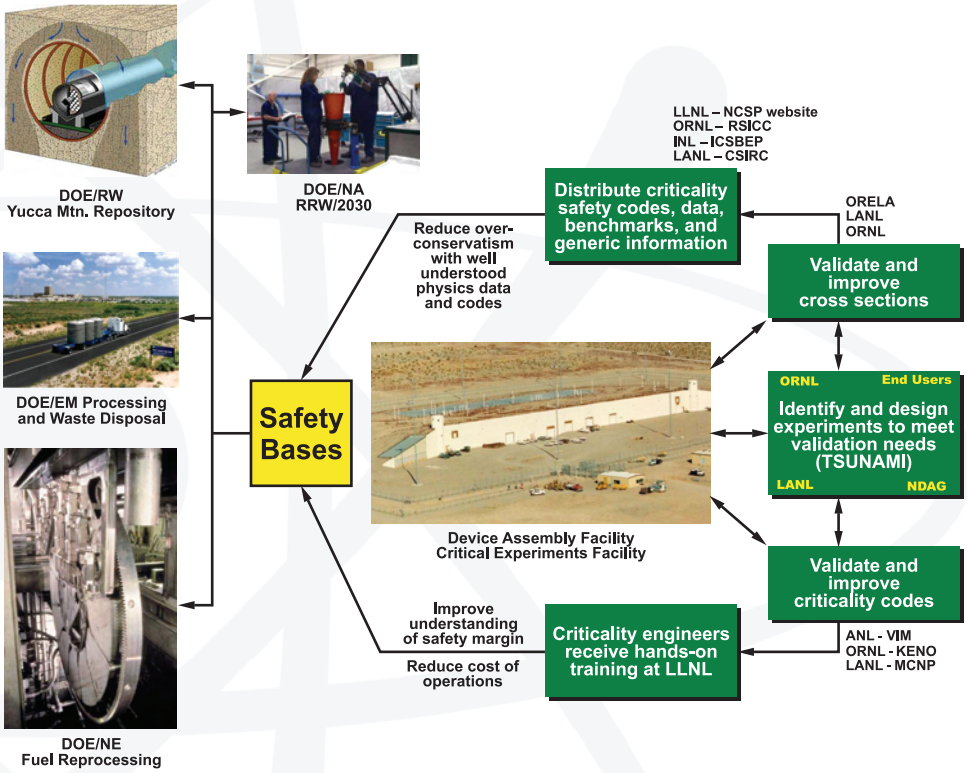
The Mission and Vision

of the United States Department of Energy Nuclear Criticality Safety Program

for the Fiscal Years 2009-2018

National Nuclear Security Administration

The Nuclear Criticality Safety Program Infrastructure Supports Safe and Efficient Fissionable Material Operations DOE-Wide



The Integrated Nuclear Criticality Safety Program

For the past decade, the Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP) has been chartered with maintaining the technical infrastructure necessary to ensure safe, efficient operations from a criticality safety perspective. The NCSP and its initiatives have been planned and executed annually in a series of updates to a rolling Five-Year Plan. However, out-year planning beyond the execution year was not based on any integrated long-range plan. The Mission and Vision for the NCSP for the next five to ten years facilitates development of a coherent, integrated implementation plan. Therefore, beginning in Fiscal Year 2009, the Five-Year Execution Plan will be the plan to achieve the five-year vision of the NCSP. As such, the next edition of the Five-Year Plan will not roll forward but will be a roadmap to achieve the NCSP described in this Mission and Vision. After the first five years, the Mission and Vision will be revisited and the current ten-year goals and attributes revised to reflect progress during the previous five years. This document will provide the planning basis for all funding and initiatives undertaken by the NCSP. It also defines the values and operating culture of the NCSP.

Nothing is more fundamental to operations with fissionable material than criticality safety. Ensuring that a criticality accident never happens again in a DOE facility is one key facet of the DOE mission supporting the national security and energy needs of the United States. It is with this ultimate goal in mind that this Mission and Vision for the NCSP is dedicated and approved.

Approved:

March 2008

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MISSION

The NCSP mission is to provide **sustainable expert** leadership, direction, and the technical infrastructure necessary to develop, maintain, and disseminate the essential technical tools, training, and data required to support **safe, efficient** fissionable material **operations** within the DOE.

VISION

The NCSP will be a **continually improving, adaptable,** and **transparent** program that **communicates** and **collaborates** globally to incorporate technology, practices, and programs to be **responsive** to the essential technical needs of those responsible for developing, implementing, and maintaining nuclear criticality safety.

VALUES

- **Continual Improvement** – The NCSP assesses its products and processes.
- **Adaptability –** The NCSP encourages innovation.
- **Transparency** – The NCSP discloses its plans, processes, and accomplishments.
- **Communication** – The NCSP dialogues with its stakeholders.
- **Collaboration** – The NCSP engages national and international resources.
- **Responsiveness** – The NCSP responds to the needs of its DOE stakeholders.
- **Sustainability** – The NCSP prepares the next generation of technical leaders.
- **Expertise** – The NCSP involves world-class criticality safety experts.
- **Safety** – The NCSP resolves any threat to criticality safety.
- **Efficiency** – The NCSP tailors solutions to maximize efficiency.
- **Operations** – The NCSP adopts DOE missions and goals as its own.

STRATEGY

The NCSP Mission and Vision will be achieved by identifying and accomplishing a set of five-year programmatic goals in six broad technical program elements that support identified ten-year goals. The yearly implementation plans to accomplish these goals will be developed with the advice and assistance of **experts** appointed by the NCSP manager or working under charters approved by the NCSP manager. The six technical program elements are:

- Analytical Methods
- Information Preservation and Dissemination
- Integral Experiments
- International Criticality Safety Benchmark Evaluation Project
- Nuclear Data
- Training and Education

The following sections identify the mission, vision, strategy, and goals for each of these elements as related to the overall mission and vision of the NCSP. Each section contains a list of the specific goals to be attained by the end of Fiscal Year 2013. Detailed lists of five- and ten-year goals and attributes (a quality or characteristic; a distinctive feature) for each element have been developed to support the NCSP Mission and Vision and are tabulated in Appendix A.

