

## Draft Interim Report: Nuclear Safety II Research Group

### 1. Objectives

The Research Group examines the conceptual tasks of communications systems with respect to three issues: safe plant operation and handling, decision-making support for management and operation entities within an organization, and local disaster prevention, focusing on residents in the vicinity of a plant. The Group conducts design and evaluation based on these factors.

### 2. Members

	Name	Affiliations
FY 2001 -2002	Fumiya Tanabe	Chief Research Scientist, Japan Atomic Energy Research Institute (JAERI)
	Hiroyuki Kaiho	Professor, University of Tsukuba
	Sadao Horino	Associate Professor, Kanagawa University
	Hiroyasu Iida	Division Chief, Institute for Science of Labour
	Kazuo Kadota	
	Masao Yokobayashi	Senior Research Scientist, JAERI
	Yukichi Yamaguchi	Section Chief, JAERI
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FY 2003	Fumiya Tanabe	Chief Research Scientist, JAERI
	Yukichi Yamaguchi	Section Chief, JAERI
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### 3. Target Achievements

#### 3-1. Communications systems for safe plant operation and handling

Construction of a conceptual framework for an integrated human-work interface (human-machine interface, operating procedures, education and training methods)

- Construction of a prototype integrated human-work interface
- Establishment of a design methodology for an integrated human-work interface (Drawing up of design guidelines)

#### 3-2. Communications system related to decision-making support for management and operation entities in complex systems

- Identify the current status of modes of transmission of information between those in

charge of management and operations, and between entities involved in management and operations and those engaged onsite in the large-scale complex systems of which nuclear facilities are typical

- Clarification of the various constraints and factors hindering appropriate communications
- Construction of a concept of appropriate communication system

### **3-3. Communications systems for local disaster prevention**

- By means of thorough investigation of past field studies, etc., on the accident-related information received by local residents involved in the JCO criticality accident, and on the means and channels of communicating such information, the specific tasks of the public information system will be clarified from the perspective of science and technology for society.
- The design of the concept of a public information system, the preparation of a prototype, and tests to evaluate the efficacy thereof will be conducted.

## **4. Status and Self-evaluation**

### **4-1. Communications system for safe plant operation and handling (progress rate: 80%)**

As regards the operation and handling of plants such as nuclear facilities, it is important that the intention of the design that was taken into consideration when designing a plant, the meaning and structure of safety regulations and criteria, and the purpose/intentions of the organization and management/handling entities to enable efficient and safe plant operation, are precisely and correctly communicated to those in charge of plant operation and handling. As a prerequisite thereof, the Group proposes a means of explicitly communicating the various constraints that govern technological systems, particularly the tolerable limits for safe operation, and the meaning and structures behind these constraints. In other words, this entails, (1) in the case of the human-work interface (HMI), the construction of a new communications method incorporating functions and the stressing of limitations based on the concept of Ecological Interface Design (EID), (2) the incorporation of function and the attaching of great importance to theoretical education in the case of education and training, as well as (3) the stressing of task-goal linkage in the case of operational procedures.

To date, with a view to evaluating the prospects for implementation of this communication system and its ultimate effectiveness, a mock control room environment was newly constructed, incorporating HMI based on the above-mentioned EID concept,

on a full-scope reactor simulator (simulating a small reactor [PWR type] system generating propulsive power for a nuclear vessel). In addition, simulated operation trials (yielding a total of roughly 120 hours of operation data) were conducted in this environment by specialists with operating experience of this kind of reactor (4 crew, 8 persons), and test data were obtained to evaluate the effectiveness of the system. Furthermore, to enhance the efficiency of analysis of the test data, “tools for re-creating operating conditions” were developed to enable the almost complete reproduction of operating conditions on a computer using a simulator log, operation log, and video recordings of operations from the operation trials. In addition to these efforts, the test data are under ongoing analysis.

