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OSART MISSION

BLAYAIS NUCLEAR POWER PLANT

13 – 31 January 1992

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PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Blayais Unit 3 and 4. It includes recommendations for improvements affecting operational safety for consideration by the responsible French authorities and identifies good practices for consideration by other nuclear power stations.

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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 further. The IAEA Safety Series documents, including the Nuclear Safety Standards (NUSS) programme and the Basic Safety Standards for Radiation Protection, and the expertise of the OSART team members form the bases for the evaluation. The OSART methodology involves not only the examination of documents and the interviewing of staff but also reviewing the quality of performance. It is recognized that different approaches are available to an operating organization for achieving its safety objectives. Proposals for further enhancement of operational safety may reflect good practices observed at other nuclear power plants.

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

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

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

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INTRODUCTION

At the request of the Government of France, an International IAEA Operational Safety Review Team (OSART) of experts visited the Blayais Nuclear Power Station (NPS) near Bordeaux, France, from 13 to 31 January 1992 to review operating practices at the power station and to exchange technical experience and knowledge between the experts and power station counterparts on how the common goal of excellence in operational safety could be pursued. The Blayais OSART review was the third in France.

The team (Annex I) was composed of experts from Canada, Hungary, Japan, Sweden and the United States of America and IAEA staff members with a scientific visitor (observer) from Romania.

Before the OSART review of the power station, the team studied relevant information made available to them to familiarize themselves with the power station's main features, important programmes and procedures, and the operating record of recent years. At Blayais, the team of experts, using techniques derived from their collective nuclear experience of 163 years, reviewed the power station's operational safety indicators and other documentation, examined procedures and instructions, observed work being carried out and held extensive discussions with power station personnel. Throughout the period of review, there was an open exchange of experience and opinions between the power station personnel and the OSART experts.

Plant description

The Blayais Nuclear Power Station (NPS)has four 910 MW(e) pressurized water reactors (PWRs). The units achieved criticality and commercial operation as follows: Unit 1 - 20 May 1981 and 1 December 1981; Unit 2 - 27 June 1982 and 1 February 1983; Unit 3 - 29 July 1983 and 14 November 1983; and Unit 4 - 1 May 1983 and 1 October 1983. The four units are of the CP-1 standardized series of EdF 900 MW(e) reactors. EdF currently operates 34 900 NW(e) units.

Blayais NPS was built by Framatome and is located approximately 55 km north of Bordeaux. The condenser is cooled by salt water from the Gironde River.

Each reactor core consists of 157 fuel assemblies with 53 containing control rod clusters. Each fuel assembly consists of 264 fuel rods arranged in a square array. The fuel is 3.7% enriched UO_2 with a core thermal output of 2785 MW. The primary circuit pressure is maintained at 15.5 MPa with the coolant temperature on exit 323°C. The primary circuit is served by three loops each having a vertically mounted steam generator and a coolant pump.

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

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

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

Main conclusions:

Three areas were subjected to an in-depth review by the experts who covered training and qualification, maintenance both at the corporate and plant level and chemistry. The main conclusions can be summarized as follows:

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

- A high commitment to safety by both staff and management

- Knowledgeable and dedicated staff

- High quality procedures

- An excellent corporate and plant chemistry programme

- Excellent outage planning and optimization of resources

- A commitment to high quality training and provision of training resources.

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

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

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

- A systematic follow-up programme has not been developed to ensure the correction of maintenance related Quality Assurance (QA) deficiencies. In addition, quantitative performance indicators to monitor the effectiveness and trends of the station QA programme are not used. A1 number of deficiencies were noted in the implementation of the station's quality programme during the team's review.

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

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

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

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

1. CORPORATE MAINTENANCE IN EdF

Electricité de France (EdF) is a large nationalized electrical utility which produces and distributes electricity throughout France. Nuclear power accounted for 72% of the electrical generation in France in 1991. In 1991 EdF operated thirty-four 900 MW and seventeen 1300 MW pressurized water reactors (PWRs) which had a total capacity of 54,000 MW. There is considerable standardization of design, components, and equipment suppliers at the nuclear power plants and in the nuclear industry. As a result there is an incentive to standardize the maintenance programmes at the power plants as much as possible.

The NPPs are supported by an extensive centralized organization which provides support and assistance in the areas of maintenance, technical support, nuclear safety, in-service inspection, materials analysis, and personnel to assist in outages. The supporting departments also have a considerable impact on the maintenance policies in force at the stations the extent that there is very little local control over maintenance policy. Extensive use is made of the experience feedback process to develop maintenance policies and programmes by the centralized departments and to monitor and analyse equipment related faults of a generic nature. However, with this extensive centralization, backlogs have developed in the processing of equipment related fault reports, and in the completion of analysis of these events.

EdF has developed an extensive preventive maintenance programme for its NPPs. Most of the preventive maintenance programme is conducted during outages but it is well supported by the centralized departments which provide technical expertise and resources to carry out the programmes. In particular, the in-service inspection programme is extremely well organized and staffed.

Nuclear safety with respect to maintenance is receiving appropriate attention with considerable emphasis being placed on maintenance policies which stress the concept of "Safety Culture".

The centralized control and co-ordination of modifications, outage management and spare parts are other strong points in the standardization and centralization policies of the Nuclear Generation Division of EdF. Centralized direction, policy and planning ensures that these activities are carried out in a cost effective manner with proper regard to nuclear safety.

1.1. Organization and Functions

Although the station management is responsible for the execution of the various parts of the maintenance programmes at their stations, there is considerable assistance provided by the centralized Corporate Maintenance, Technical Support, Nuclear Safety, Central Laboratories and Regional Maintenance Departments in the Nuclear Generation Division of EdF. The EdF Engineering and Construction Group and Equipment Quality Control Group, along with equipment suppliers and various contractors, also play important roles in the development and implementation of the maintenance programmes in EdF.

The main function of the EdF Nuclear Maintenance Department is to produce and transmit the maintenance policy to the stations. The maintenance policy is based on knowledge of equipment technology, operating conditions and analysis of operating feedback.

Technical support for the maintenance programmes in the Nuclear Generation Division of EdF is provided by the Central Technical Support Department, Unite Technique Operationnelle (UTO). UTO provides the plants with the technical advice and support, personnel resources, and equipment and material resources which are necessary to conduct the maintenance programmes.

With the large size of the nuclear programme in France and the extensive standardization, centralization of the maintenance and technical support functions provides a means of ensuring that consistent policies are applied at all facilities. However, centralization can have drawbacks if management and personnel at the individual stations lose control of or fail to become involved in processes and events which may have affect the safe operation of the facility for which they are directly responsible. There may also be a tendency for station personnel to lose accountability for the equipment for which they are responsible and thus be reluctant to raise standards above the normal EdF standards. This concern has been allayed to some extent in that a recent decision has been made to expand the engineering function at the stations by having some engineers in the plant maintenance sections monitor equipment performance and perform more detailed analysis of equipment faults before they are addressed to the Nuclear Maintenance Department.

(1) **Suggestion:** Consideration should be given to carrying out a study to determine whether or not the extensive standardization of equipment and design in the NPPs and the centralization of maintenance and technical affect the safe operation of the station. This may be the case if the local station management is not fully involved in matters which affect the station for which it is held responsible by the safety authorities. Personnel should be held accountable to maintain equipment to high standards and allowed to show initiative to raise the standards above the minimum.

1.2. Maintenance Programme

The EdF maintenance policy and maintenance programmes are largely based on feedback of equipment performance from the nuclear power stations. All sections in the Nuclear Maintenance Department are responsible for the collection of relevant information in their own areas on equipment characteristics and equipment operating history from all stations. Operating history is derived from equipment damage reports, significant incident reports on safety-related equipment, reports from in-service inspections, and reports on equipment availability and maintenance costs. Meetings are also held between the Nuclear Maintenance Department and the stations following maintenance/refuelling outages at which post mortem evaluations are conducted and outage reports are produced. Similarly, meetings are held between stations to discuss component specific problems.

With the extensive equipment standardization and centralized co-ordination of maintenance programmes, the elements of an effective maintenance policy exist in EdF. However, with the large number of units and large volume of information being sent to the central department from the stations, delays in the processing and analysing of non-safety related event reports have occurred. For some faults on non-safety related equipment, detailed analyses are not required and there could be a tendency for such faults not to receive appropriate attention or priority from the Nuclear Maintenance Department. The data are input to an events database but there is no automatic system to annunciate the fact that a generic issue may be arising from an increasing number of occurrences of similar events unless the responsible engineer searches for the information in the computer.

The Nuclear Maintenance Department is also responsible for developing global maintenance performance indicators and monitoring and trending equipment performance. The data from equipment related failure reports is input to a reliability database by the plants and the Nuclear Maintenance Department receives summaries of these reports.

The Nuclear Maintenance Department has devoted considerable attention to new developments in the nuclear maintenance field including reliability centred maintenance and innovative predictive maintenance techniques.

There is presently a backlog in the dispatching of equipment related event reports and in the completion of analysis of these events. Delays in identifying common equipment problems and analysing events could affect safety.

(1) **Recommendation:** The Nuclear Maintenance Department should streamline their procedures in order to reduce the delay in the dispatching of equipment related event reports from one month to one week.

(2) **Recommendation:** The Nuclear Maintenance Department should develop a means to prioritize non-safety significant equipment event reports.

(3) **Recommendation:** The significance of the backlog should be evaluated and the backlog should be monitored. Goals should be established for reducing the backlog and maintaining it at a low level.

(4) **Suggestion:** With the large number of plants in operation and large volume of fault reports being transmitted, consideration should be given to the possibility of the Nuclear Generation Division at the corporate level carrying out systematic audits to ensure that maintenance policy and programmes are being consistently applied at the stations.

(5) **Suggestion:** EdF should consider developing a means by which the equipment history database computer would automatically annunciate the fact that a generic equipment fault may be occurring. This should apply to all equipment classifications and not just to major components such as steam generators, etc

Good Practice: The Nuclear Maintenance Department has developed an extensive experience feedback system. With the large number of NPPs and extensive standardization of equipment, this database is an excellent tool to monitor equipment data, identify possible generic faults, compare experience from station to station, compile data for feedback to manufacturers and suppliers, and to provide a basis for the resolution of problems.

1.3. Preventive Maintenance Programme

The Nuclear Maintenance Department is also responsible for the development of maintenance doctrines and programmes that are also universally applied to all units in a particular series. The maintenance doctrines are based on design evaluations of equipment, analysis of manufacturer's recommendations, appraisal of the ratio between the cost of preventive maintenance and the cost of failures, analysis of potential failures, and analysis of experience feedback. Maintenance doctrines can be established by equipment family, by equipment, or by specific apparatus.

