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U.S. National Committee on
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National Research Council

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INTRODUCTION

The U.S. National Committee on Tunneling Technology (USNC/TT), a unit of the Assembly of Engineering, was formed within the National Research Council in 1972 by the Presidents of the National Academy of Sciences and the National Academy of Engineering. It was formed in response to a request from the Chairman of the Federal Council for Science and Technology for a "U.S. focal agency to be responsible for assessment of tunneling activities, and where appropriate, for stimulation of improvements in tunneling technology."

The committee's purposes, as stated in its constitution, are the following:

- To serve as the national organization for stimulating advancement in the state of the art of tunneling technology and in the effective use of the subsurface by promoting the coordination of activities pertaining thereto—assessment, research, development, education, training, and collection and dissemination of information.
- To effect appropriate participation in all activities of the International Tunnelling Association (ITA) through the National Academy of Sciences—National Academy of Engineering—National Research Council, which adheres to the ITA on behalf of the scientists, engineers, and technologists of the United States interested in tunneling technology.

The committee's functions are the following:

- Collection and dissemination of technical information related to tunneling, including current research, development, and innovative activities, as well as data on cost and performance of tunneling components and systems.
- Continuing assessment of the state of the art of the tunneling system to identify technical needs which might be met through research and development, to ascertain the overall level and structure of research and development, to review periodically the extent to which it is appropriate to the future demand for different types of tunneling, and to stimulate cross-fertilization of advanced technology developed for other purposes.

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- Periodical statistical demand forecasting and collection of demand data.
- Study of contracting practices in relation to the present state of the art of tunneling, including consideration of how the risks are shared and how to encourage the use of improved techniques.
- Action necessary to improve the understanding on the part of planners, officials, and the general public of the benefits to be obtained from increased and planned use of the subsurface.
- Review of the adequacy of education and training of engineers in the field of tunneling.
- Participation in international activities concerned with the applications, planning, and practice of tunneling.

This biennial report describes the work of the committee and its subcommittees in calendar years 1979 and 1980. The committee is grateful to the federal agencies that sponsor its activities. The committee also expresses its appreciation to the 14 corporations that contributed funds totalling approximately $5,000 for the conduct of the ITA meeting in 1979.

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ACTIVITIES OF THE COMMITTEE

NOMINATION AND APPOINTMENT OF MEMBERS AND OFFICERS, 1979

Twelve members completed terms on the committee on June 30; eight were succeeded by new members, and four were reappointed for a second term.

The following new members were appointed for a term ending in 1982:

Bruce F. Baird (academic/research)
J. Joseph Casey (industry)
Edward Cross (industry)
Donald J. Duck (government)
Fred H. Kulhawy (academic/research)
Raymond E. Levitt (academic/research)
Thomas J. O'Neil (academic/research)
Winfield O. Salter (industry)

The following members were reappointed:

Edward J. Cording (academic/research)
Norman A. Nadel (industry)
Eugene B. Waggoner (representative of the American Society of Civil Engineers)
Chris F. Woods (representative of the Associated General Contractors of America)

Dr. Tor L. Brekke completed his term as Committee Chairman on June 30 and became Immediate Past Chairman and *ex officio* committee member. He was succeeded as Chairman by Mr. David G. Hammond, who served in that capacity from July 1, 1979 to June 30, 1980. Mr. Norman A. Nadel was appointed Vice Chairman for the same period.

A roster of the committee and its subcommittees for the period July 1, 1979 to June 30, 1980 is included as Appendix A.

NOMINATION AND APPOINTMENT OF MEMBERS AND OFFICERS, 1980

Six members completed their committee terms on June 30; five were succeeded by new members, and the term of one was extended for one year.

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The following new members were appointed for terms ending in 1983:

William D. Alexander (government)
G. Stanley Bates (industry)
Gordon E. Bunker (government)
Howard A. Coombs (representative of the Geological Society of America)*

Mr. Gilbert L. Butler was appointed as a member from government for a two-year term ending in 1982. Dr. Don A. Linger's term as representative of those federal agencies engaged in or concerned with tunneling was extended until 1981.

Mr. David G. Hammond completed his term as Committee Chairman on June 30 and became Immediate Past Chairman and *ex officio* member. He was succeeded by Mr. Norman A. Nadel, who will serve as Chairman from July 1, 1980 to June 30, 1981. Professor Edward J. Cording was appointed Vice Chairman for the same period.

The membership of the committee and its subcommittees for the period July 1, 1980 to June 30, 1981 is listed in Appendix A.

ANNUAL MEETINGS, 1979 and 1980

Two regular topics of discussion at annual meetings are the programs of the subcommittees and the activities of the International Tunnelling Association (ITA). These programs and activities are summarized in subsequent sections of this report.

The Eighth Annual Meeting of the committee was held June 16-17, 1979, in Atlanta, Georgia, in connection with the Fifth Annual Meeting of the ITA and the Rapid Excavation and Tunneling Conference (RETC). The committee meeting included plenary sessions, individual subcommittee meetings, and a meeting with representatives of the federal agencies that provide funds for the committee's activities. The record of the meeting is included as Appendix B.

The Ninth Annual Meeting was held May 8-10, 1980, in Albuquerque, New Mexico. The first two days were devoted to individual meetings of the subcommittees and a general session attended by all members. A field trip, conducted on the third day, included visits to two projects. The first was a test chamber on the site of a pumped-storage hydroelectric power plant planned by the Public Service Company of New Mexico; the second project was the Jackpile open-pit uranium mine operated by the Anaconda Copper Company. The record of this annual meeting is included as Appendix C.

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*Lloyd B. Underwood was later appointed as GSA representative to replace Professor Coombs, who was unable to serve due to other commitments.

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COORDINATION WITH OTHER U.S. ORGANIZATIONS INTERESTED IN TUNNELING

One of the committee's primary purposes is "to serve as the national organization for stimulating advancement in the state of the art of tunneling and in the effective use of the subsurface by promoting the coordination of activities pertaining thereto—assessment, research, development, education, training, and collection and dissemination of information" (emphasis added). In its continuing effort to achieve this aim, in 1979 the committee undertook a more formal approach to promoting coordination than it had previously. A stimulus was the scheduling of two meetings for 1981 (the RETC in May in San Francisco and the Underground Space Conference and Exhibition in June in Kansas City) so close in time that both meetings might be adversely affected. The committee initiated arrangements for a meeting of various groups that sponsor technical activities related to tunneling and the underground. After an exchange of correspondence, a meeting was held in Atlanta on June 18, during the RETC, at which officers and members of the following organizations discussed coordination of plans and other subjects of mutual interest:

- ASCE Committee on Tunneling and Underground Construction
- American Underground-Space Association
- Rapid Excavation and Tunneling Conference
- Transportation Research Board Committee on Design and Construction of Underground Transportation Structures
- Underground Technology Research Council (ASCE and AIME)
- U.S. National Committee for Rock Mechanics
- U.S. National Committee on Tunneling Technology

On the next day, at a special breakfast meeting open to all registrants of the RETC, representatives of these organizations and of the ITA gave speeches outlining their organizations' interests and activities.

It was generally agreed that this coordination was helpful to all concerned, and representatives of the organizations agreed that the USNC/TT should continue to foster coordination. The next opportunity for a similar meeting appeared to be at the RETC in 1981, and one was tentatively scheduled. In the meantime, the USNC/TT offered to act as a clearinghouse for scheduling meetings and agreed to continue publishing announcements of meetings in the *Tunneling Technology Newsletter*.

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ACTIVITIES OF THE SUBCOMMITTEES

The substantive activities of the USNC/TT are carried out primarily by *ad hoc* subcommittees. From time to time a subcommittee conducts a separately funded study resulting in a published report, but generally the subcommittees conduct their work as part of the committee's continuing activities and are supported with core funding. Some of the subcommittees perform work that supports U.S. participation in the activities of the ITA while others undertake tasks primarily related to tunneling within the United States. The programs of the six subcommittees and one working group active during 1979 and 1980 are summarized below. Rosters of the subcommittees and working group are included in Appendix A; additional information on their activities appears in Appendices B and C.

SUBCOMMITTEE ON CONTRACTING AND MANAGEMENT PRACTICES

The subcommittee defined and initiated work on three tasks in 1979 and 1980. These were (1) to review the implementation of recommendations discussed in three previously published reports—*Better Contracting for Underground Construction*, *Recommended Procedures for Settlement of Underground Construction Disputes*, and *Better Management of Major Underground Construction Projects*; (2) to facilitate participation in the ITA Working Group on Contractual Sharing of Risks; and (3) to study contractual arrangements among owners, engineers, and designers in order to effect innovation in design. To accomplish the first task, the subcommittee began preparations for conducting an inventory of which recommendations had been adopted and by whom. With respect to the second task, the subcommittee had prepared first drafts of position papers on contract variation in price, type of contract, and disputes. It was planned to refine the drafts and then forward them to the moderator of the ITA working group. (Additional information on this activity is given in a subsequent section of this report.) As a means of initiating work on the third task, the subcommittee identified several practices and procedures that can have adverse influences on innovation in design and planned to review typical contractual provisions that bear on these procedures.

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SUBCOMMITTEE ON DEMAND FORECASTING

In 1979 the subcommittee proposed a new approach to accomplishing the work needed to produce a forecast of tunnel and other underground construction, believing that the data would be helpful to many organizations and individuals even though no source of funds for a special effort in this area had been identified. The committee endorsed the subcommittee's effort and confirmed the need for a forecast. Accordingly, the subcommittee developed a plan of action that included preparation of a preliminary list of planned works; distribution of that list to individuals for suggestions, corrections, and additions; communication with federal agencies that construct or finance underground projects to learn of their plans; and solicitation of additional information from readers of the *Tunneling Technology Newsletter*. By the end of 1980, much of this work had been accomplished and publication of a report was expected in 1981.

SUBCOMMITTEE ON DESIGN CONSIDERATIONS

In 1980, the need for a subcommittee on underground design was perceived, and a small group was appointed for this purpose. Its initial charter included support of three ITA working group topics—structural design models for tunnels, standardization of tunnels, and seismic effects on underground structures. Additionally, the subcommittee was asked to review design requirements and report back to the committee on recommended additions or changes to its charter. Design-related construction problems and the constructibility aspects of design were suggested as appropriate topics for subcommittee consideration.

SUBCOMMITTEE ON EDUCATION AND TRAINING

The subcommittee concentrated on three activities during 1979 and 1980. The first was the compilation of a set of slides and accompanying text to illustrate tunnel construction. The primary purpose was to aid professors in teaching graduate and undergraduate students; however, it appears that the set can prove valuable to industry and government organizations as well. By the end of 1980, a large number of slides had been accumulated and reviewed and 212 had been selected for inclusion in the set. Descriptive text for each slide had also been drafted. It was expected that the slides and text could be duplicated early in 1981 and the sets offered for sale at a price sufficient to recover the costs of duplication and mailing. An announcement concerning future availability of the set was published in the December 1980 *Tunneling Technology Newsletter* and ordering instructions were planned for the March 1981 issue.

A second activity was the preparation of a list of movies illustrating tunnel construction, including brief descriptions and instructions on how to borrow each film. By the end of 1980 a draft had been prepared. The annotated list will be included as a supplement to the *Newsletter* in 1981.

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The third activity was the preparation of a questionnaire on a student employment cooperative program, the purpose of which is to facilitate arrangements between employers and students seeking work experience during the academic year or summer months. The questionnaire will be distributed in the coming year; responses will assist in providing referrals.

