisor. The chemistry section is responsible for the conditioning of the circuits, production of demineralized water, monitoring fuel integrity, testing of gaseous and liquid effluents and assessing the environmental impact as well as the performance of chemical and radiochemical surveillance.

The head of the chemistry section has two senior foremen, who supervise longer term work and three foremen for the daily work of the Unit 1, Unit 2 and effluent-environmental groups. These groups in total consist of fourteen technicians and four skilled workers: they are not assigned to shifts. The duties of the staff are rotated between all jobs of the groups. The minimum staffing level of skilled technicians and supervisors for the routine daily work is specified. One foreman and two technicians are on call to provide cover in case of plant events that require chemistry expertise.

A daily meeting takes place in each group to distribute the work and to give information on conditions of the units. The senior foreman or the head of the section participates in a daily work request meeting, where work orders are assigned to operations, I&C, nuclear safety, mechanical departments or the chemistry section. These meetings are effective in assigning the routine work and in the exchange of information.

GDL provides technical support, perform tests and analyses, provide controls, training activities, examinations and investigations, and give advice in their technical area. GDL also organizes technical exchanges on the national and international level. GDL is also responsible for determining the chemical specifications and for defining and controlling the water chemistry policy. Improvements cannot be introduced before GDL has checked and approved the proposal.

A specific GDL engineer is responsible for supporting Flamanville's chemistry section. Regular meetings take place four times a year. This liaison engineer from GDL, who can provide and obtain assistance for all chemical problems on site, is considered to be a valuable contribution to good performance.

The industrial safety radiological protection and environmental department (DSRE) of EdF gives similar support in the area of radiochemistry and develops specifications and procedures on a national level which have to be adopted by each NPP.

New staff members are trained in accordance with an individual training plan based on the national and local training programmes and the standard training plan (PTF) of the technical and environment department.

- (a) **Good Performance:** The arrangements for training new staff members are good. An experienced technician is given a contract (terms of reference) to provide shadow training for a new worker. The contract contains objectives, roles, duration, fields of knowledge and interview dates for the various stages of assessment of the trainee. The training of a new entrant includes attendance at an EdF training centre. After one year of training, authorization will be given according to the interview result. All training including refresher training is registered in the documents of individuals.

Following successful completion of training, staff are authorized at one of four nuclear safety levels. Chemistry staff who work in the controlled area need, in addition, a radioprotection authorization. Chemistry authorizations are evaluated and formally recorded by the head of the section. Evaluation covers technical and professional skills, knowledge of quality arrangements, installations and industrial safety and awareness of the consequences of her/his actions on nuclear safety. Criteria for classifying the competence of each functional group is in preparation for implementation by the end of 1995.

Fifteen performance indicators are used by the section head to monitor the chemistry section. Most are not related to plant chemistry but to improvements in management and organization, such as number of hours participating in the study and follow-up groups (GES), the amount of time spent by the head foreman in the field or number of 4x9 working hour permutations. Only a few, such as the minimum number of employees in the laboratory, calibrations of chemical monitors not completed by the deadline and the number of service operations not performed on laboratory equipment, might be considered as indicators of safety or performance of the chemistry section. Some indicators important to plant chemistry and safe operation are not included.

- (1) **Suggestion:** Consideration should be given to devising more indicators of *plant chemistry* performance. They might be based, for example, upon the goals and objectives of the chemistry section. Use of such a selection of indicators should

lead to early identification of unacceptable plant conditions allowing corrective actions to be less extreme to be effective. Indicators in use at other plants include the time during which the steam generators are without lay up during outage and the time during which the chemical concentrations of important impurities are outside certain control limits. Grouping the performance indicators into plant chemistry and management and organizational issues might help focus attention on those that are of greater immediate importance to safety.

Plant response: (May 1996) *New performance indicators have been included in the chemistry section monthly report. They were defined during a liaison meeting with the liaison engineer from the corporate chemical and metallurgical laboratory (GDL).-*

- *definition of a local limit for sodium content during steam generator blowdowns;*
- *definition of a local limit for cationic conductivity during steam generator blowdowns;*
- *definition of a local limit for dissolved oxygen content in the extracted condensate;*
- *computation of the quantity of dissolved oxygen transported in the extracted condensate. This value is compared to a reference value which is computed based on the above mentioned local limit,*
- *computation of the quantity of sodium ingressing into the secondary circuit as makeup water impurities. This value is compared to a reference value which is computed based on the makeup water sodium limit value.*
- *computation of the quantity of dissolved oxygen added to the primary circuit by the reactor boron and water makeup system (REA). This value is compared to a reference value which is computed based on a theoretical value of makeup water and the dissolved oxygen limit value.*

These various indicators are used for rapid detection of changes that, over time, could lead to a specification overshoot. Changes and local limit overshoots must be explained in writing.

A summary table showing the overshoots of these sodium and conductivity limits in the steam generator, oxygen overshoots in the extracted condensate, and lithium overshoots in the primary circuit is included in this report. A graphic follow-up of the WANO chemistry indicator has also been included.

This monthly report is written by a senior foreman, checked by the section head and distributed to all the departments on site.

IAEA comment on status: (May 1996) *The power plant expanded the list of plant chemistry performance indicators, mainly those that are related to the quantity of the corrosion products in the circuits. The intent of the suggestion has been met. The monthly reports are well structured and useful for following and analysing the results.*

Some of the analyses have already triggered field activities such as blow-down design changes.

Conclusion: *Issue resolved.*

7.2 Chemistry Control in Plant Systems

Plant chemistry is controlled and monitored in accordance with a guideline that was developed and published by GDL. This EdF guideline, which includes specifications for the primary circuit, the secondary circuit and the auxiliary systems, is valid for all NPPs of the PWR type. However, differences in materials and design are taken into consideration. Moreover, action levels and advice with regard to transients are described. The size and frequency of the surveillance programme and on-line monitoring are also specified in this document.

Power operation is characterized by frequent variations of power. This has a negative influence on water chemistry of the main circuits in general, and, for example, on cladding condition and activity buildup. Strict compliance with chemistry specifications is therefore all the more important. A co-ordinated boron/lithium chemistry regime is used for the primary circuit. During most of the fuel cycle, the pH_{300} will stay at 6.9, in accordance with the actual specification, before it gradually increases to about 7.3 by the end of the cycle. GDL has successfully carried out tests for operating at a constant pH of 7.2. EdF wish to move to this new regime as soon as possible and has applied to the safety authority (DSIN) for this change. Safety has been considered in the manner by which the pH change is to be accomplished, that is by keeping lithium at its present level. Higher corrosion rates of primary circuit components would occur if the change was wholly or partly achieved by allowing lithium levels to rise. EdF is encouraged to implement the new regime as soon as possible since this will assist in minimizing activity build up. Avoiding the use of materials with high levels of cobalt and monitoring for the development of the activated corrosion products are means to minimize dose rates as well as an optimized chemistry regime. These objectives should be given more attention.

The chemists at Flamanville do not carry out evaluation of data covering longer periods, for example by comparing data from successive cycles. This type of review is widely used elsewhere to assist in identifying slowly changing plant chemistry conditions, for example, to detect influence of materials in the primary circuits. One typical parameter is the ratio of Co-58 to Co-60. It is well known that nominally similar units at the same place have different dose rates. Changes in concentration and changes in the activity of corrosion product nuclides are caused by factors such as performance of coolant chemistry, materials, condition of surfaces, power manoeuvre, number of start-ups and shutdowns.

- (1) **Suggestion:** Consideration should be given to including into the ALARA work the issue of activity buildup. The need to evaluate the issue should be given added importance, because of the planned change of primary chemistry. The objective should be to ensure that the dose rate will decrease as expected and, generally, that unwanted influences on dose rate can be detected and then excluded by corrective actions.

Plant response: (May 1996) A working group, as part of the ALARA project has studied the reduction of 'hot points' due to activity accumulations in parts of the circuits:

- flushing procedures have been developed to remove them;
- circuit modification studies are being carried out in order to eliminate them completely.

The chemistry section, using weekly measurements, monitors the value of corrosion products, which are kept as low as possible by filtration and passing them over ion exchange resins. 0.45 micron filters are used for filtration. The corrosion product content analysis is performed by the chemistry section and written up in its monthly report. In a similar manner, the annual report will show an analysis over several years.