Most of the preventive maintenance programmes are structured around activities to be performed during refuelling outages. Some activities are performed every outage and but many are performed at less frequent intervals.

The in-service inspection programme for reactor pressure vessels, pressurizers, and steam generators forms a large part of the preventive maintenance programme. Detailed outage reports are prepared following every outage which report the results of the in-service inspections, modifications, and preventive maintenance activities. This information is fed back into the preventive maintenance programme in order to modify the programme for the next outage or outages on other plants.

Another important part of the preventive maintenance programme is the monitoring of transients and collection of data relative to stress related events on many components or parts of the primary circuit which have the potential for fatigue damage. This practice is commendable and will be enhanced by the installation of an on-line computerized monitoring and analysis system which will remove the human error factor which could occur with such complex analytical systems.

(1) **Suggestion:** Consideration should be given to developing more extensive preventive maintenance programmes for non-safety related components such as local pressure gauges and temperature indicators.

Good Practice: EdF is in the process of developing very extensive on-line computerized monitoring and data analysis systems for stress related components. These systems will enhance the capability to predict potential fatigue damage in primary system components.

1.4. Interface with the Nuclear Safety Section

Nuclear safety with respect to maintenance at the EdF nuclear power stations has been receiving increased attention since recent the occurence of events at NPPs and significant maintenance related events at some French NPPs. Considerable emphasis has been placed on the development of policies and procedures to improve the "Safety Culture" in maintenance related activities. A "Safety-Quality Policy" concept has been developed which stresses detailed maintenance plans, attention to detail, improved training of maintenance personnel, verification of important check or hold points, and reporting of anomalies or problems during maintenance.

The EdF Nuclear Generation Division has recently set up a Co-ordination Section that reports at a high level and whose task it is to monitor significant events related to operations, maintenance, training, etc. Experience feedback from equipment or maintenance related problem areas is provided by the Nuclear Maintenance Section. Early anticipation of possible generic problems is an important aspect of this concept, particularly with the extensive standardization that exists within EdF's NPPs.

The Co-ordination Section is also responsible for organizing and co-ordinating working parties which can respond to important safety-related events and for co-ordinating the response to the safety authorities. All information flow such as analyses is handled by this section, thus ensuring a co-ordinated response.

Good Practice: EdF has developed a number of safety policies and initiatives in the maintenance area which if properly implemented address the concepts in the "Safety Culture" approach to plant maintenance, i.e. appropriate attention is directed towards nuclear plant safety rather than towards plant availability.

1.5. In-service Inspection Programme

The EdF Central Laboratories (GDL) provide the nuclear power programme in France with the technical support and resources to conduct the in-service inspection programme and to provide centralized services in the fields of chemistry, metallurgy, and non-destructive testing.

Approximately one-half of the GDL personnel are employed in the non-destructive testing section (SCND) . SCND is responsible for providing the following assistance to the NPPs: to prepare the in-service inspection (ISI) programmes and to report results; to perform the ISI activities during outages with the assistance of contractors; to develop and validate new ISI technologies and methods; to draft and update ISI procedures and specifications; to train and qualify inspection personnel; and to maintain extensive data banks of ISI test results from all stations. The ISI programme which is defined by the Central Nuclear Maintenance Department is very extensive and forms the basis of the preventive maintenance programme performed during outages. ISI programmes at the stations are still the responsibility of the station manager with GDL providing the technical support and personnel to carry out the programme.

1.6. Control of Modifications

The control of modifications and the management of outages at the NPPs are two activities which must be closely integrated and carefully controlled. UTO plays a vital role in these functions by acting as the co-ordinator and manager of all modification requests from the initiation phase through to implementation. UTO also acts as the contact with the design and engineering departments in EdF and with the safety authorities for the preparation and approval of modifications. The EdF NPP modification control process is well documented and centrally controlled. UTO in its co-ordination role is fully aware of the needs and justifications for all modifications since it can closely monitor the experience feedback database from all NPPs.

There is a deliberate policy in EdF to standardize all units within a series and thus this policy must also apply to the installation of modifications. By the end of 1992, all 900 MW units are supposed to be at the same modification level.

Good Practice: The deliberate policy to standardize all units within a series of NPPs and to ensure that all units are at the same modification level has the advantage of ensuring that when equipment related faults arise, they can be dealt with by a very broad experience base by exchange of information with other plants and take advantage of the centralized experience feedback databases. In the long term, maintenance costs should be reduced and nuclear safety enhanced.

1.7. Outage Management

Almost all ISI inspections, modification installations and the preventive maintenance programme are scheduled to take place during annual maintenance and refuelling outages. As a result, outage scheduling' is a very complex task. UTO is responsible for the overall co-ordination of outages. However, there are a large number of different EdF departments which either provide information or play important roles in the scheduling and planning process. NPP outages are scheduled by a centralized planning department in EdF which uses a computer software scheduling package known as "Planum".

The UTO Outage Resources Branch (MEA) which is responsible for national maintenance planning and resources liaises with the Central Nuclear Maintenance Department, the

NPP Maintenance Managers, and the Corporate Operations Department which is responsible for utility requirements and fuel management in order to define the restrictions and input the outage requirements to the "Planum" programme.

The "Planum" programme is updated monthly as the inputs, variables, and restrictions change. The main purpose of the programme is to optimize the NPP outages on both a resource and a cost basis. The programme contains sufficient flexibility and provides sufficient data so as to be a valuable tool in the scheduling of outages.

UTO also has an additional function in the overall management of outages in that it serves through its Contract Management Branch (GMI) as the co-ordinator, contract administrator, and QA auditor of all contractors who are employed at EdF NPPs during outages.

(1) **Suggestion:** Consideration should be given to the development of performance indicators which would form a basis to measure and compare maintenance performance from station to station.

Good Practice: In view of the size of the nuclear power programme in France, the centralized planning and co-ordination of outage resources is a positive step to ensure that outage durations are optimized and costs are minimized.

1.8. Stores and Warehouses

UTO also has the responsibility to procure and manage all equipment and spare parts which are considered to be strategic for the operating units for nuclear safety, availability, or economics. This function is performed by the Equipment and Resources Branch (MDE) of UTO. MPE has the task to collect, verify, and analyse technical and economic data from the experience feedback database from maintenance outages at the NPPs. These data then form the basis 'to make recommendations to purchase spare parts. MDE also has the responsibility to qualify, monitor, and administer the contracts of suppliers of spare parts. Another function of MDE is that of management of all technical documentation in the Nuclear Generation Division including design documents from the original installation, documents that are required for modifications, manufacturers' maintenance manuals and equipment drawings.

This warehouse is well equipped to conduct visual inspections for acceptance, to monitor the condition of spares in storage, and to arrange for shipping to the required locations with the proper documentation. A good computer based database exists for the identification by stock codes of quantities and reorder points but this database does not at present contain information on the location of the components in the stores.

(1) **Suggestion:** The management of spare parts in the centralized warehouse could be improved by expanding the computer system to provide information on the location of the components in the warehouse.

2. PLANT MAINTENANCE

Plant maintenance personnel and site work department personnel make a well qualified and dedicated group. The management of the Operating Department and Technical Sub-Unit Department are firmly committed to implementation of the National and Local Maintenance Programmes. The Blayais site is well supported by the EdF Central organization which defines the National Programme and National Maintenance policy. Clear and well implemented policies exist for providing direction to the site and for returning appropriate maintenance feedback experience to EdF. Site management and programmes provide for a strong focus on plant safety and availability.

The relationship of the EdF and support organization to the site creates a complex interdependent organization. Functions and responsibilities are well defined. The on-site organization functions in a disciplined matrixed manner based on a spirit of co-operation between the operating Department and the Technical Sub-Unit to achieve the common goals of implementation of maintenance programmes and preparation and conduct of unit outages.

Performance reporting to management appears minimal with existing indicators of maintenance focused on unit availability. Further consideration should be given to the development of a visible, meaningful hierarchy of safety based indicators to measure the effectiveness of maintenance programme.

The strong presence and control provided by EdF establishes the basis for the local programme and the level of national performance standards. This national standard should be utilized to formulate site policy and goals which foster an attitude of excellence and continual improvement.

The station is benefiting from the ongoing implementation of the Quality Safety Plan and the planned full utilization of the "SYGMA" computer system. Many initiatives from the Quality Safety Plan are pending and should achieve long term benefits to improve maintenance. The Quality Safety Plan concept of dedicated safety system maintenance planning and monitoring during outages to minimize human factor based risks provides for a strong contribution to safety.

The level of involvement and depth of audit reviews by quality assurance in the maintenance area and the handling and disposition of audit findings should be reviewed to ensure that an effective, accountable function is being performed.

The physical facilities provided to support the site are excellent.

The station is generally clean and orderly but additional efforts in this area are needed. Material conditions indicate that management focus on both safety and availability priorities. Physical plant conditions are generally good with notable exceptions in some cases. The presence of maintenance managers in the plant should be utilized to clearly identify maintenance programme goals and to communicate expectations.

The maintenance work order process at the Blayais plant is a good example of comprehensive preparation for maintenance work. The work order permission process provides for an effective blocking and tagout system which results in the safe guarding of equipment and maintenance personnel. The maintenance procedures are implemented well and the organization for outage preparation and execution is well structured and very effective.

Greater attention to detail and a clear policy are necessary to ensure that a method exists to provide for authorization, accountability and documentation of changes made during use to procedures, quality documents and recorded data.

The calibration and condition of installed local instrumentation and devices used to support operations need improvement. The OSART team understands that the EdF Central Maintenance Department has a directive under consideration.

Overall, on-site maintenance is functioning well to achieve the defined goal of ensuring plant safety and reliability.

2.1. Maintenance Organization and Functions

Organization

The Blayais organization provides separate Maintenance Departments for Units 1/2 and 3/4 with each group having the primary responsibility for the maintenance of all electrical and I & C equipment during operation and outage conditions and for the maintenance of mechanical, boiler making and general services during operation only. A Site Work Department under the Technical Sub-unit Manager, which services all units, is responsible for mechanical and civil engineering activities on each unit during outages, as well as for providing technical support to all units for the development of maintenance methods, tools, spare parts and liaisons with external support organizations.

A high priority is placed on the co-ordination and liaison with the EdF central organization. EdF central organization provides the site with national maintenance policy, strategy and technical support, including performance of in-depth analyses of main incidents and generic operating experience feedback. The site is responsible for development and implementation of a site preventive maintenance programme based on the national maintenance policy and programme. The site remains fully responsible for the quality of maintenance performed, for scheduling and for managing human resources.

The functional lines of reporting provide for good communications between maintenance and operations for each unit group and between technical departments within the Technical Sub-Unit (SUT). Technical issues are focused within the three departments which constitute the SUT.