SUBCOMMITTEE ON RESEARCH NEEDS

The subcommittee is planning to use case histories to determine research needs in tunneling. Activities in 1979 and 1980 included the development of a case history format and consideration of the design of large cavities and tunnel supports. A workshop for implementing use of the format for recording case histories and developing means of reporting research was considered. Members of the subcommittee devoted significant effort to providing data to the ITA Working Group on Research; their work is discussed in a subsequent section of this report.

SUBCOMMITTEE ON GEOLOGIC SITE INVESTIGATION

During 1979 and 1980, the subcommittee prepared a plan to satisfy the acknowledged need for guidance in developing better geologic site investigations for tunnels and other underground projects. The subcommittee concluded that the best procedure was to study completed projects—both successful and less than successful—and compare construction histories with site investigation data used in design and planning construction. The conclusions drawn from the study of a large number of projects should enable the subcommittee to formulate guidelines for better site investigations. The proposed study, and the plan to conduct it as a separately funded activity, were approved by the committee at the 1980 annual meeting. Subsequently, a meeting of potential sponsoring agencies and committee and subcommittee members was held in July 1980. The response of the federal representatives was favorable and a proposal for the study was prepared and forwarded in November 1980. It was expected that the study could begin in early 1981.

WORKING GROUP ON TUNNEL DETECTION

Early in 1979, the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), one of the committee's funding agencies, requested that the committee review MERADCOM's tunnel detection program. This stemmed from a request by the U.S. Commander of Korea for a review of measures being undertaken to detect tunnels being driven by the North Koreans under the Demilitarized Zone. Part of the work involved classified data, so a special *ad hoc* group of knowledgeable individuals with requisite security clearance was appointed. The group met March 28-29, 1979, and was briefed by MERADCOM representatives. Following the briefing, the group considered the program elements described and possible

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alternative approaches to the problem of detecting tunnel construction. The approaches that appeared to be most promising were recommended to MERADCOM in a report forwarded in early 1980. That report, *A Review of the U.S. Army Mobility Equipment Research and Development Command's Tunnel Detection Program*, carries a confidential security classification. It is available for review by those with a need to know and appropriate security clearance at the offices of the National Research Council's Naval Studies Board and at MERADCOM.

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REPRESENTATION OF THE UNITED STATES IN THE ACTIVITIES OF THE INTERNATIONAL TUNNELLING ASSOCIATION (ITA)

MEETINGS OF THE GENERAL ASSEMBLY, 1979 and 1980

The Fifth Annual Meeting of the ITA was sponsored by the committee, which devoted a major part of its efforts in the first half of 1979 to planning this activity. The meeting, held in Atlanta, June 15 to 17, 1979, attracted 167 participants from 24 nations. The United States was represented by a delegation of eight persons, headed by the Committee Chairman, Tor L. Brekke. A report of the meeting is included as Appendix D. The meeting was scheduled in conjunction with the Rapid Excavation and Tunneling Conference and ITA members took advantage of the opportunity to participate, presenting a total of 13 technical papers and attending the RETC field trip to the Atlanta Research Chamber on June 21. As part of the ITA program, the committee arranged field trips for June 23, following the RETC. These trips included visits to the sites of Baltimore subway construction (14 participants), Chicago tunnel and reservoir construction (10 participants), and Washington, D.C., subway station construction (40 participants). Additionally, the committee helped arrange an extensive field trip for 25 ITA participants from Japan to visit underground construction in Baltimore, New York City, Chicago, Colorado, Arizona, and California.

The Sixth Annual Meeting of the ITA was held in Brussels, May 19-23, 1980, in conjunction with the international symposium "Safety of Underground Works." Representatives of 22 nations and two international organizations participated in the meeting. The United States was represented by a delegation of seven persons, headed by the Committee Chairman, David G. Hammond. A report of the meeting is included as Appendix E.

ACTIVITIES OF THE WORKING GROUPS, 1979 and 1980

Two persons associated with the USNC/TT were appointed to key positions as moderators of technical working groups: Michael B. Barker was appointed to lead the Working Group on Planning Use of the Subsurface, and William W. Hakala was appointed moderator of the newly formed Working Group on Seismic Effects on Underground Structures. Norman A. Nadel resigned his position as moderator of the Working Group on Contractual

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Sharing of Risks due to his increased duties as an officer of the committee. A new moderator from the United Kingdom was selected, but the United States continued its active participation with the appointment of Jack K. Lemley as vice moderator. (Mr. Lemley was elected ITA Vice President in 1980; his position as vice moderator will be assumed by Winfield O. Salter, a committee member and subcommittee chairman.)

During the 1979 meeting in Atlanta, each of the eight previously established working groups met twice and reported its progress to the General Assembly; the working group on seismic effects held a meeting to plan future activities. The standardization group continued preparation of a glossary of boring machines, which will be followed by a glossary of traditional methods of drilling and blasting. The research working group presented a preliminary report on shield tunnels, which included the report of an extensive investigation and collection of data by Don U. Deere of the United States. The contractual sharing of risks group distributed its recently published report (reproduced as Appendix F). The group continued preparation of additional recommendations concerning variations in price, types of contract, and disputes. The group on subsurface planning considered planning procedures, human reactions underground, and energy savings. The group invited member countries to report on projects in their countries, with particular emphasis on energy conservation, public services, and storage and housing. The group studying works in progress continued preparation of a catalog, which is planned for distribution in 1980. The group on maintenance and repair of underground structures prepared a questionnaire and program to deal with such special difficulties as long-term settlements, water leakage, and freezing. The group on structural design models for tunneling was preparing a comparative study of support design for four types of tunnels: a shield-driven tunnel in soft soil, a tunnel supported by deep anchors and concrete, a deep tunnel in moderately hard rock, and a cut-and-cover tunnel of rectangular cross section. (A more detailed account of each working group's activities is contained in Appendix D.)

During the 1980 meeting in Brussels, each of the nine working groups met twice and reported its activities to the General Assembly. The seismic working group had collated information on earthquake damage and was planning to prepare a bibliography. The standardization group had completed the glossary on boring machines and continued work on one concerning drilling and blasting. The research working group's report on shield tunneling was expected to be ready for publication at the end of the year; a new report on tunnel boring machines was in the discussion stage. The group on contractual sharing of risks presented recommendations on disputes and variations in price; these were adopted by the ITA. Three other recommendations were in preparation, and topics for future study had been selected. The subsurface planning group had discussed papers received from six member countries and was comparing planning techniques. The group cataloging works in progress had received lists from several countries and was preparing a document for publication by the end of the year. The safety-in-work group submitted a document for publication and

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had begun to collect statistics on construction accidents. The group on maintenance and repair was planning to study and publish an analysis of case histories of repairs. The structural design group had received responses to its questionnaire and was preparing a draft report. (A more detailed account of each working group's activities is contained in Appendix E.)

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PUBLICATIONS

Tunneling Technology Newsletter

The committee published eight issues of the *Newsletter* in 1979 and 1980. Each featured a technical article on an aspect of tunneling technology as well as notices of meetings and other items of interest; most issues also listed recent reports on tunneling and underground construction. Each issue was distributed to approximately 1,350 individuals and organizations. The technical articles published in 1979 and 1980 were:

- "High Speed Excavation in the Austrian Alps"
- "Development of a Quantitative Method for Analyzing the Allocation of Risks in Underground Construction"
- "Rail Tunnels Cross on the Northeast Corridor"
- "Factors Influencing the Performance of Full-Face, Hard-Rock Tunnel Boring Machines"
- "Underground Nuclear-Power-Plant Siting After Three Mile Island"
- "A Review of Empirical Approaches to Tunnel Support Design"
- "Stillwater Tunnel—A Progress Report"
- "Ore Body Ground Conditions"

Also, a supplement was issued to the March 1980 *Newsletter,* entitled "Catalog of Tunnels—Existing, Under Construction, and Planned."

A Review of the U.S. Army Mobility Equipment Research and Development Command's Tunnel Detection Program

This report, which carries a confidential security classification, was transmitted to the U.S. Army Mobility Equipment Research and Development Command (MERADCOM) on January 21, 1980. Copies are maintained in the National Research Council's Naval Studies Board's classified files and at MERADCOM.

Better Contracting for Underground Construction

Because of continuing heavy demand for this 1972 report, 400 copies were reprinted during 1980 for further selective distribution.

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JULY 1, 1979—JUNE 30, 1980

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Daniel, Mann, Johnson & Mendenhall
Baltimore, Maryland

Vice Chairman
Norman A. Nadel
MacLean—Grove and Company, Inc.
Greenwich, Connecticut

Immediate Past Chairman
Tor L. Brekke
Department of Civil Engineering
University of California
Berkeley, California

Designated Representatives

Federal Agencies
Don A. Linger
Structure and Applied Mechanics
Federal Highway Administration
Washington, D.C.

Associated General Contractors of America
Chris F. Woods
Al Johnson Construction Company
Minneapolis, Minnesota

American Society of Civil Engineers
Eugene B. Waggoner
Consultant
San Jose, California

JULY 1, 1980—JUNE 30, 1981

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Vice Chairman
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University of Illinois
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JULY 1, 1979—JUNE 30, 1980

American Institute of Mining, Metallurgical, and Petroleum Engineers
George L. Wilhelm
Exxon Minerals Company
Houston, Texas

Geological Society of America
Don U. Deere
Consultant
Gainesville, Florida

Association of Engineering Geologists
Victor L. Wright
Consulting Engineering Geologist
Placerville, California

Industry

J. Joseph Casey
Dillingham Construction
San Francisco, California

Edward Cross
Compressed Air and Free Air Tunnel Workers Union
New York, New York

Terence G. McCusker
Consultant
Wayne, New Jersey

Winfield O. Salter
Parsons, Brinckerhoff, Quade & Douglas
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JULY 1, 1980—JUNE 30, 1981

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George L. Wilhelm
Exxon Minerals Company
New York, New York

Geological Society of America
Lloyd B. Underwood
Consultant
Omaha, Nebraska

Association of Engineering Geologists
Victor L. Wright
Consulting Engineering Geologist
Placerville, California

American Underground-Space Association
J. Gavin Warnock
Acres Consulting Services, Ltd.
Toronto, Ontario, Canada

Industry

G. Stanley Bates
Pacific Gas & Electric Company
San Francisco, California

J. Joseph Casey
Dillingham Construction
San Francisco, California

Edward Cross
Compressed Air and Free Air Tunnel Workers Union
New York, New York

Terence G. McCusker
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Winfield O. Salter
Parsons, Brinckerhoff, Quade & Douglas
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Government

William D. Alexander
(formerly Metropolitan Atlanta Rapid Transit Authority)
Pawley's Island, South Carolina

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JULY 1, 1979—JUNE 30, 1980

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Consulting Engineer
MacLean, Virginia

Kenneth G. Knight
Metro Construction Division
Niagara Frontier Transportation Authority
Buffalo, New York

Walter H. Paterson
(formerly Toronto Transit Commission)
Consulting Engineer
Toronto, Ontario, Canada

Homer B. Willis
(formerly Army Corps of Engineers)
Bethesda, Maryland

Sheldon P. Wimpfen
U.S. Bureau of Mines
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Academia and Research

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College of Business
University of Utah
Salt Lake City, Utah

G. Wayne Clough
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School of Civil and Environmental Engineering
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JULY 1, 1980—JUNE 30, 1981

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Gilbert L. Butler
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Donald J. Duck
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Construction Management Office
Harza Engineering Company
Chicago, Illinois

Walter H. Paterson
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Consulting Engineer
Toronto, Ontario, Canada

Sheldon P. Wimpfen
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Consulting Engineer
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Academia and Research

Bruce F. Baird
College of Business
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JULY 1, 1979—JUNE 30, 1980

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Thomas J. O'Neil
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University of Arizona
Tucson, Arizona

International Tunnelling Association

Member, Executive Council
Jack K. Lemley
Morrison-Knudsen Company
Boise, Idaho

Animateur, Working Group on Seismic Effects on Underground Structures
William W. Hakala
Earthquake-Hazards Mitigation
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Washington, D.C.

