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Report of Foreign Travel

by

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First Meeting of Task Group
on the Seismic Behavior of Structures
OECD Nuclear Energy Agency
Paris, France

SUMMARY

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Dates of Trip: May 21, 1996 - May 26, 1996

Destination: OECD Nuclear Energy Agency
Issy-Les-Moulineaux, Paris, France

Purpose: To participate in the 1st meeting of the Committee on the Safety of Nuclear Installations (CSNI) Principal Working Group No. 3 Task Group on the Seismic Behavior of Structures which was held at the OECD NEA Offices in Issy-Les-Moulineaux, Paris, France on May 23-24, 1996.

Abstract: The traveler participated in the first meeting of the Task Group on Seismic Behavior of Structures which was held in Paris, France on May 23-24, 1996. Each of the task group members discussed current topics of interest to member countries. The group also developed a list of issues which will be presented in tabular form with 1-2 sentences characterizing each issue both for design and re-evaluation. Each issue will be prioritized by member countries as high/medium/low/not relevant based on the consideration of both safety and lack of knowledge. The group members will also provide information in narrative form which will address for their country the following items: seismic considerations, design practice, re-evaluation practice, status of research, summary of important issues. The traveler, who is serving as a consultant to the group under the sponsorship of the USNRC, will collect the information from the member countries and prepare a draft status report for discussion at the next meeting which will be held in Paris on October 15-16, 1996.

TRIP REPORT FOR TRAVEL TO FRANCE

Travel Dates: May 21, 1996 - May 26, 1996

Traveler: Dr. Charles H. Hofmayer
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Itinerary:

May 21	Departure from New York
May 22	Arrive Paris, France
May 23	PWG 3 Seismic Task Group Meeting
May 24	PWG 3 Seismic Task Group Meeting
May 25	Weekend
May 26	Departure from Paris and Arrive in New York

Purpose of Travel:

The purpose of this trip to France was to participate in the 1st meeting of the Committee on the Safety of Nuclear Installations (CSNI) Principal Working Group No. 3 Task Group on the Seismic Behavior of Structures which was held at the OECD NEA Offices in Issy-Les-Moulineaux, Paris, France on May 23-24, 1996.

Background:

The Nuclear Energy Agency (NEA) is an agency that operates within the framework of the Organization for Economic Co-operation and Development (OECD), an intergovernmental organization based in Paris. The major policies and programs of NEA are guided by the Steering Committee for Nuclear Energy which is assisted in specialized areas by Standing Committees composed of experts from various member countries. One of these committees is the Committee on the Safety of Nuclear Installations (CSNI) whose work is conducted primarily through five Principal Working Groups (PWGs).

The Principal Working Group 3 (PWG-3) of CSNI has expanded its scope to include a Task Group on Seismic Behavior which will deal with issues related to the seismic structural behavior of nuclear power plants, with emphasis on aging aspects. An ad hoc task group, consisting of six or seven representatives from various member countries, has been formed to finalize the mandate for the Task Group and propose a CSNI program of work in this area. The CSNI bureau will review the recommendations of the task group and submit a proposal to the 1996 meeting of the CSNI.

Under the sponsorship of the USNRC Office of Nuclear Regulatory Research, BNL is providing consulting services to the CSNI ad hoc task group and will draft an assessment report covering:

- the status of research and concerns on the area of seismic analysis;
- current international activities in this area; and
- the formulation of recommendations for a medium-to-long term CSNI program of work (specialists meetings, workshops, preparation of state-of-the-art reports, data base formation, etc.).

Summary of Meeting

The meeting was opened by Dr. Gianni Frescura, head of the NEA Nuclear Safety Division. He welcomed the participants and provided background on the PWG-3 activities and the formation of the Task Group on the Seismic Behavior of Structures. The secretary of the PWG-3, Dr. Alex Miller, also welcomed the participants and served as the chairman of the meeting. The participants in the meeting included the following:

Canada	Medhat Elgohary, AECL
France	Pierre Sollogoub, CEA
Italy	Giuseppe Maresca, ANPA
Japan	Kinji Akino, NUPEC
Korea	Sang-Kook Lee, KINS (observer)
	Yun Suk Chung, KINS/INSA Lyon (observer)
Switzerland	Daniel Kluge, HSK
UK	David Shepherd, NII
USA	Nilesh Chokshi, NRC
	Charles Hofmayer, BNL (consultant)
IAEA	Aybars Gürpinar
CEC	Ioannis Papadopoulos, JRC Ispra
NEA	Gianni Frescura (part-time)
	Alex Miller (secretary)

The initial discussions focussed on the mandate of the task group which is to deal with issues related to the seismic structural behavior of nuclear power plants, with emphasis on aging aspects. It was agreed that the task group would address all safety related structures, including systems and components. The engineering aspects of the hazard and siting would also be considered. Seismic PSA would also be discussed in the report. The group will concentrate on the seismic requalification of old plants and how structures that have aged can deal with seismic loads.