Staffing levels within the Maintenance and Site Work Departments are appropriate, with recent increases in the work preparation areas consistent with implementation of the National Quality Safety Plan goals.

Maintenance contribution to plant safety

The National Maintenance Programme focuses on prioritized implementation of generic maintenance and modifications. Appropriate site-specific feedback is provided to the EdF corporate office to evaluate programme scope and effectiveness by a formal programme of short term reporting of damage (Form 222) and a series of evaluation meetings (Synthesis Process) and formal reports to the National Policy and Programme offices.

The Plant organization contains a Nuclear Safety and Quality Assurance Sub-Unit which reports directly to the Plant Manager. Within this Sub-Unit a Maintenance Safety and Quality Section provides for a maintenance overview.

Maintenance and technical sub-unit performance are clearly focused on evaluation of identified conditions with a high priority on safety related and availability related maintenance. As an overall goal the success of the maintenance programme is measured by unit availability and successful preparation, planning and performance of outages.

Management expectations are defined in annual contract documents which contain objectives and goals. Limited tracking of performance data is performed with improvements planned in the future dependent upon full implementation and refinement of the SYGMA database.

The safety culture and dedication of the Maintenance Department and Technical Sub-Unit Departments are evident. Plant processes and policy focus on Important-to-Safety issues for identification, evaluation and correction.

There is a strong interface with the EdF National Policy and Maintenance Programme and site activities rely on prompt, complete evaluation by EdF to support the approval and performance of Important-to-Safety work. In some cases the evaluation of site specific issues seems to be deferred to EdF which may preclude prompt policy decisions (calibration of instruments policy, policy of applying temporary lead shielding to installed systems).

The material condition and defect evaluation process may indicate an over emphasis on Important-to-Safety classified components and plant availability. The accepted level of component material conditions and housekeeping could be improved.

Maintenance quality assurance

The Nuclear Safety Quality Assurance (NSQA) department is responsible for QA reviews and audits in the maintenance area utilizing a dedicated Maintenance Safety and Quality section (MPQS). The NSQA department reports directly to the plant manager and is independent of the operating and technical sub-units. The NSQA department is also responsible for conducting QA audits in all of the other operating areas of the plant (i.e. radiation protection, operations, etc.), utilizing the Industrial Safety and Radiological Protection Section and the Production Safety and Quality Section.

The MPQS establishes an annual audit schedule that specifies the audit areas and the specific outage maintenance work (i.e. by equipment name) that is to be audited. The schedules are approved by the NSQA manager and plant manager. Examples of audit topics include the following: handling of non-conformities; steam generator tube pluggings; outage maintenance on the high pressure injection system.

The audits are primarily directed at safety related topics. Audits of maintenance on equipment important to safety and on programme (or mission) implementation areas were not included. The area of electrical and I & C maintenance also was not separately identified for audit. These areas would normally be included if associated with the works on a mechanical system.

Detailed reports are prepared at the conclusion of each audit. The reports provide some general conclusions in the introduction and more specific details in the body. However, the conclusions are broad and not quantitative. In addition, the specific deficiencies identified in the bodies of the reports are not converted into QA deficiency reports or other visible, trackable items for future follow-up and action confirmation. The summary reports are sent to plant management but no formal follow-up system has been developed. Formal responses and action plans to determine root cause(s) and correct the deficiencies are not required.

Deficiencies which were identified during the various audits (i.e. improper treatment of non-conformities, missing documentation, uncorrected preparation of quality plans) are not trended or tracked to provide for the identification of recurring problems and programmatic weaknesses for further follow-up and/or root cause analysis. Similar deficiencies were noted during reviews conducted by the team. Quantitative performance indicators and station goals to assess the health and effectiveness of the plant's QA programme have not been developed. Formal follow-up on QA problems is necessary to ensure a credible quality function and an effective approach to safety.

(1) **Recommendation:** A formal system for the tracking and follow-up of QA activities should be established and implemented for all maintenance areas, to identify items and problematical areas which should be improved and, if needed, more intensively reviewed. Plant goals should be established to monitor and ensure the effectiveness of the programmes. The scope of QA audits should be expanded to include all areas of maintenance and programme reviews to effective implementation.

(2) **Recommendation:** Maintenance QA audit conclusions should be presented by quantitative facts and examples. General conclusions without a basis (i.e. number of deficiencies, trend of deficiencies since last review) may not provide an accurate view of the situation.

2.2. Maintenance Programme

The overall EdF maintenance policy provides direction to the EdF National Maintenance Programme. Maintenance management of the plant provides the maintenance organizations with a local maintenance programme which is based on the national programme of EdF.

The local and national maintenance programmes used at the plant cover the functions and tasks of plant maintenance to ensure satisfactory reliability of operation throughout plant life. The programme addresses preventive, predictive and corrective maintenance, outage planning, recurrent testing including ISI, modification of plant components, warehouse systems, feedback evaluation, lessons learned and quality assurance and control of the maintenance.

Plant management evaluates the activities of the maintenance organization to focus on effective contribution to plant availability. Policies and programmes are established to implement station requirements. The process of evaluation and revision of maintenance policy documents is responsive to local maintenance activity needs and includes those of other EdF nuclear sites.

The maintenance staff of the plant are very capable. The workers, foremen, technicians, head of sections and departments as well as the management show a high level of professionalism knowledge and experience. The maintenance experts are well trained and have a high level of qualification.

The maintenance personnel's safety culture and awareness during the maintenance activities were found to be good and consistent with established policy.

2.3. Material Conditions, Facilities and Equipment

Material condition and housekeeping level of the machinery spaces, work areas, reactor spaces and site support areas were observed during tours and review activities and were found to be generally satisfactory.

The overall condition of the spaces and equipment was generally good with some notable exceptions. The controlled area is maintained at a level significantly above that of the secondary-side spaces.

The plant system components and equipment are properly insulated, although lagging damage exists, and the holders and snubbers of pipes are well maintained. The technical condition of equipment and systems is good but a surprisingly large number of water and steam leaks were found in the turbine hall of Units 3 and 4 which should be evaluated and analysed by the plant staff for safety and reliability. These leaks were not always identified to provide for worker safety.

(1) **Recommendation:** Measures should be taken to ensure prompt identification, evaluation and correction of system leaks during plant operation. The basis for delays in repair should be documented and reviewed for impact on safe plant operation and on the scope of future repairs. A plant policy of continual improvements, high standards of safety and continued reliability should be considered.

Excellent support facilities are provided on site for the staff. The overall condition of the facility was satisfactory with some exceptions. The condition of the Auxiliary Building was generally satisfactory; however, boric acid residue and several valve and pump leaks were noted. The condition of the refuelling floor area was initially unsatisfactory owing to recently completed spent fuel transfer work. This condition was subsequently corrected.

The combustible material storage and fire area availability of control policy does not provide for clear marking of areas and availability of fire fighting equipment. For example, paint, solvents and other highly combustible material were stored in a storeroom with no installed fire fighting equipment and no labelling to aid in fire fighting assessment. The temporary storage of lubricating oil in unmarked containers was also observed. The personnel policy on smoking results in fire hazards and the appearance of poor housekeeping. An example was noted where an individual who was painting a turbine hall machine housing, with a large amount of machine oil in the machine base plate, was smoking.

(2) **Suggestion:** Consideration should be given to establishing a clear combustible material storage and identification policy to evaluate fire loading in storage areas and during work. Appropriate hazard marking and suppression equipment should be provided.

(3) **Suggestion:** Consideration should be given to establishing a plant no smoking policy to reduce fire risks and improve housekeeping.

The maintenance of mechanical systems and equipment is performed well in the field; the system tagout process is clear and well controlled.

Mechanical, electrical and I & C equipment was found to be in good condition but several installed inoperable pressure measuring instruments were found with no local notation of the condition to operators. Pressure gauges were found damaged, non-calibrated and out of order. A calibration programme for local gauges has not been established even though some of them are used for surveillance on systems important to safety.

(4) Recommendation: The basis for a lack of a process calibration and instrument accuracy identification should be evaluated. Inoperable or inaccurate instruments should be evaluated and repaired. As a minimum, local gauges used for surveillance on systems important to safety should be calibrated.

The number of temporary installations was low but several inappropriate examples were noted: the use of scaffolding as temporary shelves with no analysis or review for impact on adjacent systems or components; and the use of lead blankets and blocks, authorized by the radiological protection department, with no analysis of impact on piping or components.

(5) Recommendation: Evaluate the policy for review and approval of the temporary use of materials and equipment on components and piping, such as lead shielding and scaffolding, to assess the impact of such use on plant design and operation. A formal temporary modification process should be considered to ensure the evaluation and control of such material.

The high voltage systems and equipment were found to be in very good condition. The protection of the site transformers and overhead lines was notable.

Maintenance facilities and equipment

Maintenance facilities and equipment were reviewed during tours of the Maintenance Shop, Technical Sub-Unit Shop, and Electrical and I & C Shop as well as during observation of ongoing maintenance activities.

Housekeeping in the workshops was found to be generally adequate, but in several workshops cleanness and organization should be improved. The workshops have been provided with very well supplied instrument and equipment storage areas. These facilities are maintained both in the secondary and the primary side of the units. The storage areas serve the maintenance activities in the field, but more attention should be paid to the verification of electrical cables and the maintenance and documentation of electrical equipment condition. Despite the approved chemical licensing system, unlicensed and inadequately labelled chemical material was found stored in the warehouse of the Auxiliary Building.

The lifting devices and mechanical instruments in the shops were well controlled and documented. The inappropriate storage of stainless steel and carbon steel materials together on the stand was noted.

(6) **Suggestion:** Material storage conditions in the workshops should be reviewed. Consideration should be given to ensuring that workshops only contain identified, documented and properly segregated raw materials and parts for metal construction.

The welding workshop has a good supply of tools, but the condition of the welding machine ground cables was poor and did not meet the technical requirements. Technical problems were also noted concerning the storage and proper accountability for the issuing of welding electrodes. Various electrode issue points were noted and no documentation or environmental preservation or conditioning of the electrodes was provided. Welding procedures are carefully regulated and reviewed. Welders are maintaining their qualifications up to date.

(7) **Recommendation:** only controlled welding machines and electrodes should be used. Deficient equipment should be upgraded and marked to prevent use.

(8) **Suggestion:** The policy for accountability and proper environmental conditions for welding electrodes should be reviewed to ensure that welding tasks are performed with appropriate and properly conditioned electrodes.

There are marked and calibrated instruments in the instrument storage area; however, in the field the workers use unmarked and unidentified instruments. This should be addressed so that only calibrated and appropriately functioning instruments are used at the plant.

