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# Nuclear Energy Knowledge and Validation Center (NEKVaC) Needs Workshop Summary Report

Hans Gougar

February 2015

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**Idaho National Laboratory**

**Idaho Falls, Idaho 83415**

**http://www.inl.gov**

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# Nuclear Energy Knowledge and Validation Center (NEKVaC) Needs Workshop Summary Report

**Manufacturing Related Disciplines Complex (MRDC)**
**Georgia Institute of Technology**
**Atlanta, Georgia**
**January 15-16, 2015**
**February 2015**

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**Lori Braase**
**Systems Analyses**

# INTRODUCTION

The Department of Energy (DOE) has made significant progress developing simulation tools to predict the behavior of nuclear systems with greater accuracy and of increasing our capability to predict the behavior of these systems outside of the standard range of applications. These analytical tools require a more complex array of validation tests to accurately simulate the physics and multiple length and time scales. Results from modern simulations will allow experiment designers to narrow the range of conditions needed to bound system behavior and to optimize the deployment of instrumentation to limit the breadth and cost of the campaign.

Modern validation, verification and uncertainty quantification (VVUQ) techniques enable analysts to extract information from experiments in a systematic manner and provide the users with a quantified uncertainty estimate. Unfortunately, the capability to perform experiments that would enable taking full advantage of the formalisms of these modern codes has progressed relatively little (with some notable exceptions in fuels and thermal-hydraulics); the majority of the experimental data available today is the "historic" data accumulated over the last decades of nuclear systems R&D.

A validated code-model is a tool for users. An unvalidated code-model is useful for code developers to gain understanding, publish research results, attract funding, etc. As nuclear analysis codes have become more sophisticated, so have the measurement and validation methods and the challenges that confront them. A successful yet cost-effective validation effort requires expertise possessed only by a few, resources possessed only by the well-capitalized (or a willing collective), and a clear, well-defined objective (validating a code that is developed to satisfy the need(s) of an actual user).

To that end, the Idaho National Laboratory established the Nuclear Energy Knowledge and Validation Center to address the challenges of modern code validation and to manage the knowledge from past, current, and future experimental campaigns. By pulling together the best minds involved in code development, experiment design, and validation to establish and disseminate best practices and new techniques, the Nuclear Energy Knowledge and Validation Center (NEKVaC or the 'Center') will be a resource for industry, DOE Programs, and academia validation efforts.This implies that Center personnel have a good grasp of the needs and priorities of potential collaborators. One of the first tasks of the Center, therefore, is to open a dialogue with stakeholders and solicit firsthand their views on what is needed and how the Center can help. This dialogue began with a 'Needs Workshop' in which representatives of different stakeholder groups were invited to discuss common and not-so-common challenges, identify opportunities, and offer advise on the direction and priorities of the Center. This workshop was help on the campus of the Georgia Institute of Technology on January 15th and 16th of 2015. This document summarizes the content and outcome of that meeting.

# NEKVaC WORKSHOP

## Objectives

At the time of the workshop, NEKVaC was still mainly a broad concept without much form. One of the intended outcomes was therefore to begin the process of defining the "Center's" structure by soliciting stakeholders' needs for nuclear code/model validation and the relative priority of those needs and identifying challenges and opportunities that would influence the scope and direction of DOE-sponsored validation efforts. These include:

- New system codes/models
- Multiphysics, multiscale code development
- Access to legacy experimental data

- New experiments in physics, thermal fluids, fuel materials, structures (fundamental, separate and mixed effects, integral experiments)
- New approaches to measurement and validation
- Validation for knowledge, performance, licensing.

The other goal of the workshop was to gather overall views on validation needs and practices and to identify the high priority validation needs of different stakeholders. This was accomplished mainly through breakout sessions in which the participants were divided into two groups among which there were common challenges, light water reactor technology and advanced reactor technology.

## Proceedings

The morning session of the first day consisted primarily of overview presentations covering the mission of the NEKVaC and the meaning of validation in the context of today's nuclear analysis codes. Hans Gougar, NEKVaC Director, opened the meeting and reviewed the objectives and mission. Philip Finck, INL Chief Scientist and Director of the OECD Experts Group on Multi-Physics Experimental Data, Benchmarks and Validation (MPEBV), discussed the background of the Center, the purpose of code validation, and complexity of the endeavor.

Validation serves different purposes for different stakeholders. Utilities and vendors validate codes as a necessary part of plant licensing. Vendors also require validated codes to accurately predict the performance of systems, structures, components, and plants. Scientists need validated codes to investigate the behavior of phenomena. A validated code can help reduce the need and frequency of experiments, which reduces product development time. Modeling helps to discover unknown phenomena. The nuclear industry is becoming more reliant upon validated simulations to integrate modeling with experiment to aid in the design process and to focus limited resources on the areas

Bill Oberkampf, WLO Consulting, discussed "Modern Code Validation Presentation." Traditional experiment goals understand the physics and mathematics. The goal of modern validation is to focus on the model, not the safety issue, margin, or plant safety. He then went into detail on the differences between traditional experiments and proper validation experiments. Oberkampf described the Hierarchy of validation experiments which capture individual phenomena at the unit scale and connect it up through the behavior of the complete system (Figure 1).

