

November 12, 2003

MEMORANDUM TO: John H. Flack, Chief
Regulatory Effectiveness Assessment and Human Factors Branch
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

FROM: Joel J. Kramer */RA/*
Regulatory Effectiveness Assessment and Human Factors Branch
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Office of Nuclear Regulatory Research

SUBJECT: TRIP REPORT ON MEETING AT EdF FITNESS SIMULATOR IN LYON,
FRANCE, OCTOBER 2-3, 2003, AND TO PARTICIPATE IN THE
OECD'S NUCLEAR ENERGY AGENCY'S (NEA) WORKSHOP ON
MODIFICATIONS AT NUCLEAR POWER PLANTS - OPERATING
EXPERIENCE, SAFETY SIGNIFICANCE, AND THE ROLE OF HUMAN
FACTORS AND ORGANIZATION IN PARIS, FRANCE,
OCTOBER 6-8, 2003

Attached is a summary trip report for my travel to Lyon from October 2-3, 2003, to observe and discuss the operation of Electricite de France's (EdF) new advanced control room simulator (FITNESS), to discuss the potential for cooperative human performance research using this simulator, and to participate in the OECD/NEA workshop on Modifications at Nuclear Power Plants - Operating Experience, Safety Significance, and the Role of Human Factors and Organization in Paris, France, from October 6-8, 2003.

The FITNESS simulator is a leading candidate for conducting computer-based, human-system interface research on human performance issues involving advanced reactors. EdF, EPRI and DOE are interested in exploring alternatives for cooperative research using the FITNESS simulator, and possibly building one in the U.S. I understand that Ashok Thadani will be visiting the simulator in Lyon in early December.

The OECD/NEA workshop was attended by 45 people, representing 13 countries (including IAEA and WANO). There were several plenary and break-out discussion sessions. International experience of events and modification processes were discussed during the workshop and there was considerable sharing of good practices for both regulators and licensees. The workshop results will be published in the near future and will be used to steer international developments in the area of NPP modification safety.

F. Eltawila

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No Actions by the Commission are recommended as a result of this trip.

Attachments: As stated

cc w/att:

W. Dean, AO

J. Dunn Lee, OIP

T. Rothschild, OGC

F. Eltawila

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NRC INTERNATIONAL TRIP REPORT

Subject: Meeting with EdF on Advanced Control Room Simulator (FITNESS), and Participation in OECD/NEA Workshop on Modifications at Nuclear Power Plants - Operating Experience, Safety Significance and the Role of Human Performance and Organization

Dates of Travel, Country and Organizations Visited: October 2-3, 2003, Lyon, France, EdF; October 6-8, 2003, Paris, France, OECD/NEA

Author, Title, and Agency Affiliation: Joel J. Kramer, Sr. Engineering Psychologist, REAHFB, Office of Nuclear Regulatory Research

Sensitivity: Not applicable.

Background/Purpose: Little is currently known about the planned role of humans in the operation and maintenance of advanced reactors, because the concept of operations has not yet been developed by vendors or potential licensees. What is known indicates that there will be a change from the human's role from what we are currently familiar with. To develop a detailed NRC human factors research agenda for advanced reactors, it is necessary to first determine from best available information what human performance issues need research, what research facilities might be needed, what regulatory review guidance may be needed, and what confirmatory research the NRC should be prepared to perform.

This trip contributed to this effort in two ways. First, it provided an opportunity to visit one of the most advanced control room simulators in the world in order to collect information about the envisioned role of the operators and the new methods of plant monitoring and control that are being prototyped.

Second, the workshop provided an opportunity to collect information on operating experience. Operating experience of plants currently using modern digital technology is one of the sources of data that are being used to develop human performance research plans and it is difficult to acquire by other means. NRC contributed to the information exchange by presenting some of the results on lessons-learned from plant upgrades using digital technology.

Abstract: Summary of Pertinent Points/Issues:

The EdF FITNESS (Functional Integrated Treatments for Novative Ecological Support System) Simulator) in Lyon can be used to perform human performance evaluations in order to compare various operating situations and conditions. In addition to exploring the simulator's design and capabilities, discussions were also held concerning the tests and evaluations performed by EdF thus far. These tests have had generally favorable results and are being used to further modify the approach to human-system interaction. The simulator is a potentially extremely valuable research tool, because it is very flexible and has been designed to permit flexible levels of

automation, information presentation and control. The simulator is also suitable to examine different concepts of operations, an essential feature for advanced plant research.

In Paris, I attended a OECD/NEA/CSNI Workshop on Nuclear Power Plant Modifications. In addition, the Institute de Radioprotection et de Surete Nucleaire (IRSN) helped set-up the meeting. The workshop was divided between paper presentations and working groups. Main conclusions of the workshop were that operating experience shows that safety significant issues can arise from failure to address the human factors aspects of both major and minor modifications. The workshop recommended that a systematic process for tracking and maintaining a “data base” of world-wide operating experience for plant modernization be developed. Such information can then be made available to vendors, utilities, regulators, and researchers. The workshop results will be published in the near future and will be used to steer international developments in the area of NPP modification safety.

