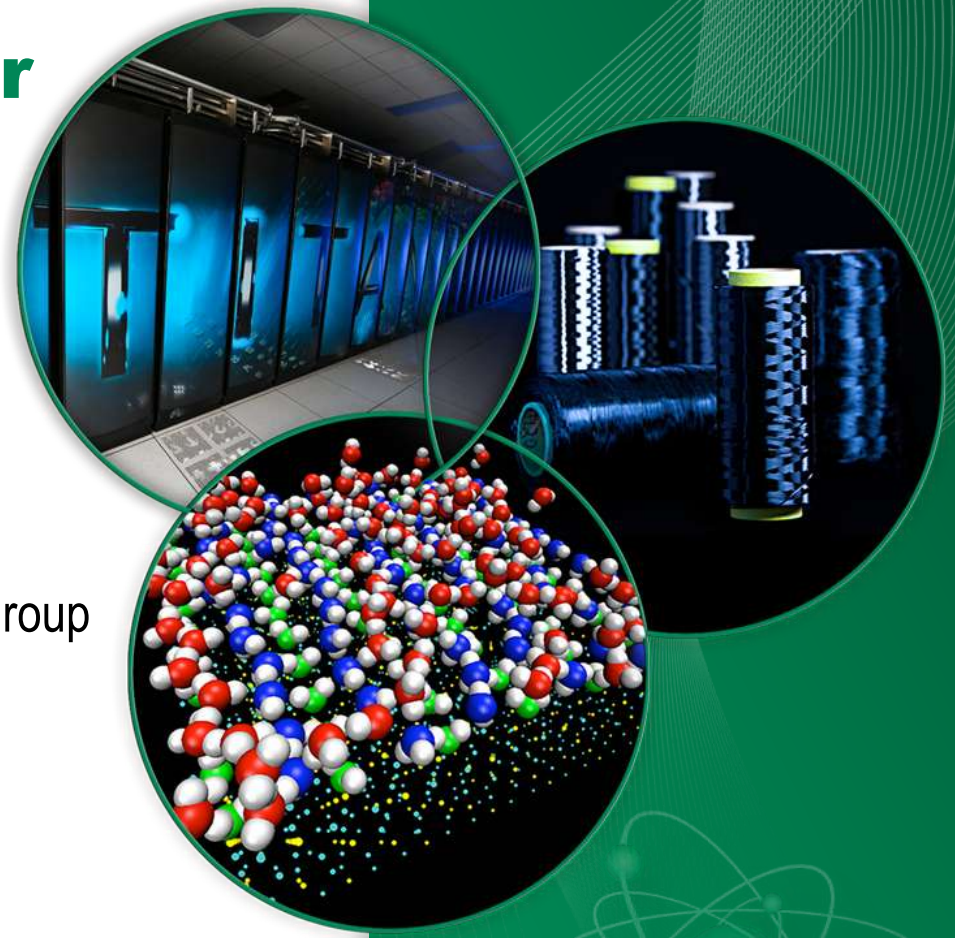
Nuclear Data Advisory Group (NDAG) Technical Support for the U.S. Nuclear Criticality Safety Program (NCSP)



Michael Dunn

ORNL Nuclear Data and Criticality Safety Group Leader

NCSP Management Team

American Nuclear Society Winter Meeting
Anaheim, CA
November 10, 2014

Outline

- NCSP Overview
- NDAG Mission and Objectives
- NDAG Membership and Chair Status
- Status of NCSP Nuclear Data Work
- Summary

US DOE NCSP Mission

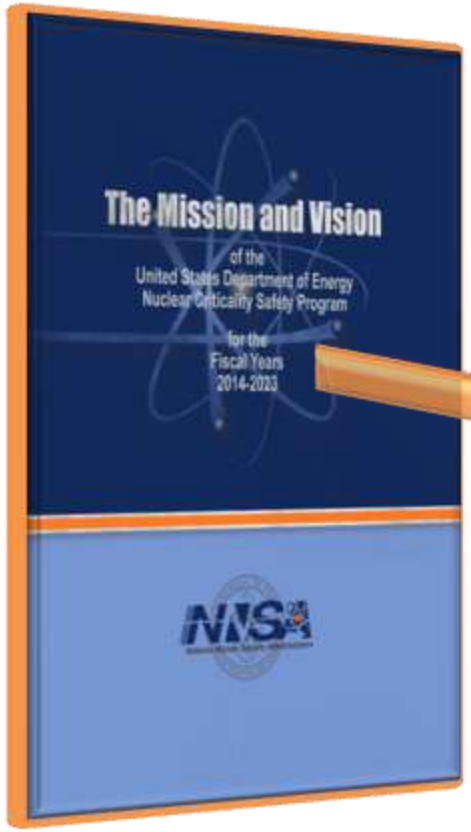
Is to provide sustainable expert leadership, direction and the technical infrastructure necessary to develop, maintain and disseminate the essential technical tools, training and data required to support safe, efficient fissionable material operations within the DOE.