At the national level, there are plans to modify the primary chemistry specifications: increasing the pH to reduce the amount of corrosion products. The corporate chemical and metallurgical laboratory is overseeing this operation; the above mentioned weekly measurements will be used to ensure:

- a drop in corrosion product content
- an accompanying drop in the activity indices of the units.

Before each outage, the radiation protection section establishes the dosimetric index based on 13 specific points in the primary circuit and measures the dose rate. The long term follow-up shows that this index is decreasing at a rapid rate.

IAEA comment on status: (June 1996) In addition to the plant's response, a policy application document was produced, from which all the described activities stem. The calculation of the dosimetric index is based on an EdF definition and is used by all EdF plants. Activities resulting from the suggestion include the review and upgrading of flushing procedures, circuit modifications aimed at eliminating some hot points and to change to filters of smaller mesh.

Conclusion: Issue resolved.

The materials used for the main components of the secondary circuit are generally in agreement with accepted international practice, for example, stainless steel is used to reduce the effects of erosion/corrosion in low pressure feedwater heaters. The use of titanium for condenser tubes should avoid an ingress of copper into steam generators and also tube leaks. The lack of tube leaks avoids an ingress of sea water into steam

generators. Carbon steel is used for tubes in the high pressure feedwater heaters. However, this difference is unlikely to have any significant adverse effect because an all volatile treatment (AVT) chemistry regime with a pH range of 9.6-9.8 has been adopted, a regime that is permitted because the secondary circuit is free of copper bearing alloys. The relatively high hydrazine concentration in feedwater of 120 ppb ensures that reducing conditions are maintained in steam generators. The use of inconel 600 for steam generator tubes imposes a further need for strict compliance with the specifications of the chemistry regimes of the primary and secondary circuits, particularly with respect to the sodium limit. A new lower limit for sodium in the make-up water (< 2 ppb instead of < 5 ppb), as planned by GDL, should be introduced as soon as possible. This is particularly important as the cation resins of the blow down purification system (APG) are used in the ammonia form. A further concern is that no attention is given to organic pollutants although it is acknowledged that the few steam generator tube leaks that have occurred at Flamanville NPP have not been caused by secondary side corrosion. However, there is no criteria for total organic carbon content in demineralized water. Routine measurements of organics in demineralized water are not made even though it is possible for organic pollution to cause corrosion problems in steam generators. It is a widespread international practice on PWR plants to periodically measure total organic carbon mainly in demineralized water. The last measurements at Flamanville were carried out in 1986.

- (2) **Suggestion:** Consideration should be given to taking periodic measurements of total organic carbon (TOC) in demineralized water, to check if satisfactory conditions persist. Further actions should be placed as appropriate depending on the actual presence of TOC. This measure could minimize a potential corrosion problem of steam generator tubing.

Plant response: (May 1996) A letter (D5330/BNN/STE 003110) was sent to the corporate chemical and metallurgical laboratory (GDL) asking it to take this suggestion into consideration. It has not been demonstrated that the presence of organic matter in the steam generator causes steam generator tube deterioration.

Demineralized water is prepared according to a clarification process followed by a demineralization process over cationic and anionic resins and on a mixed finishing bed. The operation of the demineralization station is checked annually.

A study carried out in Flamanville in 1986 (D5001/086 2857/LND/BLA) has shown that this water preparation process considerably reduced organic compound content. Since 1986, given that the water preparation process has not been modified, EdF feels that measuring TOCs on a regular basis is not necessary. Moreover, in the steam generators, the presence of organic matter would be detected by measuring the cationic conductivity during the steam generator blowdown. All of the above elements give us cause not to need this type of measurement.

IAEA comment on status: (June 1996) *The follow-up team accepts the EdF arguments supported by a corporate report done for Chinon NPP about the results of TOC measurements.*

Conclusion: *Issue resolved.*

Although some good precautions are taken during startup to ensure that the water in the secondary circuit is sufficiently pure before feedwater is diverted to the steam generators, the criteria for suspended corrosion products are not considered when deciding when to finish purification. This is of concern because many corrosion products that may form during the outage will migrate at this time and their concentration should be below that given in the feedwater specification.

- (3) **Suggestion:** Consideration should be given to including a limit for suspended corrosion products in the criteria for deciding when to stop the purification of the water in the secondary circuit during startup and prior to diverting the feedwater to the steam generators. This will assist in avoiding the ingress of suspended corrosion products, which can accelerate wastage and pitting in the steam generators. Care is needed to ensure that the presence of corrosion products that may form during the outage are within acceptable limits before feedwater is admitted to the steam generators.

Plant response: (May 1996) *A letter (D5330/BNN/STE 003110) was sent to the corporate chemical and metallurgical Laboratory (GDL) asking it to take this suggestion into consideration.*

GDL is aware of potential corrosion problems linked to the presence of suspended solids in the steam generator feed water (they could form during normal operation or during outages). GDL tries, through the choice of treatment or the equipment lay-up policy during outages, to minimize their quantity and the harm that they cause. Nonetheless, GDL is not favourable to establishing a total suspended solids limit as a criteria for switching between the auxiliary feed water (ASG) and feed water flow control (ARE) systems. Setting up such a limit could be envisaged only if there were a reliable associated measurement method. Manual measurement by filter integration does not come under this category given that not only is it difficult to have a representative sample, it has the disadvantage of providing a long and discontinuous measurement. Measuring for total suspended solids can only provide an approximate assessment which would be inadequate as a criteria for ASG/ARE switching.

At Flamanville, the steam generator tubes are made of thermally treated Inconel 600 and the spacer plates have quadrafoil holes. For this reason, the presence of suspended solids in limited quantities in the steam generator feed water during ASG/ARE switching does not pose a major risk of corrosion in the steam generator. This is confirmed by, the absence of tube deterioration after several operating cycles.

Moreover, a national modification involving installation of a mobile secondary circuit purification system at start-up will be gradually implemented at all the sites, which will reduce even further the suspended solids transported in the steam generator during start-up.

Nonetheless, a local indicator, based on measuring total suspended solids, has been implemented. Among other things, it is used to assess any pollution stemming from outage work and determine the quality of equipment lay-up during outages.

IAEA comment on status: *(June 1996) A reliable method for measuring suspended corrosion products cannot be achieved at Flamanville unless sampling systems are changed. There is no intention to change sampling systems. Measures to minimize corrosion products, in place before the 1995 OSART mission, included modification of equipment layout during an outage, use of hot blowdowns of the secondary circuit, use of hot, dry air for cleaning and drying of heat exchanger tubes during an outage. The new mobile secondary circuit purification system will additionally substitute for the intent of the suggestion. The corporate technical operating committee (CTE) has prioritized the sites based on the extent of steam generator tube damage. Flamanville is ninth out of fifteen sites to receive the mobile system. All sites will have received their mobile system by the year 2000.*

Conclusion: *Satisfactory progress to date.*

7.3 Chemical Surveillance Programme

The chemical surveillance programme is based on three EdF documents that have been incorporated into an application memorandum, ST/004. The memorandum contains all the chemical and radiochemical tests that are required to be carried out during each operational phase of the plant, including the frequency and maximum time period between tests. The results of each day's tests are recorded in special weekly logbooks. After an independent check of the result by a chemistry foreman, a copy of the record sheet is sent to the operations department.

Quality assurance in the chemistry section is based on a corporate national quality manual and the plant quality manual. A QA management team and a QA supervisor in the nuclear safety department coordinate all checks. Spot checks are made by the nuclear safety department to check compliance with the manuals. Cross checks, all part of the QA measures, are carried by other organizations such as DSRE. Checks on the authorization of personnel are also included.

Maintenance, calibration and checks of on line and laboratory monitors are excellently, managed and documented. Flamanville receives valuable corporate support with respect to advice for on-line monitors. GDL is responsible for testing these

instruments, and issues lists of equipment that they have authorized for use in EdF's nuclear power plants. Flamanville uses only approved on-line monitors.