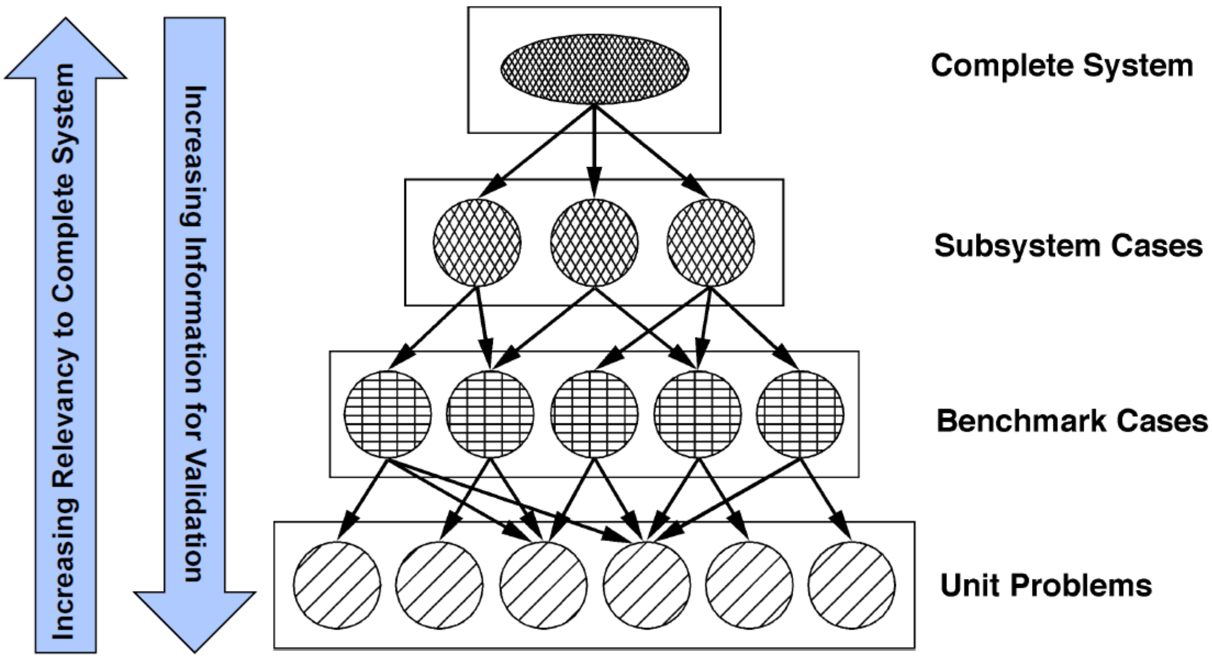


Figure 1: Validation Experiment Heirarchy (AIAA Guide, 1998).

Oberkampf described the six characteristics of a validation experiment and went on to give numerous examples of validation databases related to nuclear power. The goal of a modern validation experiment is to obtain an estimate of the model form uncertainty for the specific conditions and physics of the experiment, which subsumes an assessment of the accuracy, calibration, and it predictive capability. He concluded with suggestions for planning of new experiments and activities by the Center.

Shortly after lunch, two participants volunteered to present issues and thoughts on behalf of specific stakeholders. Gregg Swindlehurst, a private consultant for the Electric Power Research Institute, presented the EPRI perspective. Any research and development supporting the existing fleet must be considered important by both the industry and the regulator. This means the product of a validation effort must maintain or enhance public safety, address legacy, emerging, and aniticpated regulatory issues, sustain the operation of the fleet, improved operating margins, and economics, facilitate power uprates and life extension, and improve fuel reliability. Swindlehurst went on to list many existing data sets that need to be updated with new data. He shared results of a survey conducted by his company of industry organizations which identified key LWR phenomena for which validation data is lacking.

Steve Bajorek of the Nuclear Regulatory Commission followed with a discussion of legacy data which continues to have high value but may be under-utilized. Additional legacy data that may be used can be identified by PIRTs (Phenomenon Identification and Ranking Tables) and prior submittals. The efficient use of this data, however, requires a consistent electronic format, details of instrumentation, and detailed facility description, a full data report documenting the tests, and a scaling report. He recommended that NEKVaC focus on *model* uncertainty, as opposed to *code* uncertainty which is scenario specific. Bajorek indicated that the NRC is will to help link their extensive database with the Portal to be constructed by the Center.