The remainder of the meeting on the first day was devoted to reports by members on current topics of interest in member countries. Reports were also made on programs of international organizations (IAEA, CEC). A brief summary of each of the participant's presentations is included in the secretary's "Summary Record of the First Meeting" which is included in the Appendix to this report. The presentation material provided during the meeting is listed below and maintained in the traveler's files.

Mr. Gürpinar discussed a number of interesting seismic activities being performed by the IAEA. He referred to two safety guides that were recently revised which may prove to be very useful to the group (50-SG-S1, " Earthquakes and Associated Topics in Relation to NPP Siting," 1991 (Rev. 1) and 50-SG-D15, "Seismic Design and Qualification of NPPs", 1995). He also mentioned that there are many voluminous reports available related to the IAEA Co-ordinated Research Program (CRP) on the Benchmark Study for the Seismic Analysis and Testing of WWER type Nuclear Power Plants. The IAEA is in the process of compiling a document of lessons learned which would be very useful for the Task Group effort. During the meeting Mr. Gürpinar agreed to send two IAEA reports. One on the advisability of automatic seismic trip systems and another comparing seismic input criteria for the plants studied by the IAEA.

The meeting on the second day concentrated on developing a list of issues that might be addressed by the group. The issues were divided into the following ten categories:

1. Engineering Characterization of Seismic Input
2. Site Response
3. Soil Structure Interaction
4. Identification of Functions and Classification of Systems, Structures and Components
5. Structural Response
6. Component and Equipment Response
7. Distribution Systems (Piping, Cable Trays, Conduit, HVAC)
8. Load Combination and Acceptance Criteria
9. Uncertainties (PSA and Margins)
10. Plant Seismic Instrumentation and Trip

The meeting participants identified various issues that they felt should be addressed for each of the above items. These issues are listed in Table 1. Each participant agreed to further characterize each issue by providing one or two sentences explaining the issue as it relates to new plant design and existing plant re-evaluation. The participants will also prioritize the issues as high/medium/low/not relevant based on the consideration of both safety and lack of knowledge.

In addition to providing input for the table, each participant agreed to provide information in narrative form which will address for their country the following items: seismic considerations, design practice, re-evaluation practice, status of research, summary of important issues. The traveler will collect the information from the member countries and prepare a draft status report. A questionnaire together with the U.S. example of text and tables will be sent to NEA member countries not represented at the meeting in order to solicit their input as well.

A second meeting of the Task Group will be held in Paris on October 15-16, 1996 to review the draft status report. A second draft of the report will be prepared in early November 1996 to support the next CSNI meeting scheduled for December 4-5, 1996.

Documents Obtained:

The following documents were obtained during the trip and are maintained in the traveler's files:

1. Current Activities in the Seismic Area in Canada, M. Elgohary, AECL Canada.
2. Overview of Activities in Seismic Domain, J. Touret, EDF France.
3. R/D Related to Seismic Behaviour of NPPs in France, P. Sollogoub, CEA France.
4. Extract of Technical Guidelines for Aseismic Design of NPPs, NUREG/CR-6241, Translation of JEAG 4601-1987.
5. Overview of Research Activities on Seismic Design of NPPs in Japan, K. Akino, NUPEC.
6. Seismic Behaviour - Current Topics of Interest in the UK, D. Shepherd, UK NII.
7. Seismic and Structural Engineering Research, N. Chokshi, USNRC.
8. Summary of Activities Related to Seismic Safety at IAEA, A. Gurpinar.
9. SMiRT papers on Seismic Safety of NPPs in Eastern Europe and Benchmark Study for the Seismic Analysis and Testing of WWER Type NPPs, A. Godoy and A. Gurpinar, IAEA.
10. Information on JRC Ispra European Laboratory for Structural Assessment and Large Dynamic Test Facility, I. Papadopoulos, JRC Ispra.
11. 2nd Announcement of 14th SMiRT Conference 1997.
12. Secretary's Report on 1st PWG-3 Concrete and Seismic Sub-Group Meetings.
13. Draft Summary Record of the 2nd Workshop for the NUPEC/NEA Seismic Shear Wall ISP, Yokohama, April 1996.
14. Draft NEA/IAEA/CEC Common Aging Terminology.
15. Extract from NEA Report on Nuclear Safety Research in OECD Countries.
16. Previous CSNI Report on Seismic Design, 1975.
17. Fax from Czech SONS.