(9) **Recommendation:** All unmarked instruments, devices, etc. being stored in the different rooms, in tool boxes and mechanical, I & C, and electrical workshops should be controlled. Only controlled and calibrated instruments and devices should be in use at the plant.

The storage spaces are clean and well organized. The storage facilities in the workshops are provided with an excellent computerized documentation system.

Electrical and I & C maintenance workshops were found to be well organized and in good condition. In the area of maintenance activity the site staff is mainly limited to the replacement of equipment in plant systems, with repairs being performed by contractors or under the national programme. The mechanical electrical and I & C workshops satisfactorily serve the needs of plant maintenance.

Good Practice: The establishment and continued development of a computerized tracking and inventory system in the technical sub-unit workshop provide excellent control and accountability of tools and material.

2.4. Procedures, Records and Histories

maintenance procedure

A highly developed work request/work order system is used at the Blayais NPP. All maintenance work and activities are prepared and executed following this general procedure. A maintenance procedure ensures implementation of the permission tagout - turnover system. At the plant, the preventive predictive and corrective maintenance activities on the plant systems and in the workshops and during the outage performance are implemented well and meet the requirements of the general procedure in the preparation, permission and execution phases.

Work orders and the attached work package documentation were found to be very well prepared and were observed to be in use in the plant and in the workshops during maintenance. The maintenance work order process used at the Blayais plant is a good example of comprehensive preparation for maintenance work.

Maintenance records and equipment history

Blayais NPP has a good system of administrative procedures which detail how technical documentation is to be handled in accordance with the plant procedures and national requirements.

Detailed maintenance instructions are used by maintenance staff and craftsmen in the field. Appropriate arrangements are implemented for orderly collection of records and reports on maintenance activities. Maintenance history records are easily retrievable and available for use. The work history and documentation process are computerized.

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

The preparation, review, approval and revision of procedures and other work related documents are generally properly controlled; however, several examples of shortcomings were found during the review. Not wholly approved, not properly modified and changed work documents were found to be in use or in the history files. [Refer to Recommendation 2.5 (2) and (3).]

The documentation storage is satisfactorily arranged. The documents, manufacturer manuals, drawings, films, etc. are properly stored. There is a file with maintenance history and applicable procedures for maintenance of each equipment.

(1) **Suggestion:** The document storage methods and spaces should be evaluated for proper environmental protection and fire loading and fire suppression methods. The use of mixed space for the storage of construction and maintenance documentation with surplus furniture should be reviewed. Fire loading should be considered in the use of wood panelling and construction material.

Work control system

The work request/work order system at Blayais Nuclear Station is handled very well. The responsibilities and functions are well defined. The maintenance work order process uses a computer based system (SYGMA) which is the main tool for identification and execution of work. The submission of a Work Request provides the initial identification and assignment of work priority based on a tight review system and final authorization by the operations shift supervisor. The work order formulation stage results in the preparation of a work file that includes all documents necessary to perform the work, such as blocking, worker listing, spare parts, quality plan, dosimetry requirements, permissions, etc.

The work order process includes a quality plan which specifies the necessary maintenance steps and verification hold points, external and internal audits, work site reviews, etc., which results in an effective independent quality control system. The Maintenance Department controls contractor work to ensure that acceptable work files are provided and reviewed prior to the generation of a work order to authorize commencement of contractor work.

The staff of the SUT, which provides for site work department work order preparation and final work file review, are well organized and qualified. Records are readily available and well organized, including historical work files, construction records and work plan proposal packages. Completed work orders can be readily retrieved for future reference and work analysis.

Blayais is implementing a Quality Safety Plan concept which is intended to limit the human factors based risk on safety related system outage maintenance. This process provides for dedicated review and oversight of maintenance on safety systems to identify and resolve interface and common mode vulnerabilities.

Good Practice: The Quality Safety Plan concept of dedicated safety system maintenance planning and monitoring during outages to minimize human factor based risks provides a significant contribution to safety.

Conduct of maintenance

At Blayais, maintenance is performed in accordance with national maintenance doctrine, a plant specific maintenance programme and approved procedures at the plant level. Good industrial safety and radiological protection considerations are provided for by the work preparation and planning process.

The work order permission process provides for an effective blocking and tagout system which results in the safe guarding of equipment and maintenance personnel. The AIC (Automatic Blocking Information) system is well utilized and implemented to support maintenance area isolations and personnel safety. The existing database control system does not provide for the routine periodic review and updating of the standard padlock lists.

(1) **Suggestion:** Consideration should be given to routine periodic reviews and verifications of the standard database used for preparation of blocking for maintenance activities. This periodic activity could avoid unnecessary danger for maintenance personnel due to outdated data lists.

Mechanical, electrical and I & C maintenance activities were reviewed and found well organized and performed. A daily operational maintenance meeting takes place in the units to clarify the jobs to be performed and determine the priority, terms and conditions of the work. Preventive and corrective maintenance activities are scheduled weekly by means of a computer printout and manual methods.

Upon the completion of maintenance activities it was determined that the work conduct control system provides for appropriate post maintenance testing before the work order is considered to be complete.

During the review the team observed many QA type deficiencies in the review of work and test documentation, for example: uncontrolled/unreviewed changes to quality plans, changes to work procedure data tables, changes to data recorded for a safety related component maintenance test, and incomplete stop point documentation which had been reviewed by the quality section and the site restart committee.

(2) **Recommendation:** The plant policy should be reviewed to ensure a method exists to provide for authorization, accountability and documentation of changes to procedures, quality documents and recorded data made during use.

(3) **Recommendation:** Greater attention to detail should be given to the proper completion of quality and procedure documentation by both the personnel conducting the work and personnel verifying the work. Additional emphasis and reviews should be provided by plant management.

2.6. Preventive, Predictive and Corrective maintenance

Preventive maintenance

The preventive maintenance (PM) of Blayais NPP is organized by two sections: the Technical Sub-Unit which is responsible for planning and scheduling of the preventive maintenance activities on the mechanical area during outages and the operational Sub-Units 1/2 and 3/4 which are responsible for all preventive maintenance actions during the operational period in addition to the electrical and I & C preventive maintenance during the outages.

The preventive maintenance performance flowchart was reviewed and the process found to be well defined. The plant is fully using the prescription, programmes and the requirements of EdF Central Organization.

Outage preventive maintenance programmes and preventive maintenance schedules for the operational period were well controlled and found to be correct.

The evaluation of preventive maintenance is performed meeting central requirements, but in general the PM programme does not utilize a standard set of specific performance indicators for periodic review by the site and EdF central. The maintenance management focuses on analysis of the effectiveness of preventive maintenance activities only as far as the availability of the plant is concerned. This is an appropriate performance indicator but does not provide a comprehensive evaluation of programme effectiveness for predictive purposes and to foster corrections and modifications in the preventive maintenance programme.

(1) **Recommendation:** Consideration should be given to the establishment and use of performance indicators, including those which can directly characterize the relationship of preventive and corrective maintenance works performed, to establish goals and measure the benefit and efficiency of maintenance activities on the site.

Predictive maintenance programme

Predictive maintenance techniques are widely used at Blayais NPP in order to complement the preventive maintenance programme. The predictive maintenance programme is very extensive, for example: valve monitoring, acoustical loose part analysis, vibration monitoring, thermovision (thermography), lubricating oil analysis, control rod drop speed spectrum analysis and eddy current inspection. The loose parts analysis for reactor coolant pressure boundary and the vibration analysis for main rotating equipment are performed by an on-line system at the site. The predictive maintenance programme utilized by Blayais NPP appears effective and provides for the analysis of equipment condition and the follow-up of operational consequences.

Corrective maintenance

Corrective maintenance work activity is initiated with the computer based SYGMA system and originates as a Work Request. Any plant individual may originate a Work Request and initially assign one of five levels of work priority. Direct communication and attention are given to the evaluation of high priority work Requests, otherwise the request is dealt with during a work review meeting held each morning. At this departmental interface meeting proposed work requests are reviewed and clarified and a final work priority is assigned by the operations department. A work request may be cancelled only upon agreement of its originator.

Upon completion of the work request review, the SYGMA system is utilized to transmit the information to the appropriate technical department for conversion into a work order and development of a work file which contains appropriate work authorization, blocking, procedures and safety and quality verification documents.

Corrective maintenance work is performed utilizing an extensive and well constructed work file, which is typically originated by the maintenance or site-work technical sponsor preparation section. This work file utilizes the SYGMA computer system to search for similar past maintenance work and thus the preparer utilizes past component history, standard procedures, blocking considerations and quality verification considerations.

Corrective mechanical maintenance that is scheduled for performance during an outage is prepared by and typically performed by the SUT, with electrical and I&C work and preparation being done by the appropriate operating unit maintenance department.

Outage corrective maintenance utilizes a Quality Safety Plan concept which requires a dedicated safety system sponsor who reviews, co-ordinates and monitors system maintenance to minimize interface and common mode problems caused by human factor influences.

National contractors and the SUT are utilized to supplement the maintenance department for work performance and job preparation. Approved contractors have an approved quality organization and receive work preparation and performance monitoring from Blayais.

The site typically does not perform welding or repairs to safety related components but rather replaces these components or utilizes an approved national contractor following consultation with EdF centre.

Some changes to Quality Plans and to completed work files did not have appropriate notation of when the change(s) was/were made and better if subsequent technical and safety reviews were performed. [Refer to Recommendations 2.5 (2) and (3).]

2.7. Outage Management

The outage management and administration programmes ensure the effective scheduling, implementation and control of maintenance activities to support outages. The strategy of outages is based on the safety and reliability of the plant. A long term national outage schedule is prepared, which includes all EdF nuclear power plants. This schedule is co ordinated to control planned outage dates and duration, and in order to plan for additional manpower and the availability of the major suppliers and technical expertise to support the outages. The outage preparation and planning for the next annual refuelling /maintenance outage starts three months before the outage is scheduled to begin.

The outage co-ordination team is organized from all technical departments of the plant having responsibility for execution of the outages. The tasks and responsibilities of defined.

The outage execution organization is well thought out. The daily management and co-ordination meetings serve well the successful outage execution. The on-line updating of the schedule during the outage is a good example of extensive conduct and control of work execution during the outage.

The outages are evaluated in post-outage review reports prepared for site use and for the EdF centre information. The lessons learned and recommendations for the next outage are appropriately evaluated and implemented.

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

2.8. In-service inspection

Standards and performance

The substance of the In-Service Inspection (ISI) Programme for the primary circuit is contained within the text of the Decree of 1974, a National Requirement. The corporate maintenance department writes and updates the EdF National Programme based on the Decree of 1974 and incorporation of experience feedback.