- (a) **Good performance:** The excellent management and documentation of calibration, checking and maintenance of on-line monitors and laboratory equipment is considered to be a good performance. Each activity that has to be carried out has been described in a procedure. Different forms for recording such jobs as calibrations, tests, preparation of laboratory reagents, all of which have to be performed weekly, enable the foremen to easily distribute the daily work and to check that all tasks have been fulfilled. Further forms permit an effective evaluation of the conditions of each instrument and monitor. These documents form part of equipment's lifetime history.

The sampling systems for the primary and secondary circuits of both units are in a good condition and are connected to a sufficient range of on-line monitors. The same sample lines are used for taking grab samples. The management and documentation of the sampling and on-line systems are excellent, with suitable procedures for maintenance, calibration and cross checks. However, grab samples for corrosion products are taken without waiting long enough for samples to be representative. Samples taken too early will give misleading results. The sampling procedure does not specify the waiting time. Technicians wait for a period between 1 and 15 minutes depending on who is taking the sample.

- (1) **Suggestion:** Consideration should be given to ensuring that grab samples taken for corrosion products are representative. After changing the flow condition by opening the sample isolating valve, corrosion products that have built up in the sample line would collect in samples that are taken too early. A waiting time of between one and two hours is generally considered to be sufficient to overcome this effect depending on the piping arrangement. The appropriate waiting time should be established taking into account the local arrangements, and the procedures should be amended accordingly. For some countries the required waiting time is defined in national standards, for example, DIN standards for Germany.

Plant response: (May 1996) Subsequent to this suggestion, two new procedures were written concerning sampling procedures on the primary circuit and its annexes, as well as the secondary circuit and its annexes. They have the following numbers respectively: GICH001101 and GICH01103. They contain:

- a description of all samples taken,
- the functional identifier of the isolation valves,
- the functional identifier of the sampling valves,
- the length of the sampling line,
- the minimum blowdown time (in minutes) which ensures sampling quality.

IAEA comment on status: (June 1996) *As a result of implementing new procedures in the field, the personnel have been more attentive when taking samples. The quality of sampling has increased as has the quality of samples.*

Conclusion: Issue resolved.

7.4 Chemistry Operational History

After checking the chemical and radiochemical results by the foreman, the data are stored daily by the technicians in a computer database system. Every two to three days, the head of the section validates the data by inspection which freezes the data. A computer network enables other departments on site and GDL to readily access the data. Results of infrequent analyses and test reports on chemical monitors and measuring equipment are manually recorded on forms that are distributed and then archived in the laboratory. These records do not form part of the computer database.

In addition to monthly and annual reports, the chemistry section writes reports about investigations, tests, various internal incidents and events. The monthly report is extensive and contains graphical presentations that are effective. With regard to the effluents the monthly report covers all data of the current year. This means, for example, that in the December report a survey for the whole year is given. The annual report is dominated by administrative evaluations and balances and consumptions of chemicals. It contains the corresponding objectives for the following year and the WANO chemistry index for the past year but insufficient indications of the plant chemistry performance. There are no technical evaluations, conclusions, predictions or graphs to give assurance that there are no undesirable trends.

- (1) **Suggestion:** Consideration should be given to including appropriate evaluation of plant chemistry in the chemistry annual report. Such evaluation should be directed to detect and to report changes that occur slowly over the. In this way the effects of, say, changes in materials or any other unknown causes may be identified and corrected. These evaluations could be more beneficial if comparison with other plants and with previous times were included.

Plant response: (May 1996) *Subsequent to this suggestion new indicators have been included in the annual report :*

- *Tracking the WANO chemistry index for each unit, compared with several reference values (previous years and values of other French plants conditioned with ammonia).*
- *Tracking of the number of overshoots for local values and specifications (sodium and steam generator conductivity, extraction oxygen, and reactor coolant system*

(RCP) (lithium hydroxide). These overshoots are analysed by a senior foreman and validated by the section head.

- *Any long term changes in parameters detected and deemed important are also included in the annual report (silica change in the borated circuits of Unit 1, reactor boron and water makeup system (REA) water diaphragm.)*

All of these indicators give an overall view of developments in chemical parameters. These indicators have been chosen due to their importance to circuit integrity. Annual objectives have also been established in an effort to measure any deviations observed and improve the quality of chemistry in our units.

IAEA comment on status: *(June 1996) The content of annual reports has been enlarged also by the monthly reports assessments. All abnormal values are explained in the report and comments on all trends are included.*

Conclusion: *Issue resolved.*

In addition to the experience feedback system (REX), where the Flamanville information is entered by the nuclear service section and is available both to EdF and all competent departments, EdF has set up a rapid experience feedback system (RER) to capture national experience. In contrast to REX, which requires the fulfilment of demanding administrative regulations, RER can be used by all engineers directly. This system is often used by plant chemists to request information from colleagues elsewhere and so benefit from experience in other EdF plants. International experience feedback is provided to the plant by GDL only. Plant chemists have a national meeting once a year. Meetings take place quarterly with the on-site GDL liaison engineer.

Despite these arrangements, the staff were found to have a narrow view of the work and to have little appreciation of issues outside the immediate scope of the work assigned to them. Plant chemists in many other countries have a wider international perspective. For instance, the chemists at Flamanville do not appear to be familiar with the wider chemistry issues that chemists in nuclear power plants in other countries consider to be important to their ability to provide fully effective plant chemistry service. Flamanville's chemists do not appear to be familiar with topical issues of foreign nuclear power plants, including plant chemistry, chemistry policy, new international results, trends and investigations with which to compare with their own results and to improve chemistry performance and nuclear safety. A technical library does not exist on site to provide them with a sufficient number of corresponding journals and publications. A suggestion with regard to this issue is given in section 1.2.

7.5 Laboratories, Equipment and Instruments

The chemistry section has enough laboratories for their activities. These comprise a cold and a hot laboratory with a separate room for activity measurements in the administrative building, two well equipped laboratories (SIT) containing on-line monitors that are located in each turbine hall, two laboratories (REN) for primary sampling in the auxiliary buildings and a laboratory in the demineralization plant. All laboratory rooms are kept clean and tidy including storage of laboratory reagents. All chemicals are appropriately labelled including the expiry date. All necessary industrial safety equipment is available. All guides and procedures are available in cabinets in each laboratory. The personnel were competent in the use of all devices and procedures. Sufficient laboratory equipment is available for carrying out tests in nuclear power plants, such as titrimeters, gas chromatographs, atomic absorption spectrometers (flame and graphite tube), ion chromatographs, pH-, conductivity- oxygen meters and several devices for measuring alpha, beta and gamma activities. All instruments are well cared for. The documentation including calibration data is kept next to each instrument. Replacement of laboratory equipment is in accordance with a schedule which ensures that older equipment is replaced in due time.

All on-line monitors are labelled with the dates of calibration and when calibration is due. The use of on-line lithium monitors is exceptional. The sampling system in the controlled area is in good condition. Samples to be measured in the hot laboratory are deposited in closed plastic bags for transportation.

- (a) **Good performance:** The use of on-line lithium monitors to provide an early indication of chemical conditions of the primary circuit is considered to be a good performance. The load following mode of operation at Flamanville nuclear power plant requires that more frequent sampling of the primary circuit should be carried out to assess chemical conditions. The installation of on-line monitors for lithium, in addition to the more usual range of on-line monitors, avoids daily manual sampling. This also avoids the consequent radiation dose to the chemists who would otherwise be required to obtain the samples.

Dose rates in accident situations can be measured by KRT channels 40, 43 (air containment) and 61 (RCS water), which have a sufficient measuring range. Post accident sampling equipment for gaseous and liquid samples has been developed by DRSE and the design division (SEPTEN). The whole chemistry section has been trained in the use of the equipment (two days basic course). Individual and refresher training has yet to be organized. The expected dose for the post-accident sampling actions is estimated by corporate organizations to be less than 10 mSv. This appears to be optimistic and may be due to non-conservative assumptions. The equipment for handling and analysing the liquid samples is largely unshielded. Other technical problems exist with the taking of liquid samples and the procedures for obtaining post-accident samples do not have any radiation protection measures or estimation of doses for the samples. It appears that only, a limited

range of accidents that will not lead to serious fuel cladding damage have been considered. The equipment is therefore unsuitable should an event requiring the use of ultimate procedures such as U1, U2, U3 or U5 occur.