Table 1 - List of Issues

Item	Design	Priority*	Re-Evaluation	Priority*
1. Engineering Characterization of Seismic Input - high and low frequencies - 2 earthquake levels - 3 components - response spectrum (site specific versus std) - displacement (near-field/base isolation) - input for non-linear analyses - power spectral density				
2. Site Response - site categorization (stratigraphy, shallow) - soil properties uncertainties (damping/shear wave velocity) - linear/non-linear - real time histories (minimum number) - liquefaction				
3. Soil Structural Interaction - coherency - validation of analytical techniques - soil properties (uncertainty range/strain reduction/radiation damping) - embedment - structure-structure effects - pile foundations - simple models				

Table 1 - List of Issues (continued)

Item	Design	Priority*	Re-Evaluation	Priority*
4. Identification of Functions and Classification of Systems, Structures and Components - redundancy - common mode failure - fire protection system - two over one interaction				
5. Structural Response - structural detailing - modeling analysis - Guyan reduction - modal combination - linear-nonlinear (global/local, ductility, damping) - material properties uncertainties - base isolation - accidental torsional loading - construction issues - generation of floor response spectra - coupled analysis - computer code validation - ageing-effects (e.g., prestress cables) - masonry walls - buried pipes - tank sloshing - spent fuel racks - earth structures (dams, dykes)				

Table 1 - List of Issues (continued)

Item	Design	Priority*	Re-Evaluation	Priority*
6. Component and Equipment Response - anchoring - supports/energy absorbers, snubbers - sliding/impacting - damping - simplified methods - equipment qualification (active) - experienced based approach - relay chatter - I&C issues - in-cabinet response - inelastic behavior - ageing effects - core problems - base isolation				

Table 1 - List of Issues (continued)

Item	Design	Priority*	Re-Evaluation	Priority*
7. Distribution Systems (Piping, Cable Tray, Conduit, HVAC) - design by rule - damping - multi-input response techniques - use of experience based data - flexibility - qualification of line-mounted equipment - linear/non-linear (support loads, displacements) - failure modes (stress allowables) - low cycle fatigue - ageing degradation - support design - nozzle loads (valves) - validation of analytical methods				
8. Load Combination and Acceptance Criteria - time at risk/temporary facilities - justification of ductility - limit load analysis - ageing - anchorages - load path - 1/2 earthquakes - low cycle fatigue				

Table 1 - List of Issues (continued)

Item	Design	Priority*	Re-Evaluation	Priority*
9. Uncertainties - need for margin - need for PSA - seismic PSA/margins - choice <u>PSA issues</u> - hazard - single parameter - spectra - fragility (ground response, different failure modes) - generic versus site/plant specific - validation of analytical methods and data - human factors - uncertainties (random versus modeling) - fire - seismic interactions - spatial interactions - non-seismic facilities <u>Margins</u> - adequate margin (cliff edge) - review level earthquake - scope of systems and components - non seismic events - human factors				

Table 1 - List of Issues (continued)

Item	Design	Priority*	Re-Evaluation	Priority*
10. Plant Seismic Instrumentation and Trip - need for automatic trip versus alarm - exceedance of inspection level earthquake - inspection after earthquake/restart - type of instruments - logic				

*. Priority

1 - High
2 - Medium
3 - Low
NA - Not applicable

FOREIGN TRAVEL TRIP REPORT

WILLIAM S. BROWN, Associate Scientist
(516) 344-7230
Human Factors & Performance Analysis Group
Department of Advanced Technology
BROOKHAVEN NATIONAL LABORATORY

July 3, 1996

Dates of Trip: June 7 - 15, 1996

Destination(s): Halden Reactor Project, Halden, Norway

Statement of Purpose of Trip:

The purpose of this trip was to continue the detailed development of the design of the U.S. Nuclear Regulatory Commission (NRC) experiments on the effects of alarm system design features on human performance. This involved a trip to the Halden Reactor Project in Halden, Norway to meet with the project technical staff and to observe simulation runs being conducted to test the experimental procedures, simulator scenarios, and performance measurement techniques.

Abstract:

In support of Brookhaven National Laboratory research on human factors associated with advanced technology, specifically the "Advanced Alarm System Review Criteria" (FIN W6290) program being conducted for the U.S. Nuclear Regulatory Commission (NRC), a trip was made to Norway on June 7-15, 1996. The purpose of this trip was to prepare for NRC-sponsored experiments on the effects of alarm system design features on human performance. The experiments will be performed at the OECD Halden Reactor Project (HRP) in Halden, Norway using the HAMMLAB simulation facility. Aspects of the experiments that were observed or discussed included the design of test scenarios, methods for performance measurement, and the simulation procedures to be used during the experiments. The objective of the trip was accomplished. The visit to HRP provided an opportunity to identify the information needed to prepare a final revision of the test plan and to discuss issues concerning the upcoming experiments.

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Summary of Activities and Technical Discussions:

The overall purpose of the research is to evaluate the impact of alarm system design characteristics on plant/system and operator performance in order to contribute to the understanding of potential safety issues and to provide data to support the development of design review guidance in these areas. Three alarm system design factors will be evaluated: (1) display type, (2) processing methods, and (3) availability of processing results.

