CSNI ACTIVITIES IN KNOWLEDGE MANAGEMENT AND KNOWLEDGE TRANSFER - AN INTERNATIONAL DIMENSION

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Abstract. The Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency (NEA) was set up in 1973 to develop and to co-ordinate the activities of the NEA concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations. Although there is currently no formal "CSNI knowledge management strategy", i.e. defined CSNI approach and the appropriate resources for activities related to knowledge management as such, the CSNI has been actively involved during its 30 years of existence in a number of areas closely linked with knowledge management. The paper gives a number of specific examples of various CSNI activities which, all together, represent from an international perspective a significant contribution to knowledge management efforts at the national level of the OECD/NEA member countries.

1. Introduction

By the term "CSNI Knowledge Management", it is further understood the ***sharing, generation, distribution and preservation*** of nuclear safety knowledge and expertise through its permanent working groups, special expert groups, ad-hoc expert groups and joint research projects. Though the term "knowledge" may have wider contents, for the purpose of this paper it refers to all kinds of scientific and technical information and data handled in CSNI documents.

The Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency was set up in 1973 to develop and co-ordinate the activities of the NEA concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations. The Committee's purpose is to foster international co-operation in nuclear safety amongst the OECD Member countries. The CSNI's main tasks are :

- to exchange technical information and to promote collaboration between research, development, engineering and regulation organisations;
- to review the state of knowledge on selected topics of nuclear safety technology and safety assessments, including operating experience;
- to initiate and conduct programmes to overcome discrepancies, and develop improvements and reach consensus on technical issues;
- to promote co-ordination of work, including the establishment of joint undertakings.

The technical fields of nuclear safety in which the CSNI is currently actively involved are grouped broadly into four Working Groups (WG) and two Special Expert Groups (SEG):

- Operating Experience and Human Factors (WGOE) and its subgroup on Fuel Cycle Safety
- Integrity and Ageing of Components and Structures (IAGE)
- Analysis and Management of Accidents (GAMA)
- Risk Assessment (WGRisk)
- Fuel Safety Margins (SEGFSM)
- Human and Organisational Factors (SEGHOF).

In order to deal with issues of particular importance and complexity, and for limited periods of time, a Task Group on a Safety Margins Action Plan (SMAP) and a Senior Group of Experts on Nuclear Safety Research - Support Facilities for Existing and Advanced Reactors (SESAR/SFEAR) was recently established.
In addition, there is a number of joint research projects under the auspices of the CSNI.
Their brief characteristics will be given below.
Although there is currently no formal "CSNI knowledge management strategy", i.e. defined CSNI approach and the appropriate resources for activities related to the generation, sharing, distribution and preservation of nuclear safety knowledge and expertise, the CSNI has been actively involved in each of these areas during its 30 years of existence.

