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REVIEW OF THE INTERNATIONAL CONFERENCE ON NUCLEAR CRITICALITY—ISSUES, DISCUSSIONS, AND CHALLENGES

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INTRODUCTION

The Fifth International Conference on Nuclear Criticality Safety (ICNC'95) was held September 17-22, 1995, in Albuquerque, New Mexico, USA. Organization and support for the conference was provided by the Sandia National Laboratories (SNL), Los Alamos National Laboratory (LANL), the University of New Mexico, and the Organization for Economic Cooperation and Development (OECD). This conference traces its history back to 1981 when a group of select criticality safety specialists (mostly experimentalists) from France, Germany, Japan, the United Kingdom, and the United States participated in a small conference at LANL in the United States. The motivation for the conference had been provided by Dr. J. C. Manaranche of France who had asked D. Smith and G. E. Whitesides of the United States if it would be possible for the French experimentalists to be able to visit the experimental facilities at LANL. This first conference was followed by a similar conference held in Dijon, France, in 1983. Then in 1987 the conference was hosted by the Japanese and opened to much wider participation by criticality safety specialists involved in experiments, methods development and analysis, and operations. With the 1987 conference in Japan and the fourth conference (ICNC'91) held in the United Kingdom, the interest and international participation by the criticality safety community has grown rapidly. With this background, the occasion of ICNC'95 was one of much expectation.

THEME AND SPECIAL SESSIONS

The conference focused on the theme, "A Half Century of Nuclear Criticality Safety," with special sessions that provided a historical perspective on the technical accomplishments of the last fifty years. The first of these special sessions was the Pioneers Session held on Sunday evening and featuring speakers from France (P. Lecorche), the United Kingdom (C. Chatburn), Japan (R. Kiyose), and the United States (D. Callihan). These speakers provided a perspective on the origins and directions of criticality safety practice over the last fifty years. The presentations served to highlight the "pillars" of criticality safety: experiment, computation, and practical application.

The pioneers indicated the importance of early experiments to help understand the physics of particle interaction in fissile material systems and to provide data and prototypic demonstration for handling and production processes. Early analyses were simple (in view of today's high-speed computations) processes to aid the experimentalist in the design of a new system or aid in transitioning the narrow gap from the experimental data to the production environment. Analyses have grown increasingly complex as computer programs have evolved to model detailed geometries and simulate the physics of particle interaction. The criticality safety specialists responsible for design or operation of a facility, system, or process must use the data obtained

from experiment or computation as tools to help ensure a safe environment. Similarly, the experimentalist and the analyst (or code developer) should be mindful of the needs and concerns of the practitioner as experiments are designed, methods and data are revised, and analyses are performed. The Pioneer Session left one with a keen sense that these pillars (or areas) of criticality safety must be appropriately considered, and if any one pillar is relied on too heavily, then safety may be compromised. One definitive concern in this regard was the decline in the number of critical experiments being performed. Another resounding theme from the pioneers was the fear that safety could be compromised under the weight of the additional documentation needed to justify or perform an experiment, defend the validity of a code or data library, and prepare a safety assessment. The concern is that the criticality safety community (and the approving management) will get so involved in completing or overcoming required documentation that important work may be left undone or the understanding of safety concepts may be lost.

The ICNC conference in the United Kingdom in 1991 was the first time that there were participants from the former Soviet Union. This participation was greatly increased at ICNC'95 and was tied into the theme of "A Half Century of Nuclear Criticality Safety" by having a plenary session of Russian speakers who highlighted the history and achievements related to criticality safety in the former Soviet Union. The speakers represented the four major nuclear research facilities in Russia: Kurchatov, Arzamas-16, Institute of Physics and Power Engineering (IPPE) at Obninsk, and Chelyabinsk. The presentations demonstrated the willingness of the Russians to share their data and experiences with the rest of the world. One of the major discussion topics among attendees of ICNC'95 was the availability of an extensive amount of new and expanded experimental information that has practical applications to fissile material operations that are ongoing or planned throughout the world. Of particular interest in the area of experiences was the paper from IPPE entitled "A Review of Criticality Accidents Which Occurred in the Russian Industry." This paper briefly discussed 12 criticality accidents and their consequences, none of which had been widely available in the literature. The accidents reported in the paper covered a wide range of initiating events and fissile material. More technical details on these accidents will surely benefit the ongoing worldwide work to better simulate accidents and predict their consequences.