US DOE NCSP Vision

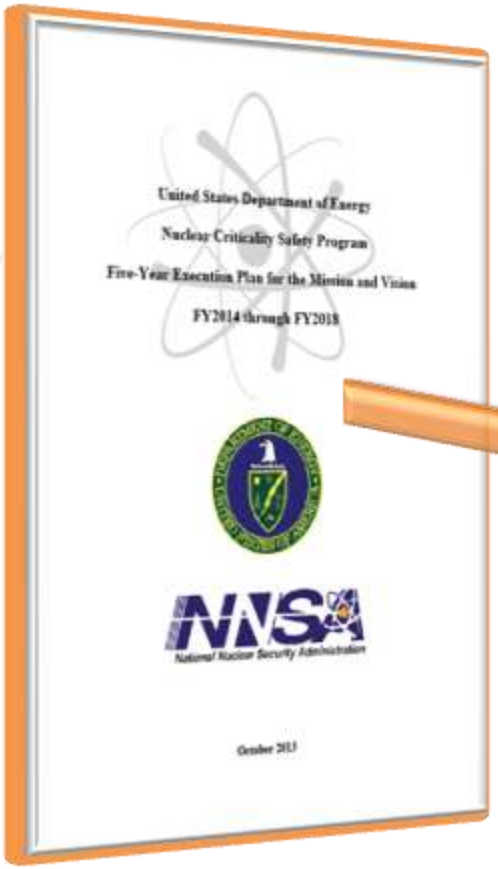
Will be a continually improving, adaptable and transparent program that communicates and collaborates globally to incorporate technology, practices and programs to be responsive to the essential technical needs of those responsible for developing, implementing and maintaining nuclear criticality safety.