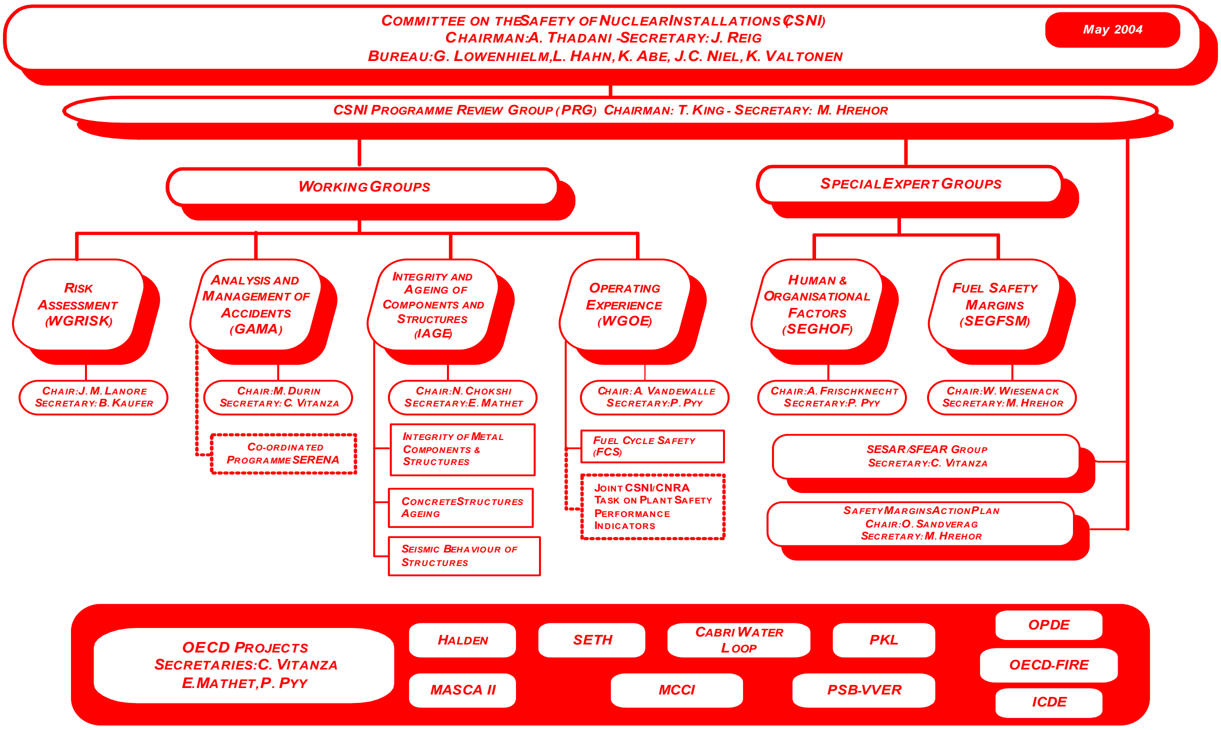

FIG. 1 Structure of the CSNI

2. Knowledge sharing

Reviewing the state of knowledge on selected topics of nuclear safety technology and safety assessment, including operating experience of NPPs, with the aim to identify gaps and future research needs, is one of the main functions of the CSNI. For this, the CSNI organizes every year a number of ***workshops and topical meetings*** on various topics which provide an efficient forum for experts of Member countries to discuss issues of mutual concern and to arrive at consensus views and conclusions.
As an example, the following expert meetings were held in recent years:

- Redefinition of Large Break LOCA
- Building the New Human reliability Analysis
- Advanced Nuclear Reactor Safety Issues and Research Needs
- Passive System Reliability
- Recurring events
- Safety Management
- Concrete Behaviour

- Topical Meetings on LOCA and RIA (Reactivity Initiated Accidents) Fuel Issues Workshop on the Development and Use of Risk Monitors, etc.

Important facets of the CSNI's work involve analysing, interpreting, understanding and summarising existing knowledge coming from various sources. International technical consensus on major topics is materialised through the preparation of the ***State-of-the-Art Reports (SOAR) and Technical Opinion Papers (TOP)***. These "situation reports" bring together the latest developments in a given area or give a "snapshot picture" of the international situation regarding a particular issue, stimulate the formation of common understanding, and provide a source of up-to-date information for those countries that may not have an activity in the area. Below are some examples of recent CSNI SOARs and TOPs:

- SOAR on Containment of Thermal-hydraulics and Hydrogen Distribution
- SOAR on the Current status of Methodologies for Seismic PSA
- SOAR on Boiling Water Reactor Stability

SOAR on Identification and Assessment of Organizational Factors Related to the Safety of NPPs

- SOAR on Fire Risk Analysis, Fire Simulation, Fire Spreading and Impact of Smoke and Heat on Instrumentation Electronics
- Topical Opinion Paper: Apparent Discrepancies Between Nuclear and Conventional Seismic Standards
- Technical Opinion Paper on Fuel-Coolant Interaction
- Topical Opinion Paper: Human Reliability Analysis in Probabilistic Safety Assessment for Nuclear Power Plants
- Technical Opinion Paper on Fire Probabilistic Safety Assessment for NPPs
- Technical Opinion Paper on Seismic Probabilistic Safety Assessment for Nuclear Facilities.