- (1) **Recommendation:** A post-accident sampling system capable of obtaining, handling and analysing samples for a full range of accidents including those requiring the use of ultimate procedures should be developed that ensures that doses to individual in worst case conditions are acceptably low. Procedures that describe all steps and radiation protection measures, including dose estimations should be available on-site. This will ensure that samples could be taken and analyses carried out effectively and without endangering the staff taking the samples.

Plant response: (May 1996) In a letter (D5330/BNN/STE 003111) to the industrial safety, radiological protection and environment department (DSRE), Flamanville NPP asked the DSRE to take this recommendation into consideration.

EdF's policy in this matter, in the period from the OSART mission in February 1995 to the follow-up visit in June 1996, has been defined in the fossil and nuclear generating plants studies and project groups (SEPTEN) memorandum dated June 1995 (ref. EN.SN.95001A) and in a revision of the same document dated January 1996 (ref. EN.RN.95001B). This revision is still being discussed at the corporate level and has not yet been published. The memorandum defines:

- For any type of accident, which might occur inside the containment building the information available (core temperature, reactor building airborne dose rate) has allowed us for several years to:
 - evaluate potential source terms
 - make the necessary decisions for the protection of the population.

Consequently, the modification to the sampling device on the containment atmosphere monitoring system is therefore not necessary.

- Currently, no normal sampling need has been identified for beyond design-basis and design-basis accidents during the crisis management. For design-based and beyond design-based accidents involving a loss of primary coolant, reactor building air sampling can be carried out using 'normal operation' equipment (24 hours after the accident at the earliest).
- In the longer term, in order to complement the information already available and based on a corporate level decision of the plant operating review committee (CTE) held in June 1995, two automatic meter for continuous monitoring of hydrogen content will be installed in four locations in the reactor building in 1998.

The first statement is based on the EdF study accidental situation evaluation of environmental gaseous releases (D581-SRE/EV-90/859). A study carried out by SEPTEN, post-accident sampling equivalent dose rates near the sampling equipment (THRP 95 FC 11 dated 14.2.95), shows that the dose rate when manually obtaining air samples after a loss of primary coolant accident using the equipment set aside for normal operation would be acceptable. The computed contact dose rate is approximately $0.2\text{mSv}\cdot\text{h}^{-1}$ for 20cm^3 of air.

Different EdF departments are conducting independent studies to confirm the above policy. The regulatory authority is aware of the project but has not yet been asked to approve the policy.

IAEA comment on status: *(June 1996) The plant response and EdF strategy has moved on from February 1995 to June 1996. A number of studies and discussions for confirming the new strategy are still going on. Automatic hydrogen meters designed to provide continuous monitoring of hydrogen in the containment have yet to be installed. Corporate staff do not expect substantial changes to the already developed but unapproved strategy.*

Conclusion: Satisfactory progress to date.

7.6 Quality Control of Operational Chemicals

A guide, *Materials and Equipment for use in Power Plants*, (PMUC-list), specifies which substances and materials can be used by the NPPs. The list, in its present form, has been created recently by several corporate departments such as operational technical unit (UTO), nuclear generation division (EPN), GDL, DSRE, general department for occupational medicine (SGMT) and industrial projects departments (SAI). Management of the PMUC-list is regulated by Directive 43. The substances included in the PMUC-list are grouped under 23 headings such as lubricants, products for non-destructive testing, paint, oils and conditioners. Each group, which also has sub-groups, is periodically updated by the service and engineering units (USI). Each regional USI is responsible for certain groups of substances. The PMUC-list includes a register of suppliers whose products have been tested. Criteria used in selecting the substances and materials include nuclear safety as well as industrial safety, health and environmental aspects. The quality of operational chemicals is ensured by contracts, certificates, inspections and tests. Satisfactory procedures control the procurement of substances and materials covered by the PMUC-list. At the time of the mission, interim measures existed with respect to the purchase of some materials because the new arrangements were in an early stage of implementation as a consequence of the recent introduction of the complete PMUC-list. For a period, some materials that do not meet the requirements of the PMUC-list will continue to be purchased in the present manner. This does not apply to chemicals which are in group 21. Their procurement conforms with the requirement of the PMUC-list.

- (a) **Good Performance:** The controls placed on the procurement and use of chemicals as specified in group 21 of the PMUC-list, *Material and Equipment for use in Power Plants*, a guide that specifies which substances and materials can be used by the NPPs, is considered a good performance. All materials contained in group 21 of the PMUC-list, that is, the materials that are used by the chemistry section, are procured and controlled by the chemists in accordance with the PMUC-list. This is ensured by the management document MQ/06/TS/117 *Purchasing Policy*, the supplier list for these chemicals as part of PMUC-list, the manufacturer's certification (ISO 9000) and an application memorandum of chemistry section (STE/010) *Management of Conditioning Chemicals in the Laboratory*. A further memorandum exists for resins (STE/024) and there are some procedures with regard to the procurement of laboratory chemicals. In this way chemists can ensure that only authorized chemicals are used.

Quality tests of diesel fuel are managed by the mechanical department. The requirements for testing are given in corporate directive 029. Fuel is supplied in accordance with a military specification. On receipt, the supplier's test analyses are checked for conformity. Samples are taken on-site and tested for density, colour and smell before the contents of the tanker are discharged into storage tanks. Once a year analysis of samples from each storage tank are analysed by an external laboratory.

7.7 Radiochemical Measurements

The radiation monitoring system (KRT) at Flamanville has 53 channels per unit and is used by both the chemistry and radiation protection section. Tasks and responsibilities of each section are strictly defined to avoid gaps and overlaps. 36 of the 53 channels per unit check the integrity of different barriers, effluent discharges, and other normal and high radioactivity measurements. Some channels are used for surveillance of steam generator leakages and these use the latest technology based on the detection of N-16. The most important channels are hard wired to chart recorders in the control room. Others, in groups of up to eleven, can be selected to six channel chart recorders, the choice being left to control room operators. Alarms from each of the KRT channels are routed to the operator via the dual (redundant) microprocessor driven CONTROBLOC system.

Monitoring of fuel integrity, based on the corporate procedures of DSRE is the responsibility of the chemistry section. The chemistry section receives sufficient support from a number of EdF departments and from the fuel supplier. The section uses DSRE's policy and criteria for sipping or removing and repairing of fuel assemblies. Fuel monitoring is carried out during power operation and after transients. After evaluation a decision is made as to whether sipping will take place during the next outage. Some defective assemblies have been detected and removed.

Effluents are sampled and the tightness of barriers are tested by a range of instruments that determine total alpha, total beta, total gamma, gamma spectrum and tritium. Effluents are checked before release in accordance with procedures. In 1992 about 100 m³ gaseous effluents were inadvertently released during sampling. Following an investigation, a new mobile device and a new procedure for sampling of the gaseous waste treatment system (TEG) was developed to avoid a recurrence. This mobile equipment is used in the two sampling rooms (REN) in the auxiliary buildings. The laboratory staff are familiar with its use.

The governmental agency, the Office for Protection against Ionising Radiation (OPRI), has specified the types of equipment, the method of preparing samples, and the conditions of measurement and calibration. All tests of liquids, gases and environmental samples are performed in accordance with these requirements. Up to 1994, the results were recorded in four regulatory logs. More recently, a computer application, DATAID, has been implemented. Liquid effluents are also tested to determine the concentration of a few compounds. The measurements show that the Flamanville releases are typically well below the statutory limits as described in section 6.6.

8. EMERGENCY PLANNING AND PREPAREDNESS

The on-site emergency response arrangements are well integrated with EdF headquarters, off-site emergency response services, local and national authorities. The Prefecture directs the off-site command organization and all local supporting emergency response organizations. The objectives of the on-site and off-site emergency plans are approved by the safety authorities and are well co-ordinated with the government authorities and organizations concerned, including foreign authorities. They are adequate to deal with situations that may arise in radiological and conventional accidents. Appropriate countermeasures for the protection of the public are stipulated.

