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SEVERE ACCIDENT MANAGEMENT PROGRAM AT COFRENTES NUCLEAR POWER PLANT

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ABSTRACT

Cofrentes Nuclear Power Plant (GE BWR/6) has implemented its specific Severe Accident Management Program within this year 2000. New organization and guides have been developed to successfully undertake the management of a severe accident. In particular, the Technical Support Center will count on a new "Severe Accident Management Team" (SAMT) which will be in charge of the Severe Accident Guides (SAG) when Control Room Crew reaches the Emergency Operation Procedures (EOP) step that requires containment flooding. Specific tools and training have also been developed to help the SAMT to mitigate the accident.

1 INTRODUCTION

Cofrentes Nuclear Power Plant has recently implemented its Severe Accident Management Program. This Program is based on the "Accident Management Guidelines Overview Document" from the US-BWROG [1] and it is also in agreement with the general criteria for severe accident management implementation defined by the Spanish BWR Owners Group [2].

Cofrentes has been aware of the work done by other similar plants. In particular, personnel from the plant and from IBERINCO had the opportunity to attend the pilot demonstration of Severe Accident Management at Duane Arnold, a BWR plant in the USA [3]. This demonstration allowed the team project to know the way in which this process was being undertaken in other countries. Counting on this experience and based on the reference documents [1 and 2], Cofrentes prepared a general procedure [4] for implementing the Severe Accident Management Program. This procedure establishes the content of the Program, the

documents to be written, the plant internal organization to face severe accidents and the specific training required for the involved people.

2 SEVERE ACCIDENT MANAGEMENT TEAM

Among the new features introduced at the plant by the Severe Accident Management Program, it is worthy to remark the introduction of the Severe Accident Management Team (SAMT) in the Technical Support Center of the Emergency Response Organization of Cofrentes. This team will be in charge of the accident mitigation when the Control Room Crew reaches the EOP step that requires containment flooding and entering to the Severe Accident Guides (SAG) [5]. Since that moment, the severe accident management responsibility will be on the SAMT. The Control Room Operating Crew will act under their instructions. The SAMT is integrated by three members: Coordinator (decision-maker) and two Evaluators, one of them in charge of the Severe Accident Guide 1 (RPV and Primary Containment Flooding) and the other responsible for the Severe Accident Guide 2 (Containment Control and Radioactivity Release).

The Coordinator is in charge of mitigation strategy selection, after gathering all the available information about the plant status and the recommended SAG actions from the Evaluators. Additionally, the Coordinator should be in permanent communication with the Shift Supervisor, either to get additional information or to give instructions. Finally, it is the Coordinator responsibility to inform the Emergency Director about the actions to be taken and the state of the plant, in order to get permission for that actions which involve potential releases and, also, for the best implementation of the Emergency Plan.

For the SAMT, it has been designed the plant personnel who currently hold or held in the past the Operations Supervisor License, having performed the functions of this License charge at least for 5 years. So, candidates to the SAMT are the seven Shift Supervisors and the seven Operations Supervisors who are part of the Control Room Operations Crew at present. Also, there are six individuals at Cofrentes who fulfill the second requisite of having held this kind of License during 5 years or more, being nowadays responsible for diverse technical areas of the plant. Hence, there are twenty people at the plant who will be prepared to form a SAMT. The Cofrentes procedures [4] also establish that, when possible, the Coordinator functions will be assumed by one of those elder licensees whereas the Shift Supervisor and the Operations Supervisor will act as Evaluators. Even though, all of them should be able to accomplish any function of the SAMT.

3 SEVERE ACCIDENT GUIDES

3.1 Introduction

Based on the US BWROG generic Severe Accident Guidelines [6], Cofrentes has developed its specific Severe Accident Guides (SAG) [5]. In consequence, Cofrentes Emergency Operation Procedures (EOP) [7] have been modified accordingly to guarantee an appropriate transition to the specific SAG [5].

Cofrentes SAG have been prepared as flowcharts, keeping the same format as Cofrentes EOP. Nevertheless, it is important to notice that the SAG are not exactly the type of procedures as the EOP are. Because severe accidents are beyond design bases, SAG instructions are proposals while EOP steps are requirements. In a severe accident mitigation process, the Coordinator (decision-maker) is the one who has the ultimate decision of carrying

out the SAG suggested strategy or not, taking into account all the available information about the plant conditions collected by the Evaluators. This is because of the existing uncertainty in severe accident phenomenology and also to the difficulties associated for obtaining information on plant status: instrumentation missfunctions or out-of-range.