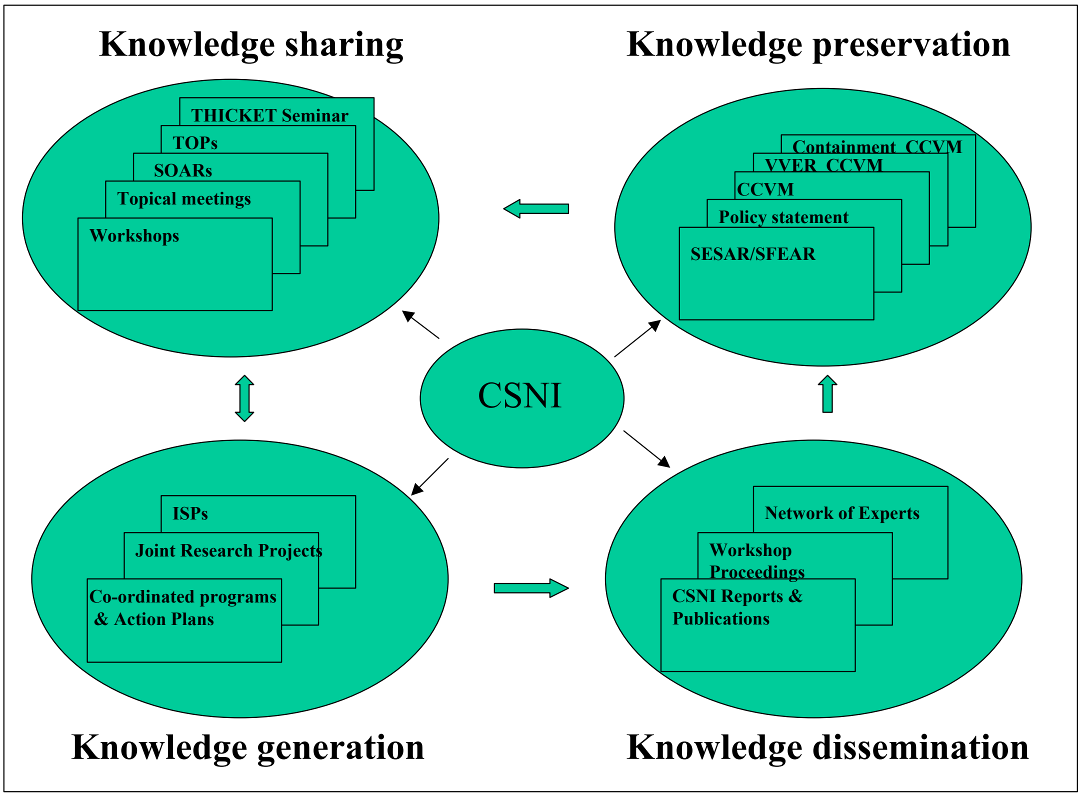

FIG. 2 The CSNI involvement in the knowledge management

A special part of knowledge sharing is its organized transfer to the young generation. Many prominent experts involved in the CSNI's activities are close to retirement; some are moving to non-nuclear activities. Their knowledge and experience should be transferred to younger specialists. With this objective, the CSNI organized its first Seminar in June 2004 on the Transfer of Competence, Knowledge and Experience Gained Through CSNI Activities in the Field of Thermal-Hydraulics (THICKET-2004). The audience was composed of a wide community of nuclear safety specialists unfamiliar with CSNI's activities, and newcomers in the field (advanced beginners). The lecturers were recognized experts who have been associated with CSNI programmes over a long period of time. It is planned that this transfer of knowledge will continue in other technical disciplines as well, such as structural integrity, fuel safety, etc.

3. Knowledge generation

3.1. *Co-ordinated Programmes and Action Plans*

In cases where there is a gap in knowledge which requires additional "development" effort, a special ***Co-ordinated Programme or an Action Plan*** is set up by the CSNI to investigate particular complex issues. Recent examples include the BEMUSE (Best-Estimate Methods – Uncertainty and Sensitivity Evaluation) Co-ordinated Programme and the Integrated Assessment Safety Margins Action Plan (SMAP).

