

# Verification and Validation: Staff Reviews and Comments

*presented by*  
Sitakanta Mohanty

NRC/DOE TSPAI Issue Resolution  
Technical Exchange

Las Vegas, Nevada  
August 6-10, 2001

*Legacy, Main - 21*

# Working Definitions

---

- Verification (Software)
  - Provides assurance that a computer code correctly performs the operations specified in a numerical model
- Validation (Model)
  - Provides assurance that a model (e.g., conceptual or mathematical) as embodied in a computer code is a correct representation of the process or system for which it is intended. Validation demonstrates that the model accurately represents the real system.

# Verification: What is Involved?

---

- Conduct tests to provide adequate evidence of
  - Correct and successful implementation of algorithms
  - Correct model calculations over the whole uncertainty range of relevant data
  - Appropriate level of agreement with analytical models and other well-established software
- Implementation of adequate quality assurance and review procedures
  - Follow a well-defined and rational assessment procedure
  - Apply procedures across the software consistently
  - Document the verification process, potential deficiencies, and limitations
  - Disclose results fully

# Validation: What is Involved?

---

- Provide information to demonstrate that
  - Processes are properly formulated mathematically and parameterized following “commonly” accepted theories
  - Model accurately represents a specific component (e.g., waste package) or aspect (e.g., heat flow) of a real system
  - If a new theory is used [e.g., the active fracture model] then the new theory tested
  - Numerical schemes used have acceptable convergence properties
  - Dimensionality (space and time) is appropriate
  - Simplification does not introduce “optimistic” biases

# Verification (Software)

# Results of Staff Review

---

- General:
  - DOE has the elements of verification in their TSPA-SR and supporting documents, but rigorous verification yet to be accomplished
  - No verification plan
  - Verification not uniform across the document
  - Limited set of random hand calculations do not represent a systematic approach to verification

# Results of Staff Review (cont'd)

---

- Specific:
  - Various errors found in DOE hand calculations
  - Abstracted models used outside the range for which they were developed
  - Significance of warnings and errors in the GoldSim error log file not explained
  - TSPA model behavior verification did not include extremes of the input values
  - Verification did not step through different parts of the model in large segments of the TSPA code

# Current Status

---

- TSPA-SR Technical Document has several good examples of appropriate level of detail to explain how the models function. Examples:
  - Figures 4.1-10, 4.1-13, and 4.1-14
  - Discussions on pages 3-93 and 4-8 of the TSPA-SR Technical Document
  - DOE has responded to the concerns noted in the May 17, 2001 letter from Reamer to Brocoum
- NRC is reviewing DOE's July 6, 2001, response

# Path Forward (Summary)

---

- Provide a plan/strategy to verify and document the calculations and computer codes supporting TSPA
- Provide minimum requirements for completing verification
- Provide a plan for how verification action and results will be documented

# Validation (Model)

# Results of Staff Review

---

- DOE's model validation efforts are ineffective
  - Two Corrective Action Reports (CARs) have been issued
    - CAR BSC-01-C-001
      - Failure to consistently implement quality assurance (QA) program requirements (AP3.10Q)
    - CAR YMSCO-01-C-002
      - Failure to implement Quality Assurance program related to software
      - Lack of effective independent verification and validation

# Results of Staff Review (Cont'd)

---

- Validation efforts are too limited
  - DOE has validated conceptual models but not the corresponding mathematical models (e.g., biosphere)
  - Objective comparisons are not provided for the constituent models
  - Validating a detailed process model does not validate the corresponding abstracted model
  - Rigorous model validation at the system level has either not been conducted or has not been adequately reported
  - DOE requirements for model validation (AP-3.10Q) have not been consistently implemented
- Use of peer review
  - Peer review is not a substitute for objective information that is reasonably available ( e.g., field data, laboratory data, or natural analog information)

# What Needs to be Done?

---

- DOE needs to define model validation program (strategy/plan)
- Validation strategy should include the following attributes:
  - Theoretical support for models
  - Additional lines of supports
    - Natural analogs
    - Field tests {provide technical basis for selection}
    - Laboratory studies
  - Peer review can be used but not as a first recourse
  - Extent of model validation is commensurate with importance (i.e., all models should be validated, but the important models should be validated more rigorously)

# What Needs to be Done? (cont'd)

- An example strategy has the following elements:
  - Define a compliance demonstration strategy
  - Determine the goals for model validation
  - Determine the existing degree of validation for the selected model(s)
  - Compare the validation goals to the existing degree of validation
  - Decide whether to revise the compliance demonstration strategy
  - Obtain additional information to support validation of the preferred model (where appropriate)

# What Needs to be Done? (cont'd)

- Provide appropriate documentation
  - Document statements of model validity (i.e., a framework to facilitate acceptance (or rejection) of models used
    - Use transparent and logical reasoning
    - Show all steps of implementation of model validation strategy
    - Document the extent of peer review. Peer-reviewed material should find support from quantitative analyses of experiments or other proofs
  - Show explicitly validation results against the validation criteria

# Path Forward (Summary)

---

- Provide an appropriate plan/strategy to validate the models
- Justify the qualitative and/or quantitative validation criteria in the plan and discuss further in the TSPA and other supporting models/results documents
- Provide documentation that the approach taken to validate the TSPA model satisfies the requirements of an adequate quality assurance procedure
- Provide appropriate documentation with statements of model validity with validation results against validation criteria