COMMISSARIAT A L'ENERGIE ATOMIQUE

INSTITUT DE PROTECTION ET DE SURETE NUCLEAIRE

DEPARTEMENT D'ANALYSE DE SURETE

RAPPORT DAS N° 393

PERIODICAL TEST PROGRAM IN DEPTH REVISION

C. FELTIN*, R. ZERMIZOGLOU**

CSNI-UNIPEDE - Specialist meeting
on improving technical specifications
for nuclear power plants.
(Madrid, 7-11 septembre 1987)

CEA-DAS--393

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PERIODICAL TEST PROGRAM IN DEPTH REVISION

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ABSTRACT

Inspection visits made to different sites during 1980 and 1981 evidenced the need to extend and define more precisely the periodical tests performed on safety related systems ; thus Electricité de France was requested by the Safety Authorities to re-examine the periodical test program for all safety related systems.

This paper presents the methodology adopted by Electricité de France in order to perform an exhaustive analysis of the periodical test program for the 900 and 1300 MWe plants, and the organisation set up at the IPSN at one hand and Electricité de France on the other hand for the purpose of elaborating a periodical test program which would be ratified by the Safety Authorities.

RESUME

Des visites d'inspections effectuées sur différents sites en 1980 et 1981 ont montré la nécessité de compléter et de préciser les essais périodiques effectués sur les systèmes importants pour la sûreté. Aussi, les autorités de sûreté ont demandé à Electricité de France de réexaminer les programmes d'essais périodiques pour l'ensemble des systèmes importants pour la sûreté.

Cette communication présente la méthodologie adoptée par Electricité de France pour effectuer une analyse exhaustive du programme des essais périodiques sur les tranches PWR 900 et 1300 MWe, ainsi que l'organisation mise en place à l'IPSN, d'une part, et à Electricité de France, d'autre part, en vue d'aboutir à l'élaboration d'un programme d'essais qui ait reçu l'accord des Autorités de Sûreté.

1. Introduction

Considering the vital role of periodical testing in assuri the long term safety level of nuclear reactors, it is essential to ascertai. at these tests effectively provide for:

Testing of all functions contributing to plant safety,

test periodicity and acceptance criteria such as to guarantee that the systems checked will remain fully capable of fulfilling their functions during the interval between two successive test campaigns.

2. Review of Periodical Test Programs Requested by the Safety Authorities

Following inspection visits made to different sites during 1980 and 1981, it became evident that the periodical tests performed on safety-related systems had to be extended and more precisely defined.

The periodical test sequences cover the measurement of a certain number of parameters, such as:

rated flowrate,

pressure head,

vibrational amplitude,

valve opening and closing times

but it was found that the permissible values, the measured variables with associated uncertainty factors, were sometimes missing, operating times were not stipulated.

This meant that both the test performance quality and the result assessment and interpretation had to be improved.

In addition, for systems which are safety-related but not classified as engineered safeguard systems, site inspections and analysis evidenced a need for greater stringency in the definition of the test programs.

Generally speaking, it was found that if the evolution of equipment characteristics with time were to be correctly monitored, greater consistency between the periodical tests and operating technical specifications and maintenance rules would have to be achieved.

As a result of these observations, the operating utility EDF was requested by the safety authorities to re-examine the periodical test programs for all safety-related systems.

3. Periodical Test In-depth Analysis Methodology

In order to comply with the safety authority requirements, EDF undertook to perform an exhaustive analysis of the periodical test programs devised for the PWR 900 and 1 300 plant unit safety-related systems.

The methodology adopted by EDF was based on a system by system analysis, following, for each system, the steps indicated below:

- determination of the possible operating configurations and the modes of transit from one configuration to another (reactor operating under normal conditions, reactor operating under emergency conditions, reactor shut down),
- identification of the safety criteria associated with each configuration,
- inventory of the components implicated in each configuration (pumps, the various types of valve, etc.) and determination of the most penalizing cases (valve opening with maximum ΔP, valve closing under full rated flow conditions),
- definition of the appropriate tests and their periodicity.