MISSION

The Analytical Methods (AM) program element provides for the development and maintenance of state-of-the-art analytical capability for the processing of nuclear data from the Evaluated Nuclear Data File (ENDF) and the radiation transport analysis needed to predict system k-effective values. An essential aspect of this capability is the human expertise required to develop the analytical software, provide software configuration control, and train and assist the user community.

AM Vision

The AM element will **sustain** state-of-the-art radiation transport modeling capabilities and the **expertise** necessary to develop, maintain and disseminate the analytical tools and data libraries in a manner that is **responsive** to the needs of those responsible for developing, implementing, and maintaining criticality safety.

AM Strategy

The following strategy has been developed to direct the AM element towards achieving its vision. The AM element will:

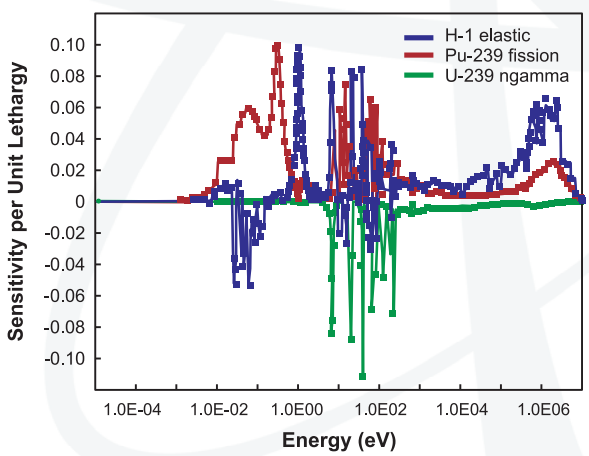
- Actively engage the criticality safety end-users to identify their analytical methods needs through various means of *communication* and develop and implement capabilities to meet those needs.
- Provide and support radiation transport codes and tools containing rigorous physics models, *efficient* solution algorithms, sophisticated and user-friendly modeling capabilities, comprehensive outputs to facilitate user understanding, and methods to perform sensitivity/uncertainty analyses.
- Provide and support data processing codes and tools containing rigorous physics models to produce data libraries required by the transport codes from cross-section evaluations.
- Provide products that are developed and maintained in accordance with modern software quality assurance practices and are *adaptable* to meet changing criticality safety user needs and computing environments.
- Support criticality safety users through various mechanisms including newsletters, users forums, phone and e-mail consultation, and by utilizing a well-defined mechanism for timely distribution of software and data libraries.
- *Sustain* the NCSP analytical capabilities and *expertise* through *continual improvement* of methods and mentoring of the next generation of experts.

Five-Year Goals for AM

The AM element provides users more than one independent method to achieve criticality safety analyses.

- Perform analyses for criticality safety evaluations
  - Normal
  - Upset
- Perform sensitivity/uncertainty analyses
  - Range of applicability
  - Adjusted libraries
    - *posteriori* group constants
    - *posteriori* Calculated/Experimental (C/E) values and uncertainties
- Design experiments
  - Critical
  - Subcritical
- Analyze benchmarks
  - Critical
  - Subcritical
- Develop approaches and tools for analysis of accidents
  - Real time response capabilities
  - Kinetics
  - Multiphysics
- Analyze Shielding and Criticality Accident Alarm Systems (CAAS) coverage
- Analyze burnup/depletion
- Participate in Critical-Subcritical Experiment Design Team (C_edT) process

The projected goals and attributes of the AM element to be achieved in the five- and ten-year periods are listed in Table A.1.



Sample TSUNAMI Output

MISSION

The Information Preservation and Dissemination (IP&D) program element preserves primary documentation supporting criticality safety and makes this information available for the benefit of the technical community. The NCSP internet website (http://ncsp.llnl.gov) is the central focal point for access to criticality safety information collected under the NCSP, and the gateway to a comprehensive set of hyperlinks to other sites containing criticality safety information resources.

IP&D Vision

The IP&D element will identify, preserve, and disseminate selected technical, programmatic, and operational information that enables those responsible for criticality safety to **sustain,** enhance, and **continually improve** performance in support of **safe, efficient** fissionable material **operations**.

IP&D Strategy

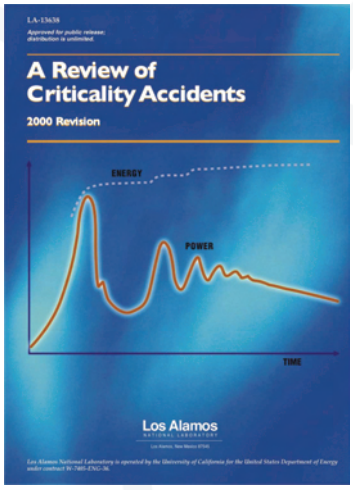
The following strategy has been developed to direct the IP&D element towards achieving its vision. The IP&D element will:

- Establish a structured approach to using expert groups and individuals that will assist in identifying and selecting existing sources of organized information and other types of technical, programmatic, and operational information for preservation.
- Establish an easily accessible repository(ies) that can be *sustained* to provide for preservation and digital dissemination of the selected information.
- Conduct succession planning to provide continuity of *expertise* and prepare the next generation of leaders.