NNSA Nuclear Criticality Safety Program

10 Year Mission & Vision



5 Year Plan

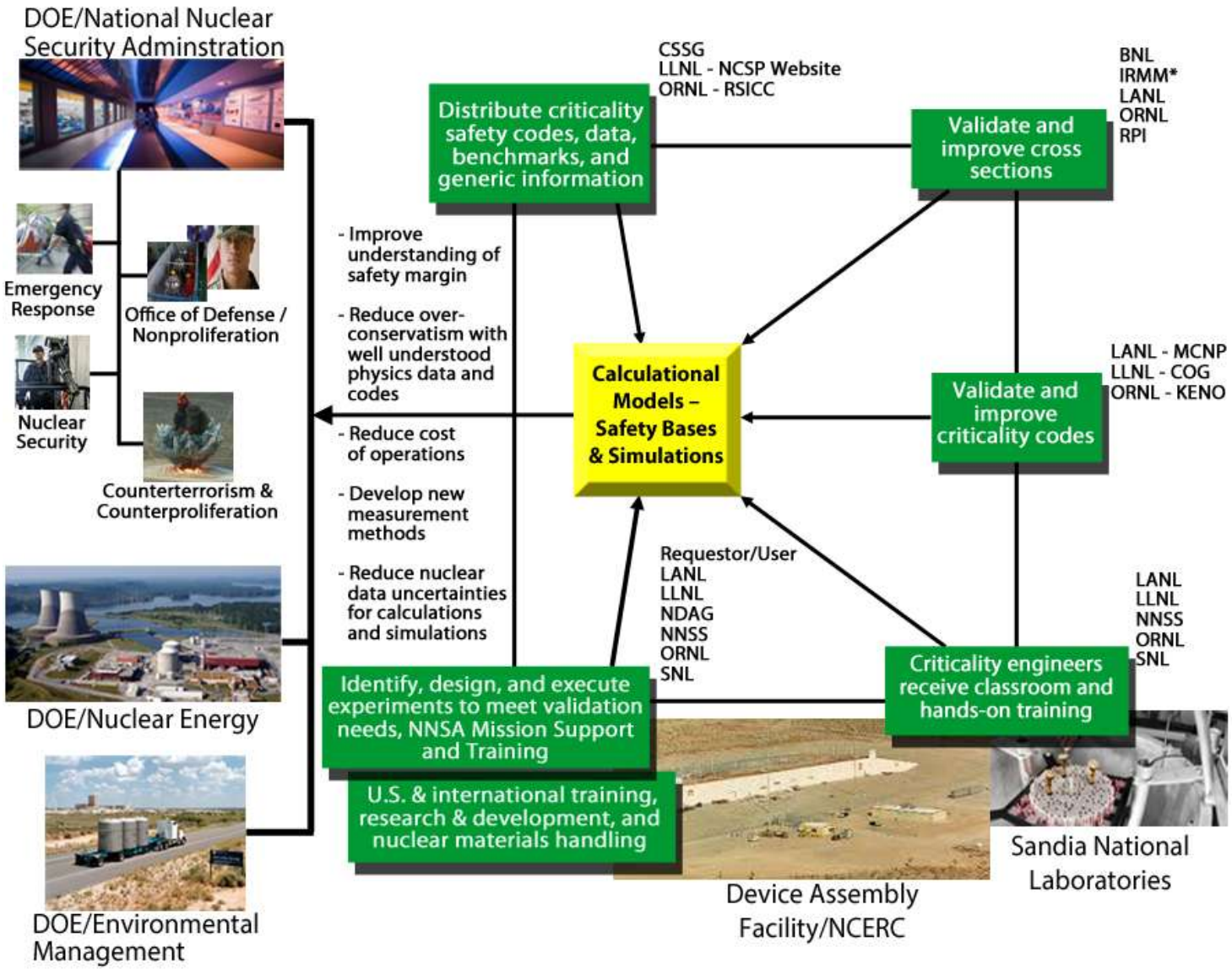


Work Tasks

NCSP Technical Elements

- **Analytical Methods (AM)** – Maintain and improve the cross-section processing and radiation transport codes needed for NCS (MCNP, SCALE, COG, AMPX and NJOY)
- **Information Preservation and Dissemination (IPD) –** Preserves primary documentation and information supporting criticality safety (includes ICSBEP)
- **Integral Experiments (IE)** – Critical and subcritical experiments at the critical experiments facility (CEF) at the device assembly facility (DAF) in Nevada and SNL Pulse Reactor Facility– provides integral tests of codes and data
- **Nuclear Data (ND)** – Perform measurements of basic nuclear (neutron) physics cross sections and generate new evaluated cross-section evaluations with covariance data for use in production criticality safety codes
- **Training and Education (T&E)** – Web-based training modules, 1 and 2-week Hands-On Criticality Safety Course for Criticality Safety Engineers, Line Management, and Oversight Personnel
- **Technical Support (TS)** – provides NCSP Manager with expert guidance on NCS technical issues within the Complex

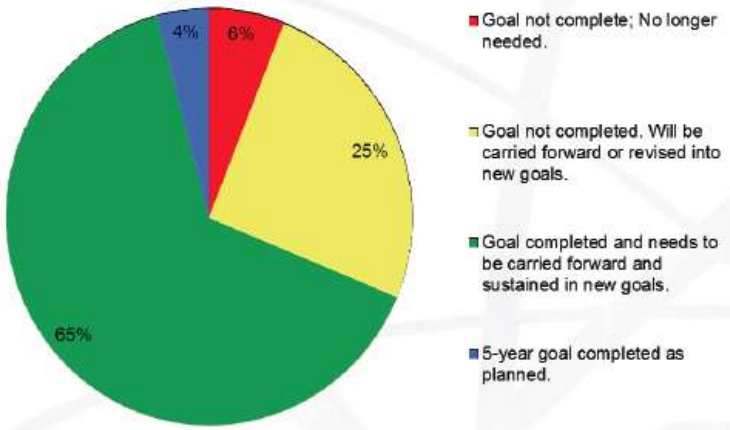
NNSA Nuclear Criticality Safety Program Infrastructure Supports Safe and Efficient Fissionable Material Operations DOE-Wide



*International Partner

NCSP is Mission and Goal Driven Program

- In FY13, the NCSP completed multi-lab "mid-term" review and update to 2009-2018 MV Document
- Graded performance for completing goals during past 5-years—**excellent performance during past 5 years**
- Revised goals as needed to address current and emerging NCS needs in the Complex
- Updated 2014-2023 MV Published in October 2013 with prioritized goals for all NCSP Program Elements
- Specific work tasks to meet 5-year MV goals are defined in current Five Year Plan for 2015-2019—work progress assessed annually and task "course corrections" made as needed to Five Year Plan



NCSP Mission & Vision FY2009-2018
Goals Mid-Term Assessment

Example 2014-2023 MV T&E Goals

26 Training and Education (T&E)

Training and Education - Budget and Technical Priority Rankings

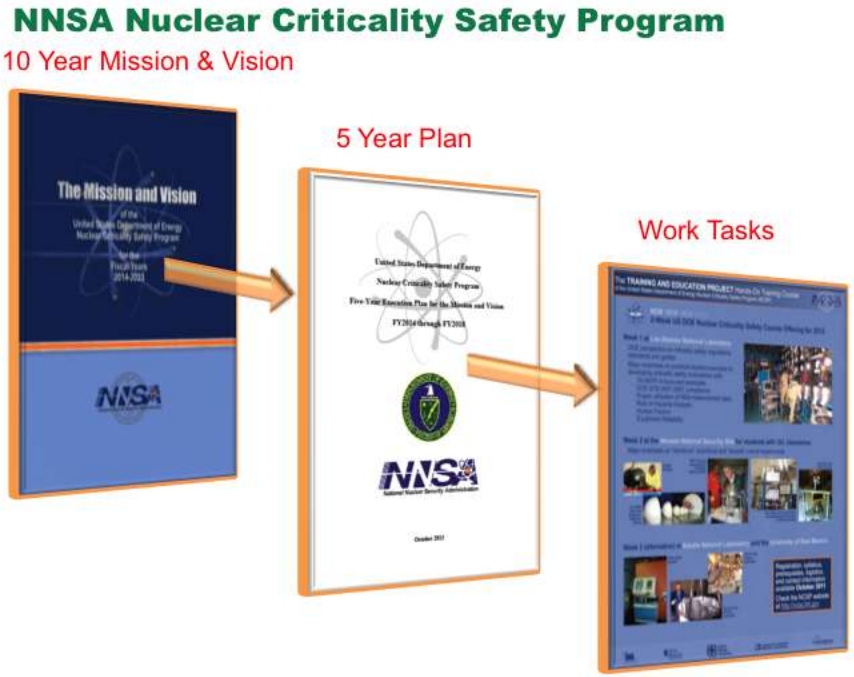
Attributes	Goals	5y	10y
Personnel/Facilities:		Budget Priority Technical Priority	
Access to an integrated, coordinated, and consistent compendium of criticality safety training and education resources that provide effective training commensurate with need	A sustainable process to identify and communicate available training classes and education resources in the national and international communities		
	A gap analysis of training needs based on an assessment of available training and education resources in the national and international communities		
	An integrated compendium of training and education resources that is coordinated for consistency across US agencies and institutions and accessible to the criticality safety community		
	An integrated compendium of training and education resources coordinated with international partners to foster consistency on material and maximize use of unique resources		
	A sustainable process to obtain and incorporate feedback to expand or improve training course(s), training modules, or NCSET modules		