Animateur, Working Group on Subsurface Planning
Michael B. Barker
Department of Practice and Design
American Institute of Architects
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Member, Auditing Committee
William N. Lucke
Consultant
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Liaison Representatives

Building Research Advisory Board
John P. Gnaedinger
Soil Testing Services, Inc.
Northbrook, Illinois

Transportation Research Board
John W. Guinnee
National Academy of Sciences
Washington, D.C.

JULY 1, 1980—JUNE 30, 1981

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International Tunnelling Association

Vice President
Jack K. Lemley
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Vice Animateur, Working Group on Contractual Sharing of Risks
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Animateur, Working Group on Subsurface Planning
Michael B. Barker
Department of Practice and Design
American Institute of Architects
Washington, D.C.

Liaison Representatives

Building Research Advisory Board
(to be appointed)

Transportation Research Board
John W. Guinnee
National Academy of Sciences
Washington, D.C.

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U.S. National Committee on Tunneling Technology

Virginia M. Lyman, *Administrative Assistant*
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SUBCOMMITTEE ON RESEARCH NEEDS

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NATIONAL RESEARCH COUNCIL

ASSEMBLY OF ENGINEERING

2101 Constitution Avenue Washington, D.C. 20418

EIGHTH ANNUAL MEETING

U.S. NATIONAL COMMITTEE ON TUNNELING TECHNOLOGY

JUNE 15-16, 1979
ATLANTA, GEORGIA

Record of the Meeting

ATTENDEES

COMMITTEE AND SUBCOMMITTEE MEMBERS:

Tor L. Brekke, *Chairman 1978-1979*
David G. Hammond, *Vice Chairman 1978-1979*
J. Donovan Jacobs, *Immediate Past Chairman 1978-1979*

Michael B. Barker
Joginder S. Bhore
G. Wayne Clough
Edward J. Cording
Edward Cross
Don U. Deere, *GSA Representative*
Eugene L. Foster
Fred H. Kulhawy
Dennis J. Lachel
Thomas A. Lang
Jack K. Lemley
Raymond E. Levitt
Don A. Linger, *ICET Representative*
Terence G. McCusker
Phillip R. McOllough
Norman A. Nadel
Paula J. Omansky
Solomon Ribakoff
Samuel Taradash
Eugene B. Waggoner, *ASCE Representative*
Frank T. Wheby
Homer B. Willis
Sheldon P. Wimpfen
Chris F. Woods, *AGC Representative*
Victor L. Wright, *AEG Representative*
George B. Clark

EX OFFICIO MEMBER: William N. Lucke, *Senior Vice President, International Tunnelling Association*

GUESTS: Howard J. Handewith, *The Robbins Company*

STAFF:
Robert L. Bangert, *Executive Secretary*
Susan V. Heisler, *Assistant Executive Secretary*
Virginia M. Lyman, *Administrative Assistant*

(Attendance of certain officers, committee members, and staff, were on a part-time basis because of concurrent International Tunnelling Association (ITA) activities.)

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Tor L. Brekke, Chairman, called the meeting to order at 8:30 a.m. He welcomed all participants, and stated that he would be absent from a part of the committee meeting, because of concurrent activities of the Fifth Annual Meeting of the ITA, which was being sponsored by the committee. All attendees were then introduced.

The draft agenda, Enclosure 1, was adopted with one added item, consideration of a possible change in the committee's name, a subject raised by the Assembly of Engineering.

Potential Sources of Bias

Robert L. Bangert, Executive Secretary, informed the members that every committee within the NAS-NAE-NRC is required to review annually the status of members with regard to potential sources of bias. He then read the letter from Dr. Handler, President of the NAS, which is printed on the reverse of each bias form and explains relevant Academy policies and procedures. The members were asked to notify the Secretariat of any changes to the information in the form submitted at the time of their appointment to membership.

STATUS REPORT—Administration and Finances

Mr. Bangert reviewed with the committee the completion of the Department of Energy contract for the committee's activities through 1978. He informed the committee that the proposal for 1979-1980, described at the 1978 annual meeting, had been approved by the Bureau of Mines, the contracting agency, and the other agencies from which funds had been requested.

Mr. Bangert made special mention of the contributions received from industrial organizations at the request of Jack K. Lemley. These contributions, totalling approximately $5,000, were to be used for the ITA meeting. All firms contributing funds had been thanked by letter. A list of contributing corporations is attached as Enclosure 2.

PLANS FOR ITA MEETING

Dr. Brekke then turned the discussion to the ITA meeting, to be held on Saturday and Sunday, June 16 and 17. The official U.S. Delegation, Dr. Brekke, voting delegate, and Mr. Hammond, alternate delegate, were named. Other U.S. participants include William N. Lucke, Vice President, ITA; Michael Barker, Working Group on Subsurface Planning; Don U. Deere and Terence G. McCusker, Working Group on Research; William W. Hakala, named animateur of new Working Group on Seismic Effects on Underground Structures; J.K. Lemley and W.O. Salter, Working Group on Contractual Sharing of Risk. Several other U.S. persons, both committee members and nonmembers, were expected to attend.

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Other activities discussed in connection with the ITA meeting included:

- o a report of the most recent meeting of the ITA Executive Committee by William N. Lucke.
- o a discussion of post-RETC ITA field trips to Baltimore, Chicago, and Washington and a special Japanese field trip including, in addition to those cities, San Francisco, New York, Bureau of Reclamation facilities and projects, and the Helms Pumped Storage Project by Robert L. Bangert.

The discussion of the ITA meeting concluded with an expression by the chairman, on behalf of the committee, to the staff—particularly Mrs. Heisler and Mrs. Lyman—for their excellent preparation for the ITA meeting.

Plans for Activities during RETC

A discussion of two breakfast meetings during the RETC was next on the agenda. Dr. Brekke discussed a coordination meeting to be held on June 18, at which coordination among the several organizations interested in tunneling and underground construction would be discussed. Plans for briefing RETC participants in the activities of the various organizations at a breakfast meeting on June 19 were also to be discussed. The organizations involved are:

- o ASCE Committee on Tunneling and Underground Construction
- o American Underground-Space Association
- o International Tunnelling Association (June 19 only)
- o Rapid Excavation and Tunneling Conference
- o Transportation Research Board Committee on Design and Construction of Underground Transportation Structures
- o Underground Technology Research Council (ASCE and AIME)
- o U.S. National Committee for Rock Mechanics
- o U.S. National Committee on Tunneling Technology

The major point of coordination to be discussed were planned meetings in 1981 of AUA and RETC that appear to conflict.

TASK ASSIGNMENTS FOR SUBCOMMITTEES

Dr. Brekke briefly discussed the subcommittee meetings scheduled for the afternoon. He charged each subcommittee to discuss what new activities it should recommend, and what current activities it should continue. The meeting then was adjourned for lunch. Following lunch, and for the duration of the afternoon, subcommittees on contracting practices, education and training, site investigation, research needs, and demand forecasting met.

PRESENTATION OF CERTIFICATES AND CHANGE OF OFFICERS

Dr. Brekke presented certificates to retiring members J. Donovan Jacobs, Phillip R. McOllough, Vincent J. Murphy, Eugene L. Foster, Thomas A. Lang, George B. Clark, and Michael B. Barker at the committee dinner on the evening of June 15. Mr. Hammond then presented a certificate of appreciation to Dr. Brekke for his service as committee

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chairman. Dr. Brekke responded by thanking all the committee members for their support during his term of office. He congratulated Mr. Hammond on his assumption of the chairman's duties and pledged his support for the new chairman. Mr. Hammond thanked Dr. Brekke and stated that he was looking forward to another successful year of committee activity. He congratulated Mr. Nadel, the incoming Vice Chairman.

SUBCOMMITTEE REPORTS

The committee reconvened at 8:00 a.m. June 16, and reports by subcommittee chairmen were the first order of business.

Subcommittee on Contracting Practices

Norman A. Nadel reported on the subcommittee's discussions. First, he announced that because of his assumption of duties as Vice Chairman and the consequent need to use his time for all committee activities that he had elected to turn over his subcommittee duties and his membership on the ITA Working Group on Contractual Sharing of Risk to Winfield O. Salter.

The subcommittee's discussions included both the implementation of previous committee reports and new initiatives. In the former category, it was decided to review the implementation of 3 reports:

- *Better Contracting for Underground Construction* (1974)
- *Recommended Procedures for Settlement of Underground Construction Disputes* (1977)
- *Better Management of Major Underground Construction Projects* (1978)

After this review, the subcommittee foresaw the possibility of further recommendations.

The new initiative discussed was to study the contractual arrangements between owners and engineers (designers) with the goal of recommending means of promoting design innovations that will reduce costs and speed construction without detracting from utility or safety.

Additionally, the subcommittee will facilitate U.S. participation in the activities of the ITA Working Group on Contractual Sharing of Risk.

The subcommittee's proposed activities were approved by the committee.

Subcommittee on Education and Training

Professor Cording reported on two activities under way during the past year:

- o student employment-intern program
- o status of the slide set for education purposes.

He then discussed the activities planned for the coming year:

- o distribution of educational material
- o updating of the annotated reading list
- o further consideration of an exchange program (depending on sponsor interest)

The committee approved the planned activities outlined by Professor Cording.

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Subcommittee on Site Investigation

Eugene B. Waggoner reported that the subcommittee had concluded that an investigation of case studies—both successful and less-than-successful ones—is needed. The first step would be development of a format and a plan for the study, to be followed by a proposal to potential sponsoring agencies. These might include the Department of Transportation (particularly the Federal Highway Administration) and the U.S. Geological Survey.

The committee approved the subcommittee's recommended program.

Subcommittee on Research Needs

Terence McCusker reported the subcommittee's progress and its planned new work. The question of design of large cavities had been considered by the subcommittee, and a conclusion was reached that specifications should reflect the design process, as in the case of the second bore of the Eisenhower tunnel.

Support design was considered, and the subcommittee concluded that current investigations do not cover the subject and that further research is required.

Case history formats were also discussed, and it was concluded that a one-page summary, supplemented by a detailed long form containing additional factual information (as opposed to opinion). The subcommittee plans to develop proposed form and try and circulate for review. A workshop may be proposed to define the forms and make recommendations for its adoption.

The committee approved the subcommittee's plan of action.

Subcommittee on Demand Forecasting

Dr. Foster recounted the difficult time the subcommittee had experienced in attempting to get government support for preparing a forecast of the demand for underground construction. He described 3 proposals that had been prepared, none of which had been accepted for funding by the National Science Foundation.

Dr. Foster indicated that the subcommittee would be attempting a new approach to the problem that would not rely on federal funding and that he would report the plan to the Executive Committee at its fall meeting.