Five-Year Goals for IP&D

- Implement data calls for available material
- Provide processes for evaluating available material for IP&D value
- Develop a repository for all evaluations/reports associated with criticality safety from this point forward
- Archive and disseminate training and operational videos (historical and current)
- Develop and maintain a searchable registry of nuclear criticality safety personnel with areas of expertise
- Preserve unclassified topical (waste drums, vault storage, onsite and offsite transport, criticality alarm placement, decontamination and decommissioning (D&D), etc.) references
- Distribute approved criticality safety program description documents
- Develop a process for keeping the Criticality Safety Coordinating Team informed about emerging regulatory actions, impacts, and initiatives (DOE letters to contractors)
- Implement a process to rapidly disseminate information to all DOE criticality safety practitioners ("crit spam")
- Maintain a U.S. Compendium of Near Misses and Lessons Learned (Historical)
- Provide periodic reports on NCSP accomplishments to communicate and promote to the criticality safety related community (published, American Nuclear Society [ANS] session)

The projected goals and attributes of the IP&D element to be achieved in the five- and ten-year periods are listed in Table A.2.



U.S./Russian Collaboration on Preservation of Criticality Accident Information

MISSION

The Integral Experiments (IE) program element maintains a fundamental capability for the DOE/NCSP to be able to perform critical, subcritical, and fundamental physics measurements, within the limits of its resources, to address specific site needs on a prioritized basis. This program element also supports maintaining a fundamental nuclear materials handling capability, which supports hands-on nuclear criticality safety training programs and various other programs for the DOE/NCSP and other government agencies.

IE Vision

The IE element will provide a **sustainable** infrastructure and a systematic, interactive process to assess, design, perform, and document integral criticality safety-related benchmark-quality experiments to support **safe**, **efficient** fissionable material **operations**.

IE Strategy

The following strategy has been developed to direct the IE element towards achieving its vision. The IE element will:

- Provide and *sustain* integral critical, subcritical, and fundamental physics experiments capability.
- *Sustain* a systematic and interactive process for identifying, assessing, and *continually improving* an *adaptable* integral experiment infrastructure, which incorporates programs, practices, and technology that provide the most *efficient* means of realizing the NCSP vision.
- Conduct succession planning to provide continuity of *expertise* and prepare the next generation of leaders.

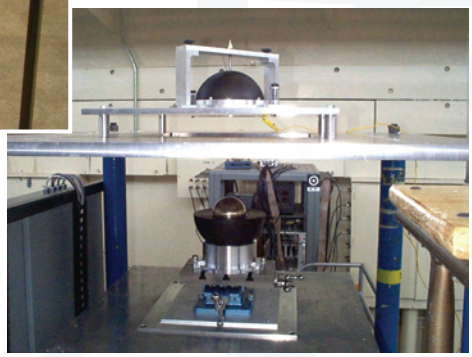
Five-Year Goals for IE

- Fully functional C_edT process
  - Identifies integral experiment needs
  - Evaluates and assesses experiment needs
  - Develops, evaluates, and modifies (as necessary) conceptual and final experimental designs
  - Conducts integral experiments
  - Formally documents experiment results
- Fully staffed Criticality Experiments Facility (CEF) with succession planning
- Infrastructure required to support CEF operations (outside scope of NCSP)
  - Administration
  - Security Category I/Hazard Category II nuclear operations, including critical operations
- Fully functional CEF
  - Fast burst assembly
  - Two general-purpose vertical assembly machines
  - Fast benchmark assembly
  - Two general-purpose measurement laboratories

- Access to a wide variety of nuclear material and materials required for nuclear experiments (e.g., structural materials, reflector and interstitial materials, test materials)
- Fissionable material storage vaults
- Machine shop
- Counting room
- Rabbit system (rapid sample handling)
- Operator education, training, and qualification programs

- New projects development
  - Solution assembly
  - General-purpose horizontal split table
  - Radiochemistry/processing
  - Conceptual development
    - k-, α-meter
    - Tomographic imaging of fluxes
    - Fundamental physics measurements
  - Low scatter facility
  - Remote material handling capability
  - Security posture capable of supporting work with uncleared personnel and foreign nationals (U.S. facilities)

The projected goals and attributes of the IE element to be achieved in the five- and ten-year periods are listed in Table A.3.



Example Critical Experiments

MISSION

The purpose of the International Criticality Safety Benchmark Evaluation Project (ICSBEP) program element is to (1) identify and evaluate a comprehensive set of criticality safety-related experimental benchmark data; (2) verify the integral data, to the extent possible, by reviewing original and subsequently revised documentation, and by talking with the experimenters or individuals who are familiar with the experiments or the experimental facility; (3) evaluate the data and quantify overall uncertainties through various types of sensitivity analyses; (4) compile the data into a standardized format; (5) perform sample calculations using standard criticality safety codes and data; and (6) formally document the work into a single source of verified, extensively peer-reviewed benchmark data.

The ICSBEP helps reduce operational costs and inefficiency by providing benchmark quality data and related search software that supports validation activities consistent with the American National Standards Institute / ANS standards and Nuclear Regulatory Commission requirements.

ICSBEP Vision

The ICSBEP element will maintain a **sustainable** and **continually improving,** globally interactive program that provides identification and acquisition of needed experimental criticality safety-related benchmark data, rigorous evaluation of those data, and formalized documentation of those data for preservation and distribution in support of **safe, efficient** fissionable material **operations** worldwide.

ICSBEP Strategy

The following strategy has been developed to direct the ICSBEP element towards achieving its vision. The ICSBEP element will:

- Provide *transparent responsiveness* by maintaining awareness of the criticality safety end-user integral data needs through various means of *communication* to facilitate interaction among all stakeholders and draw upon the international criticality safety-related community to help fill those needs.
- Provide and disseminate precise, structured and formalized documentation of criticality safety-related benchmark data, along with best-estimate uncertainties, to users in a form that enables them to reliably validate analytical methods and nuclear cross-section data.
- Identify and *communicate* methods and data discrepancies.
- Investigate and implement *improved* data characterization, analysis, and presentation methods.
- *Sustain* capability through mentoring highly motivated next-generation *experts* by involving them in the evaluation process and providing opportunities for them to interact with the broader criticality safety community (e.g., through participation in technical review meetings and presentation of their work).