Once this procedure had been approved by the safety authorities, an organization was set up at the IPSN (Institute of Nuclear Protection and Safety), on the one hand, and at EDF, on the other hand, for the purpose of elaborating a periodical test program which would be ratified by the safety authorities.

4. Organization Set up by EDF, Safety Authorities and IPSN

4.1. Definition of the Systems to be Considered

The criteria underlying determination of the functions (and consequently the systems) to be subjected to periodical testing on safety grounds had to be defined.

This was necessary since, if the inclusion of certain functions, such as engineered safeguard functions was obvious, it became apparent in the light of operating experience, that certain other systems, less evidently implicated, should also be included, either because they were auxiliaries of the former or because an even limited part of their function was safety-related.

In the course of meetings between EDF and the safety authorities held in parallel with the system by system analysis, the systems were divided into two classes: A and B:

List A: protection and engineered safeguard systems, the reactor coolant system, the chemical and volume control system, the residual heat removal system and their essential auxiliary systems. EDF is required to subject all these systems to periodical safety-related tests, defined on the basis of an in-depth analysis (28 systems).

List B: systems subjected to some periodical tests, aimed at checking certain operating technical specifications (23 systems). These periodical tests could be determined on an engineering judgement basis without an in-depth analysis.
Lists A and B for 900 MWe PWR reactors are given in full hereafter.

List A

ASG	Auxiliary Feedwater System
ARE	Feedwater Flow Control System
DVC	Control Room Air Conditioning System
DVH	Charging Pump Room Emergency Ventilation System
DVI	Component Cooling Room Ventilation System
DVK	Fuel Building Ventilation System
DVL	Electrical Building Main Ventilation System
DVS	Safety Injection and Containment Spray Pump Motor Room Ventilation System
EAS	Containment Spray System
EPP	Containment Leakoff Monitoring System
ETY	Containment Atmosphere Monitoring System
GCT	Turbine Bypass System
KRT	Plant Radiation Monitoring System
LGI/LHI	6.6 kV ac Normal and Emergency Supplied Distribution Systems
LHP/LHQ	6.6 kV ac Emergency Power Supply System (Trains A and B)
LLS	380 V ac Emergency Supplied Distribution System
RCP	Reactor Coolant System
RCV	Chemical and Volume Control System
RGL	Full Length Rod Control System
RIS	Safety Injection System
RPN	Nuclear Instrumentation System
RPR/SIP	Reactor Protection System (Process Instrumentation System)
RRA	Residual Heat Removal System
RRI	Component Cooling System
SEC	Essential Service Water System
VVP	Main Steam System

List B

APG	Steam Generator Blowdown System
DMK	Fuel Building Handling Equipment
DMR	Reactor Building Handling Equipment
DVF	Electrical Building Smoke Exhaust System
DVN	Nuclear Auxiliary Building Ventilation System
DVR	Computer Room Air Conditioning System
JDT	Fire Detection System
JPP	Fire-fighting Water Production System
JPI	Nuclear Island Fire Protection System
KPR	Remote Shutdown Panel
LAX	230 V dc Power System
LBX	125 V dc Power System
LCX	Relaying 48 V dc Power System
LN	220 V ac Power System
PMC	Fuel Handling System
PTR	Reactor Cavity and Spent Fuel Pit Cooling and Treatment System
REA	Reactor Boron and Water Makeup System
REN	Nuclear Sampling System
RPE	Nuclear Island Vent and Drain System
SAP	Compressed Air Production System
TEG	Gaseous Waste Treatment System
TEP	Boron Recycle System
TAG	Gas Turbine System

4.2. In-depth Analysis of System Periodical Test Programs

Each of the systems listed was analyzed according to the following method:

1. Elaboration of basic documents by EDF

The method to be adopted differed according to the importance for safety of the systems considered and the complexity of the tests and inspections to be performed.