US DOE NCSP Nuclear Data Advisory Group (NDAG)

Nuclear Data Advisory Group

- **Mission**: "The Nuclear Data Advisory Group, through making recommendations to the NCSP Manager, enhances the coordination of the NCSP Nuclear Data Element work program with current and future DOE needs and promotes the integration of this work program with the other elements of the NCSP."
- Key functions
  - Identifies deficiencies in evaluated differential and integral data and recommends priorities and specific resources for meeting identified NCS nuclear data needs
  - Supports the NCSP Manager in approval of IERs and NDRs

NCSP Nuclear data work documented in Five Year Plan and performed to achieve goals documented in NCSP Mission and Vision Document



Nuclear Data Advisory Group

- Meet at least annually
- Key meeting topics from November 19, 2013 at BNL
  - Nuclear data requests
  - Review 5-year measurement and evaluation work plan (Appendix B Gantt Charts)
  - Status of RPI nuclear data measurement capabilities and refurbishment effort
  - NDAG charter/review and revision
    - Establish procedure for selection of NDAG Chair
    - Membership policy
  - Membership
  - Evaluation testing
  - Reviewed FY2014-2023 NCSP Mission & Vision Nuclear Data Goals

NDAG Membership FY2014

U. S. Department of Energy
Nuclear Criticality Safety Program

NCSP Home Page
DOE CS Coordinating Team
Accomplishments
tasking/responses
CSSG
Charter
Work Instructions
Membership Policy
Accomplishments
tasking/responses
CSSG Minutes
Member List
Biographies for CSSG Members
Career Awards
NDAG
NDAG Charter
Work Instructions
Membership Policy
Accomplishments
tasking/responses
Member List
Privacy & Legal Notice

Current Members		
Michael E. Dunn, (Acting Chair)	ORNL	dunnme@ornl.gov
J. Blair Briggs	INL	j.briggs@inl.gov
David A. Brown	BNL	dbrown@bnl.gov
Yaron Danon	RPI	danony@rpi.edu
Klaus H. Guber	ORNL	guberkh@ornl.gov
David K. Hayes	LANL	dkhayes@lanl.gov
David P. Heinrichs	LLNL	heinrichs1@llnl.gov
Michal W. Herman	BNL	mwherman@bnl.gov
Albert (Skip) Kahler	LANL	akahler@lanl.gov
Toshihiko Kawano	LANL	kawano@lanl.gov
Luiz Leal	ORNL	leallc@ornl.gov
Robert C. Little	LANL	rcl@lanl.gov
Norman Schwers	SNL	nfschwe@sandia.gov
Fredrik K. Tovesson	LANL	tovesson@lanl.gov
Mark L. Williams	ORNL	williamsm@ornl.gov
Michael Zerkle	Bettis	Michael.Zerkle@unnpp.gov
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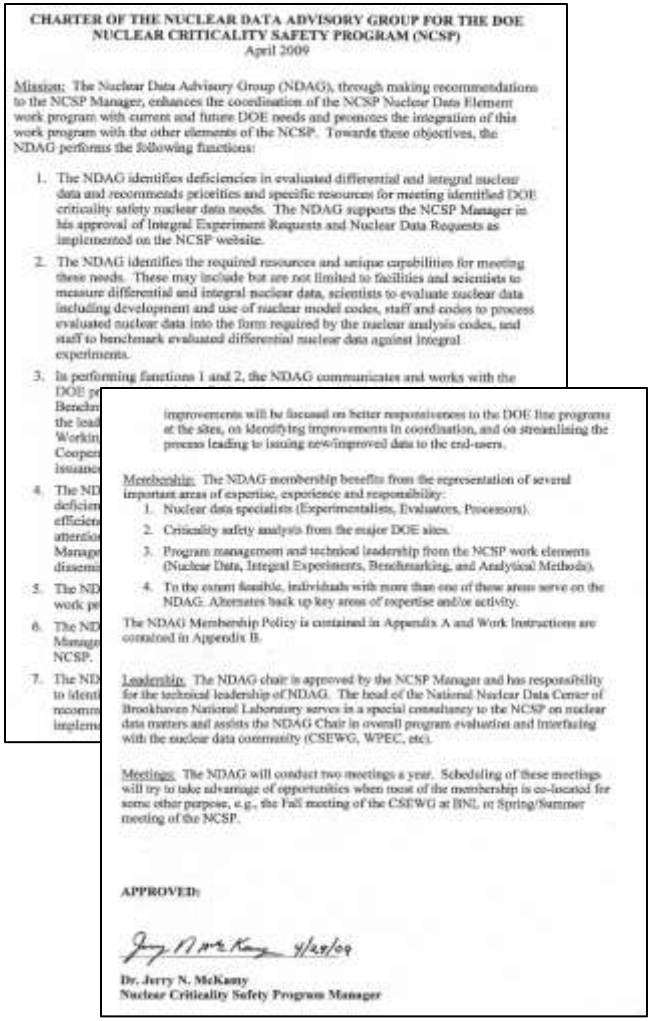
Jerry N. McKamy	DOE	Jerry.McKamy@nnsa.doe.gov
Nichole Ellis	SAIC/DOE	ellis_9899@msn.com
Lori Scott	SAIC/DOE	Lorisc0tt@aol.com
Gladys Udenta	DOE	Gladys.Udenta@nnsa.doe.gov
Fitz Trumble, CSSG Chair	URS	fitz.trumble@urs-ps.com

