MEETING NOTICE

September 16, 1986 (M. Board)

U.S. Nuclear Regulatory Commission meeting with Itasca (Contract No. NRC-02-85-002), to discuss generic geomechanical and thermomechanical issues.

SPONSOR: U.S. Nuclear Regulatory Commission (NRC)
Division of Waste Management
Engineering Branch

CHAIRMAN: D. Tiktinsky, WMEG

DATE/TIME: September 15-17, 1986
8:30 - 4:00PM

LOCATION: Willste Building
Silver Spring, Maryland
1st floor conference room

PURPOSE: To review and discuss the generic mechanical and thermomechanical issues.

PARTICIPANTS:

NRC	ITASCA
J. Buckley	M. Board
D. Gupta	J. Daemen
M. Nataraja	L. Lorig
J. Pearring	
J. Peshel	
N. Tanious	
D. Tiktinsky	

AGENDA ITEMS:

Monday, September 15, 1986

Rock Mechanics Design and Analysis (M. Board)

A. Methods of Analysis
1. analytic techniques
2. numerical techniques
3. empirical techniques

Tuesday, September 16, 1986 (M. Board)

Geotechnical Site Characterization Testing

A. Site Exploration
B. Insitu Testing/Construction Monitoring
C. Representativeness of testing
D. Testing Methods

Wednesday, September 17, 1986 (J. Daemen, L. Lorig)

Rock Mechanics

A. Rock Mass Deformability and Strength
B. Thermal Behavior

Distribution
WM file: D1016
WMEG r/f
REBrowning
MJBell
JLinehan
JGreeves
MNataraja
DGupta
JPeshel
DTiktinsky
JPearring
JBuckley
BJagannath
NTanious

feedback to Dave

GEOMECHANICS IN REPOSITORY DESIGN, PERFORMANCE ASSESSMENT AND SITE CHARACTERIZATION

course outline

I. OVERVIEW OF REPOSITORY DESIGN AND PERFORMANCE ASSESSMENT PROCESS; THE ROLE OF GEOMECHANICS IN SITE CHARACTERIZATION

II. REVIEW OF ROCK MECHANICS PRINCIPLES

A. Rock Mass Deformability and Strength

1. <u>intact rock, general stress-strain curve</u>

   (a) constitutive laws
   (b) meaning of properties
   (c) strength/creep/laboratory techniques

2. <u>joints</u>

   (a) stress-strain behavior, properties, etc.
   (b) laboratory techniques

3. <u>rock mass deformability</u>

   (a) concept of size effect

   (b) combination of joints and intact rock

   (c) concept of equivalent continuum (review of Singh's approach to calculating equivalent moduli)

4. <u>rock mass strength</u>

   (a) meaning of rock strength (a discussion of modes of failure in jointed and viscous rock masses

   (b) yield criteria

      (i) Mohr Coulomb

      (ii) von Mises

      (iii) Hoek and Brown

      (iv) cap models

      (v) viscosity (power laws, visco-elasticity, visco-plasticity)

(c) size effect on strength (empirical relations from pillar and lab)

(d) practical demonstration of determination of opening stability by analytic means

B. Thermal Behavior

1. thermal conductivity and specific heat lab techniques/temperature and stress dependence

2. thermal expansion/lab techniques/temperature and stress dependence

3. creep — effects of temperature

III. METHODS FOR DESIGN AND ANALYSIS

A. General Philosophy on Rock Mechanics Design (use of analytic, numerical and empirical techniques)

B. Discussion of Methods

1. analytic techniques

(a) closed-form solutions for mechanical and thermal applications (useful solutions and when, and how to use them)

(b) pillar design formulae

(c) ground reaction curves

2. numerical techniques

(a) introductory remarks (role of modeling in repository design and performance assessment)

(b) types of numerical methods (where best applied, coupling phenomena, advantages/disadvantages)

(c) demonstration of MUDEC and FLAC, possibly for problem of size effect

(d) current DOE approach to modeling at various sites—i.e., current state-of-the-art (problems, limitations)

(e) strategies for validation and verification (what constitutes a qualified model)

3. empirical techniques

(a) rock support design methods (Barton, Bieniawski

(b) opening design (Hoek and Brown)

IV. GEOTECHNICAL SITE CHARACTERIZATION

A. Introduction (Geomechanics in the Site Characterizatin Process)

B. Site Exploration

1. in-situ stress measurement (different methods/ limitations)

2. drilling (methods, geotechnical core logging)

C. In-Situ Testing/Construction Monitoring

1. philosophy on in-situ testing (its role in providing rock mass behavior and model validation)

2. general forms of in-situ testing

(a) construction monitoring

(b) rock mass properties determination

(c) thermomechanical (small scale)

(d) large-scale excavation response/full-scale simulation

3. representativeness of testing

   (a) geologic variability
   (b) scale effects
   (c) excavation influence
   (d) anisotropy
   (e) boundary conditions

4. testing methods

   (a) instrumentation

      (i) instrument types, uses, limitations, accuracies

      displacement, stress change, strain, temperature, pressure, water content, crosshole ultrasonics, acoustic emission, borehole measurements, data acquisition

      (ii) review of nuclear waste testing methodology to date

      hard rock — Stripa, NSTF, CSM, Spent Fuel, G-Tunnel; salt — Avery Island, WIPP, Salt Vault

      (iii) construction monitoring

      purpose, methodology, data analysis, case study—The Silver Shaft

      (iv) rock mass properties determination

      discussion of scale effects, two approaches to rock mass constitutive model determination—empirical or continuum equivalent and mechanistic (based on discrete properties of intact rock and joints), types of tests (plate bearing, block tests, heater tests—discussed in detail as to how constitutive properties are determined using real test data and possibly using FLAC or MUDEC to model to illustrate equivalent continuum).

(v) large-scale excavation response

purpose, "mine-by" and thermomechanical room scale, back-calculation, use in model validation, determination of confidence limits in modeling

V. SPECIAL TOPICS

A. Dynamics

B. Excavation Techniques

C. Support Mechanics/Systems

VI. CONCLUDING REMARKS

GEOMECHANICS IN REPOSITORY DESIGN, PERFORMANCE ASSESSMENT AND SITE CHARACTERIZATION

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF WASTE MANAGMENT

DISCUSSION TOPICS

Monday, 15 September 1986 — Geotechnical Site Characterization and Testing

Morning
- in-situ stress measurement techniques and data interpretation
- in-situ testing (forms of testing and representativeness of results)

Afternoon
- in-situ testing methods
- instrumentation and data acquisition
- testing techniques (heater, block tests, large-scale excavation)
- analysis of data

Tuesday, 16 September 1986 — Design Methods in Rock Mechanics

Morning
- design methods
- numerical techniques (boundary element, differential, discrete element)
- demonstration of PC code
- model validation

Afternoon
- empirical techniques for rock support design (Barton, Bienawski), rock support methods
- empirical opening design
- rockburst mechanics (types, causes, prediction, prevention)

ITASCA

Wednesday, 17 September 1986 — Principles of Rock Mechanics Engineering

Morning
- — behavior of intact rock
- — behavior of rock discontinuities
- — rock mass deformability
- — failure modes in jointed rock
- — support mechanics

Afternoon
- — salt creep
- — rock mass strength
- — size effects
- — opening stability