As set before, there are two Severe Accident Guides: SAG-1 for RPV and Primary Containment Flooding, and SAG-2 for Containment Control and Radioactivity Release.

SAG-1 is divided in three branches, for monitor and control RPV and primary containment water levels, RPV pressure and reactor power. SAG-2 has ten branches, which are devoted to control suppression pool, primary containment and secondary containment temperatures, primary containment pressure, drywell and containment hydrogen concentrations, containment radiation levels, secondary containment water levels and radiation release.

It is due to observe that the vessel and containment level control made in SAG-1 is very detailed. This control is divided into six branches, depending on the conditions identified during the accident. One of these branches should be followed only in the case that the vessel has been identified as breached by the molten corium. This could not be an easy task, but there is a call to a particular support guide of the Cofrentes Technical Support Guides (TSG) [8] to help the SAMT. If this is not the case, there would be more conditions to monitor for determining the best strategy to follow: RPV level over the TAF or over the BAF, if the RPV level is known. If not, RPV injection rate over a minimum already defined as enough to cool the debris. And, when the injection rate is below this defined minimum, the condition determining the branch to follow is the containment pressure, over or above the Pressure Suppression Pressure.

3.2 SAG Technical Validation

Cofrentes SAG [5] have been undergone a technical validation process [9] through which it has been proven that they are the most appropriate option for the plant, according to the results of its Individual Plant Examination (IPE/Level 2 PSA) results [10] and the state-of-the-art on severe accident phenomenology.

For this technical validation process several accident sequences have been selected and simulated with the MAAP code [11]. The selection has been based on two main purposes: sequences significant on the IPE results and also, sequences in which the impact of the most controversial actions of the SAG could be tested.

As a result of this validation process, Cofrentes SAG have been improved and some calls have been included to specific Support Guides that were developed ad-hoc. These guides are part of the Cofrentes Technical Support Guides (TSG) [8].

3.3 SAG Practical Validation

Once the Cofrentes SAG [5] were finished and technically validated they were put on a practical validation process [12], as were established on the plant procedures [4]. First of all, they were verified by the plant quality assurance personnel and proven in agreement with the generic SAG [6]. Afterwards, they were tested on a drill performed by the SAMT, to check that the people in charge of the accident mitigation understood every step of the SAG branches and were able, following such guides, to carry the plant to a controlled state.

For the drill preparation [12], two different scenarios were developed, with the purpose of testing all the branches of the SAG. In the scenario selection, the intent was to choose sequences relevant on the technical validation process [9]. To cover all the SAG branches, several restrictions were imposed for the selected scenarios. After the definition process, the final scenarios were simulated with the MAAP code [11].

The SAMT who carried out the drill was provided periodically with the values of the main control parameter of the plant, most of them obtained from the MAAP simulations, and those not provided by the code, but expected available at the plant, were provided by expert judgment.

SAMT drill performance was satisfactory: The Evaluators analyzed the information that they were provided with as it was expected to properly determine the plant status in each accident evolution step. Once the team was aware of the plant conditions, the Coordinator, helped by the Evaluators, selected the right strategy to follow through the SAG, ending up, in both scenarios, driving the plant to a controlled state.

4 TSG DEVELOPMENT

4.1 Introduction

As stated before, SAG instructions are proposals while EOP steps are requirements. In a severe accident mitigation process, the Coordinator (decision-maker) is the one who has the ultimate decision of carrying out the SAG suggested strategy or not. For this reason, in the "Accident Management Guidelines Overview Document" from the US-BWROG [1], it was contemplated the need of some "Technical Support Guides" [13]. These guides have the objective to be useful for the accident management team, providing them with some aids to better understand the plant status and helping them to choose the best mitigation strategy.

The main purpose of the Cofrentes TSG [8] is then to provide the SAMT with a method of support and optimization for decision-making to better undertake the actions proposed by the SAG [5].

4.2 Cofrentes TSG

The Cofrentes TSG [8] have been developed as four practical handbooks including the original objectives of the US-BWROG Technical Support Guidelines [13], which have been adapted to the specific SAMT of Cofrentes.