The local programme at Blayais is based on National Programme requirements and written by the Site Work Department (SUT). The local programme is unit specific and updated after each outage based on National Programme requirements and the results of inspections performed. The local programme is approved by the SUT Manager and presented to the safety authority at the Ministry of Industry for approval. Once the programme for each unit is approved, local implementation begins.

ISI results are evaluated at various stages throughout the programme with each defect or indication being tracked with a specific monitoring sheet which notes location, size, etc.

Final ISI programme results are documented and presented to the safety authority, and provided to other on-site and EdF units. The ISI programme results are used to provide component specific results for EdF such as unit comparison and experience feedback. The results must be reviewed with the safety authority prior to unit restart.

ISI activities

Maintenance work performed which results in welding is performed and tested by the National Contractor for safety related activities and checked by Central Laboratories (GDL). Auxiliary safety systems are subject to local programme inspections as specified by applicable codes and standards. Pilot testing is currently being performed within EdF for erosion/corrosion in auxiliary systems.

The Decree of 1974 requires monitoring and evaluation of primary circuit, stress imposed by heat and/or pressure. This function is performed at Blayais by the Technical Checking Section within the Operating Sub-Unit. Inputs are provided by the computer log, from the safety engineer's weekly report and from operators. Input functions are monitored daily and gathered weekly.

Appropriate evaluation and dispositioning of the data is provided for on-site with periodic reporting to EdF Central. Components are tracked individually and replacement component packages include the history of stress cycles.

A non-controlled, non-calibrated measuring device was noted to be used to evaluate data. Although use of the device may be appropriate, its origination and continued use must be monitored to establish its accuracy and to control changes if needed.

(1) **Recommendation:** Provide for the review, qualification and control of data interpretation devices.

2.9. Modifications

Policy and preparation

The modification process is well defined by task documents and is focused within the Technical Sub-Unit, Technical Management Department. Individuals from the Operating Sub-Units are detached and assigned to the Modifications Section to provide support and technical expertise for specified periods of time.

Modifications are programmed on a national level by Blayais in co-ordination with EdF centre. Two types of modifications exist: national and local. The definition of a local modification is controlled by procedure and is limited to small, site specific activities which do not compromise the overall design or function of the plant system.

Modification packages are prepared and a meeting is held to decide which proposed modifications will be implemented during the next outage. Safety related national modifications are mandatory to maintain French reactors in a standardized design. Pilot modifications are used in specific sites to test the effectiveness of design modifications, and then are evaluated for generic application.

Conduct of modifications

An effort has been made to implement the backlog of modifications to 900 MW plants with approximately 660 total modifications completed. This backlog has been essentially eliminated and the number of modifications is trending down. For example at Unit 3 in 1990, 232 modifications were made during the outage and in 1991, 67 modifications, of which 10% were local

National modifications typically result from EdF operating experience and are provided to the site as a complete modification file which includes background, description, reference drawings, contract specifications and retest requirements. Contractor preparation qualification and performance are monitored by site representatives, IPE and/or the constructor.

It was noted that the Maintenance Safety and Quality Section does not typically become involved in the planning, preparation and scheduling of modifications but ma monitor modification implementation.

Since the system was originated (10 years ago) approximately 1004 requests for local modifications have been originated and presently approximately 50 remain outstanding. Tracking of high priority modifications is performed and work load backlog and assignment of duties are tracked by the Modification Section Head.

Good Practice: The EdF central policy and local site application of the modification identification, evaluation and implementation process is viewed as a strength to ensure consistency and configuration control for plants.

2.10. Stores and Warehouses

The Procurement and Contracts Department is responsible for purchasing and storage of material and spare parts provided to the plant. The maintenance departments and the technical sub-unit organizations are responsible for parts requests and criteria. Receipt, storage and issue of spares and materials are clearly defined at the department level which is part of the administrative subsection.

The purchase and store activities of the plant met the requirements of the EdF centre. The procedure gives an exact definition of classification of plant materials and spare parts, dividing these into three categories of safety related, non-safety-related and for general use spare parts. The spare parts ordering, purchasing and buying receipt chain were reviewed and found to be good.

A site storage procedure has not been developed for the receipt inspection and preventive maintenance of the spare parts. Receipt inspection and periodic quality control of stored spare parts, in long duration storage, are necessary to ensure the proper condition of spare parts for issue.

(1) **Recommendation:** Procedures should be amended to include the quality control actions to be performed during the storage period. These procedure should take into account the different functions and the safety classifications of items and determine the method and periodicity of control inspections.

The facilities and storage equipment rooms were reviewed and found to be adequate, clean and organized. Appropriate tools, including remote control devices, are in use. The parts inventory system is computerized.

Shortcomings were noted in the storage of chemicals in that toxic and flammable materials were located in the same room, which is not acceptable. Additionally stainless and carbon steel materials are stored together on the racks and shelves. The spare parts of safety related equipment are stored adequately and correctly.

(2) **Recommendation:** Adequate storage should be provided for flammable materials and chemicals with an appropriate fire protection evaluation and suppression system.

(3) **Recommendation:** Consideration should be given to the appropriate identification, labelling and segregated storage of metals to provide for proper preservation of metallic properties.

An air conditioned room for computer and electronic spare parts is used in the storage area, but some circuit cards and component items are not protected from the environment. The general condition of the store facilities is good.

(3) **Suggestion:** Consideration should be given to the establishment and implementation of a policy to provide for proper protection and storage of electronic components to prevent damage due to handling or environmental conditions such as heat, moisture, light, etc.

3. TRAINING AND QUALIFICATIONS

The organization of training and qualification of personnel at Blayais NPP have been significantly reoriented since 1987. Line management, at both the corporate or site levels, has been seriously involved in establishing policy guidelines and co-ordinating activities leading to this new approach in training. This reorganization of training has followed quality improvement principles and a systematic methodology to establish task analyses for all positions and training objectives related to job descriptions.

The training programmes are supported by an effective structure allowing a precise determination of required knowledge and skills for employees to perform in a safe and efficient manner. The content of training programmes reflects the concerns of management about safety aspects, quality assurance, prevention of risks and awareness of responsibilities on the part of the employees.

The documentation associated with training is of very good quality and is effectively controlled for accuracy. An important characteristic of the various training programmes is the technical competence of the instructors and the quality of training facilities, equipment and material.

Evaluation of trainees with respect to qualification requirements is also very well structured and their competence is closely monitored by management with an incentive to job progression. Revision of training programmes and material according to changes in tasks, systems or procedures is undertaken with efficient control mechanisms.

There are, however, a number of aspects in which training could be improved. The effectiveness of on-the-job training (OJT) would be improved if the instructors who conduct OJT were trained in teaching pedagogical methodology.

The minimum OJT requirements in radiation protection, chemistry and testing for each grade of personnel should be defined and included in structured and obligatory training.

Operating technicians should be considered to be included in team training using the full scope simulator for enhancing the communication and teamwork between control room operators and operating technicians.

3.1. organization and function

Training organization

National training policies are governed by the Nuclear and Fossil Generation Division. Most personnel in the Division come from the nuclear power plants and very experienced. Training goals at the corporate and the NPP level were set for period from 1987 to 1992 and were updated in 1990.

The corporate training section is responsible for generic national actions that are common to all the plants. It foresees future needs and improves working methods in training. It also supervises and controls operational experience feedback consistent with management policies.

Administrative policies and procedures are established in all units and sub-units to clearly define the mission and responsibilities of the training centres, emphasizing development of training activities and adaptation of training methods. The training organization undertakes several types of training to respond to collective and individual needs. The various training activities are well defined.

A new training approach based on "total quality" was developed in 1987 at the corporate level and adapted in each NPP. It implies a systematic analysis of tasks, training needs and job descriptions by sub-working groups in training and management. Training requirements and activities are reflected in a Standard Training Plan and an Individual Training Plan for each plant staff member. The revision of training plans is undertaken annually. Training and management committees, composed of all levels of plant staff, seem to be very effective in defining the training requirements.

The overall training process is controlled by quality assurance policies. The training process includes experience feedback, training at off-site centres, work site training, on-the-job training and simulator training.

External organizations provide training services at different on- and off-site training centres. These organizations are submitted to the same prescribed requirements of competence and are controlled effectively by line management.

Training for operations is carried out by the nuclear training centres of Bugey, Caen and Paluel. The training centres at Gurcy, La Perollière-Cetic and Les Mureaux provide training for maintenance employees.

Instructor qualifications

The instructional staff at EdF and Blayais NPP are adequately qualified technically and receive instructional skills training. Most of them have plant experience in either the technical or operational fields. Each instructor is required to rotate from one training centre to another and to return to an NPP every 3 to 4 years to maintain his or her technical knowledge. However, in-plant instructors are not consistently trained from one section to another to perform OJT with their subordinates.

(1) **Recommendation:** In-plant personnel who design and develop training materials and conduct OJT evaluations should receive training in instructional design, preparation and evaluation skills.

Training programme

All training programmes are developed according to a systematic approach to training. Structured training courses incorporate all types of training courses and are related to knowledge objectives determined by a job and task analysis.

The content of each training programme for Blayais NPP is determined by the required level of qualifications of each employee. The qualification criteria are very well established and supported by organizational notes.

The Standard Training Plan for an employee covers the above obligatory courses but also non-safety- related topics such as the emergency plan, fire-fighting, management, etc. A complementary specific training course (non-obligatory) is set up during an annual interview between the employee and his supervisor. Finally, the overall training programme is completed by OJT and continuing training. The Training Plan Guide was proposed by a training committee composed of trainers and employees and approved by a management committee.

Continuing training is given in several sections of the plant organization. It takes the form of shadow training (OJT), experience feedback on procedures, abnormal events, maintenance problems, etc.

Documentation supporting training programmes has learning objectives, lesson plans, assignments and examination processes to assess trainee competence according to specified criteria. On-the-job training is not always supported by objectives and performance criteria, a pedagogical approach, observation check-sheets or evaluation practices.

The Standard Training Plan is revised once a year by line management after interviews with each employee. Revision of training programmes and material is based on changes in tasks, systems or procedures.

(2) **Recommendation:** A systematic approach should be used to identify the minimum content of OJT and continuing training.

Qualifications of individuals for their jobs

Job descriptions have been developed and training requirements identified for all disciplines. Qualification and requalification certification are mandatory for all jobs according to the level required. This qualification is valid for two years and subject to re-evaluation by the management.

Trainees are assessed at various levels through their training progression by written examination that test the learning objectives. Performance based simulator training is evaluated in a team environment by a situational examination where malfunctions are introduced into scenarios.

Training records

The individual training files for each employee are up to date in all disciplines. However, they are not centralized in a document centre. The workers' immediate supervisor keeps the file of each staff member. In general, line management pays close attention to their employees' progress.

