

# Draft Evaluation Report: Nuclear Safety Research Group I

## 1. Objectives

The objectives of the research project are to construct a structured and systematic ontology of nuclear safety from the many issues pertinent to this field and to establish a foundation for related knowledge to be shared throughout society. Further, the project aims to contribute to the resolution of the problematic aspects of science and technology for society related to nuclear safety by developing design evaluation techniques for organizational and social risk management systems not addressed by previous safety engineering, and by building a store of knowledge for the development of support technologies and risk communication. The project is conducted with the following three ultimate goals:

- (1) Extraction and classification of value standards necessary for the creation of a concept of comprehensive nuclear safety and of technological development agendas,
- (2) Development of technology to evaluate the efficacy of, and of support technology for, organizational risk management and social programs, and
- (3) Submission of proposals on the recommended mode of risk communication for nuclear power.

## 2. Members

Name	Affiliations
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### **3. Target achievements**

#### **3-1. Systemization of nuclear safety and information sharing**

A systematic ontology of nuclear safety is to be constructed by the identification of all pertinent factors and subject fields and by bringing together all relevant foundational concepts. Thereafter, the basic technology needed for information related to nuclear safety to be shared throughout society will be developed.

#### **3-2. Evaluation techniques and support technology for crisis management systems**

Aiming to establish appropriate crisis management systems to enable response to the occurrence of abnormal circumstances, we will develop an emergency behavior simulation system based on a model that regards the operating enterprise, local residents, government official specializing in disaster prevention, local government, central government and other diverse related entities as agent units. The completed simulation system will be disclosed to local governments and other parties near designated nuclear sites.

#### **3-3. The processes of social acceptance and the formation of a social consensus regarding nuclear power**

Information will be obtained by means of social simulations and surveys regarding the dynamics of social acceptance of nuclear power and the formation of organizational culture, as well as regarding the cognitive structures and other factors influencing these dynamics. Based on a model of the formation of a social consensus, technology to actively support the process of the formation of a social consensus will be developed by applying information-communications technology. An environment that supports the formation of a social consensus will also be developed, and these developments will be disclosed.

#### **3-4. Social acceptance of the safe disposal of radioactive waste**

Regarding the various concepts related to the disposal of radioactive waste from the perspective of social acceptance, comparative surveys will be carried out on overseas programs related to phased disposal and feasibility of waste recovery, and proposals will be submitted concerning a disposal plan for Japan. Further, websites accessible by the public will be opened and maintained with a view to supporting the formation of a social consensus concerning the disposal plan.

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

##### **4-1. Systemization of nuclear safety and information sharing (progress rate: 50%)**

(1) Development of ontological authoring tools

Regarding problems in the construction of a basic conceptual system for the field of nuclear power as being problems with the construction of the ontology thereof, tools to support the construction of the ontology were developed and their efficacy confirmed.

(2) Construction of an ontology for nuclear safety

Using, as a reference, publications, handbooks, guidelines and criteria for safety regulations, and classifications of academic societies' domains, we investigated the existing systems of conceptual classification for nuclear safety and showed that the majority were specific to the facility in question, specialist scientific domains, or a combination thereof. Further, by comparison with classifications used in the field of general safety, consideration of system safety, and consultation with safety experts, an ontology of nuclear safety was constructed that encompasses a broad spectrum of subject domains related to safety. This is expected to provide the basis for non-specialist understanding of basic safety principles.

(3) Development of sector-specialized information search engines

To realize document search support on the Internet similar to that of a librarian in a library, we developed a system that conducts searches of documents related to the user's interest area by making use of this ontology, and have completed installing the search engine component.

##### **4-2. Evaluation techniques and support technology for crisis management systems (progress rate: 50%)**

(1) Simulation system for organizational behaviors in emergency situations

A simulation system for human and organizational emergency response to nuclear disaster was developed. As a model for emergency responses/behaviors, the nuclear disaster prevention training scenario in Ibaraki prefecture in FY2001 was adopted, and a simulation was carried out using this system. As a result, it was confirmed that it would be possible to re-create emergency response/behavior through the application of this system and that it was possible to clearly demonstrate the particulars of the emergency responses/behaviors by using viewers.

(2) Qualitative models for the behavior of local residents in emergency situations

To investigate the behavioral characteristics of local residents in the event of a

nuclear power disaster, we conducted case study analyses of the literature concerning 57 natural disasters and common accidents, identified the thinking and behavior of local residents in emergency situations, and, by so doing, identified and classified the factors that influenced their behavior. These findings were used to construct a qualitative model for the behavior of local residents in the event of a nuclear power disaster. The model is comprised of 3 stages, namely information input, situation assessment, and decision-making.

#### **4-3. The processes leading to social acceptance and the formation of a social consensus regarding nuclear power (progress rate: 40%)**

##### **(1) Cognitive structure of social acceptance of nuclear power**

The extent to which conclusions differ according to the area of residence and level of knowledge of nuclear power when people make judgments on issues related to social acceptance of nuclear power was analyzed. To be more precise, questionnaire surveys on nuclear power were conducted in 3 electricity consuming regions and 2 electric power supply regions; the collected data was classified according to the respondent's place of residence and level of knowledge; and the factors influencing responses to "the pros and cons of nuclear power policy" and "attitudes toward the location of nuclear power stations" in each category were compared. As a result, it was evident that in both cases, the factors influencing judgment differed according to the respondent's place of residence, and it was shown, moreover, that the difference was not affected by level of knowledge.

