

WORKSHOP ON  
EXCAVATION RESPONSES IN DEEP RADIOACTIVE WASTE REPOSITORIES -  
IMPLICATIONS FOR ENGINEERING DESIGN AND SAFETY PERFORMANCE

WINNIPEG, CANADA  
26th - 28th April 1988

P R E L I M I N A R Y  
P R O G R A M M E

Organised by the  
OECD NUCLEAR ENERGY AGENCY  
in co-operation with  
ATOMIC ENERGY OF CANADA LIMITED (AECL)

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## BACKGROUND

At the first meeting of the NEA In-Situ Advisory Group (ISAG), a review was conducted of current needs in the area of in-situ research and investigations which led to two topics being highlighted as meriting discussion at the international level. The first topic concerns the potential responses that may be induced from using different types of excavation techniques during the construction of an underground repository for radioactive wastes; in particular, how such responses may impinge upon the safety performance of a repository and affect the engineering design. Secondly, there is a need to review the materials and methods available for backfilling and sealing repositories located in different geological media. The latter was seen as being consequent to a workshop on excavation response.

Of the numerous components of the multi-barrier concept for the deep disposal of radioactive waste, the boundary between the "engineered vault" (containing waste form, canister, backfill and sealing material) and the host geological environment (geosphere) is conceptually one of the least well understood components of the system. When considering the engineering design and performance of a repository, residual stresses, potential creep or subsidence, and induced fractures leading to increased potential for groundwater flow, are phenomena requiring analysis in order to answer the following key questions: To what extent do excavation responses impinge on the safety performance of a repository? What phenomena associated with excavating a repository should be taken into account when preparing final designs? These questions apply in varying degrees to all deep disposal concepts. The answers are by no means simple, even though much is already known from experience gained from tunnelling and mining operations. Recently, there has been considerable effort devoted to research into excavation responses. Geotechnical and rock mechanical investigations are part of each in-situ research programme. A mine-by experiment has been carried out at the Climax Mine in Nevada, and one is currently being planned at the Canadian URL to assess the ability to model rock-mass response to excavations and to assess rock-mass damage caused by different excavation techniques. Other studies, for example at the Konrad Mine in the FRG, examine stability following excavation using the room-and-pillar method. In salt and clay formations, creep is particularly important, especially that induced following the introduction of heat. This has been the subject of detailed studies at several facilities, including Mol, WIPP and Asse.

Several areas can be highlighted that merit specific attention in a workshop, including: (a) the overall context in which excavation response is viewed as a phenomenon to be accounted for in the design of a repository, from both the engineering and safety aspects; (b) the type of in-situ tests and measurements conducted; and (c) the mathematical models that have been developed. The validation of the latter is particularly important if they are to be used in support of performance assessment.

ISAG therefore recommended to the NEA Radioactive Waste Management Committee (RWMC) that ISAG should organise a Workshop on excavation response. A small Consultant Group\* developed the objectives and scope of the Workshop, and a Technical Programme Committee\* was established to oversee the planning. Atomic Energy of Canada Limited offered to co-sponsor and host the Workshop.

#### OBJECTIVES OF THE WORKSHOP

The objectives of the Workshop are to review the potential responses caused by the excavation of an underground repository for radioactive waste on engineering design and safety performance, and to develop recommendations on ways of accounting for excavation effects in argillaceous, crystalline, salt and tuff geological media. It is intended that the published proceedings of the Workshop will represent a state-of-the-art report on the treatment of excavation responses in developing deep repositories, including recommendations on design, validation and instrumentation needs.

Particular emphasis will be placed on theoretical analysis and modelling, in-situ measurement techniques, excavation techniques and methods available to reduce excavation responses. In addition, specific recommendations on topics to be addressed in a subsequent workshop on backfilling and sealing will be sought. In meeting the objectives, it is intended that a thorough exchange of views occurs among scientists working on different host rock types. The Workshop will also provide a forum for discussion between those conducting in-situ measurements and those preparing predictive models on excavation response effects for use in safety assessments of repositories.

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\* Consultant Group (February 1987): A. Bonne (SCK/CEN, Belgium), W. Brewitz (GSF, FRG), G. Simmons (AECL, Canada), R. André-Jehan (ANDRA, France), P. Bourke (AERE, United Kingdom), J. Weidman (NAGRA Consultant, Switzerland), P. Zuidema (NAGRA, Switzerland).

Technical Programme Committee: A. Bonne (SCK/CEN, Belgium), W. Brewitz (GSF, FRG), G. Simmons (AECL, Canada), L. Chamney (NEA, Paris).