With respect to initiating the emergency response arrangements, it is suggested that the authority of the operations shift manager for triggering the on-site plan if the plant director and heads of the on-site local management command centre are unavailable, should be documented. This should assist in avoiding delays in notifying the safety authorities and informing the public. In another proposal, it is suggested that personal dosimetry be available to the control room staff in emergency situations.

The communication systems are of high quality. The use of the emergency call out system for the on-site emergency organization and off-site alert together with the availability of the INMARSAT satellite communication system are considered as good performances.

All on-site response centres are well equipped with necessary communication systems, documentation and equipment, and should adequately serve their intended purpose. On-site emergency equipment and resources are well in line with international standards. In addition, national corporate resources are available upon request.

The use of the two well equipped mobile laboratory vehicles will make the measuring of the off-site environment more effective. However, it is suggested that the cars be parked at different locations to assure the availability of at least one car even in circumstances where there is a risk of contamination.

The joint venture (INTRA) between the three French operators of nuclear installations in creating, maintaining, and operating equipment to cope with a major accident is considered to be a good performance.

The training programme for emergencies at Flamanville is well documented. The use of the Paluel simulator to simulate the emergency scenario on a real time basis gives realistic training to control room personnel and personnel in on-site and off-site emergency response centres; this is considered to be a good performance.

Fully equipped information facilities of high quality exist both at the EdF central and local level. The Prefecture has distributed information booklets on nuclear safety and emergency planning to the local inhabitants.

Resolution of all three issues has been largely completed. The operations shift manager having the authority to trigger the local emergency plan (PUI), in the unlikely event of not being able to contact the head of the on-site management command centre, will be formally documented when the revised PUI is issued later in 1996. This authority to trigger the PUI was implemented informally in late May 1996 by means of an internal memorandum.

Dedicated electronic dosimeters are now available to shift operations staff for use in an emergency. Again, their use is governed by a recent internal memorandum pending the issue of the revised PUI. The effectiveness of this measure has not been tested in an exercise or drill.

The two emergency laboratory vehicles are now garaged in dispersed locations on site.

8.1 Emergency Organization and Functions

The EdF corporate organization assists and supports the affected NPP with human and material resources to mitigate the radiological consequences of accidents. Strong co-operation exists between response teams at local and national levels. The EdF national crisis team (ENC) gives technical support to the on-site emergency organization. Other technical support, particularly with respect to special technical equipment (robotics), can be received through INTRA which is a joint venture between the three French operators of nuclear installations: EdF; the Atomic Energy Commission (CEA); and the fuel reprocessing plant (COGEMA).

Emergency planning and preparedness at Flamanville NPP is based on EdF's common generic plan for its nuclear power plants, adapted to the actual situation at the plant. The plant director delegates operational responsibility to the safety adviser for making all the arrangements necessary to ensure the operability of the Flamanville on-site emergency plan (PUI). To achieve this, he has the assistance of a co-ordinator who is a member of the nuclear and industrial safety department, a person in charge of each on-site response centre, five in total, and a person in charge of the PUI telecommunications resources.

In essence, the on-site emergency organization consists of three local action centres and a technical support centre all of which are co-ordinated by a management command centre (PCD). The local operations emergency centre (PCL) is located in the control room of the affected unit, the local assessment emergency centre (PCC) near the

control room and the local logistics emergency centre (PCM) on the fifth floor in the administration building. These local emergency response centres prepare and give technical support to the emergency response team (ELC) located in the emergency technical centre (LTC) near the PCC. The ELC provides information for the decision making in the PCD and for the national emergency response teams.

The organizational structure for emergency planning, the response and designation of individuals for key positions and their responsibilities and authorities are well defined in the PUI. The on-site organization is in accordance with EdF guidelines and the operability is well maintained by the staff responsible.

The plant has agreements at the local level with the police, the rescue services and the medical services to ensure support in an emergency situation. This close co-operation with the local off-site rescue services organizations is considered to be a good performance.

The number of the staff designated for key positions are 261. The number of staff on-call at any given time is 48 who will be either present at the plant or at home. This number of staff should ensure that the emergency organization is capable of dealing with emergency situations applicable to the PUI.

There is a well structured national framework for the emergency response infrastructure to implement the emergency plan. The identification of organizations and agencies, national emergency response organization, regional and local government emergency response organizations and agencies are well defined in the plan.

The lead civil organization for public safety is directed by the Prefect from the prefecture emergency centre (PCF), in accordance with the off-site emergency response plan (PPI). He is supported by his own prefecture operations support emergency centre (PCO), the public authorities' crisis organizations and EdF. The main public agencies involved are the nuclear installations safety directorate (DSIN) and the office for protection against ionizing radiation (OPRI). The central crisis organization also supports the plant in an emergency situation. The off-site organizations at all levels are well co-ordinated with the on-site organization.

- (a) **Good performance:** The co-operation between Flamanville NPP and the Prefecture organization, local rescue services and medical care organizations is good. There are agreements or contracts on the local level with the Prefecture, the rescue services and medical services to give support in an emergency situation. Regular contacts are maintained between all of them and the local risk services regularly participate in drills and exercises. This close co-operation facilitates the exchange of information and contributes positively to the organization of off-site emergency preparedness.

8.2 Emergency plans

The PUI is based on the EdF's generic guidelines and plant specifications. EdF's generic guidelines for the on-site PUI were developed in agreement with the safety authority (DSIN) and with its approval. The plan covers three levels of action; level 1: conventional accidents; level 2: radiological accident with consequences limited to the site; level 3: radiological accident with consequences for the public. The plan covers all the methods for maintaining an appropriate level of preparedness. It is periodically reviewed and must be revised at least once a year. Feedback from exercises may also result in revision.

A decree issued in 1988 concerning emergency plans defines the content of the off-site emergency response plan. The PPI is written to cope with the particular risks connected with the existence and the operation of Flamanville nuclear power plant. The PPI is designed to enable the Prefecture to take immediate counter-measures to protect the public in the case of an incident at the plant or threat of radioactive releases to the environment. The plan is well co-ordinated with the government authorities and organizations concerned, including foreign organizations. The off-site emergency plan is adequate to deal with counter-measures for the protection of the public.

8.3 Emergency Procedures

Guidelines for the effective implementation of on-site and off-site emergency plans are available. Actions during an emergency are supported by procedures or emergency instructions provided in all posts of all local emergency centres. Checklists are available to assist in the prompt and correct response. Emergency operating procedures detail the actions to be taken to safeguard the plant during abnormal conditions. Event based procedures are normally used by operators. However, state oriented procedures (permanent monitoring of safety functions) are used initially by the operations shift manager and by the safety engineer as soon he arrives at the control room (within 40 minutes after the alert for an accident situation).

The operations shift manager, the action technical supervisor and the safety engineer are responsible for using procedures which may require implementing the PUI. Only the plant director or the head of the PCD have the authority to activate external alert procedures although as a last resort, the operations shift manager may need to trigger the PUI.

- (1) **Suggestion:** Consideration should be given to documenting the responsibility of the operations shift manager to trigger the PUI, as a last resort, in the remote possibility that neither the head of PCD nor the plant director can be contacted in a reasonable time or are unavailable. Assignment of responsibilities in advance would avoid misunderstandings in emergency situations and therefore would

minimize the risk of delays in the implementation of the PUI, or of delays in the notification of the safety authority (DSIN) and the Prefecture.

Plant response: (May 1996) *The site organization gives the shift operations manager the resources to exercise, at any moment, his/her role as regards nuclear safety, and whenever necessary, to reach the local management command centre (PCD) manager in order to examine the need to launch the on-site emergency plan (PUI).*

Several means of telecommunication are made available to the shift operations manager so that he/she can reach the PCD manager:

- *on-site call: telephone network, BIP*
- *off-site call: telephone network, radio dispatching system (OPERATOR), mobile telephone (GSM).*

If, in spite of the dual redundant systems of communication, the operations shift manager is not able to contact the PCDI manager, he is authorized, as per the recommendation of the national PUI model, to launch the PUI.