Immediately following these talks, the two Breakout Sessions were organized to identify customers/stakeholders and their needs for NEKVaC, including facilities, data, validation support, etc. The first group focused on needs from Light Water Reactors (LWR), Advanced LWRs, and Small Modular Reactors (SMRs). The second group focused on other advanced reactors (non-LWRs).

The meeting concluded with a summary from each breakout team and an overall discussion of the critical short-term activities for NEKVaC success. All presentations were posted on a INL public website, https://nekvacworkshop.inl.gov.

## Specific Suggestions and Outcomes

- Establish the US Center (Hans Gougar)
  - Charter, functions, staff
  - Interface with OECD/NEA (Phillip Finck)
  - Establish relations with stakeholders/identify needs (today)
- Form a Steering Committee to Develop and Initiate a Process for Assessing and Prioritizing Legacy and New Experiment Evaluations (Hussein Khalil)
- Form the Methods/Standards Group Identify best practices/protocols of the reactor physics benchmark projects and adapt/expand them for thermal fluid and multiphysics code validation (Tim Valentine)
- Initiate identified near-term projects

Specific suggestions for Center activities were identified and listed here.

Near-Term/High Priority Activities

- Populate committees/Charter
- Data
  - Process for submitting/selecting proposals for access to non-US data
  - Legacy data recovery
  - Legacy and nonUS data qualification
  - Database Portal – construct an internet 'storefront; in which a user could gain easy access to existing databases. Some discussion ensued regarding the format and access policies.
- University project (IRP/NEUP) – advise DOE on calls for proposals and develop a plan for an integrated research project.

Specific Projects

- LOFT/EBR2/THORS Legacy Experiment Mining and Re-evaluation for Sodium Fast Reactors
- Portal Construction (hosted by the Radiation Safety Information and Computation Center at Oak Ridge National Laboratory. Initial databases to be linked:
  - NRC
  - OECD/NEA
  - NDMAS
- Build on the Nuclear Energy Knowledge Management System (NEKAMS)
- Standard Development for Data Qualification
- Value Proposition
  - Qualification/Benchmark Construction
- Develop a Roadmap for future projects

The attached Appendixes I and II includes the Agenda, Breakout Session Results, a statement of the EPRI Perspective, and a list of Attendees.

# Appendix I
# Agenda

***Thursday, January 14, 2015***

08:00 Welcome/Workshop Goals and Format ........ Hans Gougar
*Director, NEKVaC*

08:30 Introduction of Participants ........ All

08:45 Modern Code Validation – Challenges and Opportunities ........ Phillip Finck
*INL Chief Scientist and Director, MPEBV*

09:15 Modern Code Validation – How do we do it? ........ William Oberkampf
*WLO Consulting*

10:00 Break

10:15 Roundtable: Terms of Reference - Validation Definition, Objectives, Activities, and Gaps .. All

11:45 Preparation for Breakout Sessions ........ All

12:00 Working Lunch – NEKVaC Organization and Initial Activities ........ Hans Gougar

13:00 Industry Perspective ........ Gregg Swindlehurst, Electric Power Research Institute

13:30 NRC Perspective ........ Stephen Bajorek, Nuclear Regulatory Commission

14:00 Breakout Sessions ........

- LWR, SMR, and ALWR
- Advanced (non-LWR) Reactors

Identify and prioritize validation needs related to reactor and fuel performance, core physics and fuel cycle analysis, T-H design, safety analysis, structural mechanics, etc. Describe the types of experiments and/or legacy data analysis that would be needed.

15:00 Adjourn

***Friday, January 15, 2015***

08:30 Breakout Session Reports ........ Kumar Rohatgi and Hans Gougar

10:00 Break

10:15 NEKVaC Scope and Strategy ........ All

How can DOE, through NEKVaC, have the most impact given limited resources? For high priority activities, who must NEKVaC engage? What value can be obtained from legacy experiments and international efforts (MPEBV)? How can stakeholders help NEKVAC help stakeholders?

11:30 Summary and Path Forward

# Appendix II
# Attendee List

| Last | First | Email | Organization |
|---|---|---|---|
| Bajorek | Stephen | stephen.bajorek@nrc.gov | NRC |
| Braase | Lori | lori.braase@inl.gov | INL |
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| Dinh | Nam | ntdinh@ncsu.edu | NCSU |
| Edgar | Christopher | cedgar@gatech.edu | Georgia Tech |
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| Ghiaasiaan | Mostafa | mghiaasiaan@gatech.edu | GA Tech/ ANE |
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| Zhang | Hongbin | hongbin.zhang@inl.gov | INL |

# Appendix III
# NEKVaC Organization

The Nuclear Energy Knowledge and Validation Center was created to address the challenges of complex (e.g., multiphysics) code validation. The mission of NEKAVC is to re-evaluate experiments using modern numerical, analytical, and scaling techniques so the data can be used for the validation of modern codes; to establish guidelines for validation with the available and future tests; and to establish and implement a process for designing experiments using new measurement and analytical techniques that simultaneously validate high fidelity simulations and exploit their full capabilities. Mission areas include validation methodology (e.g., Energy and Mass Transfer code, Fuels and Materials codes, Multiphysics, Multiscale codes); Standards Development and Benchmark Protocols (e.g., Zuber's 2-Teired Hierarchy, ICSBEP, IRPhEP); Data Analysis (legacy data evaluation and re-use, data reduction techniques, etc.): Experiment and Code Development Facilitate Integrated planning; and Knowledge Management. These are reflected in the structure of the organization (Figure 2).