NDAG Charter Review / Revision – FY2014

- April 2009 NDAG charter does not define process for selecting new chair—need to update charter before new chair selected
- At November 19, 2013 meeting, defined procedure for electing NDAG Chair and new members
- NDAG Chair:
  - NDAG Chair candidates come from body of NDAG membership
  - Members should notify NDAG Chair if they do not want to be considered
  - Candidates site management has to concur and support nomination
  - NDAG votes to select chair
  - Term for 3 years with reaffirmation vote or possibility of selection of new chair at conclusion of 3-year term
- Membership:
  - Any NDAG member can nominate new member
  - NDAG Chair should have role in proposing new members to fill key technical areas
  - NDAG membership votes on new members
  - Send to NCSP Manager for concurrence



CHARTER OF THE NUCLEAR DATA ADVISORY GROUP FOR THE DOE NUCLEAR CRITICALITY SAFETY PROGRAM (NCSP)
April 2009

Mission: The Nuclear Data Advisory Group (NDAG), through making recommendations to the NCSP Manager, enhances the coordination of the NCSP Nuclear Data Element work program with current and future DOE needs and promotes the integration of this work program with the other elements of the NCSP. Towards these objectives, the NDAG performs the following functions:

1. The NDAG identifies deficiencies in evaluated differential and integral nuclear data and recommends priorities and specific resources for meeting identified DOE criticality safety nuclear data needs. The NDAG supports the NCSP Manager in his approval of Integral Experiment Requests and Nuclear Data Requests as implemented on the NCSP website.
2. The NDAG identifies the required resources and unique capabilities for meeting these needs. These may include but are not limited to facilities and scientists to measure differential and integral nuclear data, scientists to evaluate nuclear data including development and use of nuclear model codes, staff and codes to process evaluated nuclear data into the form required by the nuclear analysis codes, and staff to benchmark evaluated differential nuclear data against integral experiments.
3. In performing functions 1 and 2, the NDAG communicates and works with the DOE pr
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improvements will be focused on better responsiveness to the DOE line programs at the sites, on identifying improvements in coordination, and on streamlining the process leading to issuing new/improved data to the end-users.

Membership: The NDAG membership benefits from the representation of several important areas of expertise, experience and responsibility:

1. Nuclear data specialists (Experimentalists, Evaluators, Processors).
2. Criticality safety analysts from the major DOE sites.
3. Program management and technical leadership from the NCSP work elements (Nuclear Data, Integral Experiments, Benchmarking, and Analytical Methods).
4. To the extent feasible, individuals with more than one of these areas serve on the NDAG. Alternates back up key areas of expertise and/or activity.

The NDAG Membership Policy is contained in Appendix A and Work Instructions are contained in Appendix B.

Leadership: The NDAG chair is approved by the NCSP Manager and has responsibility for the technical leadership of NDAG. The head of the National Nuclear Data Center of Brookhaven National Laboratory serves in a special consultancy to the NCSP on nuclear data matters and assists the NDAG Chair in overall program evaluation and interfacing with the nuclear data community (CSEWG, WPEC, etc).

Meetings: The NDAG will conduct two meetings a year. Scheduling of these meetings will try to take advantage of opportunities when most of the membership is co-located for some other purpose, e.g., the Fall meeting of the CSEWG at BNL or Spring/Summer meeting of the NCSP.

