

MEETING NOTICE

Monday, 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

J. Buckley  
D. Gupta  
M. Nataraja  
J. Pearing  
J. Peshel  
N. Tanious  
D. Tiktinsky

ITASCA

M. Board  
J. Daemen  
L. Lorig

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

GEOMECHANICS IN REPOSITORY DESIGN, PERFORMANCE ASSESSMENT  
AND SITE CHARACTERIZATION

*feedback to Dave*

*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. intact rock, general stress-strain curve

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

2. joints

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

3. rock mass deformability

- (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. rock mass strength

- (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 Characterization 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 MANAGEMENT

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)



**GEOMECHANICS IN REPOSITORY DESIGN, PERFORMANCE  
ASSESSMENT AND SITE CHARACTERIZATION  
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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