Five-Year Goals for the ICSBEP

- A sustainable infrastructure
  - Program management, integration and coordination with NCSP elements and other programs, and international collaboration
  - Qualified technical and support staff
  - Utilization of international expertise
- Participation in national and international information exchange programs and meetings in which ICSBEP participants focus on identification of data needs and available resources
- Participation in the C_edT process
- A rigorous evaluation and review process that will evaluate and assess the quality of available data
- Assessment methods and data consistency and communicating discrepancies
- Evaluate and publish open and classified criticality safety-related benchmarks
  - Evaluation
  - Classification reviews
  - Independent and technical working group review
  - Publication management
    - Graphic arts
    - Technical editing
    - Production of current publication media
- Improved benchmark characterization

The projected goals and attributes of the ICSBEP element to be achieved in the five- and ten-year periods are summarized in Table A.4.

Current ICSBEP Partners

MISSION

The Nuclear Data (ND) program element includes the measurement, evaluation, testing, and publication of neutron cross-section data for nuclides of high importance to nuclear criticality safety analyses. The NCSP continues to improve coordination of nuclear data activities by fostering a strong collaborative effort among all of our national and international resources in this highly technical area. The objective is to solve the highest priority nuclear data problems relevant to criticality safety in a timely manner. This program element is essential for the NCSP because it provides the nuclear cross-section data required by the AM program element.

ND Vision

The ND element will **sustain** world-class **expertise** and capabilities to **continually improve** and disseminate measured and evaluated differential cross-section and covariance data in a manner that is **responsive** to the needs of those responsible for developing, implementing, and maintaining criticality safety.

ND Strategy

The following strategy has been developed to direct the ND element towards achieving its vision. The ND element will:

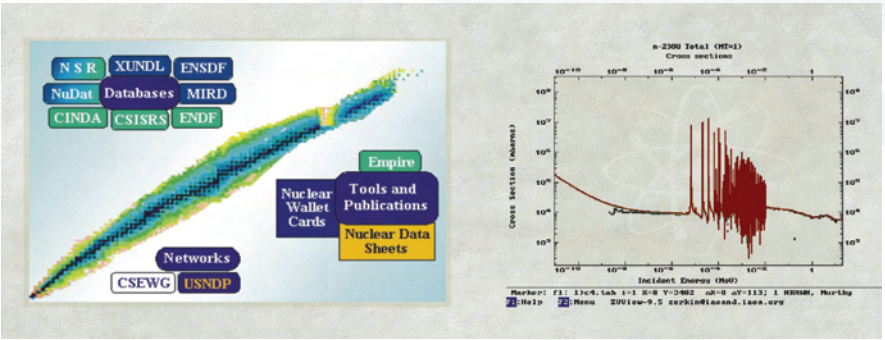
- Actively engage the criticality safety end-users to identify their nuclear data needs through various means of *communication* and will develop and disseminate evaluated nuclear data files to meet those needs.
- Produce world-class nuclear data evaluations of cross sections and covariances to address criticality safety data needs by developing and utilizing modern nuclear model codes with the best available experimental data.
- Assess, perform, analyze, and disseminate evaluated nuclear cross-section measurements to meet the needs of the criticality safety end-users.
- Test, analyze, and document the performance of nuclear data measurements and evaluations to *continually improve* the nuclear data available for the criticality end-users.
- *Sustain* the NCSP nuclear data capabilities and *expertise* through *continual improvements* of the data files and mentoring of the next generation of leaders.

Five-Year Goals for ND

The ND element will provide the following data that have been demonstrated to meet target accuracies that are developed within the AM program element.

- Measured cross-section data
  - Thermal, resonance, fast
  - Total and capture measurements for stable nuclides
  - Defined approaches to measure fission, scattering, gamma-production, multiplicity, double-differential cross sections in energy and angle, prompt and delayed data
  - Cross-section data published and archived in formalized database
- Calculated, evaluated, and performance tested cross-section data
  - Thermal, resonance, fast
  - Total, fission, capture, scattering, gamma-production
  - Multiplicity
  - Double-differential cross sections in energy and angle
  - Covariance data
  - Prompt and delayed
  - Defined approaches to obtain and use correlated data
  - Cross-section data published and archived in formalized database
  - Correlated data
- Automated data validation incorporating the breadth of ICSBEP benchmark data, developed sensitivity/uncertainty tools, cross-sections and covariance data and integral data to reduce predicted uncertainties in a rigorous defensible method which identifies and quantifies true data needs

The projected goals and attributes of the ND element to be achieved in the five- and ten-year periods are listed in Table A.5.



Evaluated Nuclear Data Files (ENDF/B)

MISSION

The Training and Education (T&E) program element will continue to offer hands-on training courses as needed by DOE and identify and develop training needs and resources in areas where no suitable materials exist. The primary purpose of the T&E element is to maintain the technical capabilities of criticality safety professionals and provide for the training and education of people entering the criticality safety discipline from related scientific fields.

T&E Vision

The T&E element will identify, develop, provide, and promote practical and excellent technical training and educational resources that foster competency in the art, science, and implementation of nuclear criticality safety and is **adaptable** and **responsive** to the needs of those responsible for developing, implementing, and maintaining criticality safety.