(3) **Suggestion:** Individual training files should be incorporated into a centralized database to avoid loss of information on trainees.

3.2. Training Facilities. Equipment and Material

Conventional training facilities

The Blayais training centre has adequate classrooms and training equipment. The classrooms contain visual aids such as overhead projectors, video equipment and models of plant systems and components.

The Bugey training centre has classrooms of various sizes that can be used by any discipline. These classrooms have adequate supplies of visual aids such as video equipment, slide projectors, overhead projectors and models of plant systems and components.

Simulator facilities

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

The present scope of simulation covers almost all systems including equipment manipulated in areas outside the control room, such as the remote shutdown panel.

Functional simulators are used to train operators on the key plant systems such as reactor control, turbine generator control and chemical volume control. Expert system simulators are also used to train operators on steam generator tube rupture events. Both types of simulators are available at the Bugey training centre and the Blayais training centre. In addition, a post-accident simulator (SIPA), the physical domain of which has been extended to post-accident situations, is available at the Bugey training centre for training of safety engineers, shift supervisors etc. The functional simulators, the expert system simulators and the SIPA are mainly used for knowledge based training.

The roles of the full scope simulators, the functional simulators, the expert system simulators and the SIPA are well defined. Computer aided training is also provided on site and in the training centre for self-study.

(1) **Suggestion:** The full-scope simulators have remote shut down panels in adjacent rooms to the control rooms but there are no additional panels which can simulate the operation of local equipment. The addition of another operating station to simulate field operator actions should be considered to further simulate remote operations and to enhance communication and team work between control room operators and field operators through team training of abnormal events.

Good Practice: The wide use of full-scope simulators for skill based training and the functional simulators, expert system simulators and SIPA for knowledge based training is considered a good practice.

The effective use of the simulators ensures the effectiveness and quality of operator training which facilitates the operators' ability to respond to complicated operational and accident situations.

Training material

Pedagogical training material has been produced for all structured training courses. The training material includes the purpose, scope, lesson plan and simplified descriptions of plant systems and functions with pictures to ease comprehension.

All training material is well documented and organized. The process for updating the training material for feedback is also well established and controlled. In addition, large collections of video tapes, slides and viewgraphs on various topics are available for training.

National level documents such as incident and accident procedures have a complete revision history table, as do plant level procedures. However, it was noted that the date had been forgotten on some alarm response procedures.

(2) **Suggestion:** Consideration should be given to applying a consistent quality approach to the revision of all procedures. Documents that have not been modified since the implementation of the current revision should be included.

3.3. Control Room Operator and Shift Supervisors

Initial training programme

Control room operators (CROs) are recruited from experienced and qualified second level operating technicians or from graduated senior technicians with 18 months of initial training. They are then given 18 months of classroom and simulator training and then qualified CRO level . After a 3 year period, they can be promoted to second level 1 CRO. After 3 to 5 years of operating experience as second level CRO, they can be promoted to the deputy shift supervisor position. Before being promoted to a shift supervisor (SS), they must have a minimum of 3 years experience. A new management position has been created to interface between shift teams and management. The Senior Shift Supervisor is a former Shift Supervisor who has received an additional 20 weeks of training over a 9 month period.

The progression of CRO and SS is extensively described in the training programmes and trainees are assessed very adequately throughout their progression. A complete job and tasks analysis has been conducted for the CRO and SS positions and learning objectives defining knowledge and skills have been adequately and systematically included in the training programmes.

Classroom training at the site and Bugey training centres is of very good quality and adequately controlled by line management.

The corporate training organization keeps track of changes in tasks, systems or procedures through a structured mechanism. Communication lines with training centres and each site are adequately established and operational. This experience feedback is incorporated into training objectives, material and facilities.

Classroom and practical training at Bugey meets high standards of quality and has highly competent instructors. The quality of training documentation, assessment methodology, simulation capabilities and fidelity, and the variety of challenging incident/accident scenarios are very good. Each pedagogical file is complete and maintained up to date.

Evaluation of trainees in a team environment is highly developed. During an observed simulation exercise, trainees and trainers were interactive in playing roles (deputy SS, CRO, SS, etc.). Communications and supervisory skills were exercised in an effective manner. Each training session started with a classroom explanation and ended with a post exercise critique with the whole team. Weaknesses were identified and corrected by additional training. An observation grid was used for CRO and SS assessments.

(1) **Suggestion:** The observation grid for simulator assessments of CRO and SS could be improved with weighting factors related to categories of actions taken, on which consequences are safety related.

OJT training is undertaken by competent tutors or instructors on shift. However, the evaluation of trainees is based on subjective criteria and observations of operator behaviour.

(2) **Suggestion:** Shadow training (OJT) is subjectively evaluated by observation of trainees and may cause a lack of uniformity between each operating team. Consideration should be given to developing a method to standardize the approach to the evaluation of OJT to be used by all shift teams.

Good Practice: Trainees are given a self-evaluation course to verify that prerequisites are met to allow more effective instruction in the following training module.

Good Practice: Pedagogical files at Bugey training centres contain annexes which describe technical experience feedback related to particular lessons.

Continuing training programmes

The amount of continuing training, including full-scope, function or multi function simulator training, is the prerogative of management and the operators.

The balance between classroom, simulator and other practical training appears to be adequate. Refresher training frequency for system knowledge is systematically identified in each lesson listed in the catalogue. The same applies for emergency procedures and seldom used procedures. Plant modifications and operating experience from the plant or industry are managed by a structured procedure at the corporate level. This allows experience feedback to be incorporated in training objectives, materials and facilities.

Job performance and training for emergencies are evaluated once a year during refresher training. Training records are adequately kept by management and these files contain all the relevant information on the required qualification of operators and shift supervisors.

Authorization and re-authorization

Initial qualification of CROs or SSs is governed by an organizational note which gives the conditions required to be qualified. The employee must have successfully completed the overall training programme leading to the qualification, and management approval is required to deliver the authorization. Verification of qualification is made through refresher training every 12 months.

The authorization certificate is renewed every year. A CRO or SS authorization can be automatically suspended if the operator has not carried out his or her activities for six months or more, or if he or she has changed departments or has left the plant.

3.4. Field Operators

Initial training programme

There are five categories of field operators: field operator, advanced field operator, senior field operator, first level operating technician and second level operating technician.

The training of field staff is well defined by job descriptions and pedagogical material.

The initial training for field operator is professional training. EdF is developing a new initial training course for field operators which upgrades the content of the present course. The classroom training and OJT are effectively mixed.

After completion of initial training the field operators can proceed to advanced field operator training and then senior field operator training. These courses are composed of additional classroom training, functional simulator training and OJT.

The operating technician training is divided into first level operating technician training and second level operating technician training which are about 5 months and 9 weeks in length respectively. These training courses are composed of classroom training, functional simulator training, full-scope simulator training and OJT.

(1) **Suggestion:** Consideration should be given to including operating technicians in the team training, using the full-scope simulator for enhancing the communication and teamwork between control room operators and operating technicians.

Assessment of training

Training progress and qualification are assessed effectively by evaluations and examinations. The evaluations are conducted to confirm the trainees' progress by oral and written tests. Written examinations are conducted for authorizing operators for nuclear safety related work.

Two levels of authorization are given to field staff: nuclear safety 1 authorization after passing the examination of initial training for field operators; and nuclear safety 2 authorization after passing the examination for operating technicians.

continuing training

Continuing training for operating technicians is well defined by pedagogical material.

The refresher training, such as functional simulator training and full-scope simulator training, is conducted for the operating technician once every year. In addition, the refresher training includes basic plant rules (once/2 years), basic quality (once/3 years), fire-fighting (once/2 years) and risk prevention (once/2 years). The frequency of the refresher training, except functional simulator and full-scope simulator training, may be too low to ensure the plant operators are kept current on operational practices and operating experience. The normal international practice is to provide refresher training courses about once every year.

(2) **Suggestion:** Consideration should be given to providing station personnel with more frequent refresher training (e.g. basic quality), to maintain their knowledge of plant policies and procedures adequately.

During the simulator training for second level operating technicians, it appeared that the operators carried out actions without requesting confirmation prior to each action. The shift supervisor only validated the action after the operation.

(3) **Recommendation:** Operators should take actions prior to the manipulation of switches to aid in preventing human error, for example, pointing to the switch and stating the name of the switch which will be manipulated. The double action is a good measure for preventing human error. It is an effective reconfirmation measure by the operator and by the supervisor.

3.5. Maintenance Personnel

Initial training programme

The maintenance line management is responsible for its staff's training. A typical training plan guide and site professional adaptation programme constitute the training. The initial training programme is documented in an individual training plan which is updated once a year after a personnel interview of the maintenance staff by their supervisors. Trainee needs and line management expectations are expressed and agreed to by each party. Training courses are delivered in several locations depending on the topic. Training is given at the plant or at off-site training centres. The maintenance training sub-areas reviewed were electrical, analogue and logics, maintenance planning, technical management department, general services section, precision and general mechanics.

A review was also conducted at two off-site training centres, La Perollière-Celtic and Gurcy-le-Châtel. The sub-areas reviewed were refuelling operation training and maintenance training on a full size fuelling machine model.

The overall training process is governed by policies and guidelines and it is adequately controlled. A systematic job and task analysis has been carried out and training requirements were defined to ensure that relevant knowledge and skills are included in the training programmes.

Classroom training conducted at the plant and off-site centres is of very good quality. The recruitment of competent and experienced instructors is adequately controlled by line management. Each instructor receives technical and pedagogical training. The technical competence of the instructors is maintained by rotation of the personnel.

Training documentation is very well structured and of good quality. The quality of instruction is very good. Training programmes and courses are monitored adequately and corrective actions are undertaken and controlled. Training is done in classrooms, workshops and/or laboratories with experienced instructors or tutors. Workshops, mock-ups, models and laboratory facilities are of very good quality and well above average.

The maintenance engineer training programme is being developed and appears to be well structured. The time allocated for training, including continuing training, varies from 8% to 12% of the total working hours.

(1) **Suggestion:** Emphasis is already placed on the effectivess of maintenance team work and communication interfaces. Considerations should be given to providing this training to multifunction units (i.e. electrical, I & C, mechanics).

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

Assessment of trainees

Assessment of trainee performance is adequately conducted by an experienced tutor or instructor by means of observation, oral examination, practical examination using models, simulators and challenging situational examinations. Following shadow training and on-the-job training, qualitative evaluations are given by foremen and are discussed with the trainee. After completion of the overall training programme, a qualification certificate is awarded to trainees by line management according to required criteria and site policies.