. For the "A class" systems, the two following documents were drawn up:

a) a periodical test analysis note:

in this note are specified all the functions to be fulfilled by the systems considered, together with modes of transit between the configurations thus identified. On this basis, the tests and inspections to be performed in each case are defined.

The detailed analysis of the components involved is used to determine test periodicity, the parameters to be considered and acceptance criteria.

b) Periodical test rules:

this document is associated with the previous one, on which it is based. It provides prescriptions for the performance of the tests (plant unit condition, system configuration, sequencing of main operations, precautions to be taken, expected results).

To this document is appended a table summarizing the periodical tests and inspections to be performed. This table shall be included in the general operating rules.

. For the "B class" systems, .

a table summarizing the periodical tests and inspections to be performed for each system was elaborated, accompanied, where necessary, by an explanatory note, replacing the periodical tests rules and analysis note.

5. Examination of the EDF Documents by the Safety Authorities

The documents elaborated by EDF were submitted to the safety authorities. After analysis by the IPSN, providing technical assistance to the SCSIN (Headquarters for the Safety of Nuclear Installations), the latter organization ratified the documents, indicating, where necessary, complementary prescriptions or requirements.

The rules formulated in these documents are summarized in the tables included in the general operating rules. These texts may not be modified without previous notification and approval of the Head of the SCSIN.

6. Scope of the Action Undertaken

The in-depth revision action concerned test principles. It was left to EDF to derive from these documents defining principles, the documents to be actually used on the site, which define the actual periodical test sequences.

The following organization was set up by EDF for the definition of these periodical test sequences:

- the work load was shared between the EDF headquarters departments and the different nuclear power plants,
- each plant was put in charge of a certain number of systems, for which it had to set up periodical test procedures based on periodical test rules and analysis notes. These procedures then became national standards for the systems concerned.

These reference procedures had then to be adapted to each plant unit, each plant being responsible for deviations between its own instructions and the national reference sequences.

7. Example of Application to a System

As a practical example, we indicate below certain tests and examinations which were added to the pericdical test programs defined for the auxiliary feedwater system (ASG):

- a performance test was added to check pressure losses in the auxiliary feedwater system piping after any operation liable to modify the ASG line pressure losses, such as, for example, any action involving opening the system, which could allow entry of foreign matter,

- since we know by experience that the sensitive parts of the ASG system are the turbine inlet valves and the turbine-driven feedwater pump speed controls, the tests listed below were performed in order to thoroughly check:

  - the turbine-driven feedwater pump runup time,

  - the capacity of this pump to start up under maximum steam conditions (70.3 bar), with simultaneous opening of two turbine inlet valves, controlled by channels A and B respectively, implying far more penalizing conditions with respect to overspeed tripping,

  - the capacity of this pump to start up anywhere in the pressure range for which it was designed and especially under pressure conditions corresponding to a switch to a residual heat removal (RRA) configuration.

8. Conclusions

At the request of the safety authorities EDF undertook the extensive task of redefining the periodical tests for safety-related systems.

This work has led to the elaboration of satisfactory revised test documents, obviating the deficiencies previously detected. It has also highlighted the need to extend the list of systems initially considered, thereby increasing the number of periodical tests.

The safety authorities, for their part, corroborating their position with operating feedback data and after examination of the justifications presented by EDF, accepted to increase the periodicity of certain tests (protection systems, certain containment isolation valves).

This action illustrates normal French procedure for the elaboration of regulatory and technical documents. The safety authorities define the objectives and the framework of the action and the operating utility proposes the practical means to be used to attain the specified ends.

In the case we are considering, the EDF proposed provisions were analysed by the IPSN, providing technical assistance to the SCSIN. The SCSIN approved the texts, with however stipulations regarding complementary prescriptions in certain cases. These new documents are already in force and have to be observed as scrupulously as the regulatory documents. They cannot be modified without the previous consent of the SCSIN.

This approach requires extensive means and is extremely time-consuming. It was made possible in France by the very high degree of nuclear power plant standardization. The documents thus elaborated in fact apply to about forty 900 and 1 300 MWe plant units.

Novembre 1987

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