IAEA comment on status: (June 1996) *The national model emergency plan, last updated and issued on 22 December 1995 includes the provision for the shift manager to trigger the local PUI in the event of his/her being unable to contact PCDI. This provision was implemented at Flamanville NPP by an internal memorandum (note d'information) dated 22 May 1996 pending revision of the local emergency plan document. The revised PUI, due to be issued by 24 June 1996, will include the provision that the shift manager has the authority to trigger the PUI if he/she is unable to contact PCDI. However, the draft amendment shown to the follow-up team did not contain this provision for level 2 and level 3 incidents. The suggestion can be considered to be fully resolved once the revised PUI with all necessary amendments has been issued.*

Conclusion: Satisfactory progress to date.

In the event of a release of activity, the control room would remain habitable since the ventilation system would automatically switch in iodine filters if more than 5iSv/h was detected in the ventilation system. Shift staff do not have ready access to their dosimetry in an emergency. This arises because they are not required, in normal circumstances, to wear their personal dosimetry at all times and because the dosimeters of control room staff are stored outside the shift operations manager's office and the dosimeters for the field operators at the entrance to the controlled area. Personal dosimeters are therefore not available to shift staff in the control room or in the surrounding area protected by the emergency ventilation arrangements. Dosimetry is not readily available for use by staff who may have to enter high radiation fields in emergency situations, times when it is most important that the dose is measured.

- (2) **Suggestion:** Consideration should be given to providing personal dosimetry in the control room or in the surrounding area where emergency ventilation exists. This would provide the operations or shift personnel with means of individual dose monitoring, when leaving the control room for field operations in the event of an emergency.

Plant response: (May 1996) Personal electronic dosimeters (10 per unit) have been made available to operations department personnel, near the control rooms in the rooms ventilated by the control room air conditioning system (DVC). This system has dual redundancy and has a filtration device (absolute filter, iodine trap). These units are also used to measure the equivalent dose rate. The personal dosimetric film badges available near the control rooms complete the absorbed dose rate equivalent measurement.

IAEA comment on status: (June 1996) The personal electronic dosimeters are held in the unit tagging office. They are stored in the non-active (switched off) condition. The dosimeters are subject to a weekly functional tests and an annual calibration. Before their use in an emergency situation each dosimeter would be subject to simple functional tests in accordance with instructions stored with them. Their use is at present governed by a temporary instruction. Permanent instructions will be contained within the revised PUI due for issue by 24 June 1996. Responsibility for ensuring that staff leaving the control room during an emergency are equipped with the new personal electronic dosimeters rests with the shift manager. In the event of an emergency, up to five persons may be required to leave the unit control room and enter plant areas. The allocation of ten personal electronic dosimeters adjacent to each control room provides adequate redundancy.

Before the suggestion can be considered to be fully resolved the following should be completed:

- the revised PUI should be issued
- the arrangements for using the dosimeters should be tested in a realistic exercise scenario. The test could seek to identify possible weaknesses in putting the dosimeters into use, the benefit of using the dosimeters' in-built alarm facilities (dose rate and dose level) and whether there is a need for instructions to persons using the dosimeter to withdraw from the radiation fields should the dosimeter go into the alarm state.

Conclusion: Satisfactory progress to date.

Once the PUI has been triggered, corporate groups will be formed to assist in classifying the category of an emergency, assessing potential on-site and off-site emergencies, recommending appropriate protective measures, and to support the Flamanville emergency response teams in the activation of the appropriate response.

The communication equipment available generally for use in an emergency is of high quality. For example EdF has a very efficient system for alerting key-staff in the emergency response organizations at central and local level. As a last resort, if other communication means fail, a satellite communication system (INMARSAT) is available.

- (a) **Good performance:** Out of normal working hours the staff on duty can be alerted from the security centre (PCP) in the entrance building by use of the emergency call out system (EdF telephone network (DAPN) installed in EdF housing and France Telecom network (DAPRCN) in non EdF housing). Calls are made to the staff in designated key positions in the response organization using redundant telephone systems which in some cases includes receivers on the public telephone network. The system can register answered calls and this information is available for the PCM to schedule personnel resources. The system is also used for alerting all off-site emergency response organizations. The use of the emergency call out system is considered as a very good method to put the emergency response procedures into action. There are several different communication networks available at the plant. The French telecom networks with normal and dedicated lines, EdF security telephone network, ministry of the interior network (phones, fax, telex, audio conference and satellite) for external communication. For internal communication there are four telephone networks, public address system, personnel paging and two radio networks. The plant has, as a last resort communication link, the INMARSAT satellite communication system which can be connected to telephones or telefax. The availability of the satellite communication system, if other communication means fail, will ensure that reliable communication remains in extreme situations.

The PPI is divided into three levels depending on how serious the accident is and the possible impact on the population near the plant. Off-site implementing procedures will be used in accordance with the information received from PCD1 or the plant director. Only in the highest action level 3 will protective actions, such as sheltering or evacuation be carried out. In the first place this will be for the public in the emergency planning zone up to 10 km from the plant. The public will be informed at all alert levels, in co-operation with the concerned municipalities.

8.4 Emergency Response Facilities

The on-site emergency response organization is based in twelve command posts (PCs) in various buildings at the plant and at a fall-back facility, the gymnasium (sports hall) in the nearby village, Les Pieux. The PCL is located in the control room of the affected unit, the PCC and ELC which are located close together in the emergency technical centre (LTC) exist in both units. The PCD and PCM is located in the administration building. All PCs are well equipped with communication means, emergency equipment and documentation.

None of the emergency response centres are specially shielded against high direct ionizing radiation. The LTC and the control room have ventilation systems protected by aerosol and iodine filters. In case of relocation, the LTC can fall back to the other unit.

The first alternative to relocate PCD and PCM will be to the entrance (security) building and the second, the gymnasium in Les Pieux. The emergency backup facilities in the entrance building and in Les Pieux are suitably equipped with furniture, communication facilities and the most important equipment and documentation, and will adequately serve their intended purpose.

The Prefecture's response facilities include an off-site command centre (PCF) and a support centre (PCO). The Prefect represents all ministries at the local level. Representatives from the nuclear safety authority (DRIRE/DIN), rescue services, police, medical care, army, municipalities and a range of support organizations concerned form part of his emergency organization.

The central EdF response centres in Paris are well prepared and, as agreed with the safety authority (DSIN), aim to be in operation within two hours of being notified. The communication facilities, computer aids, documentation and press centre are of a high quality. The crisis technical centre (CTC) of the Institute for Nuclear Protection and Safety (IPSN) has been in operation for over twelve years and has gained considerable experience through taking part in exercises. Both response centres are properly equipped with means of communication, documentation and aids for giving information to the media. All support centres in Paris are well co-ordinated with the Prefecture and the plant.

8.5 Emergency Equipment and Resources

On-site emergency equipment and resources are required by the EdF generic plan. The standard of the emergency equipment available on-site is well in accordance with international practice. The means available for communication at all on-site emergency centres are of a high standard. Responsibilities for maintenance, testing and operation of equipment are well defined. There are two well equipped mobile laboratory vehicles capable of carrying out radiological measurements both on- and off-site. The standard equipment in the vehicle is high and is regarded as a good performance but the parking of both vehicles together gives rise to a concern.

- (a) **Good performance:** There are two well equipped mobile laboratory vehicles available at the site. Both are equipped with two remotely operated autonomous measuring stations (BAP). The BAP is capable of measuring the dose rate, taking samples of the rainwater and air. The BAP-station can be programmed for two different sampling and measurements periods, which makes it possible to take representative measurements for the passage of a cloud. The dose rate measurements are read out by the computer in the vehicle, and the samples can be

analysed with the spectrometer in the car. This will make the evaluation of the off-site consequences more effective insofar as there will be more time for manual measuring and the possibility, of limiting the dose exposure to the personnel.

The defined location for the parking of the two laboratory vehicles on-site, is in a garage beside the training centre on the top of the hill. Both vehicles could be contaminated in the event of an accident as the result of the fall out if they are at the same spot.

- (1) **Suggestion:** Consideration should be given to parking the vehicles at different locations, avoiding the prevailing wind direction, in order to have at least one vehicle available, even in the event of fall out from an accident.

Plant response: (May 1996) *The two PUI vehicles are now parked in different garages. A second garage was built in the new intercompany building.*

The garages lie in a position practically diametrically opposite from the reactor and fuel buildings

Angle (garage no. 1, RB unit 1, garage no. 2) = 144°

Angle (garage no. 1, RB unit 2, garage no. 2) = 121°.