The committee encourage the subcommittee in its efforts and confirmed the need for a valid forecast of underground construction.

ASSISTANCE TO FEDERAL AGENCIES

Mr. Hammond discussed how the committee can assist federal agencies, especially in coordination of their activities now that the Interagency Committee on Excavation Technology (ICET) no longer exists. He stated that there would be a meeting with federal agency representatives after lunch to discuss subjects of common interest. Also, he said that he planned to invite federal agency representatives to meet with the Executive Committee in Washington in the autumn.

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1980 MEETING

A round table discussion of the date and location for the 1980 meeting was the next order of business. Proposed locations included Chicago and San Francisco, where urban underground projects might be visited, and Utah, where a Bureau of Reclamation project could be seen. There was no consensus, and the committee delegated to the Executive Committee the task of determining the best location and date.

COMMITTEE NAME

Mr. Hammond started the discussion by informing the committee that the Assembly of Engineering, at its March 1979 meeting, had noted that the committee's work did not appear to concentrate on the technology of tunneling, and therefore that the committee might wish to consider a name change. Considerable discussion on the pro's and con's of a change followed, and several suggested names were put forth. The committee was not convinced by the discussion whether a change was warranted, and if one was, what a better name might be.

Because no clear decision appeared feasible, Mr. Hammond requested members to give further thought to the subject and write or call further suggestions to the Executive Secretary so that the matter could be considered once again by the Executive Committee.

(The resolution of the question, i.e., to retain the present name, is contained in the exchange of letters between Mr. Hammond and H. Guyford Stever, Chairman of the Assembly of Engineering, copies attached. (Enclosure 3).

DISCUSSIONS WITH REPRESENTATIVES OF FEDERAL SPONSOR AGENCIES

The afternoon session was a discussion with several federal sponsoring agencies, including:

Don C. Banks, Army Corps of Engineering
Gilbert L. Butler, UMTA
Milon Essoglu, Navy
William W. Hakala, National Science Foundation
Don A. Linger, FHWA
Donald G. Rogich, Bureau of Mines

The discussion was rather wide-ranging, with each agency representative discussing his agency's program. In turn, the committee people discussed the committee and subcommittee activities that might be helpful to the agencies. Ways in which the committee could promote coordination among the agencies were emphasized.

Several agencies furnished program material, which is retained in the Secretariat.

It was decided that a follow-up discussion would be held in Washington with the federal agencies to be represented by the program managers and the committee to be represented by the Executive Committee.

ADJOURNMENT

The meeting adjourned at 4:30 p.m. and several committee members remained in Atlanta for subsequent ITA and RETC activities.

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Enclosure 1

U.S. NATIONAL COMMITTEE ON TUNNELING TECHNOLOGY

1979 Annual Meeting
June 15-16, 1979

DRAFT AGENDA

June 14

3:30 p.m. - 10:00 p.m. Informal Social Get-together, Committee and Subcommittee members and ladies. (Please check at committee office, Room 452, on arrival for information on location.)

June 15

8:00 a.m. - 12:00 noon, Crystal Ballroom E

Call to Order Introductory Remarks Introduction of New Members	Tor L. Brekke
Approval of Draft Agenda	Tor L. Brekke
Status Report-Administration and Finances	Robert L. Bangert
Potential Sources of Bias	Robert L. Bangert
Plans for ITA Meeting	Tor L. Brekke, et al
Official Delegation Nominations Working Groups	
Schedule of ITA Business Activities	Susan V. Heisler
Schedule of ITA Social Activities	Susan V. Heisler
Report of ITA Executive Council	William N. Lucke
Field Trips	Robert L. Bangert
Plans for Activities during RETC Breakfast Meeting of Officers of Underground Organizations - June 18 (discuss AUA's 1981 meeting and actions related thereto) Breakfast Meeting for RETC Participants-June 19	Tor L. Brekke
Task Assignments for Subcommittees (with emphasis on future plans)	Tor L. Brekke

1:30 p.m. - 5:30 p.m., Various Rooms

Subcommittee Meetings:	
Contracting Practices, Crystal Ballroom A	Norman A. Nadel
Education and Training, Crystal Ballroom B	Edward J. Cording
Site Investigation, Crystal Ballroom C	Eugene B. Waggoner
Research Needs, Crystal Ballroom F	Terence McCusker
Demand Forecasting, Crystal Ballroom G	Eugene L. Foster
Executive Committee/ITA Organizing Committee, Room 452	Tor L. Brekke

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Draft Agenda - (cont'd.)

June 15 - Continued

7:00 p.m. - 9:00 p.m., Cobb Room

Committee Dinner - committee members, subcommittee members, ladies, invited guests

June 16

8:00 a.m. - 12:00 noon, Crystal Ballroom E

Subcommittee Reports	**N. Nadel** **E. Cording** **E. Waggoner** **T. McCusker** **E. Foster**
Future Projects Assistance to Federal Agencies 1980 Meeting: Location and Date	Tor L. Brekke David G. Hammond et al
Presentation of Certificates Installation of New Officers	Tor L. Brekke David G. Hammond

1:30 p.m. - 5:00 p.m., Crystal Ballroom E

Discussions with representatives of federal sponsor agencies, including report of current and recent activities, federal programs, planned future committee activities	**Committee members, Federal Agency Respresentatives**

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Enclosure 2

CONTRIBUTORS TO FUND FOR SPECIAL ACTIVITIES OF THE FIFTH ANNUAL MEETING, INTERNATIONAL TUNNELLING ASSOCIATION

Al Johnson Construction Company

Jack J. Burke

Daniel, Mann, Johnson & Mendenhall

E.I. DuPont De Nemours & Company

Gardner-Denver Company

Gordon H. Ball, Inc.

S.J. Groves & Sons Company

Grow Tunneling Company

Guy F. Atkinson Company

Ingersoll-Rand Company

MacLean-Grove and Company, Inc.

Morrison-Knudsen Company

S&M Constructors, Inc.

The Robbins Company

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Enclosure 3

NATIONAL RESEARCH COUNCIL
ASSEMBLY OF ENGINEERING
2101 Constitution Avenue Washington, D.C. 20418

U.S. NATIONAL COMMITTEE ON TUNNELING TECHNOLOGY (202) 389-6831

December 14, 1979

Dr. H. Guyford Stever
Chairman, Assembly of Engineering
National Research Council
2101 Constitution Avenue
Washington, D.C. 20418

Dear Guy:

After the meeting of the Assembly of Engineering on March 14 and 15, 1979, Mr. Naftalin wrote to the committee's Executive Secretary, Mr. Bangert, transmitting several comments made by Assembly members. My purpose in writing you today is to respond to one of the comments, i.e. "Perhaps the committee needs a new name reflecting the scope of its activities." Apparently this comment stemmed from a question as to whether some of the committee's studies were strictly "technology."

I had already planned, as a result of hearing that comment at the Assembly meeting, to discuss the suggestion with the USNC/TT Executive Committee at its meeting on April 27. Our discussions were inconclusive at that meeting as to whether the connotation of our name was too narrow with regard to our proper scope of activities. It was decided to further consider the advantages and disadvantages of a name change at the full committee meeting in June. We did so, and in the limited time available, discussed more fully the potential benefits of a change, and possible committee names. Again, we reached no final conclusion because of the concern of most members that the primary benefit of a more descriptive name, (that is broader than "technology") could be offset by the possible confusion among a rather wide group of interested people, both in the United States and abroad, who relate to the present name, e.g., International Tunnelling Association.

Incidentally, the ITA is going through the same self-questioning as to whether to broaden the name of that association. At its last meeting, the question was shelved due to the general consensus that a change, at least at this time, was not desirable.

The committee decided to give the matter further thought, particularly with regard to names suggested. I therefore asked members to send in additional comments, and several did. The Executive Committee met again on November 16 and considered additional comments received from committee members since the June meeting. We then decided that because the committee's name is well-known, its activities generally well-understood, and no significantly better name had been suggested, the committee should retain its present name. Because of the thoughtful consideration given to this matter, I am confident that the decision is the proper one.

Sincerely,

David G. Hammond
Chairman

cy: M. Naftalin, W. Bangert

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NATIONAL RESEARCH COUNCIL
ASSEMBLY OF ENGINEERING
2101 Constitution Avenue Washington, D.C. 20418

OFFICE OF THE CHAIRMAN 202/389-6243

January 14, 1980

Dr. David G. Hammond
Chairman
U.S. National Committee on
Tunneling Technology
JH 703

Dear Dave:

Your note concerning the thinking of the USNC/TT that its name should remain the same seems most persuasive to me. Thanks for your thoughtful response.

Sincerely,

H. Guyford Stever

cc: R. Bangert

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NATIONAL RESEARCH COUNCIL
ASSEMBLY OF ENGINEERING
2101 Constitution Avenue Washington, D.C. 20418
(202) 389-6631

NINTH ANNUAL MEETING
U.S. NATIONAL COMMITTEE ON TUNNELING TECHNOLOGY

MAY 8-10, 1980
ALBUQUERQUE, NEW MEXICO

Record of the Meeting

ATTENDEES

COMMITTEE AND SUBCOMMITTEE MEMBERS:

David G. Hammond, *Chairman*
Norman A. Nadel, *Vice Chairman*

Joginder S. Bhore
G. Wayne Clough
Edward J. Cording, *Chairman, Subcommittee on Education & Training*
Edward Cross
Drupad B. Desai
Donald J. Duck
Eugene L. Foster, *Cochairman, Subcommittee on Demand Forecasting*
William W. Hakala, *Animateur, ITA Working Group on Seismic Effects*
Richard Hamburger
Delon Hampton
Howard J. Handewith
Fred H. Kulhawy
Kenneth G. Knight
Dennis J. Lachel
Raymond E. Levitt
Don A. Linger, *ICET Representative*
Terence G. McCusker, *Chairman, Subcommittee on Research Needs*
Thomas J. Moran
Thomas J. O'Neil
Walter H. Paterson
Solomon Ribakoff
Winfield O. Salter, *Chairman, Subcommittee on Contracting & Management Practices*
William C. Shepherd
Erland A. Tillman
Eugene B. Waggoner, *ASCE Representative & Chairman, Subcommittee on Site Investigatio*
Sheldon P. Wimpfen, *Cochairman, Subcommittee on Demand Forecasting*
Victor L. Wright, *AEG Representative*

GUEST:

Henry J. Jacoby, *Chairman, ASCE Committee on Tunneling & Underground Construction, & Steering Committee, Construction Risks & Liability Sharing Conference*

STAFF:

Robert L. Bangert, *Executive Secretary*
Susan V. Heisler, *Assistant Executive Secretary*
Virginia M. Lyman, *Administrative Assistant*

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During the afternoon of May 8, the Subcommittees met in individual sessions to review the status of their activities and discuss plans for continuing and new activities. On May 9 the general session convened, during which the Subcommittee's program recommendations were presented and other items of domestic and international business were considered by the Committee. A field trip was conducted on May 10 to a test chamber on the site of a pumped storage, hydroelectric power plant planned by the Public Service Company of New Mexico, and to the Jackpile open pit uranium mine operated by Anaconda Copper Company.

GENERAL SESSION

The Chairman, David G. Hammond, opened the meeting at 8:40 a.m., welcoming the participants and describing how the meeting would be conducted.

Mr. Hammond reported that the question of a change in the Committee's name (which had been suggested by the Assembly of Engineering and discussed at the Committee's 1979 annual meeting in Atlanta) had been resolved successfully—i.e., no change will be made.

