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**REPORT**  
OF THE  
**OSART**  
(OPERATIONAL SAFETY REVIEW TEAM)  
**MISSION**  
TO THE  
**CRUAS**  
**NUCLEAR POWER PLANT**  
**FRANCE**

**24 November – 11 December 2008**

**DIVISION OF NUCLEAR INSTALLATION SAFETY  
OPERATIONAL SAFETY REVIEW MISSION  
IAEA-NSNI/OSART/08/148**

## **PREAMBLE**

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Cruas Nuclear Power Plant, France. It includes recommendations for improvements affecting operational safety for consideration by the responsible French authorities and identifies good practices for consideration by other nuclear power plants. Each recommendation, suggestion, and good practice is identified by a unique number to facilitate communication and tracking.

Any use of or reference to this report that may be made by the competent French organizations is solely their responsibility.

## **FOREWORD**

**by the**

**Director General**

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

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover nine operational areas: management, organization and administration; training and qualification; operations; maintenance; technical support; operating experience feedback; 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 OSART team members and their plant counterparts are the comparison of a plant's operational practices with best international practices and the joint search for ways in which operational safety can be enhanced. The IAEA Safety Series documents, including the Safety Standards and the Basic Safety Standards for Radiation Protection, and the expertise of the OSART team members form the bases for the evaluation. The OSART methods involve not only the examination of documents and the interviewing of staff but also reviewing the quality of performance. It is recognized that different approaches are available to an operating organization for achieving its safety objectives. Proposals for further enhancement of operational safety may reflect good practices observed at other nuclear power plants.

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

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

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

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## INTRODUCTION AND MAIN CONCLUSIONS

### INTRODUCTION

At the request of the government of the Republic of France, an IAEA Operational Safety Review Team (OSART) of international experts visited the Cruas Nuclear Power Plant from 24 November to 11 December 2008. The purpose of the mission was to review operating practices in the areas of Management organization and administration; Training and qualification; Operations; Maintenance; Technical support; Radiation protection; Operating Experience, Chemistry; and Emergency planning and preparedness. In addition, an exchange of technical experience and knowledge took place between the experts and their plant counterparts on how the common goal of excellence in operational safety could be further pursued.

The Cruas OSART mission was the 148th in the programme, which began in 1982. The team was composed of experts from Belgium, Czech Rep., Germany, Hungary, Japan, Slovak Rep., UK, USA together with the IAEA staff members and observers from Sweden, Russia and Belgium. The collective nuclear power experience of the team was approximately 280 years.

- Cruas-Meysse NPP is part of the EDF nuclear fleet and has four 900MWe PWR units in operation on the site. The plant is located on the Western bank of the river Rhone, in the Ardeche region, between the towns of Cruas and Meysse.
- Unit 1 was connected to the grid in 1983 and Units 2, 3 and 4 were connected in 1984. The plant employs 1162 staff members and about 250 permanent contractors are working on site.
- Before visiting the plant, the team studied information provided by the IAEA and the Cruas plant to familiarize themselves with the plant's main features and operating performance, staff organization and responsibilities, and important programmes and procedures. During the mission, the team reviewed many of the plant's programmes and procedures in depth, examined indicators of the plant's performance, observed work in progress, and held in-depth discussions with plant personnel.

Throughout the review, the exchange of information between the OSART experts and plant personnel was very open, professional and productive. Emphasis was placed on assessing the effectiveness of operational safety rather than simply the content of programmes. The conclusions of the OSART team were based on the plant's performance compared with good international practices.

### MAIN CONCLUSIONS

The OSART team concluded that the managers of Cruas NPP are committed to improving the operational safety and reliability of their plant. The team found good areas of performance, including the following:

- The plant has a programme for performance of crew team projects to improve safety, efficiency and compliance with environmental regulations.

- An operating experience database has been introduced at the plant for effective tracking and trending of low level events, near misses and deviations.
- The plant has developed an easily accessible database with the answers to significant safety related questions.
- The plant has engaged a professional fire-fighter in order to provide assistance concerning all questions in this area and to maintain contact with the municipal fire brigades.

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

- The remedial measures to mitigate degradation of structures, systems and components are not always performed adequately to ensure good equipment condition.
- Weaknesses in the quality of some corrective actions have resulted in their being ineffective.
- The monitors of skin contamination at the Radiation Controlled Area exit are not sufficiently sensitive to monitor the workers skin contamination in compliance with the plant threshold.
- Techniques to enhance human performance are not consistently used when manipulating safety related equipment.

Cruas management expressed a determination to address the areas identified for improvement and indicated a willingness to accept a follow-up visit in about eighteen months.

## **1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION**

### **1.1. ORGANIZATION AND ADMINISTRATION**

The resource allocation policy at the plant takes safety priorities into consideration. Sufficient resources are provided by corporate management to the plant to respond to plant requests for assistance. The plant can also postpone or streamline some projects to deal with the consequences of unexpected events such as chemical cleaning of the steam generators.

In 2007, the plant successfully negotiated to obtain 12 additional work package preparators.

However, some indicators such as material condition deviations to correct (3280) and periodic tests not yet undertaken (2040) show that some safety activities are overdue. The plant is encouraged to further address this situation and evaluate whether this is related to resource constraints.

A long term succession planning is established and implemented.

The individual performance appraisal system includes assessment of behaviour towards safety but it is not evident in all cases i.e. the basis of the appraisal does not include behaviour towards safety as a major component.

The management are encouraged to address this as it could miss opportunities to reinforce safety.

Regular discussions are held between the regulator and plant management on plant operating issues.

### **1.2. MANAGEMENT ACTIVITIES**

Management is responsive to constructive criticism and feedback from plant staff.

“Work around” or shortcuts are sometimes applied in the field. This is one of the main concerns of top management and is identified as such in the roots of the “Contrat annuel de performance” 2008. Many observations in staff behaviors tend to demonstrate that it is still a concern because the accepted conventional codes, standards and industrial practices are not always strictly followed.

The management carries out assessments of subordinate activities and personnel performance monitoring and appraisal but some observations conducted in the main control rooms and during simulator training showed that error reduction tools are not used as expected. In Mechanical Maintenance department, a team manager has been coached by his hierarchy only during his team meeting during which he mainly transfers information; on the simulator, the instructors say that they “take opportunities” to promote these tools but nothing is recorded and they don’t go on the field to assess the effectiveness of their training. Error reduction techniques are one of the most powerful tools to improve behaviors; managers are encouraged to pay special attention to this matter while coaching their employees.

### 1.3. MANAGEMENT OF SAFETY

The plant has implemented a process of risk analysis at all levels (from decision taking at site level to conduct of work at technician level) and for all crafts. The process is led by a process owner and supported by a strong net of key users. This allows the plant to get a good overview of strengths and weaknesses.

A system is in place to collect suggestions (INOVAE) and ideas for improvement from the staff. Every year, one day is dedicated to innovation and stands are set up to exhibit new ideas, the personnel with the best suggestions is recognized.

A very accessible database called FQRL (local question/answer form) centralizes relevant safety related questions, especially those related to the understanding of the general operating rules (RGE). The database is considered as a good practice by the team.

During the review the team noted several work practices, situations and conditions which can be considered as an indication of safety culture at the plant.

The positive safety culture features include the following items:

- During the OSART mission the team appreciated the open atmosphere during the discussions. Most of the staff seen in the plant reacted positively when the team confronted them with, for example, a deficiency about their way of working or on a technical issue in their area.
- The team observed occasions when personnel in lower job level positions challenged their superiors when necessary. For example during reactor power reduction a junior control room operator asked the Shift Manager and the Shift Supervisor to quiet down; it was reassuring to see that they complied with the comment.
- The personnel of the plant are interested in their work. They provided the team with all requested information. The plant staff has an open mind to new ideas and different work practices. They are proud of their plant results which is a sign of ownership for their company's business.
- The team confirmed that there are several signs of progress in engaging staff to raise standards in such areas as human performance, application of error reduction tools and improved field observations. This was also noted in the case of newer and younger staff. Examples include:
  - New field operator was confident to challenge an experienced Control Room Operator to repeat back information to ensure three way communication.
  - Instrumentation and Control Team Leader reinforced good practices to work party and reminded them about the application of three way communications.

At the same time some other features indicate that additional efforts could result in the further improvement of safety culture:

- The team observed several signs of lack of respect for the general site rules. Examples include: cigarette butt present in the auxiliary feedwater pump room, failure to adhere to mandatory hearing protection requirements, trespassing barrier without overshoes as requested and not wearing identification badges as required. Lack of respect for general rules might be indicative of an overall casual approach to following expectations - individuals could feel entitled to decide what rules are important to follow and what others could be disrespected.
- Insufficient attention to leakages and spillages is still a concern at the plant, in spite of efforts having been made since the beginning of 2008 to identify and eliminate minor leaks. These results in several leaks not being identified and are thus not entered into the work request system or the leak management programme.
- Having several functions in the responsibility of EDF corporate organizations and striving for ‘standardized’ approaches and practices across the EDF fleet or across the plants operating the same reactor type is a strong feature of EDF. However, in some aspects, it has a negative ‘side effect’ that is an overdependence on corporate decisions and support. In other words, the centralized fleet concept sometimes reduces the aim for independent thinking, adversely affecting local initiatives. Examples of areas where the team thought this effect was present are in chemistry and reactor core management.
- The team observed elements reflecting an informal approach of trainees to training (e.g. fire practical training and radiological protection refresher training). This was not corrected by the trainers and therefore resulted in a decrease of the efficiency of training.

#### 1.4. QUALITY ASSURANCE PROGRAMME

In order to improve the effectiveness of quality audits, the Safety and Quality Service SSQ performs inspections with internal and/or external peers. This cross-functional viewpoint provides synergy in the detection of deviations and event analyses. In addition to this synergy, the sharing of experience extends to others' competencies and learning about other methods of investigation and detection. This is considered as a good performance by the team.