Analysis conducted to date has supplied interim findings in the form of the following information:

- It is possible to effectively apply the HMI based on the new EID concept even in the case of operators with ample experience of previous operating environments
- Accommodating the HMI based on the new EID concept is dependent to a large extent on both the operating procedures employed and modes of previous education and training. In particular, operating procedures need to be reorganized into a suitable format for the new HMI
- In the case of operators with limited operating experience, a trend was observed whereby using the HMI based on the EID concept prompted their understanding of the system, suggesting this type of HMI to be useful for education and training purposes
- In addition to the function of “tools for reproducing operating conditions” as tools for analyzing test data, they may also be used as an effective means of training and education

Concerning the application of the EID concept to the vast and complex systems that are nuclear plants, although merely a simulation, since there have been no previous attempts to actually implement it and conduct evaluation trials, the efforts of this Research Group to demonstrate the possibility and efficacy of the implementation of HMI based on the EID concept with respect to actual reactors can be assessed as extremely significant. In fact, the project has come to assume an international dimension, as evidenced by the fact that discussion is under way with Electricité de France (EDF) and the OECD’s Halden Reactor International Cooperation Project concerning specific means of carrying out joint research on the construction of HMI based on this concept. Further, apart from the question of direct application to actual reactors, as regards the education and training of operators, HMI based on the EID concept as constructed under

this project has been shown to be an effective means of promoting understanding of nuclear reactor systems, and as an education and training system, it would make a significant contribution to ensuring safety at nuclear facilities. It is planned to use the HMI and operation environment designed under this project for the training and education of both foreign and domestic people at the JAERI's Nuclear Technology and Education Center (NuTEC).

#### **4-2. Communications system related to decision-making support for management and operation entities in complex systems (progress rate: 40%)**

The aim of the research is to design a favourable communications system concept by first reviewing, with respect to securing the safety of complex systems, the status of communications by management who directly or indirectly govern operations and onsite works, and by clarifying, with respect to securing safety, concepts supporting decision-making at each level of the organization.

Further to such review and understanding of the state of intra-organization communications, it was deemed that analysis of the specific circumstances leading to the outbreak of actual disasters would prove instructive. Consequently, an independent investigation of the JCO criticality accident in 1999 has been conducted by means of a thorough examination and analysis of rules and regulations, operation records, and all other documentation disclosed to date, and the resultant findings provided the basis for participation in surveys and examinations conducted by the Atomic Energy Society of Japan's JCO Accident Survey Committee. The following points have been clarified by means of the analysis conducted to date.

One of the causes of the JCO criticality accident was that workers on the plant floor independently and without any awareness of safety constraints, devised and implemented a revised operation process with the aim of reducing the workload and achieving more efficient manufacture of uranium solution. It has been indicated that it was the equivocal nature of intra-organization communication concerning safety that led to this action.

This provides a new perspective on accident analysis. Further, the weakness of intra-organization communication thus brought to light is not limited to JCO; rather, it would appear to be a latent character common to contemporary complex systems. Accordingly, the further clarification of the problematic aspects of intra-organization communication exposed by the Research Group has enabled the accumulation of knowledge that will prove indispensable to the conceptual formulation of a system where vital safety information is communicated between, and made available to, every

level of the organization, assuming resolution of the indicated problems.

#### **4-3. Communications system for local disaster prevention (progress rate: 10%)**

In addition to the ongoing investigation focusing on documentation already disclosed by previous field studies and the like of accident-related information received by local residents affected by the JCO criticality accident, and of ways and means of communication thereof, computer servers capable of extensive information dissemination have been installed and consolidated at the JAERI Tokai Research Establishment.

Analysis to date has found the following regarding the information received by local residents at the time of the JCO criticality accident.

- Surveys conducted by JAERI Research Groups immediately following the accident found that a considerable amount of time had elapsed before local residents were made fully aware of the gravity of the situation. Other findings raised further questions about the quality of the information communication system.
- The majority of accident-related information was provided by conventional media services such as television, and also by means of the Tokaimura local government's disaster prevention information radio system that had been installed in each household many years prior to the accident.
- Elementary and middle school liaison networks and other channels of information used by residents on a daily basis – channels that were not designed specifically for disaster prevention – played a significant role in information dissemination.

The subject which the Research Group tackled is currently at the initial stage of establishing foundational concepts for disaster prevention communications systems, based on analysis to date. It will be developed into a full-scale research study in and after FY2003.