DESIGN MODIFICATIONS TO IMPROVE PERFORMANCE

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I present to you a contribution on design modifications to improve performance. Many factors have contributed to the success of the French nuclear Program. From the technical viewpoint, the importance given to experience feedback in the design and construction phases of nuclear power plants, as in the operating phase, has enabled the advantages expected from the adoption of a single system, the PWR 1, to be fully obtained by:

- concentrate design work on a limited number of projects
- rationalize the structure of the production industry
- set up adapted quality assurance procedures
- accumulate experience
- in hand with standardization, devote efforts to experience feedback.

Experience feedback process is run along with the successive phase of collection of data from events occuring in NPPs, sorting and analyzing the most significant events, definition and design of corrective proposals and completion at the site.

In France, this process is carried out on about 50 PWR Nuclear Power Plants by Electricité de France, both operator and Architect/Engineer, with a centralized organization in wich operators contribute to the choice and details to this by supplying the experience from operational NPP. Designers have direct access to all information. We can notice that about 20,000 operational events have been collected in a centralized data bank since 1980. Together they participate in incidents analysis and improvements to this in close cooperation with the main contractors, notably Framatome, with whom they share experience feedback. Analysis reports and proposals for corrective actions are submitted to EDF's expert committees in which operating and engineering services participate.

In adition of corrective actions from experience are instructed those resulting from evolution of design rules and operating objectives, such as load following, remote control, better appreciation of existing margins. At the same time, they integrate not only units coming from the whole plants operating optimization and network interfaces but also progress made by contractors like Framatome and EDF's Engineering services in their knowledge by applying the results of an important research and development program. Joint decisions of operating and engineering managements take into account expected performance gain in availability, operating objectives and safety and security aspects, regarding economic aspects such as cut cost benefit weight. Studies of corrective actions are carried out for all the plants of the serie and if necessary for ERS service. Application in a preventive way to services under construction or in planning is mainly carried-out by services. In paralel, these services update as necessary the basic design documents such as technical specifications, directives, design rules, to store these evolutions under perspective of new plants. When it touches the design of systems or equipment, the definition of corrective actions is finalized in a generic qualification file for each service. Further, the improvement of modification is planned at a national level with DM to integrate as quickly as possible in all plants a reduced number of changes judged as prioritary in relation to safety, to regroup all the other changes in packages enabling all plants at the same series to be put in an identical final state, to take advantage of plant shutdowns for maintenance or refueling, to carry out corresponding works. In practice, on the standup PWR 900 the final state, called final standardized state, in French EFP, was carried out on the last plant of this series, Chinon B-4, which was commissioned in October 1987. Bringing the

other 900 PWR plants up to this level is planned from 1988 to 1991. On the standard 1300 PWR because they are relatively new intermediate state and the final standardized state, EFP, have been forcing the first, in French EFPR. Its integration is in process and will be completed this year.

Among the many improvements we have introduced on the 900 MW plants, I present three of them. First, reactor protection system automatic tester, second protection against slow voltage drops, third a new measuring channel to monitor primary to secondary leak rates inside PWR steam generators named RAMSIS.

First of all, the automatic testing device for the reactor protection system. The problem encountered in 1982-83, periodic testing was identified as a major source of in-plant scrams. With 84 persons called by human errors, from turbine test, reactor protection system test, process instrumentation test.

The cause of human errors in manual testing procedure, where two operators are involved, are presented. The most common errors were transposition beatween different selector switches on test panel. The studies include looking selector switches, partial automation, full automation. Only full automation proved to bring significant reduction of trips, reduction of automatic testing delay, especially in the time required after refueling, significant saving in man-hours. Two operator man-hours as opposed to forty man-hours previosly necessary.