## 1.5. INDUSTRIAL SAFETY PROGRAMME

Managers are encouraged to report minor accidents and near misses but very few of them are captured at present (10 have been analysed so far in 2008). The capture of low level events is encouraged.

In the field, some safety rules, procedures and instructions are not strictly adhered to and the plant is encouraged to further enforce rule adherence.

## DETAILED MANAGEMENT, ORGANIZATION AND ADMINISTRATION FINDINGS

### 1.3. MANAGEMENT OF SAFETY

**1.3.(a) Good Practice:** In order to support the operating organization, the Safety and Quality Service SSQ has developed an easily accessible database with the answers to significant safety related questions.

This database called FQRL (local question/answer form) centralizes all relevant safety related questions, especially those related to the understanding of the general operational rules (RGE).

Every staff member has very easy access to this database, which is structured by safety function and then by system, one finds the question, the answer, references and, if needed, a deeper analysis.

These forms are very helpful in work preparation and in the real time decision taking process. It is an efficient tool to disseminate safety on the site.

The database enables everybody to input new questions.

## **2. TRAINING AND QUALIFICATIONS**

### **2.1. TRAINING POLICY AND ORGANIZATION**

Skills requirements for each position within the plant are clearly defined. Using the annual appraisal and skills mapping processes then strategies and action plans, initial and continuing training and professional enhancement are developed. Areas considered include skill shortages, succession planning, retirement losses and unexpected vacancies. The team recognised this as a good performance.

The development of the Nuclear Skills Academy provides a professional training programme which is applied to all new trainees at the plant, regardless of their background. This programme provides the trainees with a structured introduction, requirements for working at the plant and general information concerning work in the nuclear industry. Within the programme, the progress towards completing the required training is assessed prior to progressing to the next stage. The team recognises this as a good performance.

### **2.2. TRAINING FACILITIES, EQUIPMENT AND MATERIAL**

On touring the training facilities, it was noted that access to the instructor area of the simulator had to be through the simulator control room. This can distract control room trainees during an exercise and therefore the plant is encouraged to consider providing alternative access to the instructor area.

The plant has facilities to simulate plant environments. This is to allow trainees to experience conditions that replicate plant conditions and to practice applying the required techniques and behaviours appropriate to their particular skill area. The team recognises this as a good performance.

### **2.3. QUALITY OF THE TRAINING PROGRAMME**

The plant has a defined process for delivering on the job training (shadow training) through tutors and shadow trainers. However, the team considered that the process is not sufficiently established to ensure that trainees receive the required knowledge through on the job training and coaching in order to carry out duties to the prescribed standards and expectations. The team suggests that the plant should consider establishing methods to correct this.

### **2.4. TRAINING PROGRAMMES FOR CONTROL ROOM OPERATORS AND SHIFT SUPERVISORS**

The plant uses a full scope simulator to provide initial and continuing training for control room operators. It allows control room operators to be made aware of, and to practice and demonstrate the expected correct attitudes and behaviours. The team observed that use of the human performance enhancement techniques were not consistently applied. The OSART team encourages the plant, through training on the full scope simulator, to reinforce application of the human performance enhancement techniques.

## DETAILED TRAINING AND QUALIFICATION FINDINGS

### 2.3. QUALITY OF THE TRAINING PROGRAMME

**2.3(1) Issue:** On-the-job trainers (tutors and shadow trainers) are not always consistently provided with, and are not evaluated on, methods to transfer the required knowledge, standards and expectations of the plant.

Not all on-the-job trainers (shadow and / or tutors) have been given formal guidance on what is expected of them to provide appropriate training to trainees. For example of the 284 tutors who have received training, 184 of the tutors who have received training before 2005 may not be aware of the formal requirements of the role, which were introduced in 2005. Continuing training is not given to tutors.

Not all on-the-job trainers are trained, coached or evaluated in techniques to ensure the trainees receive the appropriate skills and behaviors. Examples include:

- On-the-job (shadow) training of fuel team technicians (SN3S) is not formally recorded – opinion expressed that it is more of an informal process.
- During a discussion with a fuel team section manager it was stated that shadow trainers are not formally trained and qualified to deliver on-the-job training.
- When asked what training the trainee designated tutor had received, he stated that he had not received any to date.
- During an observation of on-the-job training (shadow) of a surveillance of Unit 1, 'B' diesel building, the on-the-job trainer did not coach the trainee on noting defective plant labeling and housekeeping issues of the plant area.
- When entering Unit 1, 'B' diesel building, the trainees were observed to obey the mandatory hearing protection sign whereas the assigned trainee tutor and training department tutor entering the building did not until coached.
- During a surveillance in Unit 1 'B' diesel building, after the trainee operators had explained what they had looked at, they were questioned if they thought conditions within the room were satisfactory. It was only when prompted that they accepted that there were housekeeping issues e.g. miscellaneous debris lying on the floor, a significant number of spider webs on equipment and an authorised sign legend worn. The trainee assigned tutor had not made the trainees aware of these issues.
- When asked if any of his team that carried out shadow training were formally trained, the I & C Team leader stated that although some had been trained as tutors and now carried out shadow training, there had been occasions when an experienced technician had carried out shadow training without having received any training.

Individuals could conduct duties without all the expected knowledge and skill required by the plant. The consequence of this could impact on safety.

**Suggestion:** The plant should consider ensuring that on-the-job trainers (tutors, shadow trainers) are consistently provided with and evaluated on methods to transfer the required knowledge, standards and expectations required of the plant to new trainees.

**Basis: NS-G-2.8:**

4.15 On the job training should be conducted in accordance with prescribed guidelines provided by incumbent staff who have been trained to deliver this form of training.

4.18. The training of control room operators should include, as a minimum, classroom training, on the job training and simulator training. The classroom training and on the job training should be planned and controlled to ensure that all necessary objectives are achieved during the training period.

5.2. Training programmes for most positions at a nuclear power plant should include on the job training, to ensure that trainees obtain the necessary job related knowledge and skills in their actual working environment. Formal on the job training provides hands-on experience and allows the trainee to become familiar with plant routines. However, on the job training does not simply mean working in a job and/or position under the supervision of a qualified individual; it also involves the use of training objectives, qualification guidelines and trainee assessment. This training should be conducted and evaluated in the working environment by qualified, designated individuals.

5.6. Training programmes for managers and technical specialists, control room operators and senior technicians should provide a thorough understanding of the basic principles of nuclear technology, nuclear safety and radiation protection, of the design intents and assumptions, and of the theoretical basis for plant activities, together with the necessary on the job training.

5.24 Controls should be established to ensure that maintenance personnel are qualified to operate the equipment on which they are assigned to work. This qualification could be based on equipment mock-ups or on the job training under the supervision of experienced staff.

### 3. OPERATIONS

#### 3.1. ORGANIZATION AND FUNCTIONS

The plant has instituted a crew project programme. This programme is used to encourage operations staff to make improvements to procedures, programmes and performance. They are provided time, support, and resources to complete these improvements. This programme has led to many improvements at the plant including the optimization of the reactor protection surveillance test, to improved availability of safety equipment, reduced time within Limiting Conditions of Operation and a reduction in critical path time during outages. This programme is recognized by the team as a good practice.

#### 3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

The tagging supervisor authorises the test procedures to be performed by shift personnel. Components in the field, which are required to be in a specific position, must be tagged. The plant developed clamp rings for this purpose, which is easy to apply and remove on all equipment. Usage of these items saves time and minimizes radiation exposure. Application of these items was spread over the whole EDF fleet. The team considered this as a good performance.

Operations have designed a tool for the removal and replacement of light bulbs in the control boards and alarm panels. This tool is non conductive and was invented after a reactor scram was initiated whilst replacing lights in the control board at Tricastin NPP. This innovation is recognized by the team as being a good performance.

#### 3.4. CONDUCT OF OPERATIONS

The plant has a prescriptive policy on when and how a manual reactor trip or a power reduction can be initiated. However "... in an uncertain situation, if the shift manager identifies automatic trip criteria and such trip does not occur, he has the authority to trip the unit with the pushbuttons." The team encourages the plant to ensure that all control room operations personnel are aware of this policy and to conduct further training in this regard.

Techniques to improve human performance are not consistently used when manipulating safety related equipment. The team suggests the plant institute programmes and policies to improve the use of human performance enhancement tools.

Field operators perform periodic rounds in designated areas. Nevertheless, many unidentified deficiencies concerning proper labelling of plant equipment were observed, including on some safety related components. As part of an ambitious material condition programme (OEEI), these defects should be identified and documented by tags (FIDO-Forms). The team made a suggestion for the improvement of equipment labelling.

#### 3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

The plant's programme is based on both preventive and predictive measures. The shift staff comprises a first and a second response team to confirm an annunciated alarm, to provide first aid and to initiate mitigating measures. Municipal fire fighters will be called in immediately, guided by the second response team of the plant. The plant engaged a professional fire fighter

to provide assistance and to maintain contact with municipal fire stations and the external response centre. He is also available on call to support the plant. The approach to utilize external experience for the plant's well developed fire prevention programme is considered by the team as a good practice.

## DETAILED OPERATIONS FINDINGS

### 3.1. ORGANIZATION AND FUNCTIONS

**3.1(a) Good practice:** The plant has a programme for performance of crew (comprised of a shift manager, shift supervisor, tagging officer, control room operators and field operators) team projects to improve safety, efficiency, capacity and compliance with environmental regulations. Crew projects are developed to achieve the aims of Department and site projects.

These projects enhance crew team work while providing tangible benefits to the plant. The projects are designed to involve all crew members in solving existing issues. The target for these projects is to facilitate team building and improve all crew members' skills and safety culture attitudes.