***VISION***

**The *Nuclear Energy Knowledge and Validation Center* is a partner and essential resource for code owners, users, and developers to acquire the best practices and latest techniques for validating codes, planning and executing experiments, gaining access to and fully exploiting existing data, and preserving knowledge for use by their successors.**

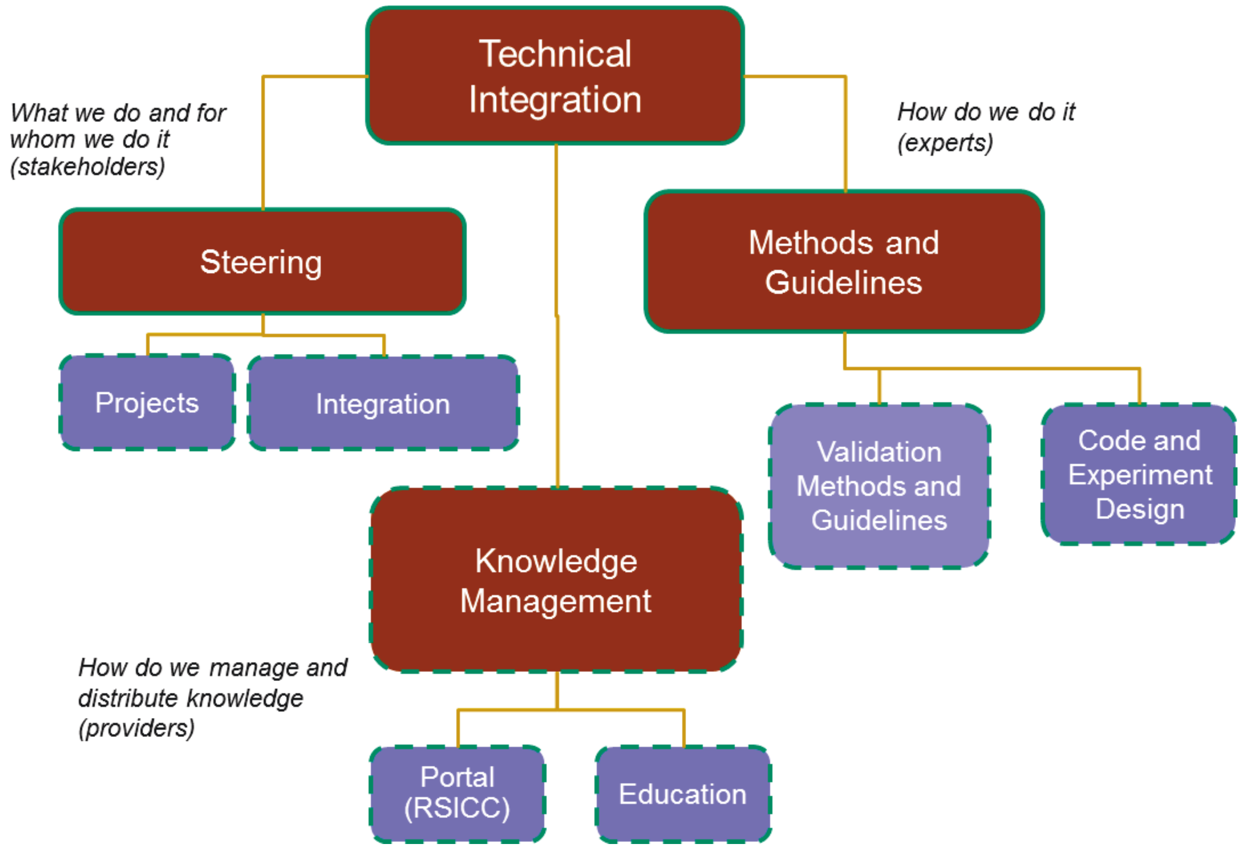


Figure 2. NEKVaC Organizational Structure

# Appendix IV
# BREAK OUT TEAM RESULTS

**Advanced Light Water Reactors and Small Modular Reactors**

The Group identified three possible stakeholders who should be kept informed and solicited for needs.