GENERAL TECHNICAL PROGRAM

The ICNC'95 conference had 288 attendees from 15 countries. The technical committee reviewed and accepted 145 papers: 59 from the United States, 25 from the United Kingdom, 19 from Japan, 18 from Russia, 14 from France, and 10 from other participating countries. The papers were presented in both oral and poster sessions over a four-day period. Table 1 provides a listing of the technical sessions for ICNC'95. Each of the "pillar" areas of criticality safety discussed above were represented by a wide range of papers. Discussions on the papers and various general issues were facilitated by the fact that the attendees were together daily to share breakfast and lunch in an informal collegial atmosphere.

Even with the decline in experimental programs in many countries, there were a number of papers that discussed new and planned critical experiments. The first experimental results from the Static Experimental Critical Facility (STACY) in Japan were reported by Y. Miyoshi of the Japan

Table 1. Titles of technical sessions at ICNC'95

Session	Session Title
1A	Current NCS Issues
1B	Burnup Credit , National Programs
2	Data and Validation
3	Codes
4	Overviews of Programs & Facilities
5	Burnup Credit
6	Codes, Data & Benchmarks
7	PRA & Safety
8	NCS Case Studies
9	Standards, Data & Training
10	Solutions, Accidents & Transients
11	Case Studies, Experiments, and Safety
12	Mixed Oxide NCS
13	Emergency Planning and Experiments

Atomic Energy Research Institute. The Russians and French reported on their ongoing critical experiment programs, while the U.S. papers concentrated mostly on needs and plans for future experiments. A paper by B. Briggs of the United States discussed a collaborative project sponsored by the U. S. Department of Energy (DOE) and the Organization for Economic Cooperation and Development (OECD) that is seeking to create an international data base of evaluated, well-characterized critical experiments that have been performed throughout the world over the last fifty years. This effort is expected to continue for several years. There were a number of papers from Japan and the United States on subcritical measurements and subcritical techniques in general. The papers indicate that these techniques are being considered and applied to help address a number of criticality safety issues related to production processes, storage, and handling of fissile material. J. Mihalczo and T. Valentine of the United States also had papers that discussed the potential for these techniques to be used to help validate codes and identify cross-section data deficiencies. The papers and discussions at ICNC'95 indicate that the criticality safety community still highly values critical experiment data. This is exemplified by the efforts being put forth to retain existing data in easily-accessed data bases, the enthusiasm over the new NUCEF facility in Japan, the availability of new data from Russia, and the continued efforts to apply subcritical techniques.

New enhancements to codes and data used for criticality safety analysis were presented. In particular, enhancements and validation experience with the SCALE/KENO, MCNP, and MONK codes were discussed in several papers. Validation of a new multigroup Monte Carlo code from France called TRIMARAN2 was also presented. Unlike previous conferences, there were some extensive presentations and discussions on nuclear data for criticality safety analyses. Some new libraries derived from JEF and ENDF/B-VI were presented. There seems to be a renewed interest

to better understand the effect of different nuclear data evaluations and processing methods on k_{eff} of applications that have not been well characterized (e.g., intermediate energy spectra).

The application of criticality safety data and principles to storage, transport, fabrication processes, disposition, and reprocessing areas were provided in an array of papers throughout the conference. At least two papers from the United Kingdom provided a perspective of the certification authorities towards criticality safety. One important contribution to the conference was the announcement that the Nuclear Criticality Safety Handbook of Japan was available in an English translation. Available copies of the Handbook were picked up quickly by attendees.

A definite trend in operational issues is the increased effort to defend assumptions, operational parameters, and personnel qualifications. This trend is causing increased emphasis to formalize operational guidelines and personnel training. Although the use of probabilistic risk analysis (PRA) methods was mentioned in several papers as a means to help defend operational assumptions, the general use of the method does not yet appear to be readily accepted by the community, except on an "as-needed" basis.