The plant benefits not only through better crew dynamics but also through enhanced plant performance, increased efficiency and an improved safety culture. When a crew project is adopted by the plant all crew members are recognized by their peers and by plant management by the use of awards and plant news releases.

As an example of a crew project the performance of the RPR (reactor protection system) surveillance test was optimized to decrease unavailability of components and systems important to safety, reduce time spent in Limiting Conditions of Operation (LCO) and save critical path time. This enhancement has already been adopted by the EDF fleet.

### 3.4. CONDUCT OF OPERATIONS

**3.4(1) Issue:** Techniques to enhance human performance are not consistently used when manipulating safety related equipment.

- There is no formal reactivity brief, supervisory oversight or peer checking required for most power changes. The operator is authorized to vary power between approximately 30% to 100% without a formal brief. This is considered by the plant to be a normal operator function
- Stop, Think, Act, Review (STAR) infrequently observed in the simulator during control manipulations.
- During power reduction, 3 way communication was very rarely used, peer checking was only observed twice, board crew focused on two control panels and monitoring of the rest of the control room was not evident for significant periods of time.

Failure to use human performance enhancement techniques could lead to more frequent human performance errors potentially causing safety significant events.

**Suggestion:** The plant should consider consistently using human performance enhancement techniques during all manipulations involving safety related equipment.

**Basis:**

NS-R-2

3.17 Human performance enhancement tools shall be used as appropriate to support operating staff responses.

NS-G-2.14

5.23 The supervisor should monitor the reactivity and the plant...while planned reactivity changes are carried out.

5.24 ...other operations relating to reactivity should be initiated only after a pre-job briefing on the expected effects of the change.

5.25 ...error prevention techniques, such as the stop, think, act, review (STAR) methodology and peer checking, should be used during reactivity manipulations.

**3.4(2) Issue:** Labelling of components and equipment needs to be improved.

In spite of efforts within the plant equipment programme the team noted deficiencies, such as missing labels, unauthorized amendments or illegible tags.

The plant expects all equipment to be clearly identified. Nevertheless some safety-related components were insufficiently labelled and were not identified as being part of the programme. Examples include:

- handwritten correction marks in fire protection cabinet 1JDT003AR
- illegible component-identification on several components of the Boron Water makeup system, Room 9NF230,
- damaged labels in the emergency-diesel building (Unit 1, train B)
- several illegible and manually marked component labels of the Component cooling system (RRI), room 2K156
- handmarked coloured thresholds and improperly marked scales on a chart recorder in the main control room, unit 4
- handwritten setpoints on tape for instrument panels 1KRT04AR and 05AR
- illegible or damaged component identifications on 4GCT105VV, 0SDP005PO, 0SDP006PO
- handwritten corrections on 1JSW623WA.

Insufficient component identification could lead to mistakes in operating equipment which could affect operational safety.

**Suggestion:** Consideration should be given to strengthening the labelling programme for plant equipment and components.

**Basis:**

50-SG-Q13

342: Plant areas and installed items shall be uniquely and permanently labelled to provide plant personnel with sufficient information to positively identify them.

NS-G-2.14:

5.1. A consistent labelling system for the plant should be established, implemented and continuously maintained throughout the lifetime of the plant. It should be ensured that the system is well known by the staff. The system should permit the unambiguous identification of every individual component in the plant. In addition to the labelling of plant components, labelling of the doors and compartments of the plant should be regarded as part of the same system.

5.2. The labelling standards used should be such as to ensure that the labels are suitable for the environmental conditions in the location in which they are to be mounted and that the equipment can be unambiguously identified. The format and placement of labels should allow

the operators to identify the component quickly and easily and should prevent the easy or inadvertent removal or misplacement of labels.

### 3.6 FIRE PREVENTION AND PROTECTION PROGRAMME

#### **3.6(a) Good Practice:** Presence of a professional fire-fighter seconded to the plant.

The plant has engaged a professional fire-fighter in order to provide assistance concerning all questions in this area and to maintain contact with the municipal fire brigades. Agreement with the local fire response centre (SDIS), aimed at strengthening the relationship, ensures that all conditions are in place to improve fire prevention and the effectiveness of fire fighting. The provision of a professional firefighter falls within the scope of this agreement.

The professional firefighter provides the plant with his expertise in prevention and prediction, training and organisation of emergency response operations. He is involved in risk assessments, training of EDF and SDIS staff and developing fire scenarios. He also participates in the improvement and consolidation of the partnership between EDF and SDIS. The ETARE plans (“listed facility plans”), which provide off-site emergency services with all relevant information about the plant facilities, were developed with his assistance.

A further benefit is the observation during exercises of operations staff by a professional firefighter with the aim of improving their approach to firefighting, their organisation and the command effectiveness of emergency response supervisors. In addition, the professional firefighter, as a first aid monitor, applies his skills at the earliest stage while awaiting the response of medical services in the event of an accident on site.

Improving the skills of members of response teams in respect of incipient fires helps control fires at the initial stage before they have consequences for nuclear safety, personnel or the plant.

## 4. MAINTENANCE

### 4.1. ORGANIZATION AND FUNCTIONS

Maintenance policies are formalized by making a contract with the plant manager each year. One of the common objectives among maintenance departments is “the use of error reduction tools.” In the field, error reduction tools are adequately mentioned, and the fulfillment of management expectations is clearly evident. However, according to the workers’ perspective, the main objectives of the department are not always understood. To implement the main objectives in a more efficient and effective manner, the team encourages the plant to reinforce its explanation about the connection between field activities and department objectives.

The team recognized a good performance in the area of contractor supervision. Coaching the EDF contractor supervisors (CSIs) by the senior management provides effective supervision skills to CSIs and solutions when CSIs encounter difficulties are addressed in a more timely manner, thus contributing to higher quality work done by contractors.

### 4.2. MAINTENANCE FACILITIES AND EQUIPMENT

A yellow tag is attached not only to the tools that have to be checked periodically such as slings and measurement tools, but also to other tools that may not have to be checked periodically. The plant is encouraged to distinguish between these different types of tags.

### 4.3. MAINTENANCE PROGRAMMES

The team recognized that the OEEI project, leak management project and the project to reduce the number of work requests in SYGMA database are in progress, and FIDO has been initiated to correct minor deficiencies. However, there is a large backlog in SYGMA and FIDO databases. Moreover, during plant walkdowns, the team found deficiencies related to material condition such as leaks and rust on equipment that have not been solved. Some of them are found on safety related equipment. The team recommends that the plant should take corrective actions to bring the plant equipment back to optimal condition.

For the condition based maintenance, the team found that the use of the thermographic inspection was rather limited. The plant is encouraged to apply the thermographic inspection more broadly to other equipments such as motors and low voltage circuit to monitor the equipment condition more effectively.

### 4.5. CONDUCT OF MAINTENANCE WORK

There were several minor discrepancies observed such as the use of tape and a transparent sheet around the spent fuel pool. The team encourages the plant to perform further walkdowns in the field to ensure compliance to the FME requirements.

### 4.7. WORK CONTROL

The work planner checks to see if a supplementary risk assessment is necessary or if any additional risk is existing even though it is routine work. The risk assessment includes not only operational safety but also industrial safety. The team recognizes this is a good performance.

The work packages contain, in theory, the necessary documents (risk analysis, quality plan, spare parts, work permit, etc.). The electrical department (AEO) recently introduced a checklist to ensure that all the documents are effectively in the work package and this list also sums up the six error reduction tools to use before the job starts. The colour of the checklist or the file folder corresponds to the unit colour. The team recognizes this as a good performance in the electrical department and encourages the plant to use this checklist throughout all departments related to maintenance work.

#### 4.9. OUTAGE MANAGEMENT

The team recognized a good practice on outage control. During draining of the reactor vessel after stopping the residual heat removal pump, a plunge tube equipped with a submersible pump and a strainer through the dummy vessel head is installed. It enables the level of the reactor vessel to be reduced to the desired level in about three hours. This contributes to reducing outage duration (by 15hours/outage), to conducting non-destructive testing of main coolant piping without interruption, and to reducing the radiation dose.

Outage preparation is conducted in a very systematic manner, and optimized and reviewed properly in cooperation between the plant (including safety engineer) and headquarters. The team recognized this as a good performance.

## DETAILED MAINTENANCE FINDINGS

### 4.3. MAINTENANCE PROGRAMMES

**4.3(1) Issue:** The remedial measures to mitigate degradation of structures, systems and components are not always performed adequately to ensure good equipment condition.

The plant has a programme on reaching exemplary plant conditions (OEEI) which has been in progress for two years. Several signs on improving material conditions such as elimination of leaks and initiation of observation sheets (FIDO) to identify minor deficiencies are obvious. However, there is a large backlog in the work control system (SYGMA) and FIDO databases. Moreover, the following deficiencies have not been solved.

In the 4LHP diesel generator room, the following leaks were found:

- Puddle of oil below diesel generator
- A few centimeters of liquid in the collection sump that collects excess diesel fuel from injection and oil
- Oil patch under air compressor
- Oil oozing from line near 4LHP103PO
- Oil leakage from the bearing between the generator and exciter on unit 4.
- There is a visible steam leak from the turbine governing valve on unit 4.
- Equipment 0SDP088VE has no side cover. Two cables are visible inside. From the uncovered side, water is dripping on the floor.
- Water leakage from the end of the fire water piping (near valve 2JPD101VE).
- One lock of the scram breaker's cabinet on unit 4 is broken. The note on the cabinet shows that all locks should be closed.
- The protective cover plate for auxiliary feed-water pump (4ASG01PO) is missing.
- Duct tape was used to seal the ducting (ventilation fan exhaust ducting to 4DVN272R5) where metal tape should be used at a minimum. The duct tape had become loose and was not sealing the fan exhaust flow, causing it to bypass the downstream filter.