The principle of the modification of the automatic testing device was the same test as manual operators with the following equipments: the test unit, micro processor and we call memory incorporating the test program, interface unit acting like the switches and a test console located in the control room enabling the operator to communicate with the tester. As regards, preventive measures against slow decrease of voltage in 48 V D.C. system, the problem encountered, an incident occured in Bourger-5 plant in April, 14th 1984, leading to loss of auxiliary transformer, loss of step-down transformer and unavailability of one of the two diesel generators. The lessons learned from this incident and its analysis are the importance of the arrange of the mini/maxi voltage and the 48 V D.C. switchboard, the necessity to install an alarm battery on discharge indicating that the charger is defective, and automatic disconnection of the supplies, charger and battery, if the battery runs down under 38 V D.C.

As concerns RAMSIS and as introduction, we can see that studies and tests of this system were started in 1983 by EDF to improve liquid assessment from primary to secondary circuits throught steam generator U-tubes diagnosis directed to steam generator tube rupture. RAMSIS has been designed for this purpose and os now available.

The basic requirements. First, the leak detection system must be highly sensitive and reliable, convenient and not time consuming, continuous and accurate. Second, SGTR detection system must allow an early detection from the hot shutdown state to the full power. Third, to check the release activities from the steam generators to the atmosphere in case of SGTR.

The principle of the system consists in monitoring nitrogen-16 activity within steam owing to high-energy gamma rays from nitrogen-16 decay, predictibility of the weight of nitrogen-16 production within the core. After spectrometric method, it is more sensitive than gamma dose rate detection, and monitoring of both gamma rays from nitrogen decay and gamma rays from noble gases decay in a low energy window, in order to meet second and third requirements.

Qualification and planning. Since 1983, more than 30 tests have been conducted in EDF plants. Since 1986, Danpierse 1 NPP has been continuously monitored by RAMSIS. As a result of these tests, EDF decided that starting in 1988, RAMSIS will be installed on all PWR steam generators and it will be achieved this year. In foreign countries, RAMSIS is installed and testing on Tihange 2 in Belgium, at Zion in USA and in operation at North Ana in USA.

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ment *means action, not reaction.* He then said: "To accomplish this, a utility must attract and select the best personnel to implement corporate strategies, and then develop those personnel".

Having sufficient and qualified personnel always available is a management task that is more and more difficult in our country due to an uncertain political situation without perspectives and the hostile attitude of the media towards nuclear energy.

A propos responsibilities: I dont believe in to many signatures on a document (three are enough) because of the danger of dividing or smearing out responsibilities.

Talking about responsability a word has to be said about the relationship plant operators and authorities. Here also it has to be clear, that the operator bears *all* the responsibility for a safe operation of the plant. In an article to the tenth anniversary of TMI I found the remarks of William Lee, president and chief executive office of Duke Power Co.

"I of course was surprised and dumbfounded that it was allowed to happen. It made me realize that we had *relied too much on government.* My own tendency was to think that if we (operating utilities) relied on this myriad of regulations we would be all right. That wasn't right. *We had to focus on safety, not on the rules.* The rules didn't cover what happened at TMI". The action has to be with the utility.

I think, in our country, up to now the relation between NPP and the licensing body was on a sound technical base. We have open discussions and open information.

But, due to the political pressure, I am afraid that the situation might change in our country, that more and more we, the operator, have to react on the action of the authority.

I dont believe that this would improve the safety, when the operators get the attitude: "Lets wait, 'big brother' will tell us what to do"!

CONCLUSIONS

We have many new ideas, new technical posibilities but the old concept is still valid: Incidents can *primarily* be avoided through a proven design and faultless operation with well trained personnel. *Second priority* is to be prepared for severe accidents and for the mitigation of the consequences of such accidents through management, containment integrity and emergency preparedness.

When a shift technical advisor tells me after his licensing exam, "Now I know very well how to handle a degraded core or core melt accident, but I am not sure, how to handle everydays malfunctions", then, something is wrong!

Safety and availability go hand in hand. In our country, the goal is not so much a further improvement of the availability, but the much more difficult task to maintain the good result of the past.

We —as everybody in the nuclear energy business— know what we have to do! Lets do it!