T&E Strategy

The following strategy has been developed to direct the T&E element towards achieving its vision. The T&E element will:

- Continually evaluate competency requirements from Orders and Standards and identify needs for training and education resources.
- Provide formal feedback to DOE relative to competency gaps.
- Actively *communicate*, promote, and evaluate new and available training and education opportunities that foster competency and *sustained* capability in nuclear criticality safety.
- Be *responsive* to identified training and education needs by developing and providing resources that *sustain* nuclear criticality safety capabilities.
- Provide *sustainable*, hands-on training in the behavior of fissionable material systems including those at or near critical conditions.
- Conduct succession planning to provide continuity of *expertise* and prepare the next generation of leaders.

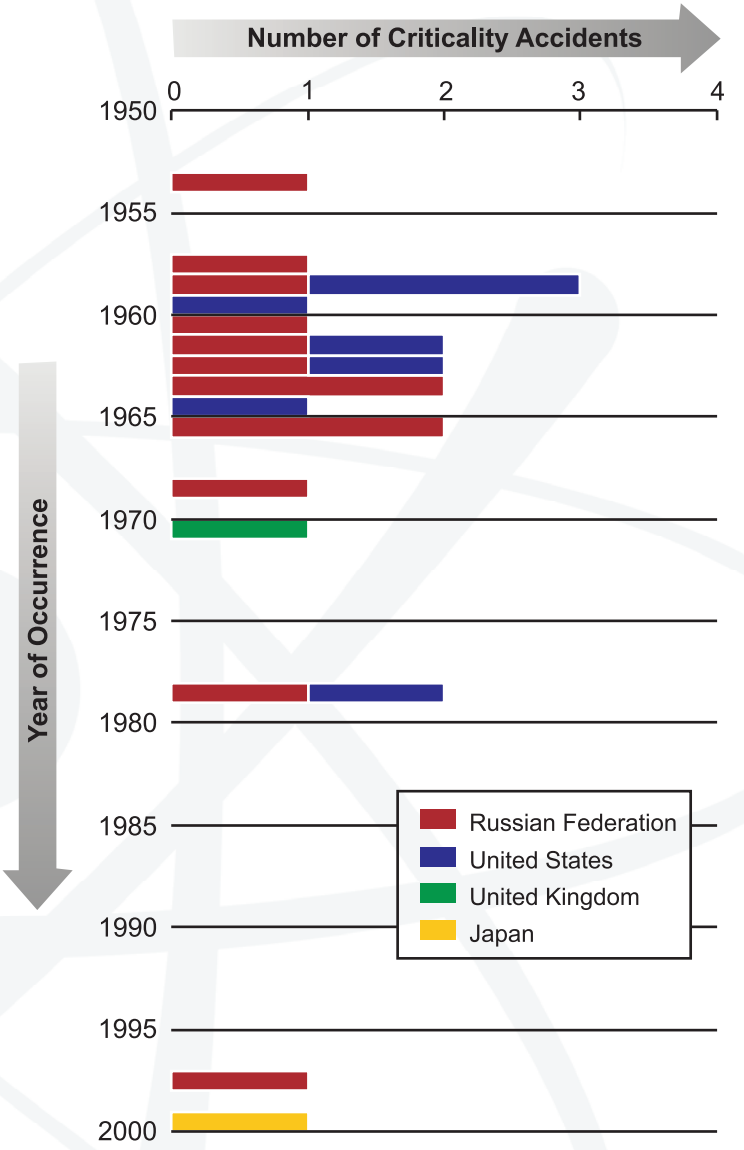
Five-Year T&E Goals

- ICSBEP
  - Handbook/Database for the International Handbook of Evaluated Criticality Safety Benchmark Experiments DICE training
  - Tutorial on ICSBEP evaluations
  - Tutorial on uncertainties/statistics
- Nuclear data
  - Tutorial on development of differential data and cross sections (experimental) for end-users
  - Multiplicity and NuBar interpretation and methods

- Analytical methods
  - MCNP training
  - SCALE training
  - Sammy training
  - NJOY training
  - Covariance and uncertainty training
- Integral experiments
  - Hands-on training on critical systems
  - Collaborative training for experimenters in U.S. and foreign facilities
  - Educational opportunities for non-experimenters at experimental facilities
  - Tutorial on subcritical noise measurement methods
- Other
  - Tutorial on subcritical methods and benchmark interpretation for nuclear criticality safety users
  - Tutorial on Material Control and Accountability (MC&A) and its relationship to criticality safety including nondestructive assay
  - Tutorial on human factors related to criticality safety
  - Tutorial on formal methods for criticality hazards analysis
  - Tutorial on plutonium chemistry/uranium chemistry/material properties
  - Additional historical Pioneer videos

The projected goals and attributes of the T&E element to be achieved in the five- and ten-year periods are listed in Table A.6.

Hands-On Training



Chronology of Process Plant Criticality Accidents

Tabulation of the Goals and Attributes of NCSP Technical Program Elements

The following tables summarize the goals and attributes of each of the NCSP program elements as envisioned in the five- and ten-year periods. A check mark in the "5-Year" column indicates that the item or sub-item is part of the Five-Year Plan, and a check mark in the "10-Year" column indicates that it is part of the longer-term plan. In many cases, five-year items are carried over to the ten-year scope.