- In room L544, the following conditions were found
- The flanges and the casings of two pumps (4DEL001PO, 4DEL002PO) are very rusty.
- The isolation of the piping of the chilled water system is not in good shape; cracked, held together with tape, painting over the taping, etc.
- Many end plugs of the piping of the chilled water system are rusty.
- The part of the floor drain piping to the drain pan (3JSK201GS) is missing. At the upper floor drain pan (upstream of this drain piping), the line is blocked.
- Some of the covers of the electrical relay (1EAS002PO, 1SEC002B, 1DEG301GF, etc.) for high voltage switchgear are cracked.

Not correcting minor deficiencies may lead to equipment degradations, and may result in emergent work or unplanned plant shutdown.

**Recommendation:**

The plant should perform remedial measures to mitigate degradation of structures, systems and components to ensure good equipment condition.

**Basis:**

NS.G.2.6

2.1. The maintenance programme for a nuclear power plant should cover all preventive and remedial measures, that are necessary to ... mitigate degradation of a functioning SSC.

## 4.9. OUTAGE MANAGEMENT

**4.9(a) Good Practice:** Draining the reactor by installing a plunge tube, equipped with a submersible pump through the dummy reactor vessel head.

During draining of the reactor vessel, the reactor coolant pump drain line was previously used after the residual heat removal pump is stopped, and it takes about 18 hours to drain down.

Because of the difficulty of determining precise water level control of the reactor vessel, it sometimes affects the performance of the radiographic testing on the main coolant piping when the water level becomes higher thus inducing an unexpected inflow into the piping and could result in a higher radiation environment than expected when the water level becomes lower.

By installing the plunge tube internally equipped with a submersible pump and a strainer through the dummy vessel head, it enables the level of the reactor vessel to be reduced to the desired level (100mm below the main coolant piping) and the duration of the drain down is reduced to about three hours.

Therefore, it contributes to:

- Reduction of outage duration (15hours/outage)
- Non-destructive test of main coolant piping is no longer affected
- Reduction of the radiation dose

## 5. TECHNICAL SUPPORT

### 5.1. ORGANIZATION AND FUNCTIONS

Risk assessment tools (like Safety or Risk Monitors) are not used by the plant for day-to-day work planning and decision-making. The plant is encouraged to consider broader use of these tools mainly for calculation of risk profiles, because this can lead to lower values for cumulative and actual risks (important during outages, when less equipment is available to mitigate possible nuclear hazards).

### 5.2. SURVEILLANCE PROGRAMME

A comprehensive surveillance programme is implemented at the plant. It is composed of regular surveillance testing of safety related equipment as well as in-service inspections (vibration, diagnostics, non-destructive testing, post maintenance testing). However, the plant does not use a consistent approach for evaluation of the trends of results in all crafts. This part of the surveillance programme could be further improved, therefore the team has made a suggestion in this area.

### 5.3. PLANT MODIFICATION SYSTEM

A sound programme is in place for plant modifications. Some space for improvement could be achieved if independent verification were used to confirm that all necessary documentation updates (operational, maintenance, training), or other commitments which are not prepared with the modification package, are actually updated before the modification is released for plant use.

The plant does not systematically evaluate the duration of temporary modifications, and does not have a requirement for how long the temporary modification can be in force before it must be converted into a permanent modification. The team has made a suggestion concerning temporary modifications.

### 5.4. REACTOR CORE MANAGEMENT (REACTOR ENGINEERING)

Only one full-time local reactor core engineer is available to support all 4 units at the plant. Additional 24 hours a day telephone support can be requested from Corporate Engineering Unit (UNIE), which has 30 engineers with responsibility for all reactors of the French fleet who prepare all reactor engineering documentation (core patterns, start-up testing, surveillance procedures) and also perform remote monitoring of core behavior, comparing it with pre-calculated results.

During start-up reactor physics testing after refueling, the core engineer may not be present for pre-job-briefings, and may not be available to provide support and expertise during potential core and reactivity management issues which can occur with the reactor at zero power. The team encourages the plant to review optimal allocation of human resources during the plant start-up.

## 5.5. HANDLING OF FUEL AND CORE COMPONENTS

The plant uses submerged floodlights associated with a camera for fuel inspection during fuel assembly movement. Significantly improved lighting enables very detailed reading and recording of fuel assemblies during core unloading and refueling. The device shows good efficiency in tracking any loose parts during televisual inspection of the lower core plate and of the reactor vessel bottom. Further advantages are (1) rapid, simple deployment of equipment, (2) no systematic maintenance of equipment is necessary after each use, (3) ease of replacement of floodlight bulb. The team has identified the use of the lights and cameras as a good performance.

## 5.6. COMPUTER BASED SYSTEMS IMPORTANT TO SAFETY

The plant uses an integrated system in which data from process meters readings (KIT) are automatically transferred to an on-line monitoring and recording data application (ORLI) and also to the surveillance and maintenance planning and scheduling application (SYGMA).

Automatic data transfer into the surveillance and maintenance planning application reduces risk of errors or omissions between reading data in the field and their entering into the application. Reliable values reduce the risk of failure to perform work in accordance with planned schedules according to meter values (e.g. motor-hours). Integrated system allows better optimization of equipment lifetimes and minimizes the risk of industrial safety accidents due to reduced presence in the field and reduced movements around the plant. The team considers this as a good performance.

## DETAILED TECHNICAL SUPPORT FINDINGS

### 5.2. SURVEILLANCE PROGRAMME

**5.2(1) Issue:** Trending analyses of parameters which can influence assumptions of the safety analyses, following surveillance, maintenance testing and inspection, are not performed consistently for all parameters.

- The I&C and testing department measures and analyzes trends of the parameters taking into account uncertainties of sensors, however a similar approach is not consistently used for all parameters which can influence the validity of safety analyses.
- I&C cabinet response times (input – output tests) are measured with only a valid/invalid philosophy, so they can not be trended.
- The trending of overall delays in actuation channels (sensor -> logic cabinets -> actuator) and comparison with assumptions of the safety analyses is not performed.
- Core conditions are not trended on day-to-day basis.

Without a consistent approach to trending analyses, the potential risk exists that ageing of structures, systems and components can cause deteriorative changes which may not be noticed before parameters are outside the assumptions of the safety analyses.

**Suggestion:** The plant should consider extending trending analyses to parameters which can influence assumptions of the safety analyses, following surveillance, maintenance testing and inspection, consistently using a uniform approach for all parameters.

The equipment reliability program as defined in AP 913 gives practical guidance on how trending of parameters could be performed.

**Basis:**

NS-G-2.6

6.10. “Additionally, the results should be examined, where appropriate, for trends that may indicate the deterioration of equipment.”

NS-G-2.6

6.12: “Historical records of MS&I should be periodically reviewed and analyzed in order to identify any adverse trends in the performance of equipment or persistent problems, to assess impacts on system reliability and to determine root causes. The information thus obtained should be used to improve MS&I programs and should be taken into account in the ageing management program.”

### 5.3. PLANT MODIFICATION SYSTEM

**5.3(1) Issue:** Administrative and physical control of temporary modifications status and quality of their identification does not encompass all the necessary steps to assure that plant configuration is sufficiently controlled in a timely manner.

- The plant does not systematically evaluate the duration of all temporary modifications in order to detect and exclude long lasting modifications. The duration of how long the temporary modification can be in force before it must be incorporated into the “as built” plant documentation is not defined.
- Administrative and physical controls for validity of temporary modifications (MTI) are not recorded consistently by all departments (performed mainly by I&C and testing dept.).
- MTI 3RPN409AA with the impact on delay times for the alarms in the control room have been in place since 19/10/1992 and is still not being implemented as a permanent modification.
- 3RGL015CR: A lot of temporary wiring (used by I&C and testing dept. for testing sensors) exists without any time limitation. The actual status and configuration are not treated as part of the temporary modification system (recorded only by I&C and testing dept.).

If temporary modifications of the plant configuration lasting too long and are not being incorporated into the “as built” documentation or if plant configuration changes are not handled within the temporary modification system, a potential exists to introduce safety issues or errors while operating or maintaining equipment or preparing and installing modifications.

**Suggestion:** Consideration should be given to improving the administrative and physical control of temporary modification status and the quality of its identification, to assure that plant configuration is sufficiently controlled in a timely manner.

**Basis:**

NS-G-2.3

6.3: “The number of temporary modifications should be kept to a minimum. A time limit should be specified for their removal or conversion into permanent modifications.”

NS-G-2.3

6.5: “... periodically review outstanding temporary modifications to consider whether they are still needed, and to check .... conform to the approved configuration. Those that are found to be needed permanently should be converted in a timely manner according to the established procedure.”

NS-G 2.14.

5.39 A time limit should be specified for the duration of temporary modifications. After this time period, the temporary modification should be reviewed for its applicability, safety and

OPERATING EXPERIENCE

necessity in the current plant conditions. After the review, an approval process similar to the initial approval process should be carried out if the temporary modification is to remain in effect.

## 6. OPERATING EXPERIENCE FEEDBACK

### 6.1. MANAGEMENT, ORGANIZATION AND FUNCTIONS OF THE OPERATIONAL EXPERIENCE (OE )PROGRAMME

At the plant, the OE process is decentralized with no single owner of the process at the operational level. A number of initiatives and databases related to OE exist in different departments and processes, which makes overall monitoring of the process very complex. The plant is encouraged to consider reorganizing OE for it to be more efficient and effective.

