U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: THERMAL STUDIES: RECENT EXAMPLE

PRESENTER: RICHARD MEMORY

PRESENTER'S TITLE AND ORGANIZATION: SYSTEMS ANALYSIS AND MODELING MANAGER,
CRWMS MANAGEMENT AND OPERATIONS CONTRACTOR
LAS VEGAS, NEVADA

TELEPHONE NUMBER: (702) 794-7247

AUSTIN, TEXAS
APRIL 30 - MAY 1, 1996

System Studies' Role in Systems Engineering Process

- **Provide an integrated technical basis for**
  - **Program decisions**
  - **Technical requirements**
    - » **Provide a balanced allocation of requirements across the system elements**
      - * **Performance**
      - * **Cost**
      - * **Risk**

Thermal Loading: A System Issue

- Repository thermal loading (mass/area or power output/area) has far-reaching system impacts
  - Influences long-term, large-scale thermal disturbance of the ambient system
  - Influences near-field, preclosure temperatures
  - Influences repository design and operations, for example:
    - » Surface facility storage
    - » Area needed
    - » Drift and waste package spacing
    - » Ground support
  - Influences EBS/waste package design
    - » Material selection/thickness

Thermal Loading: A System Issue

(Continued)

- Domain of influence of thermal loading depends on many parameters, such as
  - Level of thermal loading
  - Rock properties (permeability, liquid saturation, porosity, thermal conductivity, geochemistry, etc.)
  - Presence and extent of fractures
- Thermal loading is a highly visible issue, with many disparate opinions existing on the subject
  - Not a great deal of data available to verify influences

Thermal Loading System Study Approach

- Utilizes an Integrated Product Team, led by a system study manager
- Tasks are assigned to the team members after discussion of the issues with the team members
- Task results are provided as input to other follow-on tasks within the study
- The tasks' output and study conclusions are documented in a thermal loading system study report
- Study report is reviewed and revised, as necessary
- Study recommendations are published

Thermal Loading System Study Integrated Product Team

- Personnel from the following areas:
  - Design Engineering
  - Program Systems Engineering/Waste Acceptance
  - Scientific Programs
  - Performance Assessment
  - Licensing
  - Environmental
  - Systems Engineering
  - National Laboratories
  - University of Nevada
  - USGS

Thermal Goals: System Integration Example

Goal	Influences	Implementation
350°C waste package centerline temperature - Integrity of fuel cladding	Waste package spacing drift spacing, drift diameter, waste package power output (allowable)	19.1m waste package spacing (PWR), 22.5m drift spacing, 5m drift diameter, 14.2 kW max per package (ACD)
200°C drift wall maximum temperature - rock stability	Waste package spacing, drift spacing, drift diameter, waste package power output (allowable)	19.1m waste package spacing (PWR), 22.5m drift spacing, 5m drift diameter, 14.2 kW max per package (ACD)
115°C TSw 2/3 interface maximum temperature - zeolites - mobilization of water	Horizontal extent of repository	30m standoff from repository

Example of Task Integration

- Evaluate necessity for 200° C drift wall temperature limit
  - Sandia National Laboratories assigned the task of determining the thermal mechanical impact on the host rock of various peak drift wall temperatures
  - Results provided to subsurface design, which determines ground support requirements and associated costs
  - Performance assessment determines the impact on total system performance, if any, of the drift wall limit
  - Study manager integrates the findings, with the participation of the Integrated Product Team, to determine whether it should be recommended to modify the limit

Thermal Loading System Studies' Influences on Program

- **FY93 Thermal Loading System Study evaluated alternative thermal loadings in terms of performance, cost, and operability**
  - **Recommended narrowing range to < 100 MTU/acre**
    - » **Incorporated in Controlled Design Assumptions Document and used as input to the thermal loading strategy; used in ACD design and test planning**
  - **Updated SCP thermal goals**
    - » **Incorporated in Controlled Design Assumptions Document; used in ACD design**
  - **Provided consistency of assumptions pertaining to waste stream, repository layouts, waste package, etc.**

Thermal Loading System Studies' Influences on Program

(Continued)

- FY94/FY95 Thermal Loading System Study; identified priorities for thermal testing and evaluated potential thermal management approaches
  - Examined 10 features/processes for impact on performance
    - » Integrated Product Team members incorporated findings into test planning

Process Lessons Learned

- Integrating a broad range of areas of technical expertise involves understanding and accommodating a broad range of different cultures (or ways of doing business)
- To get the best use of the Integrated Product Team, the team must be involved in the study for the duration of the study. The team can stay involved through
  - Direct involvement in tasks
  - Periodic team meetings reporting on the status of team member tasks
- Allow ample time for a thorough technical review of the draft study report
- It is very important to anticipate and plan for completion of system studies to support customer needs in a timely manner