3.2. OECD/NEA Joint Research Projects

Another very successful way to acquire knowledge and development is through the establishment of ***Joint Research Projects.*** The OECD/NEA joint research projects enable interested countries, on a cost-sharing basis, to pursue research or obtain data with respect to particular areas or problems. The projects are carried out under separate agreements signed by participating countries or organizations. The following joint research projects are currently ongoing:

The Halden Reactor Project

The programme of work in the fuel and materials area includes fuel assessments in the high and very high burnup ranges (both at normal operating conditions and in transients) and embrittlement and cracking behaviour of internal reactor materials. These investigations are carried out under representative reactor conditions using advanced instrumentation. The key programme areas are:

- *fuel high burnup capabilities in normal operating conditions;*
- *fuel response to transients;*
- *fuel reliability issues;*
- *plant lifetime assessments (reliability of internals).*

The CABRI Project

The CABRI Water Loop Project, located in Cadarache (France), is investigating the ability of high burn-up fuel to withstand the sharp power peaks that can occur in power reactors due to rapid reactivity insertion in the core (RIA accidents). It involves substantial facility modifications and upgrades, including the construction of a water loop substituting the present sodium loop. The programme consists of 12 experiments to be performed with fuel retrieved from power reactors and re-fabricated to suitable length. The project began in the year 2000 and will run for eight years.

The MASCA 2 Project

The MASCA 2 project started on July 1, 2003 and will cover a period of three years. Thirteen countries are participating in the effort. The RRC Kurchatov Institute, in Moscow (Russia), is the Operating Agent. The project consists of a series of experiments to provide experimental data on the convective molten pool of prototypic core melt materials. The tests aim to provide important insights on the phase equilibrium for different corium mixture compositions that *can occur in water reactors; this phase equilibrium determines the configuration of materials in the case of stratified pools and thus the thermal loads on the vessel. In order to enhance the applicability of MASCA results to reactor cases, the influence of an oxidising atmosphere and the impact of non-uniform temperatures (presence of crusts or solid debris) will be addressed in addition to scaling effects. The programme is also intended to generate data on relevant physical properties of mixtures and alloys (liquidus and solidus temperatures, boundaries of miscibility gap, density, thermal conductivity, viscosity), which are important for the development of qualified mechanistic models.*

The MCCI Project

The objective of the Melt Coolability and Concrete Interaction (MCCI) Project is to provide experimental data on relevant severe accident phenomena and to resolve two important accident management issues. The first one concerns the verification that the molten debris that has spread on the base of the containment can be stabilised and cooled by water flooding from the top. The second issue concerns the two-dimensional, long-term interaction of the molten mass with the concrete structure of the containment, as the kinetics of such interaction is essential for assessment of the consequences of a severe accident.

The programme utilises the unique expertise and infrastructure that have been developed at Argonne National Laboratories (ANL), USA, insofar as conducting large scale, high-temperature reactor materials experiments. The USNRC is acting as Programme Manager organisation. The Project started at beginning of 2002 and will continue for a period of four years. Three separate-effect tests were run in 2002, and two more in 2003, aiming to verify if water ingress into the melt crust is a viable cooling mechanism. The MCCI Project involves organisations from 12 Member countries.

The SETH Project

The SETH Project covers two aspects of accident management, i.e.:

- countermeasures for two types of accidents in PWR's, to be investigated at the PKL/Framatome-ANP facility in Erlangen, Germany.
- gas flow distributions relevant for reactor containments (with focus on simulated hydrogen distribution), to be done at the PANDA facility at the PSI establishment near Zurich, Switzerland.

The Framatome/PKL tests investigate boron dilution accidents that can occur in a LOCA sequence or during mid-loop operation (shutdown conditions). In particular, the first category of tests verifies if conditions can arise for core reactivity insertion due to boron dilution during a small-break LOCA and with natural circulation restart. The second test series is to assess boron dilution that can occur as a consequence of loss of heat removal in mid-loop operation conditions. Four tests have been carried out as contemplated in the programme. They indicated that boron dilution can occur under some conditions.