### 6.2. REPORTING OF OPERATING EXPERIENCE

It is understood that the reporting of events to the IAEA/NEA IRS database is the responsibility of the regulatory authority. During the last three years (2005-07), the plant has reported about 112 significant events to the regulatory authority . However, only two of these events have been shared with the international nuclear community through the IAEA/NEA IRS database.

### 6.4. SCREENING OF OPERATING EXPERIENCE INFORMATION

The plant has two full time human-factor consultants at the site. However they do not participate in the screening of the events. The plant is encouraged to consider their participation in initial screening of events, so as to ensure timely identification of the events related to human performance.

### 6.5. ANALYSIS

In 2007, the EDF corporate OE group had asked the plant to conduct additional analyses on 7 events. While for 5 of these events, timeliness of reporting of the analysis results was the main issue, for the remaining two, re-analysis of the events had to be performed. Also, in the investigation of an event involving human performance (ESS 22/04/08) the interview of the concerned staff was conducted three weeks after the occurrence of the event. Such delays in the investigation, especially for events involving human performance, could result in inaccurate information. The team encourages the plant to investigate events promptly, after taking into account all root causes involved in the event.

### 6.6. CORRECTIVE ACTIONS

Weaknesses exist in the corrective action programme, which in many cases, have made it ineffective, resulting in the recurrence of the event. In some cases, implemented corrective actions did not take human factors into consideration resulting in their ineffectiveness. In other cases, corrective actions proposed after the event were not detailed enough, resulting in its recurrence. The team recommends that the plant should ensure that appropriate corrective actions are taken to assure their effectiveness.

### 6.8. DATABASE AND TRENDING OF OPERATING EXPERIENCE

In February 2008, TERRAIN (an OE database) was introduced at the plant for effective tracking and trending of Low Level Events (LLE), Near Misses (NMs) and deviations. Realizing that weaknesses in the monitoring and trending of LLE and NMs have been

observed as a important issue in many NPPs worldwide, the team considers an efficient tool like TERRAIN as a good practice.

#### 6.9. ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE

In the plant, the effectiveness of the OE process is not adequately assessed and monitored. OE as a separate process with a responsible owner at operating level does not exist. Key performance indicators like the number of recurring events are not tracked for monitoring the effectiveness of the OE process. The team suggested that the plant should consider establishing a programme for the effective assessment and monitoring of the OE process.

## DETAILED OPERATING EXPERIENCE FINDINGS

### 6.6. CORRECTIVE ACTIONS

**6.6(1) Issue:** Weaknesses in the quality of some corrective actions have resulted in their being ineffective.

- Unit 1 significant event ESS 29/03/08 involved closure of fire dampers in the main control room ventilation system resulting in its unavailability and entry into a limiting condition of operation. The fire dampers were actuated as a result of spreading of hot vapour, due to a blockage in a chimney filter while heating food in the kitchen behind the control room of units 1 and 2. Temporary corrective action, which is expected to be in effect for a year, involved the disabling of a smoke detector during the use of the kitchen. This corrective action effectively amounts to disabling the smoke detector almost every day resulting not only in an additional load on the operator but also the likelihood of operator error. The control room staff is expected to maintain a record each time this smoke detector is disabled. However the latest record available in the control room dates back to August 2008 indicating the possibility of the corrective action not being adhered to. It is also understood that the plant human factors consultant was not involved in the analysis and development of these temporary corrective actions.
- One of the root causes identified for the significant event (ESS 10/09/07) pertaining to working on a safety system in a wrong unit, was inaccurate data in the database resulting in the printing of the wrong room number on the work permit. As a part of corrective action, the database was checked for the accuracy of data pertaining to the system involved but the corrective action was not extended to cover other safety systems. The work permit (with the wrong room number) was handed over to the contractor staff by maintenance staff, while the tagging sheet (with the correct room number) was given to him by operations staff. Corrective actions did not address this lack of coordination between these two sections and the strengthening of this barrier.
- Organizational problems while working in mid-loop operating conditions, during plant outages, started appearing in 2007 and adverse trends were confirmed in 2008. Initial corrective action involving issuing alerts to the concerned staff (4 times) did not result in significant improvement. Subsequently, detailed corrective action holding each department responsible for its self-assessment seems to have resolved the problem.
- A safety significant event of isolation defects in the 48V DC supply system was repeated twice in 2008. The first time, corrective actions did not prevent the recurrence of the event and further corrective actions were taken only after the second recurrence.
- The plant had carried out a modification in lifting equipment in 2005. However as a result of this modification certain difficulties were experienced in operating this equipment. Corrective actions to address these difficulties have still not been identified and/or initiated because of a complex fleet wide procedure for such changes.

Lack of quality in corrective actions leads to their ineffectiveness, resulting in the possibility of recurrence of events.

**Recommendation:** Plant should ensure that appropriate corrective actions are taken to assure their effectiveness.

**Basis:**

NS-R-2

2.21 Operating experience at the plant shall be evaluated in a systematic way. Abnormal events with significant safety implications shall be investigated to establish their direct and root causes. The investigation shall, where appropriate, result in clear recommendations to the plant management, which shall take appropriate corrective action without undue delay. Information resulting from such evaluations and investigations shall be fed back to the plant personnel.

NS-G-2.11

5.2 The development of recommended corrective actions following an event investigation should be directed towards the root causes and the contributory causes, and should be aimed at strengthening the weakened or breached barriers that failed to prevent the event....

## 6.8. DATABASE AND TRENDING OF OPERATING EXPERIENCE

**6.8(a) Good Practice:** TERRAIN (an OE database) has been introduced at the plant for effective tracking and trending of Low Level Events (LLE), Near Misses (NMs) and deviations.

Until February 2008, the plant used to report LLE, NMs and deviations in a paper format which was quite slow and ineffective. In February 2008, TERRAIN was introduced and its use started in April 2008. During a short period of 8 months about 3000 reports have been put into the system and tracking by management of this vital element of operating experience has been strengthened.

Benefits: The database

- Provides plant staff with a tool to input and screen positive and negative observations collected during daily activities. Negative observations are used for correcting and enhancing human performance and behaviour while positive observations are used for acknowledging and encouraging the right behaviour.
- Is a web-based, user-friendly application which has various facilities such as extracting information on an excel sheet for a better trending and analysis.
- Helps in identifying the broken barriers for LLE and deviations. These barriers, selected by a drop down menu, are based on IAEA references.
- Is used for trending of the whole plant down to section level.

- Can also be used to monitor programme deficiencies in the “Managers in the Field” Programme as deviations observed by managers in the field are also fed into this system.

During various international operational safety missions, weaknesses in the monitoring and trending of LLE and NMs have been observed as a major weakness in the nuclear industry worldwide. An effective tool such as TERRAIN in this area will be of great benefit in improving the safety and reliability of the nuclear industry.

## 6.9. ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE

**6.9(1) Issue:** The effectiveness of the OE process is not adequately assessed and monitored.

- Key indicators such as “the number of recurrent events, number and age of reports awaiting evaluation etc.” are not used in tracking the effectiveness of the OE process. Other indicators such as corrective actions exceeding targeted date of implementation are trended at process and/or department level without leading to overall effectiveness monitoring.
- EDF corporate monitors the OE process across its fleet through the use of the OE process efficiency index. Parameters such as quality of event investigation, number of SAPHIR sheets and their quality are some of the inputs used for calculating this index. The plant has slipped from the top quartile position in 2005 to the bottom quartile in 2007. The number of SAPHIR sheets is trended monthly on an annual rolling basis. However there is no visible improvement in this indicator with an October 2008 value of 508 against the plant target of 1200.
- Even though business at the plant is conducted on the basis of various processes, OE as a process does not exist. There is no single owner at operational level accountable for overall OE monitoring and no meetings with the exclusive agenda of reviewing the effectiveness of the OE process are conducted at the plant.

Without effective assessment of the OE process, opportunities to continuously improve it could be missed.

**Suggestion:** The plant should consider establishing a programme for the effective assessment and monitoring of the OE process.

**Basis:**

NS-G-2.11

8.2 “The operating organization or licensee should periodically review the effectiveness of the process for the feedback of experience. The purpose of such a review is to evaluate the effectiveness of the overall process and to recommend remedial measures to resolve any weaknesses identified. Indicators of the effectiveness of the process should be developed. These may include the number, the severity and the recurrence rate of events and the causes of different events”

NS-G.2.4

6.62 ”.... The effectiveness of the operating experience review programme should be assessed periodically to identify areas of weakness that require improvement.”

## **7. RADIATION PROTECTION**

### **7.1. ORGANIZATION AND FUNCTIONS**

The Radiation Protection (RP) department performs calibration and functional tests of fixed devices at defined periods (for example NT2000, C1,C2, C3 CPO monitors) but control charts are not used. Consequently long term device stability is not adequately controlled. The team encourages the plant to implement such quality control techniques so as to improve stability control of some important RP monitoring devices.

### **7.2. RADIATION WORK CONTROL**

The team observed that samples of the primary coolant are measured in the counting chemistry laboratories. The laboratories are neither part of the Radiation Controlled Area (RCA), nor designated as a Supervised Area. Radiation Protection Programme of the laboratories is not established. Provisions for contamination monitoring of the place, items or workers are not provided. Such practices are not in compliance with RP standards for radiochemistry laboratories and the team developed a recommendation in this area.

The monitors of skin contamination at the Radiation Controlled Area exit are not sufficiently sensitive to monitor the workers skin contamination in compliance with the plant threshold. The team has made a suggestion in this respect.

### **7.3. CONTROL OF OCCUPATIONAL EXPOSURE**

The plant has developed and uses a specific system for crud (activated particles in the primary coolant and auxiliary systems) removal from liquid systems. It is inexpensive and effective. This ORFO device is mobile and easy to operate. It consists of a filtration unit with a filter, pump for circulation and hoses with flexible connecting flanges. Lead shielding around the filtration unit protects the operator from radiation. The team considered it as a good practice.