(2) **Suggestion:** Formalized personnel interview guidance is implemented within some plant departments specifying criteria for technical knowledge, behaviour of employees etc. Consideration should be given to using this official interview guidance in every sub-unit or section in order to have standardized evaluations of each employee.

continuing training

On-the-job training and continuing training are controlled by the Individual Training Plan. The content is defined during the interview conducted by supervisors where personnel and management needs are expressed. However, the maintenance personnel do not systematically receive training in instructional design and skills. The input of individual trainees is very important in the development of continuing training. The periodicity of refresher training is defined in the Standard Training Plan according to the complexity and frequency of the tasks.

(3) **Recommendation:** The instructors conducting OJT are experienced employees, but they should all be trained on pedagogical methodology to help them during performance assessments of their personnel.

(4) **Suggestion:** Weekly meetings are held within some maintenance sections where employees discuss problems encountered during work performance. This practice should be extended and formalized to keep track of the experience feedback for incorporation into the training system.

Good practice: After each training session, there are formalized evaluations of training with all the individuals involved. This is followed by recommendations of changes to the training centre sub-working groups. Once a year these recommendations are analysed and directed to the corporate level training division.

3.6. Technical Support Personnel

Initial training programme

Technical support personnel provide various services in such areas as safety, maintenance, operations and quality control. All these personnel are included in a corporate generic training programme.

Technical support personnel are evaluated systematically in the training programmes and refresher training is provided on a periodic basis. Training needs are identified in an interview held once a year and individual training plans are determined for every engineer. An individual training file on each trainee's progress is kept up to date by the respective supervisors.

3.7. Radiation Protection Personnel

Initial training programme

The initial training for radiation protection personnel is well defined by job descriptions and pedagogical material. It comprises professional training and common training for the technical staff, which includes induction, rules of plant, basic quality, maintenance safety, fire-fighting, plant emergency plan, industrial safety and radiological protection.

The fire-fighting training is obligatory training however, it was not codified. Therefore, the record of the training is not included in the training record of the individuals. A new codified fire-fighting training course, which is composed of three grades with upgraded content, was developed in 1991.

(1) **Suggestion:** The results of the fire-fighting training should be recorded formally in the individual training files and controlled by the section head manager.

The OJT is conducted within the radiation protection section, however, it .is not well structured or obligatory. Therefore, there is no document which defines the content of OJT for each grade, such as worker and technician.

(2) **Recommendation:** OJT is one of the most important training courses for putting classroom training into practice. The minimum OJT requirements for each grade of personnel should be defined and OJT should be included in structured and obligatory training.

Assessment of trainees

Training progress and qualification are assessed effectively by evaluations and examinations. The evaluations are conducted to confirm the trainees, progress by oral and written tests. Written examinations are conducted for qualifying radiation protection personnel for nuclear safety related work.

Three levels of authorization are given to radiation protection personnel: nuclear safety 1 : authorization after passing the examination of initial training for workers; nuclear safety 2: authorization after passing the examination for technician; nuclear safety 3: authorization after passing the examination for foreman.

Continuing training programme

Continuing training for radiation protection personnel is well defined by pedagogical material.

The refresher training includes basic rules of the plant (once/2 years), basic quality (once/3 years), fire-fighting (once/2 years) and risk prevention (once/2 years). The frequency of the refresher training may be too low to ensure personnel are kept current on operating practices and experience feedback. The normal international practice is to provide refresher training courses about once every year.

(3) **Suggestion:** See Suggestion 3.4 (2).

One sample reviewed out of many examples of individual training files showed that in one case a training course already attended was not recorded and refresher training was not scheduled correctly in the prescribed interval.

(4) **Suggestion:** The individual training plans should be made according to-a prescribed training plan and the training records should be correctly. recorded according to the prescribed format.

3.8. Chemistry and Testing Personnel

Initial training programme

The initial training of chemistry and testing personnel is well defined by job descriptions and pedagogical material. It comprises professional training and common training for the technical staff, which includes induction, rules of plant, basic quality, basic technics, maintenance safety, fire fighting, emergency plant plan, industry safety and radiological protection.

OJT is conducted within the chemistry and testing sections. However, in the case of the testing section, it is not well structured training, with no document defining the content of OJT for each grade, such as workers and technicians.

(1) **Recommendation:** See Recommendation 3.7 (2).

Continuing training

Continuing training for chemistry and testing employees is well defined by pedagogical material.

The refresher training includes basic plant rules (once/2 years) and basic quality training (once/3 years) for chemistry and testing employees, and radiological protection for chemistry employees (once/2 years) and risk prevention training (once/2 years) for testing employees.

The frequency of the refresher training may be too low to ensure that personnel are kept up-to-date with plant practices and experience related work. The normal international practice is td provide refresher training courses about once every year.

(2) **Suggestion:** See Suggestion 3.4 (2).

Assessment of trainees

Training progress and qualification are assessed effectively by evaluations and examinations. The evaluations are conducted to confirm the trainees' progress by oral and written tests. Written examinations are conducted to qualify chemistry and testing employees for nuclear safety related work.

Three levels of authorization are given to chemical and testing employees: nuclear safety 1: authorization after passing the examination of initial training for skilled workers; nuclear safety 2: authorization after passing the examination for technician; and nuclear safety 3: authorization after passing the examination for foreman.

3.9. Management Personnel

Initial training

The management development programme is in place at both the corporate and the site levels. Training programmes are conducted for all levels of management.

A hard core of training courses was defined after corporate level working groups made a survey of management personnel concerning difficulties encountered with respect to their work. The training needs identified were used to define the content of the programme. This management training is obligatory and is evaluated.

Continuing training programmes

Besides initial qualification training for managers, training needs for maintaining management and technical competence are identified through an annual interview by the hierarchy and a training committee on needs analysis. Proficiency training is given to managers on a case by case basis depending on the results of individual interviews.

Appropriate management and supervisory skills

Management careers are governed and co-ordinated by the national level and each manager is locally evaluated by his own management.

There is no systematic jobs and tasks analysis carried out but some studies have been done on several themes related to management. From the studies, training needs have been identified for each level of management.

A "personnel professional project" (PPP) has also been developed by general management to increase the staff's sense of responsibility and overall approach to their work, and to make sure that personnel development is consistent. This development project is part of the quality improvement process.

3.10. General Employee Training

Initial training programme

Initial general employee training (GET), the standard training plan for new employees, fire-fighting training and emergency plan training are given to all employees as obligatory training. Industrial safety training and radiological protection training are also given to all technical employees as obligatory. However, the standard training plan for employees was not obligatory for the administrative staff before September 1991. Therefore, it was only given to a few of the administrative staff; however, EdF has a schedule that all administrative staff will receive this training by 1993. The standard training plan for employees includes such topics as basic rules of the plant, basic PWR plant systems and basic quality.

These training courses satisfactorily cover topics needed by the general staff.

Continuing training

Continuing training for general employees is well defined by pedagogical material.

The refresher training includes basic rules of the plant (once/2 years), basic quality (once/3 years), fire fighting (once/2 years) and risk prevention training (once/2 years). The refresher training courses include subjects which refresh general plant policies and provide operating experience feedback, but the frequencies may be too low to ensure that technical personnel stay up to date with plant practices and operating experience. The normal international practice is to provide refresher training courses about once every year.

(1) Suggestion: See Suggestion 3.4 (2).

All personnel attending general employee training are given oral and written examinations for authorization. Continuing training is assessed in the same way.

4. CHEMISTRY

The plant chemistry for the Blayais nuclear power plant is maintained at a excellent technical standard with highly motivated and qualified personnel.

Responsibilities for various tasks are split between on-site and off-site organizations. The EdF Central Facilities provide long term support in physical chemistry, radiochemistry, radiology and fuel integrity areas. The on-site organization is well trained for its work which is well managed and documented. Its effectiveness is evident in the successful reduction of radioactive effluent and excellent system chemistry.

The established surveillance programme is based on the extensive use of tested, reliable on-line monitors and a strict analytical programme. The programme ensures that plant chemistry is maintained within limits and optimized.

Laboratory facilities are well maintained and meet the criteria for the various analyses. The overall cleanness was excellent. The operation related chemistry laboratories are located in various site locations, which is of some concern. Laboratory safety is in general very good; however, it could be improved in some areas such as labelling of chemicals, ventilation hood security and restricting access to laboratory areas.

The chemistry specifications and documentation are excellent and effectively support the overall programme and safe plant operations.

4.1. Organization and Functions

Organization and responsibilities

The responsibilities for chemistry are shared by the Central Facilities [GDL, (chemistry), DTCN (fuel surveillance) and DSRE (radio-chemistry)] and the site organization. Central facilities are responsible for specifications and recommendations. Specifications and recommendations are expressed in general, plant specific and topic related areas. The Central Facilities personnel are of a very high standard, with long experience and international recognition. Their laboratory facilities also act as back-up for site laboratories when needed.

The site and environmental laboratory organized under the Technical Sub-Unit is responsible for the following: effluent and environmental monitoring and industrial and demineralized water production. The effluent and environmental monitoring programme is under direct Ministry control, including the instrumentation, laboratory installations and analytical procedures.

The plant Laboratory Section is organized under the Operating Department. The Laboratory Section is divided into one group responsible for work at the plant, the Unit Team, and one group responsible for laboratory work, the Site Laboratory Team. Job rotation is used to ensure that the technicians can perform all functions.

(1) **Suggestion:** The length of rotation periods appears to be well selected but it is suggested that the rotation period be evaluated in the future according to individual experience and given needs.

Job descriptions have been developed and define the duties and responsibilities for all positions. Procedures for administration of regulating documents are defined in the National Quality Assurance Manual and the Local Quality Assurance Manual. Documents are divided into different categories based on their importance and the subject covered. The differentiation is clear and easy to follow. The system used for classification, identification and distribution of documents ensures the safe updating, handling and access to documents of importance.

Meetings concerning daily operations and laboratory work are held twice a day and ensure the good flow of information in the Laboratory Section. Morning contact with the operating department is followed up and continued during the day.

Meetings are held weekly with different sections of the Operating Department. Topics include general information concerning plant and technology status. Meetings with the Operating Department management are held monthly and cover technical items as well as human resources.

Training and qualification of personnel

The system for training is formalized and based on the Local Quality Assurance Manual and the Site and Department Application Document. It defines training procedures for newly hired personnel, technicians and senior technicians. It reflects the different analytical, nuclear and site related needs. Some improvements in Shadow Training (OJT) should be considered by better definition of the requirements and supervisory approvals, such as using checklists. The system considers each level's basic training and additional training needs and reflects/covers the technical and safety related areas. Individual programmes are updated yearly.