Potential Sources of Bias

Robert L. Bangert, Executive Secretary, informed the members that every committee within the NAS-NAE-NRC is required to review annually the status of members with regard to potential sources of bias. He then read the letter from Dr. Handler, President of the NAS, that is printed on the reverse of each bias form and explains relevant Academy policies and procedures. The members were asked to notify the Secretariat of any changes to the information in the form submitted at the time of their appointment to membership.

Appointments to the Committee

Mr. Bangert announced that the NAS and NAE had approved the nominees for membership and Vice Chairman as recommended by the Committee:

Vice Chairman, 1980-81	Edward J. Cording
Industry	G. Stanley Bates
Government	William D. Alexander Gordon E. Bunker Gilbert L. Butler

He also noted that approval had been received for a one-year extension of Don A. Linger's term as Designated Representative of Federal Agencies and for appointment of Howard A. Coombs as the Designated Representative of GSA.

Reports of the Subcommittees

Subcommittee on Contracting and Management Practices

Winfield O. Salter, Chairman, stated that the Subcommittee was mandated to pursue the following tasks:

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Task A Review implementation of the recommendations of three, previously published reports (*Better Contracting for Underground Construction*, *Recommended Procedures for Settlement of Underground Construction Disputes*, and *Better Management of Major Underground Construction Projects*).

Task B Facilitate participation in the ITA Working Group on Contractual Sharing of Risks

Task C Study owner/engineer/designer contractual arrangements to effect innovation in design

To accomplish Task A the Subcommittee plans to inventory what has been done by various groups to implement the recommendations of the reports. This will involve identifying people whose offices have control over implementation. After determining what has been done and how effective it has been, the Subcommittee will decide what else needs to be done. This may involve another mail survey and publicizing reports at professional meetings, as well as additional presentations.

To accomplish Task B the Subcommittee plans to draft position papers on subjects such as ground support, award of contracts, mobilization payments, contract variation in price, type of contract, and disputes. (The last three are in early draft stage.) The drafts will be circulated for Subcommittee review before forwarding to the Animateur of the ITA Working Group.

With respect to Task C, it has been assumed that contracts can inhibit or prevent design innovation. Other adverse influences include (a) suits for damanges from the public sector, (b) organizational arrangement within which the designer must work, (c) competitive award to low bidder with little or no prequalification, (d) difficulty in obtaining sufficient professional liability insurance, and (e) budgetary constraints. The Subcommittee will look at typical contractual provisions that bear on this.

In the ensuing discussion

- Mr. Jacoby stated that ASCE hoped to implement the recommendations of the Conference on Risks and Liabilities and perhaps would like to do a part of that in conjunction with the USNC/TT. The recommendations of the Conference are to be published separately in summary form.

- Mr. Hammond noted that a follow-on conference (scheduled for March 1981) will consider the relationship of specifications and inspections to risks and liabilities.

- Mr. Lachel indicated that the USNC/TT should consider reprinting the *Better Contracting* report. Mr. Cross concurred, and Mr. Jacoby said that one of the R&L Conference recommendations was to reprint it. (NOTE: 400 copies were subsequently reprinted.)

- Mr. Salter stated that a possible approach would be to print a combined summary of all three reports, making it attractive and less formal.

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Subcommittee on Education and Training

Edward J. Cording, Chairman, reported that the slide set had been updated to include the most current developments and was now complete. It consists of about 200 slides and includes a commentary describing each slide. The availability of the set, which will be sold at cost, will be announced in a forthcoming *Newsletter*. The Subcommittee is also considering compiling smaller sets of slides on specialized topics, such as rock bolting, ground loss, etc.

Dr. Cording noted that the questionnaire on the student employment cooperative program was ready for distribution and should be mailed soon. It is expected to take about three months to obtain responses. It is planned that the USNC/TT will maintain the files and provide referrals.

Dr. Cording indicated that the Subcommittee should now begin to focus on the "training" portion of its name. An effort is needed to raise the consciousness level of people who can encourage participation in or conduct training programs of various types for various people. The problem areas need to be identified and suggestions made for how to get all of this going. The Subcommittee needs to develop a clear statement and then follow through with the necessary "arm twisting."

Subcommittee on Research Needs

Terence G. McCusker, Chairman, reported that the Subcommittee is following up on case histories to determine if research needs are really what people think they are.

With respect to the inventory of tunnels, he stated that the format will be longer than the one used by ITA but still will not be terribly detailed. It will be somewhat similar to the one developed several years ago by Rachel Barker that was published in the September 1976 issue of the *Tunneling Technology Newsletter*. The UTRC, via Frank T. Wheby, is looking for similar information so the Subcommittee must coordinate its effort with them. It appears, however, that there will be little overlap between this effort and those planned by the Subcommittees on Demand Forecasting and Site Investigation because they are interested in different and/or more specific information.

It is obvious that the USNC/TT will need cooperation from the federal agencies funding construction to ensure that the inventory questionnaire is filled out at the beginning of a project and the case history at the end. The information should be maintained in a computer file (G. Wayne Clough will integrate this task with his computer work for the site investigation study) and later transferred to a permanent agency.

In addition, Mr. McCusker stated that the Subcommittee wishes to encourage case history presentations of problems arising in projects. A specialty conference, perhaps through the Engineering Foundation, would be one method of accomplishing this; another method would be to approach RETC and obtain agreement to have a session on case histories at each RETC.

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With respect to ITA, Mr. McCusker reported that Howard J. Handewith had developed a list of TBM's in crystalline rock for presentation at the ITA meeting in Brussels, and that requests are anticipated from ITA to update both the list of research projects and the inventory of tunnels.

Subcommittee on Site Investigation

Eugene B. Waggoner, Chairman, reported that the Subcommittee's proposed study would complement but not overlap past and current work, either by other groups or USNC/TT Subcommittees. However, some of the data developed by different Subcommittees will be useful, particularly Demand Forecasting and Research Needs.

It is intended to select about 100 tunnels that have had problems to determine if there is a relationship between site investigations and the problems encountered. This will also include a search for threads of continuing problems as well as an evaluation of standard and new techniques to see if the needed data is being provided, if the data is being communicated properly, and what the degree of credibility is for the data.

In general, only tunnels in the U.S. will be considered, but foreign tunnels also will be used if the opportunity arises. Although emphasis will be placed on recently completed tunnels, data on tunnels completed as long as 40 years ago will be used as well. Tunnel projects currently in litigation will not be considered; the tunnels that are used will be referred to in the report by some designation (Tunnel A, for example) other than their specific names.

It is anticipated that the proposed study will take two years and cost approximately $350,000 to $375,000.

Subcommittee on Design Considerations

William W. Hakala, Acting Chairman, reported that the Subcommittee had been formed primarily to support ITA Working Groups dealing with seismic effects on underground structures, standardization, and structural design models for tunneling. Much more information on exactly how the Subcommittee could assist the ITA would become available at the forthcoming annual meeting in Brussels.

Dr. Hakala stated, however, that ITA priorities may differ from priority interests in the U.S. If this is the case, then perhaps the Subcommittee's scope of work should be expanded. He asked the USNC/TT members to submit suggestions of high priority design questions.

Mr. Hammond responded that design related construction problems, or the constructibility aspects of design, might be appropriate to consider. Mr. Nadel stated that the USNC/TT definitely should review the Subcommittee's charter to see if its focus needs to be expanded and sharpened.

Subcommittee on Demand Forecasting

Eugene L. Foster, Cochairman (with Sheldon P. Wimpfen), reviewed the decision made at the 1979 annual meeting that the Subcommittee members would develop a limited

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document for publication. A letter has been mailed requesting individuals to correct and/or add information to the list of tunnels and the response has been good. The level of detail in the report is much less than that sought by other groups because little or no information is available for tunnels planned for 1980-2000. It is expected that the report will be completed by the end of the year and then forwarded to the Secretariat for publication.

Dr. Foster read a portion of the proposed introduction to the report (Attachment 1), following which he explained the format of the report in more detail. He noted that positive comments had been received from potential users of the report and also that its publication perhaps will stimulate the funding agencies' interest in the project.

Chairman's Report on AE Approval of Program Plan

Mr. Hammond briefly described the presentation of the USNC/TT program plan that he had made to the Assembly of Engineering (AE) and then read an extract from the AE Executive Session (Attachment 2). He noted that the USNC/TT now has a better understanding—and therefore a better standing—with the AE in that the AE members are more aware of what the Committee is doing, and why, and have confidence that it is being done well. However, there is a continuing problem that needs to be worked on consistently: most of the AE members really are not familiar with the fields encompassed by USNC/TT activities. The AE does feel that the Committee is responsive, even though we do not respond to the more "innovative" suggestions that are made.

Committee Membership—AUA and ICET

Mr. Hammond reported the proposal to invite the American Underground-Space Association (AUA) to designate a representative to the Committee. It is expected that the AUA would respond affirmatively. This action would require amendment of the USNC/TT constitution. The Committee voted unanimously to invite the AUA to nominate a designated representative and to amend the constitution accordingly.

Don A. Linger briefly reviewed the conditions that resulted in the demise of ICET and indicated that the formation of a similar group was highly unlikely unless the government, the President's Science Advisor, or the USNC/TT initiated some action. However, it was recognized that the forthcoming presidential elections made it virtually futile to act at this time. He asked that the Committee keep in mind the need for a similar group and keep the idea moving forward as much as possible until a more appropriate time to act.

Mr. Bangert stated that Dr. Linger's term of membership had been extended for one year to enable him to serve as the Designated Representative of Federal Agencies (rather than ICET). This action was in keeping with the recently approved amendment to the USNC/TT constitution, which was in effect but had not yet received the required approval of the Governing Board of the National Research Council.

Plans for 6th Annual Meeting of the ITA

Mr. Bangert reviewed the names of members of the delegation to the ITA meeting, scheduled to be held in Brussels on May 19 and 22-23 in conjunction with the Symposium on the Safety of Underground Works. He noted that elections would be held for officers and members of the Executive Council and that the ITA Nominating Committee was recommending the following individuals from among the nominations received:

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President	Gunter Girnau (W. Germany)
Vice Presidents	Jack K. Lemley (USA) L. Lupiac (France)
Executive Council	F. Descoeudres (Switzerland) Y. Onouchi (Japan) H.P.S. Van Lohuizen (Netherlands)

Working Group on Seismic Effects on Underground Structures

William W. Hakala, Animateur, reminded the members that the Working Group had been established in 1979 at the 5th Annual Meeting of the ITA. The first meeting would be held in Brussels (Attachment 3); it is hoped that a majority of the members nominated by 12 countries will attend. The Group is expected to produce a document that will assist in design from a sesimic point of view. Member countries have been asked to prepare summary reports; when received, these will be circulated to the USNC/TT for comment. Dr. Hakala also noted that the Working Group had accepted responsibility for conducting a special session at the 1982 ITA Annual Meeting.

Working Group on Subsurface Planning

Mr. Bangert reported that Michael B. Barker had been appointed Animateur for this Working Group, replacing Birger Jansson of Sweden. He noted that papers had been requested from the member countries (Attachment 4) and were expected to be received before the meeting in Brussles.

Working Group on Research

Mr. McCusker, the member representing the U.S., stated that the Group's current project was a report on soft ground shield tunneling. He read a draft outline for Capter 4 of the report, which will deal with future trends, and invited the members to provide input to the outline.