### **7.6. RADIATION PROTECTION SUPPORT DURING EMERGENCIES**

The plant has implemented emergency response procedures for radiation protection of workers in the event of a radiological emergency. However, the procedure for planning and implementation of emergency response worker turn back dose (an integrated dose reading on a self reading dosimeter indicating that an emergency worker dose guidance has been exceeded and that the emergency worker should leave the areas where further significant dose is possible) is not developed in the plant and the team encourages the plant to implement such a procedure.

## DETAILED RADIATION PROTECTION FINDINGS

### 7.2. RADIATION WORK CONTROL

**7.2(1) Issue:** The monitors of skin contamination at the Radiation Controlled Area exit are not sufficiently sensitive to monitor the workers skin contamination in compliance with the plant threshold.

- A test with a 1350 Bq Co-60 source was undertaken. The source was fixed to selected parts of a workers body. The body parts were as follows: chest, left knee, right hip. As requested by the EDF procedure, the sensitivity of the C2 portal monitor is to detect 800 Bq (8Bq/cm<sup>2</sup> on 100 cm<sup>2</sup>) of Co-60. The radioactive source which was used had a 70% higher value. Nevertheless the monitor response was that it only alarmed when the source was fastened on the chest. There was no alarm in positioning the source on the knee or on the hip of worker.
- The number of worker contaminations identified at the C3 monitor at the main site exit has not decreased in the last few years (in percentage of measured workers) and degrees of contamination is in the range from 800 up to 10 000 Bq of Co-60.

2002- 0,24

2003- 0,19

2004- 0,20

2005- 0,15

2006- 0,21

2007- 0,16

- EDF has already started replacement of C2 monitors at other plants. Replacement of the contamination monitors at the exit from RCA at the Cruas plant is scheduled in 2012 at the latest.

Without having sensitive enough monitors at the RCA exit, the possibility of contaminated workers exiting the RCA and spreading contamination inside plant premises cannot be prevented.

**Suggestion:** The plant should consider an earlier replacement of monitors at the exit of the Radiation Controlled Area to ensure compliance with the plant threshold for skin contamination.

**Basis:**

International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources

Safety Series No. 115

1.23. Registrants and licensees shall:

(g) provide, as appropriate, at exits from controlled areas:

(i) equipment for monitoring for contamination of skin and clothing;

**7.2(2) Issue:** The counting chemistry laboratories for radioactive process samples, are not adequately classified.

Samples of primary coolant are measured in the cold chemistry laboratory. The laboratory is neither part of the RCA, nor designated as a supervised area. Provisions for contamination monitoring of the room, of personal items or of workers is not provided. A contamination control programme is not performed at the laboratory.

Not classifying an area where radioactive process samples are analysed and consequently not implementing appropriate preventive dose and contamination measures can result in unnecessary exposure and/or spread of contamination.

**Recommendation:** The plant should adequately classify the counting chemistry laboratories.

**Basis:**

International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources Safety Series No. 115.

## CLASSIFICATION OF AREAS

### Controlled areas

1.21. Registrants and licensees shall designate as a controlled area any area in which specific protective measures or safety provisions are or could be required for:

(a) controlling normal exposures or preventing the spread of contamination during normal working conditions; and

(b) preventing or limiting the extent of potential exposures.

### Supervised areas

1.24. Registrants and licensees shall designate as a supervised area any area not already designated as a controlled area but where occupational exposure conditions need to be kept under review even though specific protection measures and safety provisions are not normally needed.

### NS-G-2.7

3.2. The RPP should be based on a prior risk assessment in which the locations and magnitudes of all radiation hazards have been taken into account, and should cover:

(a) the classification of working areas and access control;

(b) local rules and supervision of work;

(c) monitoring of individuals and the workplace;

(d) work planning and work permits;

(e) protective clothing and protective equipment;

- (f) facilities, shielding and equipment;
- (g) health surveillance;
- (h) application of the principle of optimization of protection;
- (i) removal or reduction in intensity of sources of radiation;
- (j) training ;
- (k) arrangements for the response to an emergency

### 7.3 CONTROL OF OCCUPATIONAL EXPOSURE

**7.3(a) Good Practice:** Mobile optimized flushing and filtering system for contamination and hot spots removal (ORFO).

The plant has developed and uses a specific system for crud (activated particles in the primary coolant and auxiliary systems) removal from connected and circulating system. It is inexpensive and effective. ORFO is mobile and easy to operate. It consists of a filtration unit with a filter, pump for circulation and hoses with flexible connecting flanges. Lead shielding around the filtration unit protects the operator from radiation.

As it is a mobile system, it can be connected as close as possible to a hot spot area and the membrane pump ensures circulation and removal of radioactivity by filtration of particles. An additional benefit is that it can reduce time of drainage of the cleaned system, or reduce radioactive waste production by re-injection of the cleaned water to the boron recycle system.

As example of the ORFO performance is its use in the ten years outage at unit 4. As results from dose rate measurements of hot spots indicate, the dose rate reduction of processed hot spots was 7,78 Sv/h and total dose rate on spent filter bags reached 6,4 Sv/h.

## 8. CHEMISTRY

### 8.1. ORGANIZATION AND FUNCTIONS

The team identified, as a good practice, the logbook and data sheet system to assure proper monitoring and tracking of liquid and gaseous effluents releases. This is a good example of well established coordination and communication between chemistry and operations.

### 8.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

An extensive steam generator chemical cleaning programme has been carried out at the plant in the last two years owing to tube support plates (TSP) clogging and tube fouling. Many other units are affected by this phenomena in the EDF fleet which are conditioned with low pH morpholine. In order to avoid similar effects in the future, and preserve the integrity of secondary side systems, the team suggests the plant to improve the control of secondary side water chemistry parameters.

Since primary side corrosion product transport and activity build-up monitoring programmes have not been fully implemented, the team encourages the plant to introduce detailed chemical and radiochemical analysis of primary coolant samples, including the analysis of suspended particles.

### 8.3. CHEMICAL SURVEILLANCE PROGRAMME

The Laboratory Information and Management System (MERLIN) is applied not only for scheduling chemical analyses, but extensively used for other tasks such as control of working documentation, radioactive sources, stocks of chemicals and contamination. This was identified by the team as a good performance.

### 8.5. LABORATORIES, EQUIPMENT AND INSTRUMENTS

Some examples were found by the team where hazardous chemicals are inappropriately stored and labeled. The team suggested that the plant considers improving storage and labeling of those chemicals to avoid any potential risk of improper and unproven use of chemicals, personal injury and detrimental effects on system components.

The team suggests the plant considers improving the training, maintenance and periodically testing activities of the liquid post accident sampling system to ensure operability of the system.

### 8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

Even though the approval system “Products and materials for use in nuclear power plants” (PMUC) is widely used, the team encourages the plant to introduce a system to distinguish between substances which are allowed or prohibited from entering into the primary side.

## DETAILED CHEMISTRY FINDINGS

### 8.1. ORGANIZATION AND FUNCTIONS

**8.1(a) Good Practice:** To ensure proper monitoring and tracking of liquid and gaseous releases, the environmental and chemistry section has set up a specific system which is used together by operations and chemistry. This is practically a logbook with detachable sheets that is specific to each type of release:

- red log for nuclear auxiliary building releases (KER),
- yellow log for balance of plant releases (SEK),
- orange log for the liquid waste discharge system TER (these tanks can be used only after obtaining a regulatory authorization),
- blue log for gaseous releases.

There is a set of 6 sheets per release established. Each step of the effluent processing is registered on these sheets, like:

- No.1: isolation and mixing, condition of dilution pump per release location (filled in by operations),
- No.2: sampling, analysis and definition of optimal release conditions (filled in by environmental chemistry),
- No.3 and No. 4: actual release and subsequent summary report (filled in by operations),
- No.5: report on regulatory chemistry analysis (filled in by environmental chemistry),
- No.6: One page of pre-printed sticker labels with a unique release number. These labels are put on each sample taken before the release and on those that are used for monitoring and tracking the receiving environment. The labels are filled in by environmental chemistry.

Each sheet represents a page of the “effluent” data base which is used for transmission to the regulatory body, as well.

The benefits for plant staff are clear recognition and improvement of working conditions due to the followings:

- same identification number on each sheet and label that makes a link at all times between the sample, the analysis and the release,
- color code applying to the sheets and labels, making it easy to distinguish between the various types of releases,
- the first four sheets are carbon paper, ensuring that all data are kept by the various users with limited risks of errors that could result from having to write the information several times,
- first sheet remains in the operations log avoiding double request for an analysis,
- sheets No.4 and No.5 are identical, they are used for monitoring the whole release process, No.4 being kept by operations and No.5 archived by environmental chemistry,
- radiological and chemical limit values are also indicated in the document, specific or real-time constraints can be added if necessary.

## 8.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

**8.2(1) Issue:** The control of water chemistry parameters in secondary systems is not sufficiently comprehensive to identify and trend corrosion processes.

The following facts were observed during the review:

- The oxygen concentration of condensate measured on-line and indicated in the main control rooms (MCR) is a safety related/important parameter. Action levels exist in case of overriding limit values, but without any time limitation for doing those actions.
- Concentration of suspended corrosion products (Fe, Cu) are measured only two times per year. Even after partial re-tubing of condensers (1/2 Ti, 1/2 Cu) the feedwater pH is kept according to specifications between 9,1-9,3 by using morpholine dosing, which is not optimal for erosion-corrosion control of feedwater system. Secondary side water chemistry applied following the condensers re-tubing is a compromise between traditional ammonia and morpholine water chemistry. As a consequence, the average amount of magnetite removed by chemical cleaning was 3 t/steam generator.