APPROVED:

4/28/09

Dr. Jerry N. McKamy
Nuclear Criticality Safety Program Manager

NDAG Membership and Chair Status

- Updated charter approved by NCSP Manager on July 2, 2014
- Per updated charter, NDAG nominated and elected 4 new members to fill vacancies (maximum of 20 members per charter) – September 2014
- New members joined the NDAG on September 30, 2014:
  - Bret Beck (LLNL)
  - John Bess (INL)
  - Gary Harms (SNL)
  - Morgan White (LANL)
- On October 9, 2014, NDAG completed election for new Chair to serve 3 year term
- Skip Kahler (LANL) elected as NDAG Chair

CHARTER OF THE NUCLEAR DATA ADVISORY GROUP FOR THE DOE NUCLEAR CRITICALITY SAFETY PROGRAM (NCSP)
July 2014

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APPROVED:

July 2, 2014

Jerry N. McKamy

Dr. Jerry N. McKamy
Nuclear Criticality Safety Program Manager

Nuclear Data Advisory Group

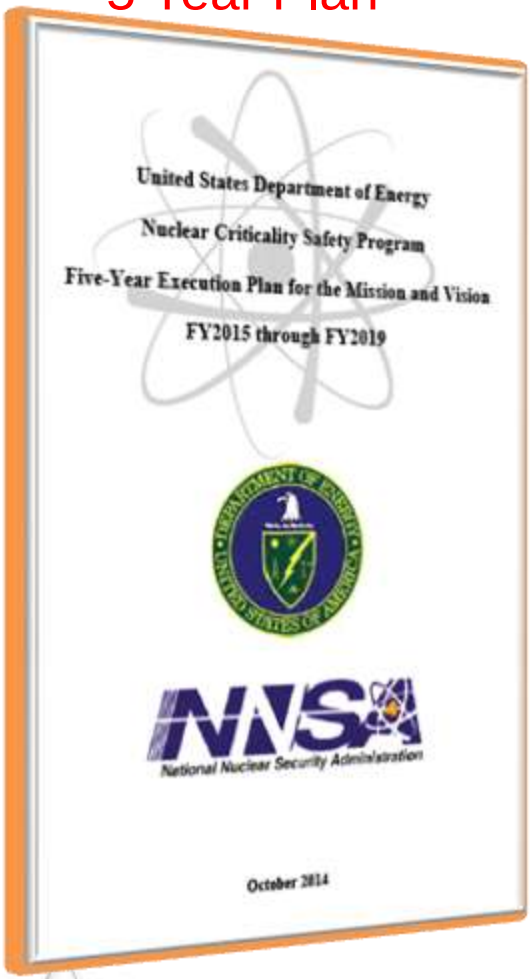
- Key topics from meeting on November 6, 2014 at BNL
- Review 5-year measurement and evaluation work plan (Appendix B Gantt Charts) and nuclear data needs
  - Move strontium (Sr) out in the schedule and address higher priority needs
  - Add lead (Pb) scattering
  - Add tantalum to work plan
  - Need to revisit ^{233}U high-energy evaluation
- Status of RPI nuclear data measurement capabilities and refurbishment effort
- NDAG charter/review and revision – assess recent elections with regard to new charter
- Membership – have 2 vacant slots but NDAG does not have plans to fill slots at this time – future slots will be filled as capability needs are identified
- Improved integration between ND and IE program elements
- Discussed new ICSBEP evaluations in progress for completion by May 2015 ICSBEP meeting

US DOE NCSP ND Work Plan

Appendix B
Nuclear Data

NCSP

5 Year Plan



Priority Needs / Additional Needs	Thermal scattering (BeO, HF, D_2O, SiO_2, CH_2, C_2F_4, $C_5O_2H_8$, etc.), ^{239}Pu, Cr, ^{237}Np, Pb, ^{55}Mn, Ti, ^{240}Pu / ^{233}U, Th, Be, ^{51}V, Zr, F, K, Ca, Mo, Na, La
Completed Evaluations (FY)	Minor Actinides (13), SiO_2 (12), ^{55}Mn (12), ^{180,128,183,184,186}W (10)

	Materials	Pre FY2014	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	Post-FY2020
Measurements	Calcium (Ca)									
	Cerium (Ce)									
	Copper (Cu)									
	Iron (Fe)									
	Lucite ($C_5O_2H_8$)									
	Strontium (Sr)									
	Tungsten (W)									
	Vanadium (V)									
	Zirconium (Zr)									
	Polyethylene (CH_2)		H_2O / CH_2							