Position in relation to dominant winds: *The wind rose shows that the distribution in the various directions is not very heterogeneous. Even though garage no. 1 is under the dominant wind, in only 371 cases /1000 does the wind come from a sector that ranges between 218° and 294°, which in case of a slight but non null wind, would place garage no. 1 in the plume from the Unit 1 reactor building. This figure of 371 cases/1000 is to be compared with the 208 cases/1000 which would be obtained with uniform wind distribution. (208/1000 = 75°/360°). Garage no. 2 is located under less frequent winds. In case of a slight but non null wind (plume 75°) and contamination, this garage would lie under the plume in 185 cases/1000).*

Cliff effect: *Garage no. 1 lies on the plateau 340 meters from the centre of the nearest Reactor Building. Garage no. 2 lies 456 meters from the centre of the nearest Reactor Building in an area where the cliff gives way to a steep slope. In both cases, the cliff effect is attenuated.*

Garage equipment: *Like garage no. 1, garage no. 2 has been thermally insulated, equipped with heating and electrical outlets required for conditioning PUI vehicles.*

Note: *If the wind is stronger (97% of the cases > 1m/s), the plume is reduced, which reduces the number of cases in which the garages would lie under the plume.*

IAEA comment on status: (June 1996) *The location of the second garage has been fully considered and appropriately justified. A potential problem with the remotely operated*

door opening mechanism (loss of control or loss of electric supplies) has been recognized by plant personnel and a solution is being developed.

Conclusion: *Issue resolved.*

In addition to the resources available on-site for emergency measures, corporate resources are available on request from the PCM. On-site and off-site available resources are well in line with the best practices abroad.

The EdF and national authorities' emergency facilities in Paris are well equipped with means of communication, documentation, computers and other aids. OPRI has well equipped fixed and mobile laboratories.

The fire station in Cherbourg houses the alarm centre for the region from which all rescue services resources in its area including the voluntary fire brigade in Les Pieux, near Flamanville NPP are directed. In the event of an alert from the plant, the alarm centre will send out brigades from both Cherbourg and Les Pieux. They will arrive at the plant within 15 to 30 minutes. The procedures at arrival at the plant are well co-ordinated. The fire brigade in Cherbourg is well equipped and experienced in planning for emergencies in high-risk installations because of transportation of dangerous goods at sea and on land, nuclear submarines, harbour, airport as well as the COGEMA plant.

The military hospital in Cherbourg has appropriate radiological equipment and will be chosen initially in the event that contaminated persons must be transported to hospital. There are also written agreements with other hospitals.

A wide range of human and technical resources are available to Flamanville NPP through the joint venture (INTRA) between EdF, CEA and COGEMA.

- (b) Good performance:** The joint venture between the three French operators of nuclear installations EdF, the Atomic Energy Commission (CEA) and the fuel reprocessing plant COGEMA in creating, maintaining and operating equipment to cope with a major accident in a nuclear installation (INTRA) is considered a good idea. There are available resources for example for television inspections, dose rate measurements and decontamination. Examples of equipment available are helicopters for environmental measurements, remote controlled machines, mobile workshop and electrical generators. INTRA provides reconnaissance, civil engineering services and offers the same services even for foreign countries. Training and maintaining of the resources are co-ordinated by the National Response Centre at Chinon NPP.

8.6 Training, Drills and Exercises

Within one month of arrival all new staff in the plant receive information on on-site emergency planning and fire protection. All personnel are retrained every three years during the safety, quality and risk prevention (SQPR) training course. The presentation of the PUI is made so the participants can identify their position in the organization. Functions in the on-site emergency organization are assigned to personnel who have normal functions similar to the duties to be performed. The activities to be carried out are divided into operations, maintenance and logistics. Personnel who will be appointed follow an individual training programme corresponding to the position in the emergency organization. Personnel with on-call duties receive specific on-site or off-site training depending on the position. The well documented training programme maintains the required competence of the emergency organization.

Internal drills and exercises are conducted both at PC level and plant level. The plant also participates regularly in regional and national exercises. An annual drill schedule is drawn up, taking into account requirements of the EdF generic document and experience feedback from previous exercises. For every drill or exercise a technical note is prepared in advance and an evaluation report is made afterwards. Exercises involving local and national off-site organizations are arranged by the safety authority (DSIN) in conjunction with EdF corporate department and are carried out at all plants every three years. The next exercise of this type at Flamanville NPP will be in May 1995. EdF corporate and governmental authorities participate in large exercises at least six times a year. The drill and exercise programme for emergency preparedness as it is carried out at present gives the personnel appropriate training in understanding and using the implementing procedures and a valuable experience in their roles in the emergency organization.

During some exercises, the shift operating team uses the Paluel full-scope simulator that will challenge them to control the plant in a realistic manner.

- (a) **Good performance:** The Paluel simulator, located approximately 250 km from the plant, is used for accident simulation during certain exercises, the next being in May 1995. The use of the simulator during exercises is considered a good performance. Moving the PCL from the plant to the simulator permits the participation of control room staff in a realistic way. Means of communication with normal on-site and off-site response centres are available at the simulator facility. The use of the simulator makes it possible to simulate the emergency scenario in near to real conditions. Experiencing in real time the fluctuations occurring during the accident and taking the necessary action accordingly gives a realistic input for the emergency response organization. The use of the simulators also avoids distributing plant operations at Flamanville.

8.7 Liaison with Public and Media

Providing the media with accurate and timely information has a high priority in the planning and is part of all PCDs at both central and local level. Several spokesmen are designated in the response organization.

The Prefecture is required by law to provide information to the public in advance on nuclear safety and emergency planning. This has been done in co-operation with the plant and the local information commissions in every municipality concerned. A brochure containing actions to be taken by the public has been distributed and another information booklet is sent, by name, to the inhabitants of the planning zone.

Information for local dissemination to the media in the event of an accident would be prepared in the Flamanville information centre. A variety of means of communication, for example telephones, telefax and data communication links, are available to journalists. The plant, the Prefecture, EdF corporate and DSIN invite journalists to participate in exercises. The Prefecture intends to invite public participation in future exercises. This should provide a useful opportunity to test arrangements for informing the media and the public. Fully equipped information facilities exist both at the EdF central and local level. The equipment at EdF PCD Murat in Paris and at the information centre at the plant is of a good standard. Aids for explaining the situation are available in French and English.

**TABLE 1: SUMMARY OF STATUS AT JUNE 1996 OF RECOMMENDATIONS
AND SUGGESTIONS OF FLAMANVILLE OSART MISSION**

	RESOLVED	SATISFACTORY PROGRESS	INSUFFICIENT PROGRESS	WITHDRAWN	TOTAL
Management, Organisation & Administration	-- 3S	1R 2S	-- 1S	-- --	1R 6S
Training & Qualification	-- 2S	-- 3S	-- --	-- --	-- 5S
Operations	-- --	2R 2S	-- --	-- --	2R 2S
Maintenance	-- 1S	-- --	-- --	-- --	-- 1S
Technical Support	1R 1S	-- --	-- --	-- --	1R 1S
Radiation Pro- tection	-- 3S	1R 2S	-- --	-- --	1R 5S
Chemistry	-- 5S	1R 1S	-- --	-- --	1R 6S
Emergency Planning & Preparedness	-- 1S	-- 2S	-- --	-- --	-- 3S
R TOTAL (%) S	1R (17)	5R (83)	-- (--)	-- (--)	6R (100)
	16S (55)	12S (41)	1S (4)	-- (--)	29S (100)
TOTAL (%)	17 (49)	17 (49)	1 (2)	-- (--)	35 (100)

DEFINITIONS - OSART MISSION

Recommendation

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

Suggestion

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

Good Performance

A good performance is a superior objective that has been achieved or a good technique or programme that contributes directly or indirectly to operational safety and sustained good performance, that works well at the station. It might not be necessary to recommend its adoption by other nuclear power plants, because of financial considerations, differences in design and other reasons, thereby not qualifying for the higher accolade of good practice.