Discussion:

Meeting at EdF’s Fitness Simulator in Lyon, France

The FITNESS simulator is located in Septen, on the outskirts of Lyon, France. It is currently used by a variety of specialists, including nuclear power plant operators, designers, and human factors professionals.

The approach to human-plant interaction is built upon a generalization of the functional representation of the plant. This approach enables the complexity of the process to be represented in various ways:

- The scheme of the operations of the main functions during normal operations as well as plant transitions, such as startups and shutdowns, is explicit (the availability of a function starts with the lowest level and goes up the hierarchy to the highest functional level).
- The propagation of the function failures from low levels to high functional levels is represented, which allows high-level, synthesized information to be generated on the availability of the key safety and availability functions.

All information, user-system dialogs, and controls are fully integrated. There are no dedicated monitor screens or keyboards, nor is there a formal distinction between primary and secondary operation or between alarms and displays for monitoring, controls and procedures.

This functional approach is developed using a formal hierarchy of displays, information and alarms. The hierarchy works following tree and zoom principles. From the plant overview display, the operator goes down to the functional level to be managed, and then to the component level, which represents elementary operating functions. Alarms are directly presented in the operating displays, with a synthetic level corresponding to the functional level being represented. Thus, an alarm is not always presented with the same “priority.” Instead, the priority takes into account all available redundancies together with the contextual data (related to the plant condition)), hence defining the need for the relevant function.

In order to determine the optimal automation level, the simulator models have been designed to vary the automation level from fully manual to highly automatic plant operations. In addition, various levels of procedure automation can also be used.

The FITNESS simulator can be used to perform human factors tests in order to compare various operating situations and conditions. In addition to exploring the simulator's design and capabilities, discussions were also held concerning the tests and evaluations performed thus far. These tests have had generally favorable results and are further being used to modify the approach to human-system interaction.

In my opinion, the FITNESS simulator is potentially an extremely valuable research tool. As a research simulator it is very flexible and has been designed to permit flexible levels of automation, information presentation and control. The simulator is also suitable for examining different concepts of operations, an essential feature for advanced NPP research.

In discussions with the simulator's technical staff and their management, it was apparent that EdF is quite interested in cooperative research with the NRC to conduct studies of mutual interest. As well, EPRI and DOE are interested in exploring alternatives for cooperative research using the FITNESS simulator.

Conference on "Modifications at Nuclear Power Plants - Operating Experience, Safety Significance and the Role of Human Factors and Organization" in Paris, France

This workshop was put on by the OECD's Nuclear Energy Agency (NEA), specifically the Committee on the Safety of Nuclear Installations (CSNI). In addition, the Institute de Radioprotection et de Surete Nucleaire (IRSN) set-up the meeting. Forty-five people, representing 13 countries (including IAEA and WANO), participated in plenary presentations and workshop discussion sessions.

The general objective of the workshop was to bring together experts to exchange and disseminate information about the safety aspects of NPP modifications. The main points included:

- Operating experience repeatedly shows that the modifications at nuclear power plants can lead to safety significant events - even when the changes are relatively minor.
- The cumulative effects of minor modifications could be a major safety concern.
- Modifications are necessary to ensure the economic and safe functioning of NPPs.
- Human input is made at different stages of the plant modification process, and these inputs may compromise safety if not properly specified and understood.
- When plant personnel have to operate and maintain altered or changed equipment, different types of problems arise.

Moreover, if problems can only be revealed when operating in accident conditions, as for standby safety systems, they can be considered latent faults. Such anomalies cannot always be identified by preoperational or periodic tests, and if spread through the plant (e.g., wrong lubricant or widely used spare part), it may be difficult to carry out corrective action in a timely manner.

Some of the other topics discussed included:

- Differences in approach to regulating and managing significant and minor modifications
- Specific examples of different approaches to the modification processes, their key elements and guidelines from both regulatory and licensee perspectives
- How human and organizational factors need to be considered in relation to modification processes
- Identification of approaches for dealing with modifications in regulation and in safety management
- Identification of topics deserving further attention from the CSNI and its working groups

With respect to the latter, it was concluded that a systematic process for tracking and maintaining a “data base” of operating experience for plant modernization is needed.

Pending Actions/Planned Next Steps for NRC: NRC staff and management to continue discussion with EdF, EPRI and DOE on cooperative research using the FITNESS simulator.

Points for Commission Consideration or Items of Interest: No action is required by the Commission

Attachments: None.

Please contact Joel J. Kramer, (301) 415-5891, for any additional information regarding this trip including copies of presentations made at the OECD/NEA/CSNI workshop.