TBM tunneling in crystalline rock is the new area of study that will be addressed in Brussels. Although it takes about two years to gather data, a new topic is proposed each year.

Plans for the Coming Year

Mr. Hammond, the outgoing Chairman, thanked the members for their support during his term of office. He then turned the meeting over to the incoming Chairman, Norman A. Nadel.

Mr. Bangert reported on three requests for assistance that had been received by the Secretariat:

- A request from the Defense Nuclear Agency to develop a report on preparation of nuclear test beds (Attachment 5)
- An inquiry from the Inspector General's Office of the Department of Energy concerning a shaft-sinking project (Attachment 6)
- A request from the Air Force to review the validity and appropriateness of research objectives currently being formulated (soil mechanics, structural dynamics, and construction materials).

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With respect to the DNA request, Mr. Bangert was asked to delve further into the situation before a decision is considered. The nature of the IG DOE inquiry was presented for information only; the Committee may or may not be asked to undertake a study. It was determined that the appropriate response to the Air Force request (since it does not involve tunneling *per se*) would be to recommend names of individuals who could provide the review services. The Subcommittee on Research Needs agreed to caucus and prepare a list of names for transmittal to the Air Force.

Mr. Nadel asked for comments and amendments to the programs that the Subcommittees had proposed in the morning session. There being none, the programs were adopted as presented.

Plans for 1981 Annual Meeting

Mr. Bangert stated that the 1981 Annual Meeting would be held May 2-3 in San Francisco, immediately preceding the RETC.

The meeting was adjourned at 3:30 p.m.

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SUBCOMMITTEE ON DEMAND FORECASTING

An industry which has a working knowledge of the future need for its products is equipped with a very powerful planning tool. The value of good demand information extends over many areas of activity, of which the following are representative:

- Those who plan and fund research and development can focus their efforts into cost effective channels.

- Those who plan construction schedules can take account of potential busts and booms in the demand cycle, balancing out the market, and obtaining more value for the dollars spent.

- Those who furnish equipment and materials can develop rational production schedules which will enable them to combine human, plant and financial resources in an optimum way, with net savings for themselves and for those who buy their products.

- Contractors can develop long range plans for growth which take account of the influence of the market on their use of available resources, thereby making their companies healthier and more competitive in the marketplace.

- Those who furnish services to the industry can focus their growth planning to optimize their effectiveness in supplying needed services profitably at a fair price.

- Those who educate professionals can compare demand data with enrollments to develop an understanding of the future needs for their students. This may be used in counseling to make students aware of career opportunities.

- The existance of a forecast will influence the awareness of everyone involved, thereby enhancing the development and use of underground space.

The underground construction and mining industries in the United States have not, to the present time, had a centralized, useable source of demand data. This has contributed to a number of difficulties, both for individual companies whose plans had to be based on incomplete data, and government bodies who developed long range schedules without knowing what others were doing.

The USNC/TT, recognizing the need, has taken this first step toward meeting it. Through its Subcommittee on Demand Forecasting, assisted by inputs from many individuals it has gathered the data given here. No government funding has been made available. This has been a labor of love by a group of individuals who believe in the cause. Limited resources have limited the scope of the present work. Even with this restriction, there is a significant amount of information about future projects. It is our hope that the present volume will be useful to you, and that your interest will encourage those who have the necessary resources to fund future, more extensive activities, to do so.

This material is arranged in parts as follows:

Part I is a compilation of specific underground construction projects believed to be in the planning or design phases. They are expected to go to construction within the indicated time frames. Although many details are known about these projects, it must be emphasized that there are still significant uncertainties in the forecast.

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Construction depends upon funding. Funding depends upon the general economic environment, the urgency of the need, and the vagaries of political priorities. Thus, in using the data of Part I, the reader may assume that most of the works will be built. He may not assume they will be built exactly on schedule. The total demand shown in Part I is therefore likely to occur in the 1980-2000 time frame, with some redistribution of construction rates to accommodate other factors.

Part II contains projections of the amount of underground construction of a nonspecific type expected during the 1980-2000 time frame. This is derived from data on the future needs for water supply, waste water conveyance, power, underground storage, and other national needs. Society, if it applies past trends to the future, maintaining reasonable national goals and utilizing existing technology, will require the amount of construction described. Obviously, the range of uncertainty in this type of projection is larger than that of Part I. The reader should apply his or her own "crystal ball factor" to the given data.

Part III contains a projection of the miles of shafts and tunnels required by the U.S. mining industry. The projections of Part III have been divided into two categories, metal and nonmetal, and coal. They are based on an analysis of trends for the individual commodities, including demand, type of mining employed, and related factors. Trends from the time period 1966-1978 have been used as the basis for best estimates of future output.

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18. EXECUTIVE SESSION: SUMMARY OF ANNUAL PROGRAM PLAN REVIEWS BY ASSEMBLY RAPPORTEURS

U.S. National Committee on Tunneling Technology--Dwight F. Metzler, the rapporteur for this committee, reported that he was impressed by the committee's broad range of activities encompassing six subcommittees, and the production of a series of reports as well as a regular newsletter. He noted that the committee proposed to operate at a level of $137,000 during FY 1981 and that funding through calendar year 1980 was assured. Questions had been raised as to why in its presentation the committee had not addressed tunneling as it relates to energy. It had been noted that water supply, water pollution control, and the locating of new power plants were related to tunneling. Increased support from the Environmental Protection Agency might thus be in order, he noted.

Since the United States is being challenged by advances in tunneling technology in Austria, England, Germany, and Japan, and German and Japanese firms are bidding U.S. tunneling work, there were questions, Mr. Metzler noted, about what action the United States needs to take to boost its technology at least to the level of that of some of the competing countries. Questions were also raised about whether systems analysis was used appropriately in tunneling technology. Companies such as Hughes and North American Rockwell might be able to contribute to some of the committee's activities in this area. The committee was encouraged to focus on the tunneling problems caused by constraints due to the increased cost of energy and increased demands for money. There seemed to be unaminity among the Assembly members, he noted, that there could be enormous cost reductions made by using small nuclear explosions to do some tunneling. The Assembly had also noted that there is an inadequate flow of trained personnel, although there has been an increase in the number of engineering schools that are turning out trained personnel in this area. The committee was also encouraged to spend more effort on drilling and boring in general, not just for large tunnels, but on the drilling and boring exploration that is characteristic of the energy business. Questions had been raised about whether the level at which the committee operates should be increased. After discussion the Assembly

VOTED to approve the program plan of the U.S. National Committee on Tunneling Technology for the period July 1, 1980 to June 30, 1981 as modified by the discussion.

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UNITED STATES GOVERNMENT

memorandum

DATE: May 6, 1980

REPLY TO ATTN OF: William W. Hakala, Animateur

SUBJECT: Progress of Working Group on "Seismic Effects on Underground Structures", International Tunneling Association (ITA)

TO: Delegates of Working Group

At the 5th Annual Meeting of the ITA in Atlanta, Georgia on June 15-17, 1979, the General Assembly approved the formation of a new Working Group "Seismic Effects on Underground Structures." The objectives of this Working Group are to (1) collect data on earthquake damage to large underground facilities throughout the world, (2) collect information on aseismic design procedures used within various countries, and (3) synthesize the information and disseminate the results to the member nations of ITA.

Since my memorandum of 10/26/79 to potential delegates of the Working Group, I have now received the official delegation list of 3/21/80 from the Secretariat's office. This official listing is enclosed as Attachment No. 1. Twelve (12) countries have designated official delegates. These countries include: United Kingdom, France, Switzerland, New Zealand, South Africa, Iceland, Italy, Peoples Republic of China, Sweden, Yugoslavia, Federal Germany and the United States. It is anticipated that several other countries will be assigning delegates in the near future.

Attachment No. 2 includes the names and addresses of individuals in the United States that have expressed an interest in contributing to the activities of the Working Group.

Based on past experiences, it is generally assumed that damage to underground facilities during earthquakes is not a significant problem. However the use of underground space is increasing both in magnitude and variety of type of function. Thus the size and shape of the underground openings range widely and could produce new problem areas. Rather than wait for a catastrophe, it appears prudent to determine potential problems in advance. Designers of underground facilities should be aware of any potential seismic problems, particularly for such critical structures as nuclear power plants, hazardous waste disposal, lifelines, pumped storage, defense installations, oil storage, etc.

While information on earthquake damage to underground structures is not plentiful, a number of specific reports and papers have been prepared in this subject area. Presently, the John A. Blume & Associates, Engineers, is completing a report on the state-of-the-art of

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earthquake effects on large underground openings. The final version will be available in September 1980; however, I will have a draft copy with me in Brussels. I anticipate that this report will provide the "core" for our activities. Upon receiving the final report, I will forward a copy to each official delegate for his comments. An abstract of this project is given in Attachment No. 3.

I would like each delegate to forward (1) data on damages caused by earthquakes and (2) aseismic design procedures directly to me. This information should be preferably in summary report form, rather than individual reports on specific projects. However, the latter is also welcome if significant conclusions are included in such reports. These reports should be in English, if possible. Copies of pertinent building code requirements, recommendations, etc. would also be of interest to the Working Group.

I have listed in Attachment 4 a number of papers and reports that have already been sent to me. If you should desire any of these publications, I will do my best to assist you in obtaining a copy.

Dr. H.C. Fischer, President of ITA, has suggested that our Working Group be responsible for one session at the 8th annual meeting of ITA in India in 1982. Because one of the most effective mechanisms for dissemination and acquisition of information is in such a forum, I am accepting this invitation. We should have significant conclusions to report at that time.

Attachment No. 5 is the agenda for the Working Group on Seismic Effects on Underground Structures, to be held in Brussels on Monday, May 19 and Friday, May 23. Provision has been made for other topics that may be suggested by the delegates.

As I stated in my memorandum of October 26, 1979, the success of our Working Group is dependent on your individual efforts. Please forward the requested information, suggestions and comments as soon as possible. I would like to thank those individuals who have already forwarded materials.

William W. Hakala

Attachments:

1. Official List of Delegates to Working Group.
2. List of Individuals in U.S. Expressing an Interest in Contributing to Working Group.
3. Abstract of State-of-the-Art Project on Seismic Effects.
4. Papers and Reports Submitted to Working Group.
5. Agenda for Working Group at 6th ITA meeting.

cc: (1) Robert Bangert, Executive Secretary, USNC/TT
(2) Jack K. Lemley, ITA Executive Council
(3) Claude Berenguier, Secretary, ITA
(4) Distribution on Attachment No. 2

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LISTE OFFICIELLE

(Réponse reçue à la lettre du 5.9.1979)

EFFETS SISMIQUES SUR LES OUVRAGES SOUTERRAINS - 9

ANIMATEUR : Dr. William W. HAKALA
National Science Foundation
1800 "G" Street, NW
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(1) non officiel communiqué par l'Animateur

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PAYS	REPRE TANT
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POLOGNE	NEANT

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LIST OF INDIVIDUALS IN U.S. EXPRESSING AN INTEREST IN CONTRIBUTING TO WORKING GROUP

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NATIONAL SCIENCE FOUNDATION

PROJECT SUMMARY

NSF AWARD NO.