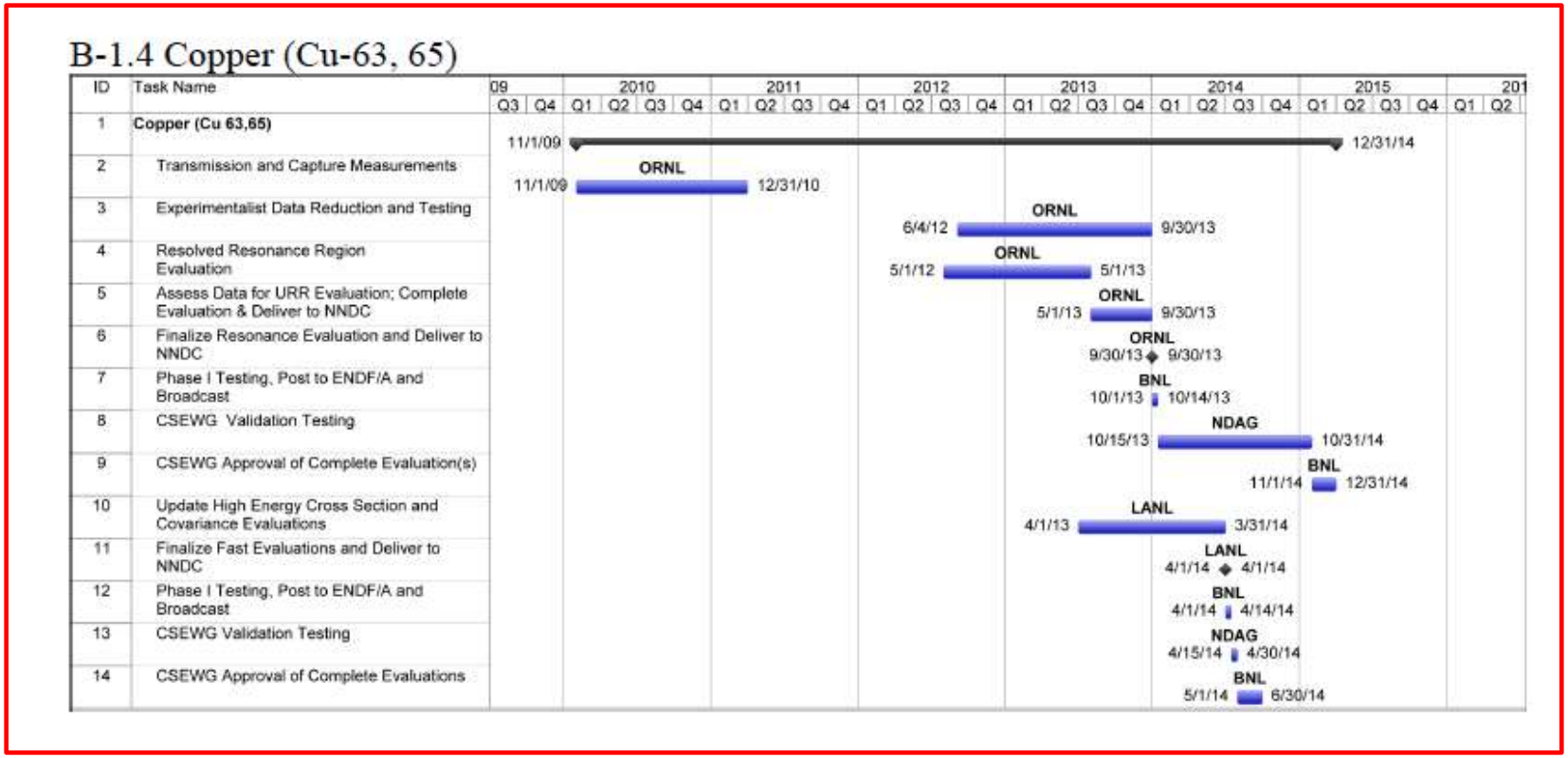
	Materials	Pre FY2014	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	Post-FY2020
Complete Evaluations	Calcium (Ca)									
	Cerium (Ce)									
	Cobalt (Co)									
	Copper (Cu)									
	Dysprosium (Dy)									
	Gadolinium (Gd)									
	Iron (Fe)									
	Lead (Pb)									
	Nickel (Ni)									
	Oxygen (O)									
	Rhodium (Rh)									
	Plutonium-239									
	Strontium (Sr)									
	Tungsten (W)									
	Uranium-235									
	Uranium-238									
	Vanadium (V)									
	Zirconium (Zr)									
	Hydrofluoric Acid (HF)									
	Lucite ($C_5O_2H_8$)									
	Polyethylene (CH_2)									
		ORNL		RPI		LANL		LLNL/NCSU		

- Requests for additional measurements: Ni, Mo, Cr (Fe-Cr alloys), Mn in intermediate energy range (VNIITF, NCERC).
- Requests for measurements and evaluation of angular distributions at high energy for Cu.
- Continuing need for thermal scattering data.