Table A.1. Analytical Methods 5- and 10-Year Goals and Attributes

Goals	5-Year	10-Year
Perform analyses for criticality safety evaluations o Normal o Upset	√	√
Perform sensitivity/uncertainty analyses o Range of applicability o Adjusted libraries ▪ *posteriori* group constants ▪ *posteriori* C/E values and uncertainties	√	√
Design experiments o Critical o Subcritical	√	√
Analyze benchmarks o Critical o Subcritical	√	√
Develop approaches and tools for analysis of accidents o Real time response capabilities o Kinetics o Multiphysics	√	√
Analyze Shielding and CAAS coverage	√	√
Analyze burnup/depletion	√	√
Participate in C_edT process	√	√
Analyze accidents o Real-time response capabilities o Kinetics o Multiphysics		√
Attributes	**5-Year**	**10-Year**
Processing codes and data libraries		
o Input evaluations in all "standard" formats from international compilations	√	√
o Reaction cross section/energy/angle	√	√
o Covariances (reaction/energy/angle) ▪ Developing methodology for angle-dependent covariances	√	√
o Create code dependent libraries ▪ Continuous-energy ▪ Multigroup	√	√
o Software Quality Assurance of processing codes and libraries	√	√
o Computational ▪ Platforms ▪ Operating systems, compilers ▪ Adaptable, sustainable (languages, etc.)	√	√
Radiation transport codes		
o Solution method		
▪ Monte Carlo	√	√
▪ Deterministic	√	√
▪ Developing plans for Coupled Monte Carlo-Deterministic	√	
▪ Coupled Monte Carlo-Deterministic		√

Table A.1 (cont'd). Analytical Methods 5- and 10-Year Goals and Attributes

Attributes (cont'd)	5-Year	10-Year
Radiation transport codes (continued)		
o Geometry		
▪ 1D → generalized 3D	√	√
▪ Developing plans for Computer Aided Design (CAD) interface	√	
▪ CAD interface		√
o Physics		
▪ Coupled neutron, photon		
▪ Eigenvalue/fixed source		
▪ Forward and adjoint		
▪ Time-dependent	√	√
▪ Continuous-energy		
▪ Fine group, problem-dependent multigroup		
▪ Subcritical techniques		
▪ Depletion capability		
o Ease of Use		
▪ Documentation, including online help		
▪ Graphical User Interface	√	√
▪ Interoperability		
▪ Materials preprocessing		
o Output, analyses, linkages		
▪ Develop plans to link to other physics codes	√	
▪ Ability to link to other physics codes		√
▪ Detailed physics edits, including detectors	√	√
▪ HTML+	√	√
▪ Graphical displays	√	√
▪ Flux, reaction rate edits for burnup analysis	√	√
o Software quality assurance of transport codes	√	√
o Computational		
▪ Platforms (including parallel)		
▪ Solution Efficiency (variance reduction, source convergence, etc.)	√	√
▪ Operating Systems, compilers		
▪ Adaptable, sustainable (languages, etc.)		
Sensitivity/uncertainty methods		
o Sensitivity analysis		
▪ Sensitivity profiles	√	√
▪ Similarity		
▪ Uncertainty propagation		
o Data adjustment	√	√
o Software quality assurance of sensitivity/uncertainty codes	√	√
Tools		
o Develop plans for automated tasks to support		
▪ Criticality safety engineer evaluation	√	
▪ Data validation		
▪ Data adjustment		
o Automated tasks to support:		
▪ Criticality safety evaluations		√
▪ Data validation		
▪ Data adjustment		
o Slide rule+	√	√
o ARH-600	√	
o Electronic ARH-600		√

Table A.2. Information Preservation and Dissemination 5- and 10-Year Goals and Attributes

Goals	5-Year	10-Year
Implement data calls for available material	√	
Provide processes for evaluating available material for IP&D value	√	
Develop a repository for all evaluations/reports associated with criticality safety from this point forward	√	
Archive and disseminate training and operational videos (historical and current)	√	
Develop and maintain a searchable registry of nuclear criticality safety personnel with areas of expertise	√	
Preserve unclassified topical (waste drums, vault storage, onsite and offsite transport, criticality alarm placement, D&D, etc.) references	√	
Distribute approved criticality safety program description documents	√	
Develop local electronic searchable archive of criticality safety evaluations and experimental logbooks (with bibliographic listings made available to DOE and contractors)		√
Develop a process for keeping the Criticality Safety Coordinating Team informed about emerging regulatory actions, impacts and initiatives (DOE letters to contractors)	√	
Implement a process to rapidly disseminate information to all DOE criticality safety practitioners (“Crit spam”)	√	
Maintain a U.S. Compendium of near misses and lessons learned from them (historical)	√	
Maintain an International Compendium of near misses and lessons learned from them (historical)		√
Provide periodic reports on NCSP accomplishments to communicate and promote to the criticality safety related community (published, ANS session)	√	√
Attributes	**5-Year**	**10-Year**
Online card catalogue technology	√	√
Partnership with other organizations (ANS, Nuclear Science and Engineering, other journals) for article retrieval	√	√
Easily accessible	√	√
Web-based	√	√
Single data source with access to all data	√	√

Critical Mass Laboratory Control Panel

Table A.3. Integral Experiments 5- and 10-Year Goals and Attributes

Goals	5-Year	10-Year
Fully functional C_edT process o Identifies integral experiment needs o Evaluates and assess experiment needs o Develops, evaluates, and modifies (as necessary) conceptual and final experimental designs o Conducts integral experiments o Formally documents experiment results	√	√
Fully staffed CEF with succession planning	√	√
Infrastructure required to support CEF operations (outside scope of NCSP) o Administration o Security Category I/Hazard Category II nuclear operations, including critical operations	√	√
Fully functional CEF o Fast burst assembly o Two general-purpose vertical assembly machines o Fast benchmark assembly o Two general-purpose measurement laboratories o Access to a wide variety of nuclear material and materials required for nuclear experiments (e.g., structural materials, reflector and interstitial materials, test materials) o Fissionable material storage vaults o Machine shop o Counting room o Rabbit system (rapid sample handling) o Operator, education, training, and qualification programs	√	√
New project development o Solution assembly o General-purpose horizontal split table o Radiochemistry/processing o Conceptual development ▪ k-, α-meter ▪ Tomographic imaging of fluxes ▪ Fundamental physics measurements o Low scatter facility o Remote material handling capability o Security posture capable of supporting work with uncleared personnel and foreign nationals (U.S. facilities)	√	
Solution assembly		√
General-purpose horizontal split table assembly		√
Low scatter facility		√
Radiochemical laboratory		√
Solution handing/mixing/purification/storage		√
Security posture capable of supporting classified activities, and activities with uncleared personnel and foreign nationals (for U.S. facilities)		√