Without adequate control of secondary system water chemistry parameters the integrity of those systems (condenser tubes, feedwater lines, and steam generator heat transfer tubes) might adversely be affected by corrosion and erosion-corrosion processes.

**Suggestion:** Consideration should be given to comprehensively control and monitor the secondary side water chemistry parameters to enable the identification and trending of corrosion processes.

### **Basis:**

DS 388

3.5:

- “the secondary side chemistry approaches should aim to minimize (i) corrosion in the integrated system; (ii) deposits in the steam generators; (iii) concentration of deleterious compounds in crevices of areas with restricted flow; (iv) condenser leaks in both water and air parts, and (v) corrosion of the Steam Generator blow-down purification system;
- appropriate chemistry controls and diagnosis parameters confirm safe and reliable operation ;”

4.6.2: “In case of deviation of some of the most important control parameters, graded action levels should be defined in advance and correction of control parameters should start progressively within acceptable period of time and go up to plant shut-down if necessary, to avoid short term degradation of the materials. Action levels for these most relevant parameters that may be indicative of a risk of corrosion inducing a lack of integrity or other consequences should thus be defined. The number of Action Levels and associated allowed

duration of operation before having the plant shutdown is specific of the design and materials;”

50- SG-Q13, 403: „Chemistry and radiochemistry work normally consists of: monitoring, sampling and trending chemistry and radiochemistry parameters at specified frequencies to ensure the timely detection and correction of abnormal or unacceptable trends and conditions;”

## 8.5. LABORATORIES, EQUIPMENT AND INSTRUMENTS

**8.5(1) Issue:** Some hazardous chemicals are stored and labeled inappropriately.

- A plastic container, without any indication of its content, was found in unit 1 auxiliary building sampling room.
- 25 kg of 24% hydrazine (carcinogenic, toxic) was stored in a plastic container in unit 1 auxiliary building laboratory (9NA293).
- In a small cabinet for storage of acids, a bottle containing sodium-hydroxide was found in the demineralization plant laboratory.
- Two drums, containing ~200 litre of FYRQUEL each, were found in the oil storage warehouse, without the standard warning label for risk (corrosive, toxic), only with text in English on them.
- One bottle of sulphuric acid (~49 g/l concentration) was found in a storage cabinet in Laboratory Central 3/4 with the preparatory date written and corrected with pen.
- Lithium-hydroxide was stored in unit 1 auxiliary building laboratory (9NA293) in an unsealed plastic bag.
- A plastic bottle was found in 9NA293 laboratory containing lithium-hydroxide solution without indication of the concentration.
- Various samples are temporarily stored in 9NA293 laboratory, behind lead brick shielding, without any identification label.

Inappropriately stored and labeled chemicals and samples may have the potential risk of improper and unapproved use, personal injury and detrimental effects on system components.

**Suggestion:** The plant should consider improving storage and labeling of hazardous chemicals in order to avoid the potential risk of improper and unapproved use of chemicals, personal injury and detrimental effects on system components.

**Basis:**

Safety in the use of chemicals at work – ILO,

4.3.2. The purpose of the label is to give essential information on:

- a) the classification of the chemical;
- b) its hazards;
- c) the precautions to be observed.

The information should refer to both acute and chronic exposure hazards.

6.7.2.: Chemicals known to have carcinogenic, mutagenic or teratogenic health effects should be kept under strict control.

DS 388

9.13: Chemicals should only be stored in an appropriate warehouse, which is fire protected, captures spillages, and equipped with a safety shower, as required. Tanks with chemicals should be appropriately labelled

9.14: Reasonable amount of chemicals can be stored in other controlled environments of the workshops or operational department.

**8.5(2): Issue:** Operability of the liquid post-accident sampling system and methods are improperly considered, maintained, trained and tested.

Post accident sampling of the recirculated water may involve high dose rates and stressful situations. Practical training on taking liquid samples and transporting them in shielded container for analysis has not been done.

Only one classroom training record was shown (November 2008) as an informal training document on theoretical training for post accidental sampling situation.

The post accident sampling box (1RIS903V), used for post accident liquid sampling, was observed with an indication of atmospheric pressure, instead of being under negative pressure.

The operability of the sampling box is checked only from a structural and integrity point of view, without testing the operation of the sampling box and the connecting systems.

Without adequately trained personnel for liquid post accident sampling and ensuring availability of system, the plant may not be adequately prepared for this work to be performed in the requested time, and may not be familiar with overall actions to be taken.

**Suggestion:** Consideration should be given to improving training, maintaining and periodically testing activities in order to ensure operability of the system and requested liquid samples in post accident situations.

**Basis:**

DS 388:

6.40: “For proper PASS operation the following should be provided:

- PASS operation procedures;
- radiation protection measures evaluated in advance and applied;
- a programme for preventive maintenance;
- regular checks of PASS operability;
- regular training for personnel designated for PASS operation (taking grab samples and performing subsequent activities).”

NS-G-2.7:

5.4 “Training for workers should cover all topics relevant to the radiation task assignments and the potential risks. Those who need to work in zones of high radiation levels should be trained in their specific work activities so as to enable them to perform their duties in the minimum possible time, in keeping with the principle of optimization. This could include, for example, training on mock-ups, rehearsing the planned work and practicing emergency actions.”

5.7 “Training on emergency procedures should be given periodically to ensure that all persons who would need to take action in an emergency know which actions to take.”

## **9. EMERGENCY PLANNING AND PREPAREDNESS**

### **9.2. RESPONSE FUNCTIONS**

When an on-site emergency is declared, non-essential site personnel are trained to immediately assemble at one of 13 designated muster points. At each of these muster points, designated muster point leaders are responsible to provide for the protection and accounting of the personnel at the muster point. Current practice is to perform this accounting manually, which has been ineffective at meeting the goal of completing accountability within one hour at some muster points. EDF-Corporate in Paris has approved funding and scheduled to install at the plant a new electronic badging system in January, 2009, and a new automated accountability system in April, 2009. The team encourages the plant to take actions as necessary to successfully install the new badging and accountability system, as planned, and develop the required procedures, processes, and training needed to ensure it is successfully implemented.

When the site crises director (PCD1) has authorized implementation of the on-site emergency plan (PUI), on-call responders are alerted to staff the emergency response facilities using an automated call-out system. This system employs efficient and innovative methods to help ensure clear understanding of the emergency message. The team recognizes this system as a Good Performance.

As emergency off-site personnel arrive on-site to support the emergency, they are afforded immediate access to the plant, as well as appropriate protective and monitoring equipment. The plant employs a dedicated emergency response mobile command post and response team equipment vehicle (PCOM van) that facilitates a more rapid and effective response to emergencies on-site, as well as more efficient coordination between on-site and off-site responders. The team recognizes this equipment and methodology as a Good Practice.

### 9.3. EMERGENCY PLANS AND ORGANIZATION

Responsibility and authorities are well described in the plant procedures, however, there is no individual on-site at all times with the authority to initiate the actions of the PUI without consultation and approval from designated plant management, who may be off-site. These actions include alerting of on-call plant staff, notification of off-site authorities, and initiation of public alerting near the plant. This practice could cause delays in the implementation of protective actions, both for on-site personnel and the public off-site. The team recommends that an authorized individual be on-site at all times, with the training and authority to promptly initiate, without consultation, emergency declarations and protective actions as needed, for both the on-site and off-site response.

### 9.5. EMERGENCY RESPONSE FACILITIES

The plant has established a public information centre, but the centre is located on the plant site. During a radiological emergency access to this centre could be restricted, or the centre could be rendered unavailable. The team suggests that the plant consider pre-designation of a local public information centre that is outside the plant's emergency protection zone, and ensure all stakeholders are aware of this designation.

In case of a site evacuation of plant personnel, the plant has established a facility situated in the town of Cruas for assembling the evacuated personnel and providing for minor medical attention and decontamination, as needed. However, procedures and processes were not established to ensure the immediate readiness of the facility. Corrective actions have been initiated and an action plan developed to correct this, and the team encourages the plant to complete actions as necessary to ensure the continued functionality of this facility.

### 9.8. QUALITY ASSURANCE

Changes that are being planned for the PUI (that are considered by plant officials to affect the local authorities), are routinely discussed with those authorities, although there is no formal process in place to require that interaction. The team encourages the plant to establish a procedure to describe this process.

## DETAILED EMERGENCY PLANNING AND PREPAREDNESS FINDINGS

### 9.2. RESPONSE FUNCTIONS

**9.2(a) Good Practice:** The availability of a dedicated emergency response mobile command post and response team equipment vehicle (PCOM van) results in more rapid and effective response to emergencies on-site, as well as more efficient coordination between on-site and off-site responders.

- First and Second level emergency response teams, as well as the Head of Rescue (EDF) and the Commander of Rescue Operations (Local Fire Service), are situated close to the event in a protected, mobile location. This provides for ease of communication and coordination of the response.
- The PCOM van is intended for use during on-site fire, medical, and radiological emergencies.
- The emergency team's response time is shortened since they can equip themselves for the emergency in the PCOM van close to the emergency location.
- Eliminates the need for response teams to transit on foot in heavy protective gear to reach the site of the emergency.
- The reduction in response time should reduce both the risk to the personnel as well as potential damage to plant equipment.
- The van is tested weekly for operability/availability, and maintenance responsibilities are established.

### 9.3. EMERGENCY PLANS AND ORGANIZATION

**9.3(1) Issue:** There is no individual on-site 24-hours per day with the authority to initiate the on-site emergency plan (PUI).