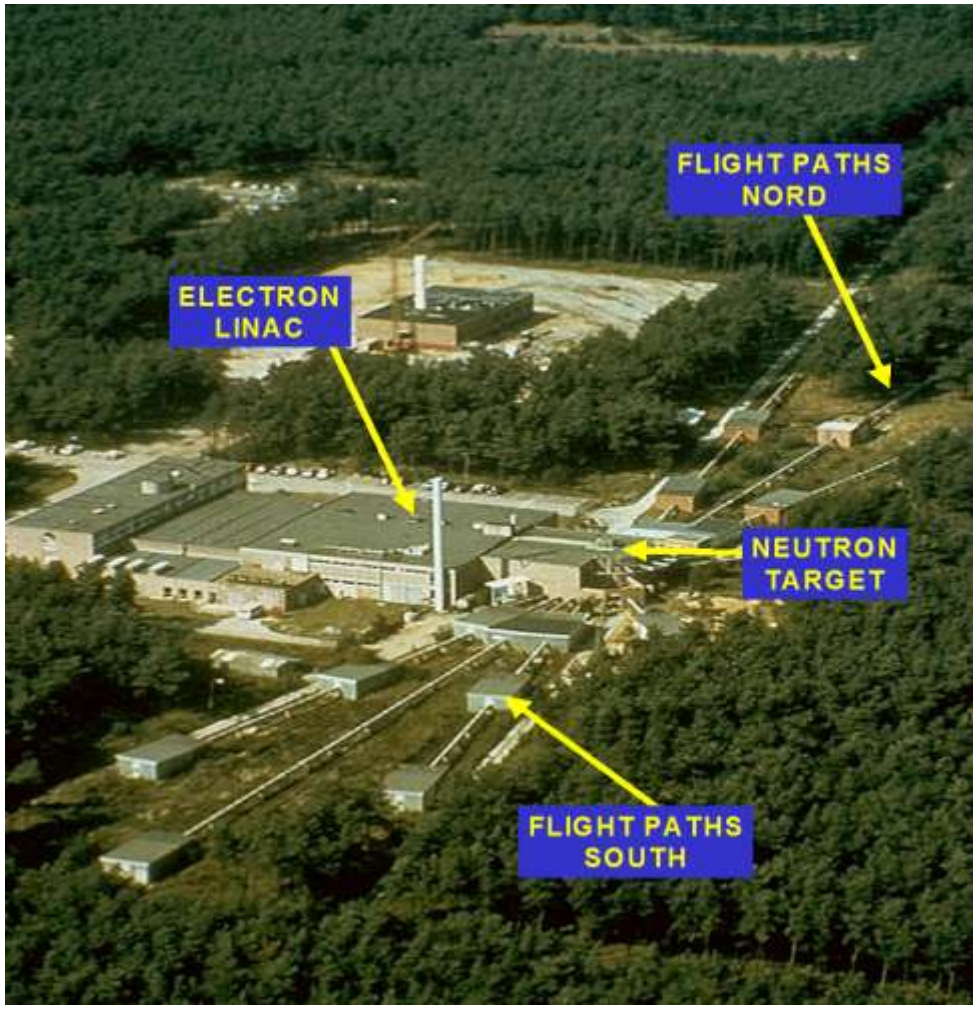
Nuclear Data Evaluation Status and Testing

- Recent evaluations completed by ORNL and LANL:
  - ORNL: ^{239}Pu, ^{63}Cu, ^{65}Cu, ^{182}W, ^{183}W, ^{184}W, ^{186}W
    - OECD/NEA WPEC CIELO Evaluations: ^{56}Fe, ^{16}O, ^{235}U – preliminary evaluations completed but work/testing still in progress
  - LANL: ^{58}Ni, ^{60}Ni; p(nu) data for ^{235}U, ^{238}U, and ^{239}Pu

Example Gantt Chart from NCSP Five Year Plan



US DOE NCSP ND Measurement Capabilities and Collaborators



Pulse Width	: 1ns
Frequency	: 40 Hz – 800 Hz
Average Current	: 4.7 μA – 75 μA
Neutron intensity	: 1.6 10^{12} – 2.5 10^{13} n/s

GELINA

- Time-of-flight facility
- Pulsed white neutron source

  (10 meV < E_n < 20 MeV)
- Multi-user facility with 10 flight paths (10 m - 400 m)
- The measurement stations have special equipment to perform:
  - Total cross section measurements
  - Partial cross section measurements

NCSP Capture Cross-Section Measurements at GELINA

Total energy detection

- C_6D_6 liquid scintillators
  - 125°
  - PHWT
- Flux measurements (IC)
  - $^{10}B(n,\alpha)$
  - $^{235}U(n,f)$

$$Y_{exp} = N\sigma_{\varphi}\frac{C_W - B_W}{C_{\varphi} - B_{\varphi}}$$

L = 10 m, 30 m and 60 m

WF : from MC simulations

The Nuclear Data Program at the RPI Gaerttner LINAC Laboratory

- Driven by a 60 MeV pulsed electron LINAC ~10^{13} n/s
- **Neutron transmission**
  - Resonance region: 0.001 eV- 600 keV,
  - High energy region: 0.4- 20 MeV
- **Neutron Capture**
  - Resonance region: 0.01-1000 eV
- **Neutron Scattering**
  - High energy region: 0.4 MeV- 20 MeV
- **Prompt fission neutron spectra and multiplicity**
- **Lead Slowing Down Spectrometer (LSDS)**
  - Assay of used nuclear fuel
  - Fission cross section and fission fragment spectroscopy.
  - (n,α) and (n,p) cross sections on small (radioactive) samples.

Rensselaer

linac The Gaerttner Laboratory

From presentation by Y. Danon at NCSP Technical Program Review May 14-16, 2012

Summary

- NCSP maintains the infrastructure necessary to ensure safe, efficient operations with fissionable materials
- Supports ND work to address priority NCS applications needs
- Nuclear data work integrated with NCSP AM and IE Program Elements
- NCSP maintains detailed nuclear data work schedule in Five Year Plan
- NDAG solicits input from end users on nuclear data needs for supporting nuclear criticality safety
  - NCSP website: http://ncsp.llnl.gov
  - Submit nuclear data request
  - NDAG members are listed on NCSP website – contact member to discuss nuclear data needs