Good Practice

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

DEFINITIONS - FOLLOW-UP VISIT

Issue resolved - Recommendation

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

Satisfactory progress to date - Recommendation

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

Little progress to date - Recommendation

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

Withdrawn - Recommendation

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

Issue resolved - Suggestion

The finding has been thoroughly evaluated and appropriate action taken to resolve it, or it has not been implemented for acceptable reasons.

Satisfactory progress to date - Suggestion

The finding has been seriously considered, but appropriate actions have not been fully implemented to resolve it.

Little progress to date - Suggestion

The finding has not been effectively considered.

Withdrawn - Suggestion

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

ACKNOWLEDGEMENTS

The Government of France, the Nuclear Installations Safety Directorate (DSIN), Electricité de France (EdF) and the staff of Flamanville nuclear power plant provided valuable support to the OSART teams. France has provided significant contribution to the OSART programme by sending experts to other OSART missions, seconding a cost free expert to the staff of the NOSS Section of the IAEA, in providing consultants to review the OSART programme and in hosting OSART missions to seven French plants. Such close co-operation between France and the IAEA in all nuclear activities has established many personal contacts and a common basis for efficient work.

Throughout the whole OSART mission and the follow-up visit, the team members enjoyed excellent co-operation and fruitful discussions with Flamanville nuclear power plant managers and staff, other EdF personnel and staff of local and national authorities. Information was provided openly and in the spirit of seeking improvements in operational safety. There was a rich exchange of knowledge and experience that established many personal contacts that will not end with the completion of the mission and follow-up visit and submission of this report. The efforts of the plant counterparts, liaison officers, interpreters and the secretarial team were outstanding. This enabled the OSART teams to complete their reviews in a fruitful manner. The IAEA, the Division of Nuclear Safety and its Nuclear Power Plant Operational Safety Service Section wish to thank all those involved for the excellent working conditions during the Flamanville nuclear power plant reviews.

ANNEX I: COMPOSITION OF THE FLAMANVILLE OSART TEAM**Experts:****ARRELILLAGA, Fernando - MEXICO**

Laguna Verde Nuclear Power Plant

18 years of nuclear experience

Review area: Maintenance

BERG, Sven Eric - Sweden

Swedish Rescue Services Board

14 years of nuclear experience

Review area: Emergency Planning and Preparedness

CRUSE, Charles - USA

Calvert Cliffs Nuclear Power Plant

26 years of nuclear experience

Review area: Management, Organization and Administration

DIAZ FRANCISCO, José Manuel - IAEA

NPP Operational Safety Officer

Division of Nuclear Safety

20 years of nuclear experience

Review area: Operations I

DOMENECH ROJO, Miguel - IAEA

Senior NPP Operational Safety Officer

Division of Nuclear Safety

23 years of nuclear experience

Assistant Team Leader

DUHÀC, Alexander - SLOVAK REPUBLIC

Bohunice Nuclear Power Plant

12 years of nuclear experience

Review area: Operations II

DULAR, Janez - IAEA

Senior NPP Operational Safety Officer

Division of Nuclear Safety

26 years of nuclear experience

Review area: Technical Support

Experts (Continued)**HIDE, Keith - IAEA**

Senior NPP Operational Safety Officer
Division of Nuclear Safety
23 years of nuclear experience
Team Leader

LEURS, Cornelius – NETHERLANDS

Borselle Nuclear Power Plant
7 years of nuclear experience
Review area: Radiation Protection

ROBERTSHAW, Neville - UK

Nuclear Electric plc
24 years of nuclear experience
Review area: Training and qualifications

VENZ, Hartmut - SWITZERLAND

Beznau Nuclear Power Plant
25 years of nuclear experience
Review area: Chemistry

Observers:**GOTO, Ken - IAEA**

NPP Operational Safety Officer
Division of Nuclear Safety
15 years of nuclear experience
Training area: Technical Support

KOC, Joseph - CZECH REPUBLIC

Temelin Nuclear Power Plant
7 years of nuclear experience
Training area: Emergency Planning and Preparedness

OUROUTCHEV, Vladimir - BULGARIA

Kozloduy Nuclear Power Plant
14 years of nuclear experience
Training area: Operations

**ANNEX II: COMPOSITION OF THE FLAMANVILLE OSART FOLLOW-UP
TEAM**

DIAZ FRANCISCO, José Manuel - IAEA

NPP Operational Safety Officer

Division of Nuclear Safety

20 years of nuclear experience

Review areas: Management, organization and administration; Training and qualification;
Operations; and Maintenance

DULAR, Janez - IAEA

Senior NPP Operational Safety Officer

Division of Nuclear Safety

26 years of nuclear experience

Review areas: Technical support; Radiation protection; and Chemistry

HIDE, Keith - IAEA

Senior NPP Operational Safety Officer

Division of Nuclear Safety

23 years of nuclear experience

Review area: Emergency planning and preparedness; and Team Leader

ANNEX III: SCHEDULE OF ACTIVITIES

- | | | |
|-----|---|-----------------------------|
| 1 . | Official request of the Government of France to the IAEA to conduct an OSART mission to Flamanville nuclear power plant | 4 January 1994 |
| 2. | IAEA confirmation of OSART mission | 9 February 1994 |
| 3. | Preparatory meeting for OSART mission to Flamanville nuclear power plant | 17-18 May 1994 |
| 4. | Recruitment of external experts | August/October 1994 |
| 5. | Operational Safety Review of Flamanville nuclear power plant | 30 January-16 February 1994 |
| 6. | Official request of the Government of France to conduct Follow-up Visit to Flamanville Nuclear Power Plant | May 1995 |
| 7. | IAEA confirmation of Follow-up Visit | June 1995 |
| 8. | Submission of OSART Mission report to the Resident Representative of France | 28 August 1995 |
| 9. | OSART Follow-up Visit to Flamanville Nuclear Power Plant | 3-7 June 1996 |
| 10. | Submission of OSART Follow-up Visit report to the Resident Representative of France | September 1996 |

ANNEX IV: Abbreviations and acronyms

AEI	Instrumentation, control, electrical and data processing department
AIC	Computerized tagging system
ALARA	As low as reasonably achievable
ANDRA	National Radiological Waste Agency
CEA	Atomic Energy Commission of France
CHSCT	Health and safety work place committee
CIF	Individual training log
COGEMA	<i>Companie Générale des Matières Nucléaires</i> , the French nuclear fuel reprocessing company
COMSAT	Outage safety committee
DM	Corporate nuclear maintenance department
DRIRE	Department for Industry, Research and Environment
DSIN	Nuclear Installations Safety Directorate
DSRE	Industrial safety, radiological protection and environment department
EdF	Electricité de France
ELC	Local emergency response team
FBSQ	Basic training in safety and quality
FSAR	Final safety analysis report
GCN	Nuclear fuels group
GDL	Corporate chemical and metallurgical laboratories group
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IPSN	Institute for Nuclear Safety and Protection
ISI	In-service inspection
JTS	Holder of a vocational training certificate
KIT	Computerized data processing system
KRT	Plant radiation monitoring system
LTC	Emergency technical centre
MCP	Corporate resources department
NPP	Nuclear power plant

OEF	Operational experience feedback
OEM	Reliability centred maintenance
OPRI	Office for Protection against Ionizing Radiation
OSART	Operational Safety Review Team
PC	Command post
PCC	Local assessment emergency centre
PCD	Local management command centre
PCL	Local operations emergency centre
PCM	Local logistics emergency centre
PDQ	Quality plan
PGF	Training guidelines
PIF	Individual training plan
PLAP	Local professional training programme
PMUC	<i>A guide, Materials and equipment for use in power plants</i>
PPI	Off-site emergency plan
PTF	Standard training plan
PUI	On-site emergency plan
PWR	Pressurized water reactor
QA	Quality assurance
RCS	Reactor coolant system
RER	Rapid experience feedback
REX	Experience feedback
SAPHIR	Computerized maintenance history and plant event system
SEPTEN	Corporate design division
SQPR	Safety, quality and risk prevention
SRP	Radiation protection section
STE	Technical and environment department
SYGMA	Computerized maintenance management system
TX	Mechanical department
UTO	Corporate technical support group
WANO	World Association of Nuclear Operators