(1) **Suggestion:** See Recommendation 3.7 (2) and 3.8 (1)

Involvement of chemistry department personnel in the plant routine activities

For monitoring plant performance, a selection of chemistry indicators is presented to operating management monthly. The chosen performance indicators provide an overview of the plant status related to established goals for various items such as waste production, release, radiochemical and chemical parameters.

WANO indicators are not in use for chemistry parameters. GDL is collecting the WANO plant data from all units for evaluation in order to determine their applicability and usefulness. The central facilities collect their own long term performance data.

Research work and tests

Site personnel are active in national working groups for the improvement of various chemistry and radiochemistry related tasks. Tests for parameter optimization are performed on-site and involve site chemistry personnel. This is important for keeping the motivation of site personnel high for improving the plant chemistry performance.

4.2. Chemical Treatment, Material Concept, Activity Build-up and Corrosion

Chemical treatment policies for water and/or steam systems

Primary coolant chemistry is based on international standards, including boron/lithium co-ordination and minimization of impurities which might be corrosive and cause deposits on fuel cladding or result in activated products. The Blayais units have tight control of primary coolant chemistry. The increased analytical frequencies used at the plant have resulted in limited variations in high temperature pH.

Secondary coolant chemistry is based on low levels of impurities and minimization of the transport of corrosion products to the SGs. Chemistry treatment is controlled by tight condensers (titanium), high purity make-up water and all volatile treatment (AVT). The basis is consistent with internationally accepted standards.

Effectiveness of chemical treatment

The Boron to lithium co-ordination model has not been updated and may not be optimum. EdF has started a project to study plant specific effects on high-pH coolant chemistry and other co-ordination models.

(1) **Suggestion:** The chemistry organization should consider updating the boron to lithium co-ordination model.

The present procedure with air oxygenation of the primary coolant system at shutdown for refuelling might not be optimum to secure final dissolution of soluble radioactive corrosion products. Lack of control of this situation might lead to delay in outage schedules or risk of unnecessary doses to personnel.

(2) **Suggestion:** With the present increasing trend of collective dose, consideration should be given to optimizing primary coolant chemistry to reduce doses from the primary coolant system.

The secondary side chemistry takes into consideration denting as well as the sensitivity for intergranular stress corrosion cracking in the tube support plate and tube sheet regions. AVT phemistry based on morpholine/ammonia and hydrazine ensures minimized erosion-corrosion and general corrosion. The chemical specifications and recpmmendations for operation reflects the concern of sensitive critical components.

4.3. Chemical Surveillance Programme and Procedures

Overall chemical surveillance programme

The chemistry surveillance programme, which identifies systems, parameters, frequency for analyses and limits/expected values, is built upon Technical Specifications and Chemistry and Radiochemistry Specifications given by GDL, DSRE and DTCN. The structure for planning and daily work orders is simple to follow. The programme and procedures used ensure that the minimum frequencies for analyses are fulfilled. The daily analytical results are easy to review by the foreman.

Daily chemistry work orders in prewritten form identify compulsory analyses and additional, situation related analyses. The analyses specified in Technical Specifications are not clearly identified in the documents used.

(1) **Suggestion:** Since analyses stated in the Technical Specifications are compulsory, consideration should be given to clearly identifying them in the appropriate chemistry documents and analysis schedule.

To monitor the system chemistry environment, the station has adopted the general EdF policy of concentrating on monitoring of essential parameters using on-line instrumentation. Based on testing and recommendations from GDL, on-line instrumentation has been installed in such a manner that manual analyses have been reduced to a large extent. The level of confidence is high and the reliability of the installations appears excellent. The replacement of old instrumentation will make plant instrumentation up to date. GDL support in this matter is of significant value.

Quality of the analysis results

QA procedures for laboratory equipment and procedures are strict for on-line instrumentation. Certified standards are used and calibration is performed by analytical procedures or as stated in work orders for on-line chemistry and radiochemistry monitors. The on-line instrumentation procedures also include tests of signal and alarm response. For laboratory radiochemistry, a system with "blind samples" from DSRE acts as back-up assurance.

Performed calibrations and tests are signed for in work orders and can easily be followed up on. However, instrument are not labelled with information of the last calibration/check.

(2) **Suggestion:** Consideration should be given to complementing the existing system for management of instrument calibration by labelling on instruments or equipment with the frequency and the date of the last performed test. This would give the user direct information of the calibration status.

All samples, reagents and standards in the laboratory are well marked with appropriate information. In some cases preprinted labels are used. Standards appear to be fresh and are replaced frequently. From procedures it was clear what standard to use.

Monitoring of fuel integrity

Monitoring of fuel integrity is based on the DTCN guides and training for analysis and evaluation of primary coolant activity. This is supported with a data based follow-up system and double supervision is maintained. The specifications include limitations and actions in the form of increased sampling frequency, information to safety authorities and operational restrictions. The applied sampling and analytical programme ensures, together with on-line monitoring and daily readings, fast identification and detailed information.

Raw water treatment and demineralized water

The raw water and demineralized water treatment system meet appropriate standards. The demineralized system is backfitted with polishing, non-regenerated mixed beds. This ensures both high quality water and no risk for intrusion of regeneration solution into the demineralized water distribution system. The instrumentation meets high standards.

4.4. Operational History and Recording of Results

Recording of analytical data is performed by the use of work orders, logbooks and a data base system. The data recording system allows access to historical and recent data for short and long term evaluations. Recorded data are trended on-site and off-site to create various reports for evaluation.

Laboratory Section reporting is performed to keep the Shift Supervisor and Operation Manager informed of significant changes in analysis parameters. Performance indicators are issued monthly for local use. Additionally there are two monthly reports issued covering radiochemical, waste and effluent data which also give comments on any events of significance. In cases of abnormal situations, i.e. shutdown and startup, separate reports are produced. The system ensures the fast and easy flow of information as well as a complete registration of safety related parameters.

Reviews of parameters entered into the data based system are also performed on a more long term basis by GM, DSRE and DTCN which report back to the site organization.

Records and reports are stored at the site and the Central Facilities. This also simplifies access to records and reports at all levels in the organization.

Reporting of effluent and environmental data is performed and recorded in the Ministry record book, which acts as a monthly report after the signature of the Plant Manager. The collected data are also used on-site for evaluation and feedback in order to minimize any impact on the environment.

Experience feedback is obtained and used for preventive purposes and to improve operations. Follow-up meetings are held within the on-site organization as well as with GDL, DSRE, DTCN and with the other EdF sites.

4.5. Laboratories, Equipment and Instruments

Owing to the plant age and design, the chemistry facilities are spread out in different site buildings, which results in the transport of radioactive samples over common areas of the plant. The instrumentation was generally up to a high standard. Computer and software aids for calculations are installed and are used for chemistry multiparameter checks. The housekeeping of laboratories, equipment and instruments was excellent.

The laboratory work areas meet normal safety standards concerning eye wash stations, gloves, showers, fire extinguishers and safety for chemistry personnel. Sampling hoods are equipped with under-pressure gauges; however, laboratory ventilation hoods are not. The physical laboratory entrance door also has no sign to restrict entrance or to provide information about the special risk environment and presence of radioactive material. The entrance door is locked only outside normal work hours.

(1) **Suggestion:** Consideration should be given to defining all chemistry and radiochemistry laboratories areas as generally restricted to non-chemists.

(2) **Suggestion:** Consideration should be given to posting a sign at the laboratory entrance to indicate the presence of gases, chemicals and radioactive material.

(3) **Suggestion:** Consideration should be given to installing gauges or signals to warn personnel of ventilation system malfunctions.

The post accident sampling system (PASS) was installed recently. Training has started but not all the chemistry staff have been trained. A general EdF training course is under development. The PASS fulfils general sampling requirements and familiarity with the system is partly maintained by its use for scheduled sampling.

Handbooks delivered by equipment suppliers are supplemented by site specific application documents which simplify handling of instruments and ensure their correctness. The documentation is available at each instrument as well as in the documentation system. The approach used fulfills all requirements.

4.6. Quality Control of operational Chemicals

The applied system for control of chemicals is based upon centralized specifications and purchasing. Each product is specified and Purchasing can only be performed from the existing list. Chemical delivery is accompanied by certifications, and samples of lots are randomly taken for analysis.

The storage and labelling of toxic and hazardous material in the laboratory and on site are not fully up to requirements. In the laboratory, labels were found that did not meet to standards in size and colour (locally made). Additionally, information on tape applied upon labels covered information about the product. Chemicals are stored in a locked room in the laboratory which ensures appropriate limitation on access; however, the labelling of the door for chemical storage should be checked against national requirements.

(1) **Suggestion:** Considerations should be given to using standardized labels (colour and text) for the safe handling of chemicals.

4.7. Radiochemical Measurements in Environmental Samples and in Radioactive Waste

Programmes for the analysis of alpha and beta emitters based on Ministerial decrees have been established. All effluents are sampled by means of representative tank samples and continuous sampling. Measurements are performed with instrumentation supplied and maintained by the Ministries. Logbooks used on site remain the property of the Ministries.

ACKNOWLEDGEMENTS

The Government of France, EdF and the Blayais NPP personnel provided valuable support to the Blayais OSART.

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

Annex I

THE BLAYAIS TEAM

__**Experts**__

ANDERSSON, Per-Olof - SWEDEN
Ringhals Nuclear Power Station
20 years of nuclear experience
Review area: chemistry

COLLINS, Samuel - USA
Nuclear Regulatory Commission
Region IV Office
20 years of nuclear experience
Review Area: Maintenance

ERWIN, Ashley - IAEA
Division of Nuclear Safety
NPP Operational Safety Services
26 years of nuclear experience
Team Leader

KAWASHIMA, Susumu - JAPAN
Japan Atomic Power Company
23 years of nuclear experience
Review area: Training and Qualification

KISS, Zoltan - HUNGARY
PAKS Nuclear Power Plant
12 years of nuclear experience
Review area: Maintenance

LEFEBVRE, Gilles - CANADA
Gentilly-2 Nuclear Power Station
21 years of nuclear experience
Review area: Training and Qualification

MOORE, Brian - IAEA
Division of Nuclear Safety
NPP Operational Safety Services
27 years of nuclear experience
Review area : Maintenance

SEKI, Hiroaki - IAEA
Division of Nuclear Safety
NPP Operational Safety Services
14 years of nuclear experience

Observer:

BOBOS, Mihaj - ROMANIA
Cernavoda Nuclear Power Station
12 years of nuclear experience

Annex II

SCHEDULE OF ACTIVITIES

1.	OSART Preparatory Meeting	6-7 November 1990
2.	Official Invitation from the Government of France to the IAEA to conduct the Blayais OSART	26 June 1990
3.	OSART Mission	13-31 January 92
4.	Submission of OSART Report	June 1992