The PSI/PANDA experiments are carried out to provide data on containment three-dimensional gas flow and distribution issues that are important for code prediction capability improvements, accident management and design of mitigating measures. The experiments also aim to provide data suitable for the improvement and validation of safety analysis codes. The discussions so far have focussed on the test matrix and on the optimal way of utilising the test facility and instrumentation. The Project is composed of 15 Member countries and will last until mid 2005.

The PSB-VVER Project

The objective of this Project, located in Electrogorsk (Russia), is to provide additional experimental data relevant for the validation of safety codes in the field of VVER-1000 thermal-hydraulics. The intended project work consists of five PSB-VVER experiments addressing:

- Scaling effects
- Natural circulation
- Small cold leg break LOCA
- Primary to secondary leak
- 100% double-ended cold leg break (indicative, actual size to be agreed upon).

Extensive pre- and post-test analyses are to accompany the experimental programme throughout the entire experimental series. The five PSB-VVER experiments and the related analytical work are to be carried out during a time period of four years. The Project started in 2003 and will last until the end of 2006.

ICDE Project

The International Common Cause Data Exchange (ICDE) Project is envisioned as including all possible events of interest, comprising complete, partial and incipient CCF events. The project currently covers the key components of the main safety systems, like centrifugal pumps, diesel generators, motor-operated valves, power-operated relief valves, safety relief valves, check valves, reactor protection system circuit breakers, batteries and transmitters. These components have been selected because several probabilistic safety assessments have identified them as major risk contributors in the case of common cause failures.

OPDE Project

The OECD Piping Failure Data Exchange (OPDE) Project started in May 2002 with 11 Member countries. It is run along the same lines as the ICDE project. It collects quality-controlled information on piping failure and is detailed enough to fulfil the needs of various applications (PRA, mechanical engineering, etc.).

OECD-FIRE Project

The OECD Fire Incident Records Exchange (OECD-FIRE) Project is an international database on fire events.

3.3 International Standard Problems

Although the use of available nuclear safety knowledge is the exclusive responsibility of the NEA member countries, since its beginning, the CSNI has been aware of the importance of the practical validation and verification of sophisticated analytical safety assessment tools such as computer system codes used in safety analysis. With the objective of helping code developers and code users, since the the early seventies the CSNI has been organizing so called ***International Standard Problems (ISP)*** exercises or comparative benchmarks in which predictions of different best-estimate computer codes for a given physical problem are compared with each other or with the results of a carefully specified experimental study. In total, 47 ISPs have been held during the whole history of the CSNI. A list of all the ISPs can be found in the CSNI report " CSNI International Standard Problems (ISP): Brief Descriptions (1975-1999)" (NEA/CSNI/R(2000)5). Among the recently completed ISPs, the following examples can be mentioned:

ISP 44 - based on the KAEVER aerosol depletion tests

(to demonstrate the capability of current computer codes to model and to calculate the aerosol distribution and settlement in containment)

ISP 45 - based on QUENCH-06 tests

(to investigate fuel rod bundle behavior up to and during reflood/quench conditions)

ISP 46 based on experiment Phebus FPT1

(to assess the capability of computer codes to model in an integrated way the physical processes taking place during a severe accident in a pressurised water reactor)

ISP-47 - ISP on Containment Thermal-Hydraulics

(to demonstrate the actual capability of CFD-codes and 'lumped parameter' codes in the field of containment thermal hydraulics, e.g. to predict hydrogen distribution under LOCA conditions)

All these ISPs have helped to increase the confidence in the use of available knowledge and validity and accuracy of tools which are used in safety assessment applications. These comparative exercises also helped to identify potential negative "user effects", which in some particular cases lead to misleading results and conclusions.

4. Knowledge dissemination

In addition to the already mentioned SOARs and TOPs, typical CSNI products include technical reports, workshop/seminar proceedings and special publications. These products are obviously documenting a specific task(s) completed by WGs or their task groups addressing specific nuclear safety and regulatory issues. A number of CSNI reports published yearly is quite high - approx. 20 - 30. Most of the reports are available free via internet through the CSNI web page.