## GENERAL INFORMATION

### 1. ORGANISATION

The Workshop is organised by the OECD Nuclear Energy Agency through the NEA Radioactive Waste Management Committee (RWMC), in co-operation with Atomic Energy of Canada Limited (AECL).

### 2. SECRETARIAT

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### 3. WORKING LANGUAGES

The working languages of the Workshop will be English and French. Interpretation will be provided.

### 4. REPORT OF THE WORKSHOP

A report of the Workshop, its conclusions and recommendations will be presented to the NEA In-Situ Advisory Group (ISAG) and the Radioactive Waste Management Committee (RWMC) at their next meetings in 1988.

### 5. PROCEEDINGS

Full proceedings of the Workshop will be published.

### 6. LOCAL ARRANGEMENTS

The Workshop will be held at the Westin Hotel (East Ball Room), 2 Lombard Place, Winnipeg, Canada. Participants are expected to make their own arrangements for accommodation and travel. Local arrangements are being considered to obtain a special group-rate for accommodation at the Westin Hotel.

Local arrangements are being co-ordinated by:

Mr. Gary SIMMONS  
Whiteshell Nuclear Research Establishment (WNRE)  
Atomic Energy of Canada Limited (AECL)  
Pinawa, Manitoba  
CANADA, ROE 1LO

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Coffee, juice and danish will be available in the meeting room each morning prior to the presentations.

Slide and overhead projectors will be available for use by the speakers.

PROGRAMME

TUESDAY, 26TH APRIL

9.00 REGISTRATION

10.00 OPENING OF THE WORKSHOP

- Welcoming Address by the Chairman: K. DORMUTH (AECL, Canada)
- Objectives and Scope of the Workshop: L. CHAMNEY (NEA, Paris)

SESSION I

OVERVIEW OF RESEARCH AT UNDERGROUND LABORATORIES  
ON EXCAVATION RESPONSES AND ASSOCIATED ACTIVITIES

Chairman: K. DORMUTH (AECL, Canada)

10.15 - 12.30

1. Accounting for Excavation Responses in Developing an Underground Repository in Clay Formations (Keynote Paper)  
A. BONNE (SCK/CEN, Belgium)
2. Accounting for Excavation Responses in Developing an Underground Repository in Crystalline Rock (Keynote Paper)  
G. SIMMONS (AECL, Canada)
3. Investigations into Excavation Effects at the Asse Salt Mine (Keynote Paper)  
W. BREWITZ (GSF, Federal Republic of Germany)

Lunch (12.30 -14.00)

SESSION II

(a) EXCAVATION EFFECTS IN CRYSTALLINE ROCK AND TUFF -  
OVERVIEW OF STUDIES

Chairman: R.A. ROBINSON (Battelle, United States)

14.00 - 17.30

4. Excavation Responses in Developing an Underground Repository in Crystalline Rock in Switzerland (Keynote Paper)  
R.W. LIEB and P. ZUIDEMA (NAGRA, Switzerland)
5. Calculation of Flow along Fractures Using Structural Data  
B. KILGER, L. LIEDTKE and A. PAHL (BGR, Federal Republic of Germany)

6. Stress and Temperature Effects on the Permeability in Granitic Rock Around a Gallery Excavated by Continuous Mining  
J. SCHNEEFUR, H. KULL and T. BRASSER (GSF, Federal Republic of Germany)

Coffee break (15.30 - 16.00)

7. Evaluation de l'ampleur et des conséquences des effets de travaux  
C. DEVILLERS, P. ESCALIER DES ORRES et J.M. HOORELBEKE (CEA, France)
8. Alteration of the Conductivity of Rock from Excavations as Indicated by the Stripa Plugging and Backfilling Tests  
R. PUSCH (SGAB, Sweden) and A. BERGSTROM (SKB, Sweden)
9. Characteristics of the Excavation Response Zone as Applied to Shaft Sealing  
A.T. JAKUBICK (Ontario Hydro, Canada), R. KLEIN (Ontario Hydro, Canada), M.N. GRAY (AECL, Canada) and L.D. KEIL (Keil & Ass. Ltd., Canada)

WEDNESDAY, 27TH APRIL

SESSION II (a) [continued]

9.00 - 11.30

10. Rock Displacement Instrumentation and Coupled Hydraulic Pressure/Rock Displacement Instrumentation for Use in Stiff Crystalline Rock  
P.M. THOMPSON, E.T. KOZAK and C.D. MARTIN (AECL, Canada)
11. Analysis Requirements for Evaluating Excavation Response in Hard Rock  
E.N. LINDNER (Battelle, United States)
12. Excavation Response Tests at NNWSI in Tuff: Past Activities  
T. BLEJWAS and R. ZIMMERMAN (Sandia, United States)
13. Excavation Response Tests at NNSWI in Tuff: Future Activities Related to Site Characterisation  
T. BLEJWAS and R. ZIMMERMAN (Sandia, United States)