1. NAME OF INSTITUTION (INCLUDE BRANCH/CAMPUS & SCHOOL OR DIVISION)

URS/John A. Blume & Associates, Engineers

2. MAILING ADDRESS

130 Jessie Street
San Francisco, CA 94105

3. PRINCIPAL INVESTIGATOR AND FIELD OF SCIENCE/SPECIALTY

Roger E. Scholl
Engineering

4. TITLE OF PROJECT

Earthquake Engineering of Large Underground Structures

5. SUMMARY OF PROPOSED WORK (LIMIT TO 32 PICA OR 16 ELITE TYPEWRITTEN LINES)

The object is to identify and evaluate the current state of the art in underground earthquake engineering practice and to determine those areas in which additional research is most needed. Transportation tunnels, utility tunnels, and other large underground structures are specifically emphasized, and instrumentation aspects are given special consideration. The studies conducted include: seismic wave propagation analyses, a summary of observed effects of earthquakes on underground structures, and a summary commentary on contemporary seismic-resistive analysis, design, and construction procedures. The research will result in the publication of a report summarizing worldwide experience concerning underground earthquake engineering, describing the important features of earthquake wave propagation, commending future experimental and analytical research.

This is a supplement to NSF Grant No. PFR77-06505.

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DIVISION (OFFICE) AND DIRECTORATE	PROGRAM	
PFR/EIS	Siting	
SECTION	PROPOSAL NO.	F.Y.
Earthquake Hazards Mitigation		1980

INSTRUCTIONS FOR USE

1. [illegible]

2. Division of Grants and Contracts will post award number, amount granted and inclusive project dates on copies 3 through 7 and distribute these copies.

NSF Form 417-75 [illegible] All Previous Editions

1. PROPOSAL FOLDER

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INITIAL BIBLIOGRAPHY

1. "Earthquake Engineering of Large Underground Structures", URS/John A. Blume & Associates, Engineers, March, 1980.

2. "Effects of Earthquakes on Tunnels and Embedded Structures", by D.A. Howells, Society for Earthquake and Civil Engineering Dynamics, October 4, 1978.

3. "Consideration of Dynamic Stress Concentrations in the Seismic Analysis of Buried Structures", by P.C. Chen, D.Z.F. Deng, A.J. Birkmyer, 1979.

4. "Earthquake Damage to Underground Facilities", by H.R. Pratt, W.A. Hustrulid, D.E. Stephenson, November 1978.

5. "A Review of the Effects of Earthquakes on Underground Mines", by Peter R. Stevens, USGS, Open-File Reports 77-313, April 1977.

6. "Essex-Diamond Ore Research Program; Tunnel Destruction, A State-of-the-Art Summary", by Charles E. Joachim, U.S. Army Waterways Experiment Station, January 1978.

7. "Dynamic Longitudinal Response of a Buried Cavity of Circular Cross Section", by A.R. Carriveau, J.M. Zanetti, R.B. Edwards; John A. Blume & Assoc., Engineers.

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Agenda
for meeting of ITA Working Group on "Seismic Effects on Underground Structures"

Animateur: William W. Hakala (United States)
Place: Brussels, Belgium
Date: May 19, 1980

I. Introduction of Delegates

II. Objectives of Working Group

III. Appointment of Vice-Animateur

IV. Summary of JAB Report

V. Bibliography Assignments

VI. Format of Working Group Products

VII. Open Discussion

VIII. Assignment of Responsibilities for 8th Annual ITA Meeting in India

IX. Report to General Assembly

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PROPOSED OUTLINE FOR PAPERS

WORKING GROUP ON SUBSURFACE PLANNING
INTERNATIONAL TUNNELING ASSOCIATION

SIXTH ANNUAL MEETING - BRUSSELS 1980

Objectives: To acquire a paper on subsurface planning from each country's delegate by March 15, 1980. These papers will be used to form the basis of a presentation to the ITA General Assembly April 1980. The papers should focus on current and future projects as well as on the planning process itself. Each paper should follow as closely as possible the proposed outline and not exceed 25 double spaced typed pages. Illustrations, photographs, and 35mm slides would be highly desirable.

I. INTRODUCTION (2 pages)

Short history of planning for the use of the subsurface in each country.

II. INSTITUTIONAL (6 pages)

Describe major private and public agencies involved in subsurface planning on the National, State (Provincial), and Local levels. Space limitations may limit this section to descriptions of two or three agencies. Try to concentrate on agencies that shape urban form. What policies are they following? Additional agencies can be covered in subsequent years.

III. BUILDINGS (6 pages)

Discuss major subsurface uses for human activity such as housing, office and manufacturing. The notion here is to gain an assessment of the existing and planned use of the subsurface for these purposes. Statistical information will probably be hard to find. Therefore, the personal observations of the delegate are encouraged. Photographs, 35mm slides, and drawings would be helpful. Energy Conservation would play an important role in this section and possibly also the following section on Transportation.

IV. TRANSPORTATION (5 pages)

Discuss major underground transportation system development. Tables and maps should be used. The impact on urban form and lifestyle should be featured.

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V. UTILITIES (4 pages)

Discuss major underground generation and distribution systems. Why was the subsurface option chosen?

VI. CONCLUSION (2 pages)

Make concluding observations on planning for the use of the subsurface for Buildings, Transportation, and Utilities. Take a long range view and speculate on the extent of subsurface use for these purposes.

NOTE: Should this outline be unduly constraining please alter it according to your needs. The important thing is to get a paper from each country.

Michael B. Barker
Animateur, Working Group
Subsurface Planning
October 15, 1979

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Attachment 5

DEFENSE NUCLEAR AGENCY
WASHINGTON, D.C. 20305

APR -7 1980

SPTD

U.S. Committee on Tunneling Technology
Joseph Henry Building, Room 703
21st & Pennsylvania Avenue
Washington, D.C. 20418

Dear Mr. Bangert:

The Defense Nuclear Agency requests your office develop an unclassified report titled, "The Preparation of Nuclear Testbeds". This request asks you to assume that you are a member of a nation's scientific community to whom the government has come for expert advice. The government desires to carry out a nuclear testing program underground that includes both the testing of specific nuclear devices and the testing of equipment and materials to the effects of nuclear weapons. At present, the nation has no capability, expertise or resources in developing underground nuclear testbeds and desires you to advise them on how and where to obtain such capabilities, expertise and resources.

Your report should center on the tunneling and drilling aspects of nuclear testbed preparation. Equipment, personnel and containment need to be addressed although they are not the only aspects you may desire to comment on.

You will no doubt have questions on the scientific parameters of nuclear weapons and the possible kinds of equipment and materials that are to be tested. Test Division of DNA will provide your point of contact for such information (LT T. J. Brown - 325-8311).

This request is hoped to capture your interest as well as provide DNA with required information. Your cooperation in this manner is greatly appreciated.

Sincerely,

Robert C. Webb Jr

THOMAS E. KENNEDY
Chief, Test Division

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Attachment 6

NATIONAL RESEARCH COUNCIL

ASSEMBLY OF ENGINEERING

2101 Constitution Avenue Washington, D.C. 20418

U.S. NATIONAL COMMITTEE ON TUNNELING TECHNOLOGY (202) 334-3457

April 30, 1980

MEMORANDUM FOR RECORD

SUBJECT: Inquiry by Department of Energy Inspector General

This memorandum discusses a recent visit by representatives of the DOE IG in connection with a review of a shaft-sinking project in Alabama.

Three persons visited on April 2, 1980: Mr. Paul Crutchfield, 252-4089; Dr. Jane Dionne (Policy & Evaluation) 252-4346; and Mr. Roy Lowery, 252-4121. They had been given my name by Sheldon Wimpfen.

Mr. Crutchfield explained that they were looking into a project to sink a 24-ft diameter shaft near Bessemer, Alabama to a coal seam 1,132 ft below the surface. The hole is now about 500 ft down, and progress is on the order of 2 ft per day (in contrast to the target of 40 ft per day). Costs had risen from $2.3 M to $18 M, and DOE is now facing a decision whether to purchase a vacuum pneumatic mucking system for approximately $7 M. The trouble is that the cutters pulverize rather than chip the material. The pulverized rock, mixed with water, is extremely difficult to muck out. With this introduction, Mr. Crutchfield then asked me why there was a need for a hole of that large a diameter. I told him that we wouldn't know that answer, that it would be best asked of coal mining interests (they plan to), Bureau of Mines or DOE Fossil Fuels Division (it's their program), or perhaps a consultant or consultants. I explained how NRC studies work and how they can be best used to give mid-range or long-range recommendations, but not short-term solutions. We discussed two earlier reports:

- o *Background Papers for a Drilling Technology Workshop*
- o *Drilling for Energy Resources*

I told them that these had been done by another committee.

They indicated that although the Inspector General would not sponsor a study there was a possibility that a study might be generated elsewhere (Fossil Fuels Division?) as a result of their inquiry.

I later discussed the visit with R.J. Burger, Executive Director, AE, and J.O. Berga, Energy Engineering Board. Burger thought that any resulting study might well be within the scope of USNC/TT's activities, especially in view of the Assembly's recent advice to the committee to get more involved in drilling and energy-related activities. Berga sees no jurisdictional problems. I think he'd be happy to have the USNC/TT pick up on the subject (if NRC were to get involved).

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Enclosed are two related papers:

- o *Blind Shaft Construction New Equipment Update*, James E. Friant, The Robbins Co.
- o *Mining Could Increase Petroleum Reserves*, Science, Vol. 207, 21 March 1980.

This might be an appropriate new activity to discuss at the annual meeting.

Enclosures

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FIFTH ANNUAL MEETING
OF THE
INTERNATIONAL TUNNELLING ASSOCIATION
Atlanta, Georgia June 15-17, 1979

ATTENDANCE

U.S. Delegation (NRC-USNC/TT)	Tor L. Brekke, Voting Delegate
	David G. Hammond, Nonvoting Delegate
	Michael B. Barker, Participant in Working Group "Planning Use of Subsurface"
	Don U. Deere, Participant in Working Group "Research"
	William W. Hakala, Moderator of Working Group "Seismic Effects on Underground Structures"
	Jack K. Lemley, Secretary of Working Group "Contractual Sharing of Risk"
	Norman A. Nadel, Moderator of Working Group "Contractual Sharing of Risk"
	Robert L. Bangert, Secretary of U.S. Delegation
ITA Officer from U.S.	William N. Lucke, First Vice President
Total U.S. Participation	34
Total Participation (A list of participants is attached)	167
Number of Countries Represented	24 (21 of 26 member countries and 3 non-member countries)
International Organizations Represented	Permanent International Association of Road Congresses (PIARC)
	International Society of Soil Mechanics and Foundation Engineering (ISSMFE)
	International Road Federation (IRF)

ADMINISTRATIVE

Composition of Executive Council	William N. Lucke (U.S.) completed his term as First Vice President and was succeeded by T. Shinohara (Japan). G. Girnau (Germany) was elected Second Vice President. J. Lemley (U.S.), L. Lupiac (France), and E. Broch (Norway) were elected to the Executive Council for three-year terms. V. Roisin (Belgium) succeeded P. Duffaut (France) as Secretary General.

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New Member Countries — The Peoples Republic of China and Poland were admitted to membership.

Future Meetings — 6th Annual Meeting, May 19-23, 1980 in Brussels, Belgium

7th Annual Meeting, May 11-15, 1981 in Nice, France

TECHNICAL ACTIVITIES

Working Groups: Eight working groups held two working sessions, and reported on their activities to the General Assembly. The working group activities are summarized in the attached press release. The groups are: Standardization, Research, Contractual Sharing of Risk, Subsurface Planning, Catalogue of Works in Progress, Safety in Work, Maintenance and Repair of Underground Structures, and Structural Design Model for Tunnelling.