The CSNI realizes how important it is to know "what is known", where is the availability of the knowledge/expertise and "who should be aware of it", so as to be able to make maximum use of the existing knowledge. In order to disseminate existing knowledge and to facilitate its access, the CSNI has established and continues to maintain, around existing permanent working groups, a network of experts covering areas such as operating experience, integrity and ageing of components and structures , analysis and management of accidents, risk assessment, fuel safety and human and organizational factors. Thus, the intended audience of the main CSNI products includes not only members of the relevant WGs but also the groups of experts belonging to the relevant WGs and other technical specialists.

Recently, in connection with the assessment of the CSNI Strategic Plan 2000 - 2004, the CSNI has realized, that dissemination and the visibility of the CSNI outcomes needs to be improved. Thus a new communication policy is under preparation as a part of the new CSNI Operating Plan 2005-2009.

5. Knowledge preservation

It is critical for the safe operation of existing NPPs that necessary research capabilities including experimental facilities are maintained and the knowledge gained is preserved in order to respond timely to new potential safety issues. However, there is an evident trend in recent years in gradual significant reduction of funding of nuclear safety research in many NEA member countries, which has taken place over the last few years. In this connection, the CSNI has repeatedly expressed in a number of its collective opinion statements such as:

- Collective Statement on Major Nuclear Safety Research Facilities and Programmes at Risk
- Collective Statement on the Role of Research in a Regulatory Context
- Collective Statement Concerning Nuclear Safety Research: Good Practice and Closure Criteria
- Collective Statement Concerning Nuclear Safety Research: Capabilities and Expertise in Support of Efficient and Effective Regulation of NPPs,

that concerns and warnings that dwindling budgets and support, as well as stagnant programmes, may lead to the untimely shutdown of experimental facilities and the breaking up of experienced research teams. Of particular concern is the direct loss of a highly competent technical workforce and existing safety knowledge.

The long-term involvement of the CSNI in maintaining adequate research capabilities, competencies which are indispensable parts of knowledge preservation can be demonstrated by the work of its Senior Group of Experts on Safety Research (SESAR) which had issued several publications addressing these issues, the most recent one on ***"Nuclear Safety***

Research in OECD Countries: Major Facilities and Programmes at Risk". Recently, the SESAR was reestablished with the aim to analyze the potential use of the existing experimental base and knowledge and advice on their use for development of advanced reactor designs (SESAR/SFEAR).

Data preservation is a subset of knowledge management. A substantial quantity of data and information exists related to reactor safety, but it resides in different organizations and countries and in diverse formats. The CSNI recently endorsed a ***Policy Statement on Data Preservation*** with the aim to establish the relative importance of data preservation in the overall context of maintaining competence and knowledge. Another activity closely related to the ISP programme is the establishment of comprehensive sets of experimental data for use in validating proper code application by experts other than the code developers. Known as the ***CSNI Code Validation Matrix (Integral tests, Separate Effect Tests, VVER)***, the results of an extensive list of selected experiments are collected and stored in the NEA Data Bank so that can they be made available to Member countries wishing to validate relevant codes. Currently, a ***Phenomena-Based Validation Matrix for Ex-Vessel (Containment) Models and Codes*** is under preparation by the WG on Analysis and Management of Accidents (WGAMA).

6. NEA Strategy for Knowledge Management

The new NEA Strategic Plan 2005-2009 recognises the concerns and challenges of knowledge management and includes this subject as a horizontal cross-cutting activity. The NEA, through its Standing Technical Committees, including the CSNI, is well suited to provide a forum for:

- sharing information and member countries' practices and experience on nuclear knowledge management
- identifying information from past NEA activities that needs to be preserved and developing new initiatives for knowledge management of nuclear information including preservation of data generated by NEA activities.

The identification and analysis of available knowledge assets and the related processes, along with the subsequent planning and actions by all the NEA Standing Committees to develop both the assets and the processes are key factors to successfully fulfilling the NEA mission in the period 2005 - 2009.