1. U.S. Research community-Universities, national labs
2. USNRC
3. Vendors/Utilities

The needs were basically the same for the three stakeholder groups. In the near-term, NEKVaC should:

1. Document and Preserve legacy data such as LOFT and related expertise.
2. Review validation practices from other science and technology initiatives and augment nuclear community's validation practices.
3. Develop standards for data documentation and preservation, addressing completeness and ease of use for validation.
4. Develop the standard for documenting quality assurance.
5. Provide a central location for data related to publications from DOE programs in citable form.
6. Initiate educational programs for validation, verification, uncertainty evaluation and quality assurance.

In the long-term, NEKVaC should:

1. Become one stop shop for stakeholders with free and fee paid access to data.
2. Become a repository of data for DOE-NE programs such as CASL and NEAM with safeguards for posterity.
3. Develop PIRT or procedure to identify data gap for intended applications.
4. Support advance code such as CFD, Multi-scale, Multi physics codes for reactor applications.
5. Acquire and preserve plant data for operating and shut down plants.
6. Acquire old and current international data, including benchmarks and other data from CSNI/NSC of OECD or provide access to these data.
7. Interact regularly with the stakeholders to assess their needs and to obtain feedback on the Center.
8. Serve as back up for NRC data.
9. Collect EPRI input for industry needs for data-TH and fuel, as well as heat transfer data in CHF/post CHF, irradiated fuel and components.

**Advanced (Non-LWR) Reactors**

The Group identified four main needs and the associated customers and facilities.

### *Need No. 1 – MET – Intermediate Subsystem Scale Data*

- Customers: NEAMS and ART-SFR,ART-VHTR
- NEAMS needs High fidelity multiphysics/multiscale tests to generate data showing mixed effects for multiscale, multisystem codes
- ART needs lower-fidelity system parameter measurements for integral codes
- Types of Experiments (Facilities)
- THORS experiment - legacy
- Cavity Cooling System performance (NSTF) - ongoing
- High Temperature Test Facility (HTTF) – <2 years
- MAX
- Fuel Assembly Seismic Response experiment
- THORS experiment used only wire-wrapped SFR bundles.

### *Need No. 2 – SET Uncertainty Data*

- Customer: NEAMS
- Most existing SET data lacks uncertainty information which is needed to estimate uncertainty in higher level models
- Data for very low/very high Pr in particular
- Challenge: More instrumentation is needed (spatial resolution and statistics)
- Opportunity
- QuBE, PLASJEST,PLANDL facilities.

### *Need No. 3 – Integral Experiments and Operating reactor data*

- Customer: ART-SFR and ART-VHTR (integral/system codes)
- Response of Structures during normal ops and transients (SFR)
- Natural circulation and transition regime data for both SFRs and HTRs.
- Radial Temperature distribution in assemblies (SFRs and HTRs).
- Sodium-air-water-concrete interactions at various pressures (SFRs)
- air ingress/oxidation data for HTRs
- At least some is legacy data (THORS, EBR2, FFTF, etc.)
- HTTF for HTRs
- New experiments needed as well
- Integral codes are more likely to be used for design, licensing (higher priority).

***Need No. 4 – Licensing***

- Customer: Vendor/Utility
- Need: Mechanistic source term data and parameters that affect it.
- Fuel performance data
- Core temperature profiles.

# Long-term (>5 years) as no design is ready for a license application or certification.ELECTRIC POWER RESEARCH INSTITUTE (EPRI) PERSPECTIVE

Any R&D initiative in the context of the operating LWR fleet must focus on the following questions and related considerations

- Is it important to the industry and/or to the regulator?
  - Maintain or enhance public health and safety
  - Address legacy, emerging, and future regulatory issues
  - Sustain operation of fleet
  - Improve design and operating margins
  - Improve fuel cycle economics
  - Facilitate power uprates
  - Facilitate life extension
  - Improve fuel reliability
- Is it technically achievable and has uncertainty been addressed?
- Can it be implemented by the industry within an acceptable schedule?
- Is it cost-effective?

Additional Considerations include:

- Need to ensure international experimental test data is captured
- Obtaining release of proprietary data may be the best approach to addressing data gaps
- Any testing program needs code analysis to be performed in parallel
- High cost of testing requires using M&S instead, so focus on assessment of fundamental physics of M&S codes (e.g. CFD, fuel rod thermal-mechanical, pin-resolved neutronics)

INDUSTRY CHALLENGE: How to work with regulators to obtain a cost-effective mix of simulation and data that can be used in regulatory decision making.