Display type refers to the mode by which alarm information is presented to the operator, e.g., spatially dedicated/permanent displays or some combination of these with alternative VDU-based presentations such as alarm lists and integrated alarm-process display presentations. Alarm processing refers to the alarm analysis that is conducted prior to presentation of data to operators. For the purposes of this study, a variety of the methods will be sampled which focus on near-term alarm system implementation, and therefore, near-term regulatory review considerations. Finally, the availability of alarm processing results will be examined, i.e., the differential effects of dynamic prioritization, suppression, and filtering.

The alarm display and processing conditions will be mainly implemented in the Computerized Alarm System for HAMMLAB (CASH) system. CASH is a very flexible alarm research tool which employs extensive alarm processing capabilities, including control over alarm processing, structuring, and presentation.

The HAMMLAB control room consists of the main control station for the operators and an optional separate supervisor control station, positioned directly behind the main control station. (The supervisor control station will not be used in the alarm experiments). The main control station consists of a U-shaped control desk facing two rows of eight CRT displays, with associated keyboards and trackballs. The compact size of the control room makes oral communication between all crew members easy. The visual contact between operators is also good. The complete control station setup is intended for two operators (reactor and balance of plant); one positioned to the left of the centerline of the control station and the other to the right.

The experiment leader, support staff, subject matter expert, and simulator operator monitor the simulation and the control room operators from an observation gallery located in the back of the control room out of the direct view of the crew.

Scenarios - The draft test plan identified two classes of scenarios, rule-based and knowledge-based, as a method to help control for scenario influences on results. However, ongoing HRP research on a scenario complexity rating system may provide a better approach to dealing with these effects. The approach involves rating scenarios on several factors which have been empirically defined based on variable loadings (derived from a statistical technique called factor analysis). The factors include scenario characteristics such as availability of information, prior experience with and severity of faults, directness of indication, degree of time pressure, and attention required. The details of the use of this approach in the assignment of scenarios to experimental conditions in the alarm study will be worked out in consultation with HRP staff in the coming weeks.

Performance Measurement - The draft test plan specified a broad range of performance measures. HAMMLAB offers a full range of data can be automatically collected including process parameters, operator actions, and simulation event logs. Forms for recording critical operator behaviors that are not automatically logged (e.g., the operators' deciding on a diagnosis or course of action) have been developed for each scenario. Videotaping of scenarios can also be performed. The number and positions of cameras necessary to allow post hoc examination of which displays the operators consulted were discussed. During the test runs, a "stop action" situation awareness assessment technique developed at HRP was refined for use in the alarm experiments. Workload assessment rating scales (using the NASA task load index approach) were also given to the operators during each scenario. The test plan calls for a secondary task to assess the load on working memory. Because such a task has not previously been used at HRP, BNL developed a laptop-based prototype which was adjusted and refined during the tests. HRP staff will integrate a task similar to the prototype into the alarm display system to maximize operator response. Finally, the use of eyetracking as a measure of operator monitoring was examined in the context of the test scenarios. BNL and HRP will consult on whether eye tracking will be used during the actual experiments and, if so, during which scenarios it will be used. In order to minimize discomfort to operators, HRP will not use the eye tracking apparatus for more than 30-40 minutes at a time.

Traveler's Role:

The objectives of the trip were accomplished. The visit to HRP was very productive and provided an opportunity to discuss the issues which must be resolved in order to prepare a final test plan. All aspects of the tests were discussed and technical approaches were developed.

Recommendations Concerning Future or Follow-up Activities:

Continued contact with HRP staff as preparation for the experiment progress.

Security-Related Concerns:

None.

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July 3, 1996

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Destination(s): Halden Reactor Project, Halden, Norway

Itinerary:

June 7	Fri	Depart New York (JFK)
June 8	Sat	Arrived in Oslo, Norway, after airport layover in Amsterdam
June 9	Sun	Travel to Halden, Norway
June 10-14	Mon-Fri	Plant visits to the OECD Halden Reactor Project (HRP) in Halden, Norway Preparations, pilot runs, discussions at HRP for the Alarm Study
June 14	Fri	Debriefing between J.J. Persensky (NRC), HRP personnel, and traveler Travel from Halden to Oslo
June 15	Sat	Travel from Oslo to New York (JFK), with an airport layover in Amsterdam

People Contacted:

Worked primarily with the following Halden Reactor Project technical staff:
- Bård Muom
- Gyrd Skråning

Other HRP staff participating in the testing:
- Asgier Driovoldsmo
- Angelia Seboc
- Ray Saarni (subject matter expert - Loviisa operator/instructor)

Discussed experimental approaches and design issues with:
- Bruce Hallbert (HRP)
- J.J. Persensky (US NRC)

Literature Acquired:

None.