Three of the handbooks are intended to be a direct support tool for the specific tasks of the SAMT members:

- ☑ Coordinator Handbook
- ☑ SAG-1 Evaluator Handbook
- ☑ SAG-2 Evaluator Handbook

Each handbook contains the information considered the most valuable for a successful performance of the duties of the related SAMT member. As a second objective, these handbooks are also designed to be useful as a self-study material for SAMT training.

These three handbooks have the same internal structure: highlighted in the first page they have a note for the corresponding SAMT individual advising what is expected of him/her during the accident management. Afterwards, the responsibilities assigned to this member are enumerated, as well as the responsibilities of the whole team. Finally, the selected support information is included, organized by topics of concern for their specific functions.

The fourth handbook of the TSG, the Support Guides Handbook, has been created to include all the 13 specific guides which will be of some help at the corresponding 13 different calls from specific SAG instructions. The main purpose of these guides will be to provide the SAMT with practical aids to identify some plant conditions, to assess the benefits and disadvantages of some SAG instructions and to evaluate the required plant capabilities for some determined SAG step execution.

In this sense, these guides will help the SAMT, among their main duties, to identify the vessel breach, to evaluate the pros and cons of the containment venting when suggested, as well as the capability of venting depending of the accident conditions.

Additionally, in this handbook some simplified P&ID have been included showing the different possibilities of system alignments to inject water to the vessel or to the containment.

During the SAG Practical Validation, it was observed how the SAMT made use of the TSG. It was concluded that they used the TSG handbooks as expected to help them in their tasks.

5 TRAINING PROGRAM

To complete the Severe Accident Management Program implementation at Cofrentes, a training program has been developed for the specific needs of the different groups of personnel involved in this matter at the plant.

According to this, the severe accident training has been accomplished in several approaches. First of all, a briefing session on severe accident general phenomena was given to Operations staff. Thereafter a more extensive course was prepared for all personnel involved on the Emergency Response Organization, in which severe accident phenomenology was reviewed in detail through the main severe accident sequences of the Cofrentes IPE [10]. Also, an introduction about the contents and structure of the specific SAG and TSG prepared for Cofrentes [5 and 8] was presented. Finally, and just for the individuals who have been designated as part of the SAMT, a detailed course on contents and use of Cofrentes SAG and TSG was offered. This last training ended up with the performance of some practical exercises, prepared as table-top drills, using the MAAP code [11] to obtain the values given as plant values during the simulated scenarios.

For the future, refresher training will be provided for SAMT members: apart from self-study or computer based training, once every two years they will have to participate in a table-top drill, involving the use of SAG and TSG.

6 SUPPORT TOOLS

Facing to the future, a practical severe accident management tool [14] is being developed starting from the MAAP code [11]. The tool will have two main uses:

On one hand, it will be a powerful auxiliary training tool in severe accident technology with a user-friendly man machine interface, not requiring a previous deep knowledge of MAAP. It will also count on a wide database of accident sequences, previously analyzed for PSA, IPE or SAG validation purposes, which would allow the users to study them, or to use them as a base for new simulations

On the other hand, connected to the plant information system, will be able to perform a diagnosis and a prognosis of the severe accident evolution that would be of great value for its adequate management. It will make possible the identification and follow up of the events that would take place, making easy the adoption of the pertinent decisions, in compliance with the Severe Accident Guides.

7 CONCLUSIONS

Cofrentes Severe Accident Management Program has been conscientiously prepared, taking into account the reference documentation of the BWR Owners' Groups, the work done by other similar plants, the results of its own IPE/PSA and the state of the art on severe accident phenomenology.

After the implementation of the Program, it could be concluded that the organization proposed to face the severe accident have been properly trained as it has been showed through the practical exercises. Furthermore, the material prepared to cope with the accident, Severe Accident Guides and Technical Support Guides, has been technically and practically validated and it has been considered suitable for the severe accident management as its presentation, contents and writing is intelligible and easy to handle by the SAMT.

The Spanish Nuclear Regulatory Body (CSN), has evaluated the new EOP and SAG, and found adequate the whole project done on severe accident management. These EOP/SAG will be implemented at the plant after the current refueling outage.

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