Table A.3 (cont'd). Integral Experiments 5- and 10-Year Goals and Attributes

Attributes	5-Year	10-Year
Research and development	√	
o k-, α-meter		√
o Tomographic imaging of fluxes		√
o Fundamental physics measurements		√
Conduct of classified experiments	√	√
Design, analyze, and conduct subcritical experiments		
o Radiation test object construction	√	√
o Neutron driven noise analysis	√	√
o Rossi-alpha	√	√
o Feynman variance-to-mean	√	√
o Oscillator	√	√
o Pulsed die-away	√	√
o Source-jerk	√	√
o Inverse multiplication	√	√
o Low scatter facility		√
Design, analyze, and conduct critical experiments		
o Fast burst metal (uranium)	√	√
o Solution burst		√
o Fast benchmark	√	√
o General purpose vertical	√	√
o General purpose horizontal		√
o Solutions/lattices (uranium, plutonium)		√
General radiation measurements		
o Spectral ratios		
o Flux mapping	√	√
o Criticality alarm		
o Shielding/transmission		
Radiochemistry		√
Nuclear materials handling capabilities		
o Manual	√	√
o Remote		√
General nuclear criticality safety experimental measurement training		
o Uncleared U.S. personnel	√	
o Uncleared personnel		√
o Training and collaboration with foreign nationals	√	√
o CEF operators	√	√
General infrastructure		
o Machine shop with the ability to work with contaminated materials	√	√

Table A.4. ICSBEP 5- and 10-Year Goals and Attributes

Goals	5-Year	10-Year
A sustainable infrastructure o Program management, integration and coordination with NCSP elements and other programs, and international collaboration o Qualified technical and support staff o Utilization of international expertise	√	√
Participation in national and international information exchange programs and meetings in which ICSBEP participants focus on identification of data needs and available resources	√	√
Participation in the C_edT process	√	√
A rigorous evaluation and review process that will evaluate and assess the quality of available data	√	√
Assessment methods and data consistency and communicating discrepancies	√	√
Evaluate and publish open and classified criticality safety-related benchmarks o Evaluation o Classification reviews o Independent and technical working group review o Publication management ▪ Graphic arts ▪ Technical editing ▪ Production of current publication media	√	√
Improved benchmark characterization	√	√

Table A.4 (cont'd). ICSBEP 5- and 10-Year Goals and Attributes

Attributes	5-Year	10-Year
A primary program focus on o Both existing and new critical and subcritical experiments o Criticality-alarm/shielding measurements o Relevant criticality safety-related fundamental physics measurements	√	
A primary program focus on o Newly measured experiments o Existing criticality-alarm/shielding measurements o Existing fundamental physics measurements		√
Periodic reassessment of the criteria for performing, reviewing, and approving ICSBEP evaluations	√	√
Periodic ICSBEP technical review meetings	√	√
Periodic publication of the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (ICSBEP Handbook) in its entirety using current media	√	√
Continual improvement in the sustainability and usability of the ICSBEP Handbook	√	√
Solicitation and response to user and evaluator needs and feedback	√	√
Periodic review, assessment, and improvement in current data characterization methods	√	√
Implementation of a formal review and comment/feedback mechanism as a means for continual improvement	√	√
Enlistment of next-generation experts in the evaluation process, technical review meetings, and publication of their work	√	√
Informing program managers and educators about technical benefits of participation	√	√
Program to systematically verify input	√	√
Verified code input descriptions	√	√

Table A.5. Nuclear Data 5- and 10-Year Goals and Attributes

Goals	5-Year	10-Year
Measured cross-section data o Thermal, resonance, fast o Total and capture measurements for stable nuclides, o Defined approaches to measure fission, scattering, gamma-production, multiplicity, double differential cross sections in energy and angle, prompt and delayed data o Cross-section data published and archived in formalized database	√	
Calculated, evaluated, and performance tested cross-section data		
o Thermal, resonance, fast	√	√
o Total, fission, capture, scattering, gamma-production	√	√
o Multiplicity	√	√
o Double-differential cross sections in energy and angle	√	√
o Covariance data	√	
o Prompt and delayed	√	√
o Defined approaches to obtain and use correlated data	√	√
o Cross-section data published and archived in formalized database	√	√
o Correlated data		√
Automated data validation incorporating the breadth of ICSBEP benchmark data, developed sensitivity/uncertainty tools, cross-sections and covariance data and integral data to reduce predicted uncertainties in a rigorous defensible method which identifies and quantifies true data needs	√	