**Use of Existing Studies to Identify Data Gaps**

**Note that many of the existing studies are old and need to be updated with more recent data.**

1) Separate effects tests
   - CSNI(1993)14 – SET Matrix for T/H Code Validation
   - CSNI(1996)16 - Evaluation of the SET Validation Matrix
   - NUREG/IA-0126 – 2D/3D Program Work Summary Report (1993)
   - NUREG/IA-0127 – Reactor Safety Issues Resolved by the 2D/3D Program (1993)
2) Integral effects tests
   - CSNI(1987)132 – CSNI Code Validation Matrix of T/H Codes for LWR LOCA and Transients
3) Containment
   - NEA/CSNI(2014)3 – Containment Code Validation Matrix
4) CFD
   - CSNI(2007)13 – Assessment of CFD for Nuclear Reactor Safety Problems (2014 rev)
   - CSNI(2010)2 – Extension of CFD Codes to Two-Phase Flow Safety Problem (2014 rev)
5) Fuel, fuel rod, and fuel assembly/bundles
   - CSNI(2009)15 – Nuclear Fuel Behaviour in LOCA Conditions
   - CSNI(2010)1 – Nuclear Fuel Behaviour Under RIA Conditions
   - CSNI(2001)21 – In-Vessel Core Degradation Code Validation Matrix
6) Transient test reactor
   - LOFT - LOCA and transients (1976-1985)
   - SPERT – RIA (1969)
7) U. S. system T/H analysis code assessment compilation (EPRI 2014 Report 3002003110)

**Industry Survey Feedback on Data Needs**

1. Critical heat flux
    a) Low-flow, flow stagnation, and reverse-flow conditions for a range of pressures
    b) Need transient CHF correlations or first-principles approach (use of steady-state correlations during transients loses margin)
    c) Surface effects currently are not included
    d) Chemical effects currently are not included
    e) Post-CHF heat transfer (cladding failure is assumed rather than modeled)
2. Effects of exposure on fuel performance (major NRC decisions based on too few data)
    a) During LOCA
    b) During RIA
3. Two-phase flow
    a) Subcooled boiling data in PWR rod bundles that quantifies the heat fluxes that result in sensible heating and in boiling (needed for both clean and crudded cladding surfaces)
    b) Void drift interior to and between fuel assemblies
    c) Multi-dimensional two-phase flow
    d) Tests in large vertical pipes, large angled pipes, and large tees
    e) Critical flow data for a range of break sizes and conditions
4. LOCA
    a) Vessel downcomer boiling during refill and reflood
    b) Boron transport (dilution and precipitation)
    c) Gravity-driven reflood
    d) High pressure radiation emissivities for steam
5. Miscellaneous
    a) Natural circulation stability
    b) CFD-grade flow patterns in reactor vessel downcomer and lower plenum (LOCA and SLI
    c) CFD-grade tests for containment effects (refer to CSNI(2014)3)
    d) Pin-resolved neutronics transient experimental data
    e) Fuel assembly distortion during irradiation and related neutronic and T/H effects

# Braase Raw Notes

## Hans Gougar

- Opened the meeting.
- Reviewed the objectives and mission.

## Philip Finck

**Discussed the background of the center and complexity of verification and validation.**

- We do V&V to Reduce the need and frequency of experiments.
  - Get the final product faster.
- Modeling helps to discover the phenomena you don't know.
  - Tried to integrated the modeling with fuels experiments.
  - Rather than 25 years, license fuel in 10 years.
  - Design fuel faster.
- Policy issues are a different matter.
- Validation levels. (See slide.)
  - Use validation to see what is missing.
    - Who are the users?
    - For what codes?
    - What are their uses?
      - Applications?
      - Level of validation?
      - Gaps?
- Take time to do this well

## Bill Oberkampf

**Modern Code Validation Presentation**

- Traditional experiments goals:
  - Understand the physics and building mathematics.
  - Parameter estimation side.
  - e.g., Loft.
- Goal of modern validation. (See slide.)
- Focus is on the model, not the safety issue, margin, or plant safety.
  - Can the model predict what is in the laboratory.
  - Customer is different.
  - NRC versus code developer.

**Slide 4:**

- Experiment Hierarchy
  - Can be drawn at any level of a system.
  - Could be a complete plant or on cladding failure.

- Any level. Tradeoffs – blue areas.
- Validation is easier at the lowest levels.
- Models need to be done at each level.

**Slide 6:**

- International Validation Data bases related to nuclear power.

  **Issue:**

  proprietary databases – no access. Valuable data.

**Slide 7:**

**Characteristics of validation experiment.**

1. You must work together.
   - Modeler needs to identify those physics models that need to be assessed.
   - Experimenter works with modeler to gather data.
   - Inputs are given
2. Use model to determine what is going on in the experiment.
   - Need to understand model weaknesses.
   - Need to quantify the uncertainty.
   - The model needs to reflect the comparison in the laboratory/experiment, not in the final application. Or system of interest.
3. Point of calibration.
4. Can't do this with existing databases.
   - New experiments.
   - Calibration versus validation.
5. Model improvement is not a validation activity.
6. Uncertainty. Modern validation. What needs to be validated by experiment to be put into the model.
   - Focus on the most important input quantities.
   - What does the modeler do?
   - Consider as uncertainty or a free parameter to tune the model.
     - Once you start tuning the model, you ruin the validation.
   - Validation
     - Focus on what is going on this experiment. No other experiments or other validation models.
       - There are other experiments/data that will be needed to reduce uncertainty.
       - There will be uncertainties, which should be reduced thru other experiments.
       - Model uncertainty is different.