Coffee break (11.00 - 11.30)

(b) EXCAVATION EFFECTS IN CRYSTALLINE ROCK AND TUFF -  
SPECIFIC GEOTECHNICAL STUDIES

Chairman: A. BARBREAU (IPSN/CEA, France)

11.30 - 12.30

14. Geotechnical Studies of Excavation Responses in Granitic Rock  
(Keynote Paper)  
N. BARTON (NGI, Norway)
15. Application of the Results of Excavation Response Experiments at  
Climax and the Colorado School of Mines to the Development of an  
Experiment for the Underground Research Laboratory  
W.F. UBBES (Battelle, United States), J.L. YOW, Jr. (LLNL, United  
States) and W. HUSTRULID (CSM, United States)

Lunch (12.30 - 14.00)

SESSION II (b) [continued]

14.00 - 17.30

16. Overview of the URL Excavation Response and Excavation Damage  
Assessment Programs  
P.A. LANG (AECL, Canada)
17. Assessment of Excavation-Related Damage in Granite  
J.J. CRAMER (AECL, Canada)
18. Mapping of the Excavation Damage Zone Around the Circular Access  
Shaft at Atomic Energy of Canada Limited's Underground Research  
Laboratory  
R.A. EVERITT (AECL, Canada), P. CHERNIS, D. GOOD and A. GROGAN

Coffee Break (15.30 - 16.00)

19. The Assessment of Excavation Disturbance Surrounding Underground  
Openings in Rock  
R. KOOPMANS and R.W. HUGHES (Ontario Hydro, Canada)
20. Room 209 Excavation Response Test  
P.A. LANG (AECL, Canada)
21. Shaft Excavation Response in a Highly Stressed Rock Mass  
C.D. MARTIN and D.W. KROLL (AECL, Canada)



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19.30 - Banquet

W.T. HANCOX (Speaker)

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THURSDAY, 28TH APRIL

SESSION III

EXCAVATION EFFECTS IN SALT

Chairman: L. TYLER (SNL, United States)

8.30 - 12.00

22. Excavation Effects in Developing an Underground Repository in Salt Formations (Keynote Paper)  
M. LANGER, A. PAHL and M. WALLNER (BRG, Federal Republic of Germany)
23. Deformational Rock Mass Response During a Nuclear Waste Repository Simulation Experiment at the Asse Salt Mine  
G. STAUPENDAHL, K. WIECZORAK and T. ROTHFUCHS (GSF, Federal Republic of Germany)
24. A Progress Report on Project COSA  
N.C. KNOWLES (Atkins Eng., United Kingdom) and B. COME (CEC, Brussels)

Coffee break (10.00 - 10.30)

25. Investigation of Cavity Responses by Microseismic Methods  
D. FLACH and C. HEICK (GSF, Federal Republic of Germany)
26. (Additional paper on WIPP investigations; SNL, United States)
27. (Additional paper on WIPP investigations; SNL, United States)

Lunch (12.00 - 13.30)

SESSION IV

EXCAVATION EFFECTS IN ARGILLACEOUS ROCK

Chairman: R.H. HEREMANS (NIRAS/ONDRAF, Belgium)

13.30 - 16.00

28. Excavation Response Studies at the Mol Facility (Keynote Paper)  
B. NEERDAEL (SCK/CEN, Belgium)
29. Excavation Response in Respect of the Repository Concept for the  
Konrad Mine as Seen by the Mining Authority  
W. ROEHL (Oberbergamt Clausthal-Zellerfeld, Federal Republic of  
Germany)
30. (Additional paper on clay)
31. (Additional paper on clay)

Coffee break (15.30 - 16.00)

SESSION V

PLENARY SESSION: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Chairman: K. DORMUTH (AECL, Canada)

16.00 - 17.30

Rapporteurs (the Session Chairmen) will provide a summary of the main points arising from Session I - IV, as the basis for discussion and for providing conclusions and recommendations on: (a) future needs in the area of excavation response, including strategies for model validation and accounting for excavation response in repository design; and (b) possible topics to be addressed at a follow-up NEA workshop on backfilling and sealing.

17.30 CLOSING REMARKS

FRIDAY, 29TH APRIL

Field excursion to the Underground Research Laboratory (URL) at Lac du Bonnet and the Whiteshell Nuclear Research Establishment (WNRE) at Pinawa. Provisional itinerary:

7.30 Depart Westin Hotel (breakfast on bus)  
9.30 Arrive URL/WNRE  
17.30 Depart for Winnipeg  
19.30 - 20.00 Arrive at Airport or Westin Hotel