##### **(2) Dynamics of public opinion formation regarding acceptance of nuclear power**

The process of the formation of public opinion on nuclear power was taken to comprise a process of acknowledgment, exchange, and dissemination of information about nuclear power by the public, which process was formulated as a multi-agent model. Following this, a simulation analysis was conducted on the influence of such factors as the structure of social networks, individual cognitive mental effects, and media characteristics, on the macro-level distribution of public opinion on nuclear power. As a result of consideration of exchanges of opinions among the general public and the influence of the communities to which people belong, a steady state regarding a favorable public image of nuclear power was achieved at the macro level. Further, it was observed that the greater the degree of an individual's network cohesion, the smaller the influence from the community to which the individual belonged, and that individuals with a similarly favorable image of nuclear power tended to cluster together. If these effects were incorporated, there was a tendency for

the overall favorable image of nuclear power to not get mixed together with other images. We therefore confirmed that it is possible to re-create the cognitive psychological effects pointed out by Slovic *et al.*

(3) Conceptual model of the formation process of a social consensus

Protocol analysis utilizing the concept of a statement schema was conducted on the transcripts of three actual government committee meetings, demonstrating that the use of the consultation space expressed in the means-end stratum was effective in understanding the process of formation of a social consensus. Comparing the divergent findings from the analyses of the case examples, patterns common to the process of formation of a social consensus were identified and a model of the process of formation of a social consensus constructed. This type of model is expected to provide a basis for the development of methods to support the efficient formation of a social consensus.

(4) Electronic conferencing systems equipped with visualization functions and intellectual support functions

To enhance the understanding of remarks made by participants and conference proceedings when electronic conferencing is used in the formation of a social consensus, and also to support the smooth formation of a social consensus, an electronic conferencing system incorporating various support functions was developed. Firstly, we proposed an opinion space as a conference model and developed PODS, a system for conducting conferences while displaying the participants' standpoints/positions on the interface by using this opinion space. The results of a trial conference confirmed the efficacy of this method in terms of promoting mutual understanding of participants' positions/standpoints. Thereafter, based on the specific features of the transcripts, we proposed methods for summarizing the contents according to topic area, methods of identifying topics representing the interests of each speaker by means of key words, and methods of identifying topics by clustering co-occurrent word graphs, and created the TSS electronic conferencing system featuring the ability to present conference topics and summaries to conference participants. We confirmed that this system was an effective method of automatic summarization of conference minutes, in that, compared to the present summarization systems, its results were closer to important evaluated documents drawn up by test subjects.

**4-4.Social acceptance of the safe disposal of radioactive waste (progress rate: 30%)**

(1) Examination of a phased approach

We investigated the views of overseas parties regarding the process featuring a phased approach capable of promoting public understanding concerning the geological disposal of high-level radioactive waste and, based on the public comprehension thereof, studied the possibility of its application to Japan. As a result, we found that open communication was important, and that, while the direct application of processes used abroad would probably be impossible, much of what was learnt would prove valuable for future reference.

#### (2) Designing a participatory performance evaluation system

Through surveys of current websites that publicize technological content in other fields, and interviews with test users, the following three points were identified as prerequisites to the system: consideration of appropriate content; an appropriate means of visualization for a variety of information and data; and methods to present archived records of consultations conducted via the Internet and of operations. We then designed a system to be constructed based on these factors.

#### **4-5. Self-evaluation of achievements**

This research project studied society-wide access to safety information, design of crisis management systems, social acceptance of nuclear power and the formation of a social consensus, and social acceptance of waste disposal. Achievements to date include the gaining of foundational knowledge, as well as the development of design evaluation technology and support technology and the laying of the groundwork for society-wide implementation of comprehensive risk management. By hereafter completing and integrating the constituent technologies and expediting their implementation in society, we believe that the project's initial objectives can be achieved.

In addition, one significant achievement has been the advancement of the universalization of concepts and technologies both applied from other fields and cultivated within the domain of nuclear power by means of exchange of opinions with representatives of other fields in this mission program. Confirmation of the presence of divergent views on safety between other industries, the human and social sciences, and previous thinking on nuclear safety proved extremely valuable with respect to the construction of an ontology of nuclear safety. It became clear that many issues in the fields of chemical process safety and seismic disaster prevention correspond to those in nuclear safety and nuclear disaster prevention; that issues previously thought specific to nuclear power could provide typical research cases to the legal systems, socio-psychology and failure study groups; and, to put it another way, that the solutions devised by these other fields would prove effective in promoting nuclear safety. The

confirmation that a) nuclear safety is not at all a special case isolated from other spheres of safety and that b) it should be regarded as integral to the concept of general safety, both validate the significance of having conducted this nuclear safety research project as an integral part of the overall mission program.