**Slide 10:**

**Goal of a validation experiment**

- Model form uncertainty.
  - Can I validate a model with one experiment? Not likely. Too much variability in the input condition.

- All input data to a model fit into these categories: See data characteristics
- Uncertainty on input is rarely done.

**Slide 11:**

- Validate for the experiment. Initial conditions. Models can be corruptions by bugs in the code, etc.
- Numeric introduced errors are sufficient
  - Estimate the magnitude of numerics and then increase the uncertainty.
    - Don't ignore it.
    - Show it.

**Slide 12:**

- Initial data provided to modeler.

**Slide 14:**

- Epistemic uncertainty input causes problems with prediction in the model.
  - Was not documented or provided to modeler.

**Slide 15:**

**Planning new experiments.**

- Two perspectives. Must identify the most important inputs.
  - Physics improvements by model builders or researchers.
  - Application improvements.

## Questions and Answers

- Changing paradigm.
- Coupling of physics as you go up the hierarchy.
- Two weaknesses.
  - Page 13
- Time series validation metrics is a new field.
  - Time dependent process.
  - Frequency discretization are both new inputs.
  - These validation procedures don't address the extrapolation problem.
- How do you estimate the uncertainties as you go up the hierarchy.
  - Alternate plausible models are used today. Common, but expensive.
  - Capture uncertainty of model and systems of interest.

### Questions

- What other fields are doing a better job in validation?
- There are other entities that look like NEKVaC. Are there other centers?
- Will NEKVaC be a repository for data?
  - Nuclear weapons labs do pretty well but not available.
  - NASA Langley, air force, underground storage for nuclear waste.
  - More statistical emphasis. They use multiple models for physics. Then they combine them to determine the applicability to the system.
  - Numerical errors are not typically dealt with.
    - NEKVaC – virtual place. Databases connected but not necessarily a storage location.
    - Validation center will perform a consistency check on data. Adopt current best practices and use their protocols. Adapt and apply as possible.

### Issues

- Export control data (national and international)
- Round Table Discussion: Establish a Baseline
- Focus of multi physics tests, Integral tests,
- NEA has disjoint specific benchmark activities.
- International has focus on multiphysics tests.
- Single effects tests or thermal
- Integral tests versus ???
- What is validation? See table with notes.

### Vision

- Discussion – 5 years.
- Best practices and latest techniques for validating codes and models

- Recommending experiments to be conducted
- Access to or in-center expertise
- Design and experiment is part of the knowledge package
- Partner and resource; for acquiring
- Preserve knowledge for transfer to next generation.
- The center will be virtual – starting at INL but partner with other labs. No facility.
- Critical mass of full time people somewhere is needed.
- SMEs in various areas will be part of the center. Point of pulling the pieces together.
- Data Base and data management tools are needed.

## Organization

- Where are the gatekeepers?
  - Physically maintaining the website.
  - 2nd level third box.
- Rethink the organization.
- Counter this issue with NEAMs.
- ICSB type of functions. ISCSVEP
- Capture the cross cutting areas of the organization, including the infrastructure
- Cross cut – level of effort functions that go on each year.
- Semi-annual meetings may be necessary for some topics with a review group to determine data relevance.
  - Check the metrics/standards and analyze the status.
  - What can the data be used for?
  - Benchmark?
  - General testing?
- Projects are not really part of the organization.
  - Consider redrawing the chart to reflect the interface with the Projects.
- Function Collaboration
  - Show integration of universities, contracting, DOE, labs, etc.
- Education function
  - Train young people to make the project sustainable.
  - Forum for students to publish
- Connection with the MeV school.

## EPRI Presentation

**Page 4.**

It would be nice to have the payoff associated with the data.

- Cross-reference this:
  - What do you need it?
  - Why do you need it.?
- This is a starting point for industry needs.
  - Use the EPRI list and add to it for LWRs.
- EPRI Report on Page 3 last bullet No. 7. Useful document.
  - Download from EPRI website.