Table A.5 (cont'd). Nuclear Data 5- and 10-Year Goals and Attributes

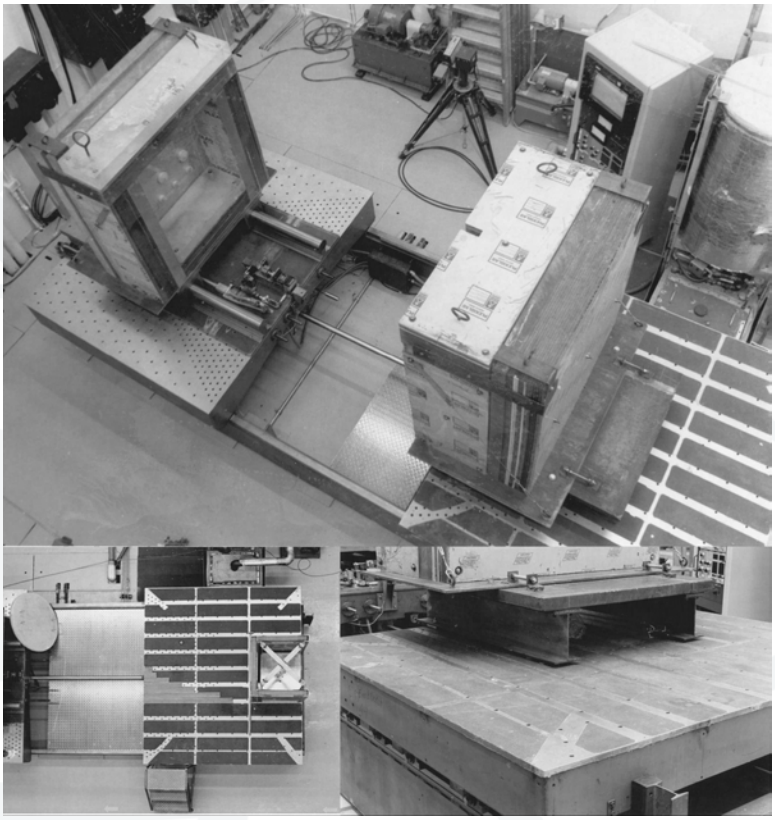
Attributes	5-Year	10-Year
Differential Measurements		
o Develop plan for procurement of long lead-time samples	√	
o Sample procurement		√
o Develop national strategy for access to and utilization of differential measurement facility(ies) and perform NCSP priority measurements	√	
o Access to and utilization of differential measurement facility(ies)		√
o Differential measurements focused on total and capture cross sections of stable nuclides while implementing a plan to include fission, scattering, etc. ▪ Experimental techniques and design to meet target accuracies ▪ Experimental apparatus including detectors, fission and scattering chambers, data acquisition, etc. to meet target accuracies ▪ Data reduction/analysis of measured data ▪ Dissemination/documentation of measured results	√	
o Differential measurements of total, capture, fission, scattering, etc. cross sections ▪ Experimental techniques and design to meet target accuracies ▪ Experimental apparatus including detectors, fission and scattering chambers, data acquisition, etc. to meet target accuracies ▪ Data reduction/analysis of measured data ▪ Dissemination/documentation of measured results		√
Models and Calculations		
o Analysis tools to evaluate experimental data	√	√
o Accuracy of nuclear model calculations to extend cross-section data to include required reaction channels and energy ranges is improving toward target accuracies	√	
o Nuclear model calculations to extend cross-section data to include required reaction channels and energy ranges		√
Evaluations		
o Complete cross-section evaluations including required reaction channels and energy ranges and covariance data	√	√
o Dissemination/documentation of evaluated data	√	√
Data Testing		
o Utilization of tools of the AM element and benchmark data, including the data of the ICSBEP element	√	√
o Report performance results of evaluated data	√	√

Table A.6. Training and Education 5- and 10-Year Goals and Attributes

Goals	5-Year	10-Year
ICSBEP		
o Handbook/DICE training	√	√
o Tutorial on ICSBEP evaluations	√	√
o Tutorial on uncertainties/statistics	√	√
Nuclear Data		
o Tutorial on development of differential data and cross sections (experimental) for end-users	√	
o Multiplicity and NuBar interpretation and methods		√
Analytical Methods		
o MCNP training	√	√
o SCALE training	√	√
o Sammy training	√	√
o NJOY training	√	√
o Covariance and uncertainty training	√	√
o AMPX training		√
o PREPRO training		√
o COG training		√
o Tutorial on development of differential data and cross sections for the end-user		√
Integral Experiments		
o Hands-on training on critical systems	√	√
o Collaborative training for experimenters in U.S. and foreign facilities	√	√
o Educational opportunities for non-experimenters at experimental facilities	√	√
o Tutorial on subcritical noise measurement methods	√	
o Tutorial on instrumentation for critical experimentation		√
o Hands-on training involving Security Category III/IV quantities		√
Other		
o Tutorial on subcritical methods and benchmark interpretation for nuclear criticality safety users	√	
o Tutorial on MC&A and its relationship to criticality safety including nondestructive assay	√	
o Tutorial on human factors related to criticality safety	√	
o Tutorial on formal methods for criticality hazards analysis	√	
o Tutorial on plutonium chemistry/uranium chemistry/ material properties	√	
o Additional historical Pioneer videos	√	
o Tutorial on CAAS system designs		√
o Tutorial on CAAS placement evaluation (accident yields, transmission, standards)		√
o Tutorial on D&D related to criticality safety		√
o Destructive analysis tutorial		√
o Tutorial for managers, supervisors, criticality safety officers or criticality safety representatives, and DOE facility representatives		√
o Module on use of criticality accident slide rule		√

Table A.6 (cont'd). Training and Education 5- and 10-Year Goals and Attributes

Attributes	5-Year	10-Year
Develop a process to allow the end-user community to identify needed training	√	
Interactive multimedia training capability	√	
Transferable cards/certificates of accomplishment from DOE for criticality engineers	√	
University partnerships	√	
Find, tailor, and adapt and make generally available training that exists at DOE sites	√	
Online university classes	√	
Survey of best contractor training practices	√	
Simulation environment for training		√
SimCity with process control and limits to "run your own electronic process"		√
DOE NCSP scholar/intern program/rotation program		√
The single center of excellence for criticality safety training that provides for tailored training commensurate with need o Criticality simulator o Ability to do hands-on material experimentation o Ability to handle cleared/uncleared o Staffed by experts with specific knowledge basis o Ability to simulate plant/process conditions and simulate walking them down (i.e., simulated facility should be staffed by role players [e.g., operators]).		√
IP&D training o Lessons learned from criticality accident near misses		√



Horizontal Split Table Critical Assembly Device

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