One application that provided a focus for the experiment, analysis, and operations areas was burnup credit (i.e., taking credit in the criticality safety evaluation for the reactivity loss due to depletion of spent fuel). Use of burnup credit requires that those spent fuel isotopics which ensure a bounding k_{eff} be used in the safety analysis. Special operational controls are needed to provide assurance that the fuel has sufficient burnup for the approved application. The lack of critical experiments with spent fuel continues to raise a number of questions relative to code and data validation. All of these areas of burnup credit were reviewed in papers from France, Japan, the United Kingdom, and the United States. Experiments to help validate fission-product cross sections in a spent fuel environment have been performed in the United Kingdom and France. Isotopic validation was the subject of papers from the United States, Japan, France and the United Kingdom. A data base of spent fuel isotopics called SFCOMPO is being developed in Japan. A spent fuel critical experiment planned in the United States was presented. Analysis issues associated with validation and demonstration of accurate, yet bounding, methods were presented by the United States and the United Kingdom. The papers indicate that burnup credit is a new and challenging area for criticality safety specialists, and issue resolution has reached the point that the method can be considered for licensing applications. (The Japanese have had burnup credit accepted for use in their new reprocessing plant that is under construction, and the French are applying actinide-only burnup credit in transportation of spent fuel.)

CHALLENGES

The ICNC'95 conference provided a useful "snapshot" of the state of the worldwide criticality safety community and the vital issues of interest. A review of the papers indicates several challenges that lie ahead in the coming years. In particular, the criticality safety community will be challenged to:

1. ensure effective and safe implementation of burnup credit,

2. facilitate acquisition and dissemination of the existing Russian data and experience,

3. consider and effectively apply PRA as appropriate,

4. continue reliance on effective linking of experiments, computations, and experience even as pressure mounts to rely more heavily on computations and formality of operations, and

5. improve routes for exchange of measured data, computational software, and experience.

These areas are challenges that the criticality safety community will be addressing between now and the next ICNC meeting that will be held in France in 1999. The authors are confident that the ICNC'99 conference will continue the history of providing an excellent format for the criticality safety community to share experiences and new information that will demonstrate that these challenges are being met.

RELATED MEETINGS

The OECD Nuclear Energy Agency (NEA) is striving to help the criticality safety community meet challenges related to exchange of information and experience. As part of this effort, the OECD/NEA sponsored a two-day Experts' Meeting on Experimental Needs in Criticality Safety which was held in Albuquerque, New Mexico, the week following the ICNC'95 meeting. The General Chair for the meeting was R. M. Westfall of the United States, and co-chairs were F. Barbry of France and Y. Naito of Japan. The meeting was truly international in perspective with 28 official participants from 28 organizations in 10 countries. In addition, there were approximately 25 observers.

The stated purpose of the meeting was to review and identify experiments that were deemed necessary to address away-from-reactor criticality safety issues. Representatives from countries that have experimental facilities discussed the status and plans for their facilities and reviewed their areas of expertise as well as the available equipment. Discussions were held on the different needs for experiments that have been identified over the years (large arrays of fissile units, low moderation systems, etc.) and the applications for which they were pertinent. The recommendations that were agreed to by the participants were:

1. encourage the performance of new critical measurements on a multilateral, international basis with regard to the sharing of facilities, staff expertise, and funding resources,

2. establishment of a Criticality Safety Working Party by the OECD/NEA,

3. expand the U.S. DOE forecast of criticality experiments to be an international effort,

4. continuation of the participants and their organizations to obtain base funding for specific critical facilities that could openly provide data needed for assurance of nuclear safety.

Unfortunately, the goal to define a list of specific experiments that were a priority need was not met. However, the cooperative spirit of the participants and organizations involved in this international meeting was a beneficial step towards cooperative efforts in acquiring new experimental data. It is clear that the OECD/NEA and perhaps the International Atomic Energy Agency (IAEA) must help to organize future meetings, and that these international agencies must play a larger role in ensuring that data for nuclear safety are obtained as needed.

SUMMARY

The ICNC'95 conference was a successful meeting by any measure of performance, that is, applied–participation, number and quality of papers, information exchange, etc. It is obvious that criticality safety issues are of growing interest as the form and quantity of fissile material being handled and stored continues to change and the demand for quantitative justification of safety assessments increases. This conference provided an excellent forum for exchange of information and ideas that will benefit criticality safety specialists for years to come. Further indication of the criticality safety community working together to address issues of common importance is demonstrated by the Experts' Meeting that was held just following the ICNC conference. Future meetings of this type will continue to help the community to share experiences and knowledge that will benefit the safety of the worldwide nuclear industry.

Proceedings of ICNC'95 and videos of the Pioneer and Russian Plenary Sessions can be obtained at a reasonable cost by contacting R. D. Busch at

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