**Day two**

**Hans reviewed an updated organization chart.**

- If you are interested in working on one of the areas:
  - Let Hans know.
  - Committee chairs are needed.
  - Some funding is available.
- Small groups can be used to identify and evaluate legacy data.
  - This is what we have
  - This is what we want
  - This is what we can offer.
- Process for new experiments:
  - Proposals come through and the steering committee
    - They will identify or guide the appropriate direction. Is it in line with growing the mission; meet a validation need? Could use NEUPS, IRP, etc.
- It could serve to help bring parties together.
  - Get people involved to improve communication and synergism.
  - Improvement in communication at the DOE level.
  - Long term strategy.
  - Efficient use of groups in experimental and computational areas. (Expand box: Experiment Planning and Code Development).
- A strategy in NE and labs to get things working together.
  - Investment strategy to determine priority funding.
- Proposals for experiments from various groups (LWRS, ARC, etc.).
  - The center advises or guides the experimenters.
  - Coordinates with DOE at a higher level. (Hans look at this area)

# Breakout Session: LWRs

## KUMAR

- Discussion on expense of getting data from irradiated tests. One integral test could be 1 M.
  - This data exists and could be leveraged.
  - Data is needed prior, during, and after irradiation. Cabri is a good example.
    - Develop a structure way to mine the data that exists and a plan to acquire data.
    - Business model to buy the data.
    - Consortiums like NFIR and Halden that have a fee that will provide access to data. \\
    - Center negotiates getting the data. Retailer.
  - International efforts that should be approached. FUMAC -Fuel modeling under accident conditions. Kickoff in November. They are looking at key accident scenarios – analyze data – validates data and then they will compare. They get data from IFPE. Everyone runs their own codes and then compares. Objective is model improvement. The center should be aware or involved. Link to the open data. Center could help with pedigree of data.
  - OECD experts group will be looking at qualification of the data. "Don't penalize a good code with lousy data."
  - NRC Perspective on NEKVaC. See Presentation.
  - Center can help make everyone more efficient.
  - Data references are available in the EPRI report mentioned yesterday.

**Slide 2:**

- Center could take the data and consolidate it.
  - Make it useful.
  - Create a high level guide of recommended tests for various listed assessments.
- Can the NRC's software format be shared?
  - Format of the data.
  - Plotting package.

    Yes. Having this data in one spot would help the modelers. Center could be Nexus between experimenters and modelers.
- NRC has a list of what is in the code development data base. Adams is the name.
- Center could link the systems together.
- Model at NRC means correlation or group of correlations.
  - Compare to applicable data.
  - This is where NEKVaC should focus.
    - Models and correlations and how they simulate the data.

    However, (Bill) we are validating the code, which is the implementation of the model.

## Education part. Nam Din

- Open collaboration.
  - Student needs to do validation on their own.
    - New way

- New culture
- Useful for students.
- New incentive for invention.
  - New V&V journal and new editors.
- High expectation in validation.
  - Calibration.
  - Promote their instruments.
  - Recognized in the community.
  - Promote new culture.
- Advanced tool support – CASL.
  - Code data needed. Need then they identify the instrument.
- Microscale, meso scale, and
- New advanced agnostic.

- Promote awareness
- Promote DOE and NEUP. Need advanced agnostics.
- NEUP and IRPs.
- Advisory body to NE for the validation needs in support of NEUPS.
- NEKVaC should have an interactive website that could have active blogs under various topics. Website development of a communication tool.
- NON-LWR Group Session Report Out.

  After break.

### Path Forward

- See Han's last slide.
- Take advantage of NEKAM
- Intent of non-US legacy data.
  - There are legal issues and treaties that the Center can help with.
- Early, quick success.
  - A customer for one of the early activities would be nice.
- Center should be forward looking to anticipate future needs.
  - Specific Projects
  - LOFT/EBR2/THORS
  - Link/Portal/Migrate:
    - NRC, OECD/NEA, format, Lessons Learned from NEKAMS.
- Value Proposition
  - How does the center add value.
    - Pedigree of data, qualification process adds value,
    - Be valuable to DOE and others.

- Create a roadmap-credible
  - How would the Center start and how would it take on broader and broader objectives.
    - Develop a business case or business model.
    - Recover other Analyses that have been performed.
    - First establish standards for data quality and validation.
    - ICSB group should be engaged in the center.
    - Physics benchmarks is a good system at OECD/NEA.
    - Look at CSNI standards/benchmarks. E.g. ROSA 3 experiment. Korean Atlas facility (APR 1480 – system 80 Plant) International standards problem. Should be public soon.
- Concern
  - List of things the Center can do is very extensive.
  - A big success would be to help NEAMS to motivate measurements that they need to motivate investment in the experiments.
  - Raise level of awareness of what is out there.
  - Preserving legacy info and associated standards.
  - Motivating new types of measurements and benchmarks
- Methods and Standards
  - NEAMS and CASL identify needed experiments
    - Could the center help align tests that could be done in other facilities?
    - Connect experimenters with facilities.
    - Help design experiments to support single and multiphysics codes.
- Motivating experiments
  - Multiphysics require a specific set of experiments that go beyond a set of facilities.
    - What data is needed.
    - How to coordinate the sets of tests.
    - Break down barriers between experimenters and code developers.