- Only the site crisis director, PCD1, and the plant manager, as PCDO, has the authority to direct initiation of the PUI actions, which include, for example, alerting of on-call plant staff, notification of off-site authorities, and initiation of public alerting in the immediate protection zone (2km) around the plant.
- This authority is not delegatable to the on-shift staff, such as the shift manager, nor the safety engineer.
- There are 5 designated PCD1s, with one designated as on-call each week. None of these individuals are required to be on-site at all times, although the on-call PCD1 is required to carry plant procedures needed for PUI initiation decision making.
- Communication off-site to the PCD1 is available through several redundant and diverse methods, including a standard pager, a digital message pager, a cellular phone, and a standard telephone.
- Plant procedure directs the Shift Manager to call the on-call PCD1 to discuss plant conditions, review the PUI initiation flowchart, and obtain the concurrence of the PCD1 for initiation of the PUI. If the Shift Manager cannot contact the on-call PCD1, contact information for the Plant Manager and other PCD1s is immediately available to the Shift Manager.
- The plant initiated some actions following identification of this issue at the Chinon plant last year, including the availability of all PCD1's contact information to the Shift Manager, and a weekly (previously monthly) communication test during non-working hours.
- EDF-Corporate in Paris has no actions in place nor planned to alter this practice.

Without a 24 hour per day on-site authority to implement the PUI, unforeseen communication problems (failed communication equipment, human error, lack of face to face communication, etc..) could cause unnecessary delays in the immediate notification of off-site authorities and alerting of the public in the immediate protection zone, especially in fast-developing events involving radiological release.

**Recommendation:** The plant should train and authorize an on-site, on-shift authority to initiate the PUI.

**Basis:**

GS-R-2, 4.23 "Each facility ... shall have a person on the site at all times with the authority and responsibilities: ... upon classification [of an emergency] promptly and without consultation to initiate an appropriate on-site response; to notify the appropriate

off-site notification point; and to provide sufficient information for an effective off-site response.”

NS-G-2.14, 5.32 “... The shift manager should be authorized to activate the emergency plan if necessary.”

## 9.5. EMERGENCY RESPONSE FACILITIES

**9.5(1) Issue:** A local public information centre (PIC), near the plant, but outside the Urgent Planning Zone (UPZ), has not been pre-designated.

- When the on-site emergency plan (PUI) is initiated for a radiological event, with immediate initiation of the off-site emergency plan (PPI), local law enforcement will isolate the plant at approximately 2km and not allow access to the plant.
- The designated local public information centre (PIC), currently located at the plant, could become inaccessible to local media in the event of such an emergency.
- For fast breaking incidents involving a release, the media could be at risk attempting to report to the facility (PIC).
- If it is determined to notify the media to go to an alternate local facility, the alternate local facility is not pre-designated and would need to be established through communication with local authorities, and/or other EDF facility representatives.
- A formal agreement with the TRICASTIN plant, approximately 40 km to the south, has been established to share facilities and equipment in case of an emergency, however, those services would need to be requested at the time of the emergency.
- EDF-Corporate in Paris (ONC), for all PUI events, establishes a media centre, and provides information to the public, through national media, to address concerns of a national level. The information does not focus on local level concerns. The specific concerns of the local population around the CRUAS-MEYSSE area is addressed by the plant, through the local media.

Failure to pre-designate a local public information centre, near site but outside the Urgent Protection Zone (UPZ), which would be available during emergency conditions at the plant, could potentially cause significant delays in the dissemination of accurate information to the public and the media on the status of the emergency.

**Suggestion:** The plant should consider pre-designation of a local public information centre that is outside the plant's Urgent Planning Zone (UPZ), for media briefings for emergency events at the plant, and ensure all stakeholders are aware of this designation.

**Basis:**

GS-G-2.1, 4.36. "These arrangements should include provision: ...of information to the public by ... the operator. This could include the establishment, as soon as possible, of a public information centre, as described in Appendix VIII... . For facilities in threat category I, the public information centre should be at a pre-established location.

GS-G-2.1, Appendix VIII. “VIII.2. Each emergency facility or location should be... usable under accident conditions;...” “VIII.4. The facilities and locations recommended for each threat category are listed in Table 14 and described in Table 15.”

GS-G-2.1, Table 14, lists the public information centre as a recommended emergency facility for threat category I facilities, with no exceptions.

GS-G-2.1, Table 15, describes the characteristics of the public information centre: “Located in the vicinity of the site of the emergency ... . For facilities in threat category I, it is a pre-designated facility outside the UPZ... .”

EPR-METHOD-2003. A9. “Arrange, in advance, a location to serve as the [Plant Information Center] (PIC), where facility, [and] local ... officials provide media briefings. The PIC should be near the facility, but outside the UPZ.”

## DEFINITIONS

### DEFINITIONS – OSART MISSION

#### **Recommendation**

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

#### **Suggestion**

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

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

#### **Good Practice**

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

- novel;
- has a proven benefit;
- replicable (it can be used at other plants);
- does not contradict an issue.

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

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

**LIST OF IAEA REFERENCES (BASIS)***Safety Standards*

- **SF-1**; Fundamental Safety Principles (Safety Fundamentals)
- **Safety Series No.115**; International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources
- **Safety Series No.117**; Operation of Spent Fuel Storage Facilities
- **NS-R-1**; Safety of Nuclear Power Plants: Design Requirements
- **NS-R-2**; Safety of Nuclear Power Plants: Operation (Safety Requirements)
- **NS-G-1.1**; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)
- **NS-G-2.1**; Fire Safety in the Operation of Nuclear Power Plants (Safety Guide)
- **NS-G-2.2**; Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants (Safety Guide)
- **NS-G-2.3**; Modifications to Nuclear Power Plants (Safety Guide)
- **NS-G-2.4**; The Operating Organization for Nuclear Power Plants (Safety Guide)
- **NS-G-2.5**; Core Management and Fuel Handling for Nuclear Power Plants (Safety Guide)
- **NS-G-2.6**; Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants (Safety Guide)
- **NS-G-2.7**; Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants (Safety Guide)
- **NS-G-2.8**; Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (Safety Guide)
- **NS-G-2.9**; Commissioning for Nuclear Power Plants (Safety Guide)
- **NS-G-2-10**; Periodic Safety Review of Nuclear Power Plants (Safety Guide)
- **NS-G-2.11**; A System for the Feedback of Experience from Events in Nuclear Installations (Safety Guide)
- **GS-R-1**; Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety (Safety Requirements)
- **GS-R-2**; Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)

- **GS-R-3**; The Management System for Facilities and Activities (Safety Requirements)
- **GS-G-2.1**; Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)
- **GS-G-3.1**; Application of the Management System for Facilities and Activities (Safety Guide)
- **50-C/SG-Q**; Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations (Code and Safety Guides Q1-Q14)
- **RS-G-1.1**; Occupational Radiation Protection (Safety Guide)
- **RS-G-1.2**; Assessment of Occupational Exposure Due to Intakes of Radionuclides (Safety Guide)
- **RS-G-1.3**; Assessment of Occupational Exposure Due to External Sources of Radiation (Safety Guide)
- **RS-G-1.8**; Environmental and Source Monitoring for Purpose of Radiation Protection (Safety Guide)
- **WS-G-6.1**; Storage of Radioactive Waste (Safety Guide)
- **NS-6-2.14**; Conduct of Operations at Nuclear Power Plants (Draft Safety Guide)
- **DS388; Chemistry Programme for Water Cooled Nuclear Power Plants** (Draft Safety Guide)
- *INSAG, Safety Report Series*
  - **INSAG-4; Safety Culture**
  - **INSAG-10**; Defence in Depth in Nuclear Safety
  - **INSAG-12**; Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 Rev.1
  - **INSAG-13**; Management of Operational Safety in Nuclear Power Plants
  - **INSAG-14**; Safe Management of the Operating Lifetimes of Nuclear Power Plants
  - **INSAG-15**; Key Practical Issues In Strengthening Safety Culture
  - **INSAG-16**; Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety
  - **INSAG-17**; Independence in Regulatory Decision Making

- **INSAG-18**; Managing Change in the Nuclear Industry: The Effects on Safety
- **INSAG-19**; Maintaining the Design Integrity of Nuclear Installations Throughout Their Operating Life
- **Safety Report Series No.11**; Developing Safety Culture in Nuclear Activities Practical Suggestions to Assist Progress
- **Safety Report Series No.21**; Optimization of Radiation Protection in the Control of Occupational Exposure
- **Safety Report Series No.48**; Development and Review of Plant Specific Emergency Operating Procedures
- ***TECDOC, IAEA Services Series etc.***
  - **IAEA Safety Glossary** Terminology used in nuclear safety and radiation protection 2007 Edition
  - **Services series No.10**; PROSPER Guidelines
  - **Services series No.12**; OSART Guidelines
  - **TECDOC-489**; Safety Aspects of Water Chemistry in Light Water Reactors
  - **TECDOC-744**; OSART Guidelines 1994 Edition (Refer only chapter 10-15 for Pre-OSART, if applicable.)
  - **TECDOC-1141**; Operational Safety Performance Indicators for Nuclear Power Plants
  - **TECDOC-1321**; Self-assessment of safety culture in nuclear installations
  - **TECDOC-1329**; Safety culture in nuclear installations - Guidance for use in the enhancement of safety culture
  - **TECDOC 1446** OSART mission highlights 2001-2003
  - **TECDOC-1458**; Effective corrective actions to enhance operational safety of nuclear installations
  - **TECDOC-1477**; Trending of low level events and near misses to enhance safety performance in nuclear power plants
  - **TECDOC-955**; Generic Assessment Procedures for Determining Protective Actions during a Reactor Accident
  - **EPR-EXERCISE-2005**; Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, (Updating IAEA-TECDOC-953)

- **EPR-METHOD-2003**; Method for developing arrangements for response to a nuclear or radiological emergency, (Updating IAEA-TECDOC-953)
- **EPR-ENATOM-2002**; Emergency Notification and Assistance Technical Operations Manual

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