One new working group, Seismic Effects on Underground Structures was formed. W. Hakala (U.S.) was appointed to be the moderator.

M. Barker (U.S.) was appointed to be moderator of the working group on Subsurface Planning.

The report of working group on Contractual Sharing of Risk was published and distributed by ITA.

Technical Papers and RETC Participation: Thirteen technical papers were presented by ITA members during the Rapid Excavation and Tunneling Conference (RETC).

Professor Hans Christian Fischer, President of ITA, was the speaker at the RETC welcoming luncheon.

Field Trips: ITA members were afforded the opportunity to participate in four technical field trips:

Atlanta Research Chamber, June 21 (organized by RETC)

Baltimore subway construction, June 23 (14 participants)

Chicago tunnel and reservoir construction, June 23 (10 participants)

Washington subway station construction, June 23 (40 participants)

The field trips in Baltimore, Chicago, and Washington D.C. were organized by the USNC/TT.

A group of 25 Japanese participants took specially-arranged field trips to view underground construction in Baltimore, New York City, Chicago, Colorado, Arizona, and California. The USNC/TT participated in planning these visits.

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GENERAL OBSERVATIONS

Planning, organizing, and conducting a meeting of this size, especially away from Washington, is an ambitious undertaking that stretches the capacity of a staff not structured to take on the additional workload. Sufficient people, time, and money must be available to insure a successful meeting.

Holding an international association meeting in conjunction with a related technical meeting enhances both meetings, and provides adequate benefits to attract participants from long distances. Officials of RETC have expressed similar opinions.

The meeting was attended by an official delegation from the Peoples Republic of China and by three individuals from Taiwan. Although during the General Assembly a representative of the Peoples Republic made known his government's position that there is one China, which includes Taiwan, no untoward incident occurred.

ITA is evolving into an organization of considerable worth. The technical activities of ITA show promise of being useful to the participating countries; the meetings are attended by persons with eminent qualifications and important responsibilities in underground construction in their countries.

The ITA continues to be a forum that will afford both short term and long term benefits to the United States. The U.S. is certainly contributing an appropriate share to ITA activities, but stands to gain even more that it contributes. Some other countries are ahead of the U.S. in certain aspects of tunneling technology; therefore, continued U.S. participation may lead to U.S. adoption of methods, techniques, and tools which may reduce tunneling costs in this country.

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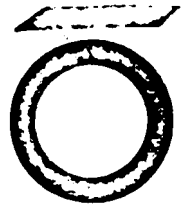

Association Internationale des Travaux en Souterrain
International Tunnelling Association

FIFTH ANNUAL MEETING - ATLANTA 1979

PRESS RELEASE

The International Tunnelling Association held its fifth annual meeting in ATLANTA (USA) from the 15th to the 17th of June 1979, immediately preceeding the fourth "Rapid Excavation Tunneling Conference". The meeting was attended by 167 participants (delegates, observers, and working group members) representing 21 of the 26 member nations of the Association, 3 nations interested in joining the Association in the near future, and 3 International Associations.

MEMBER NATIONS REPRESENTED

South Africa, Federal Republic of Germany, Algeria, Australia, Austria, Belgium, Canada, Spain, United States of America, Finland, France, Iceland, Italy, Japan, Norway, Netherlands, Poland, People's Republic of China, United Kingdom, Sweden, Switzerland.

MEMBER NATIONS NOT REPRESENTED

Denmark, Greece, India, New Zealand, Turkey

OTHER NATIONS PRESENT

Korea, Egypt, Yugoslavia

INTERNATIONAL ASSOCIATIONS REPRESENTED

Permanent International Association of Road Congresses (PIARC)
International Society of Soil Mechanics and Foundation Engineering (ISSMFE)
International Road Federation (IRF)

AITES
ITA

Secrétariat: 109, Av. Salvador Allende — 69500 BRON - FRANCE — Tél.: (78) 26-04-55 — Télex: CETELYON 37000

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ORGANIZATION

The Executive Council of the Association was modified because of the departure of the First Vice President W. N. LUCKE and of the Secretary General P. DUFFAUT, and also because of the increase in the number of supplementary members from 2 to 4, as decided by the General Assembly.

The new Executive Council of the Association is as follows:

H. C. FISCHER	Sweden	President	until 1980
A. M. MUIR WOOD	United Kingdom	Honorary President	
T. SHINOHARA	Japan	1st Vice President	until 1980
G. GIRNAU	Federal Republic of Germany	2nd Vice President	until 1982
J. LEMLEY	United States of America		until 1982
L. LUPIAC	France		until 1982
E, BROCH	Norway		until 1982
V. ROISIN	Belgium	Secretary General	

WORKING GROUPS

Each of the eight working groups previously created held two working sessions, and a new group was formed: Seismic Effects on Underground Structures, with W. HAKALA (United States of America) as animator.

The Standardization working group (J. N. PLICHON, France) reminded the Assembly of the decision made at the Tokyo Assembly concerning the use of the model bibliography system and the key words of the Thesaurus to index all the documents. The group continued working on the Glossary on boring machines, which will appear in the near future, and which will be followed by a Glossary on the traditional method of drilling and blasting. The compiling of answers to the four questionnaires on the problems of standardisation will be undertaken when the majority of member nations have answered.

The Research working group (P. KIEFT, Netherlands, new animator; Vice-animator, J. F. BOUGARD, France) presented a preliminary report (DON V. DEERE, USA) on shield tunnels. A new subject, dealing with tunnel boring machines will be studied at the request of several participants. Finally, the publication "Tunnelling Research" will be updated.

The Contractual Sharing of Risks group, (J. LEENEY, United Kingdom, who replaces N. NADEL, USA) prepared three other recommendations on contract variation in price, type of contract, and disputes. Problems of tunnel supports were discussed and they will be studied at the same time as insurance, performance guarantees and bonds, the scope of work packages, and the sharing of contractual practices in various countries.

The objective of the Subsurface Planning working group (Mr. BARKER, USA, Who succeeds B. JANSSON, Sweden) is considered to be very important in widening the activities of the Association, but several national groups do not seem to realize the importance of the subject. The most important matters under consideration are:

- human reactions while underground
- planning procedures
- energy savings

The national groups are invited to submit their analyses of the situation and of the projects in their countries, and in particular for the following subjects: energy saving, public services, storage and housing.

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The group on Catalogue of Works in Progress (MR. FUJITA, Japan) continued preparing its catalogue, which will be distributed in March 1980. The group plans to prepare descriptive bulletins for specific tunnels.

The working group on Safety in Work (MR. KRIGE, representing MR. WAGNER, South Africa) prepared a recommendation on the use of safety signals in tunnels under construction. It will be published in 1980.

The group on Maintenance and Repair of Underground Structures (MR. J. BARTLETT representing D. REES, United Kingdom) continued the study of its subject: Data bank of existing tunnels, and existing standards for inspection, maintenance repair, and safety (A questionnaire was prepared), methods of inspection limited to case histories and a program to deal with special difficulties: long term settlements, leakage of water, freezing and icicles in winter.

The Structural Design Model for Tunnelling group (H. DUDDECK, Federal Republic of Germany), which was formed only last year in Tokyo, included a large number of participants. Four types of tunnels were chosen in order to compare the concepts of support design. The answers to this questionnaire show the variety of points of view. Sub-groups are in charge of preparing a synthesis for each type of tunnel:

- a tunnel in soft soil driven by using a shield
- a tunnel supported by steel anchors and shotcrete
- a deep tunnel in moderately hard rock
- a cut and cover tunnel of rectangular cross section

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The detailed summaries of the Fifth Annual Meeting, including the annual reports of the member nations, the reports on the activities of the working groups, and the summaries of the presentations made during the Fourth RETC by the AITES members will be distributed without charge to the member nations of the Association and to the participants of the Annual Meeting. Other copies can be obtained from the editor "Pergamon Press Ltd".

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The next Annual Meeting will be held in Brussels, from May 19 through 23rd, 1980, in conjunction with the International Symposium on "The Safety of Underground Works", organized by the Belgian Tunnelling Association. The member nations of AITES are invited to encourage their members to submit texts for presentation during the Symposium.

The 1981 Annual Meeting will be held in NICE, France, from the 11th to 15th May, 1981.

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SIXTH ANNUAL MEETING
OF THE
INTERNATIONAL TUNNELLING ASSOCIATION

Brussels, Belgium May 19 - 23, 1980

ATTENDANCE

U.S. Delegation (NRC-USNC/TT)	David G. Hammond, Voting Delegate
	Norman A. Nadel, Nonvoting Delegate
	Michael B. Barker, Animateur, Working Group on Subsurface Planning
	William W. Hakala, Animateur, Working Group on Seismic Effects on Underground Structures
	Terence G. McCusker, Member of Working Group on Research
	Susan V. Heisler, Secretary of U.S. Delegation
ITA Officer from U.S.	Jack K. Lemley, Member, Executive Council, ITA
Total U.S. Participation	
Total Participation	
Number of Countries Represented	22 (17 of 26 member countries and 5 non-member countries)
International Organizations Represented	Permanent International Association of Road Congresses (PIARC)
	International Commission on Large Dams (ICOLD)

ADMINISTRATIVE

Election of Officers	G. Girnau, Federal Republic of Germany, was elected President for a three year term. Jack K. Lemley, U.S., and L. Lupiac, France, were elected Vice Presidents, both to serve for three years. Three new members were elected to the Executive Council: Y. Onouchi of Japan, F. Descoudres of Switzerland, and H.P.S. Van Lohuizen of The Netherlands.

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Future Meeting

7th Annual Meeting, May 11-14, 1981 in Nice, France in connection with the International Symposium, Cost Cutting Research in Tunnelling

Detailed Report

A detailed summary of the meeting, including the main discussions of the General Assembly, annual reports of member nations, detailed reports of the activities of the working groups, and the report of the open discussion session on safety in underground work will be published at a later date by the Secretariat of the ITA.

TECHNICAL ACTIVITIES

The technical activities were carried out by 2 meetings of each of the 9 working groups. Their activities are summarized below:

Working Group on Standardization

The working group prepared the glossary on tunnel boring machines in 4 languages (French, English, German and Japanese); it will be soon distributed and complementary terms will be added next year. The group is preparing another glossary for the terms used by the traditional method of construction by drilling and blasting. The first draft will be available at the 1981 meeting. The answers to the questionnaires on standardization of underground profiles were analyzed; a summary will be distributed and a draft recommendation concerning the standardization of circular profiles will be prepared and distributed in order to get comments before the 1981 meeting.

Working Group on Research

The working group meetings had participants representing 12 countries. The general report on shield tunnelling has been presented, and will probably be ready for publication by the end of this year. The group has discussed the basis of its new study on tunnel boring machines. The main lines for the general report should be available in Nice. A new subject has been chosen, the study of which will be undertaken after the Nice meeting: "Solution of Water Problems in Tunnelling." The necessary elements for the publication of the group, "Tunnelling Research Documentation" will be gathered before July 1.

Working Group on Contractual Sharing of Risk

The working group prepared recommendations on ground support, the award of contracts, mobilization, and advance payments. Recommendations on disputes and on variation in price were adopted as ITA policy. A future program to be studied includes bonds, the role of the engineer, working conditions, and the problems of measurement and insurance.

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Working Group on Subsurface Planning

The working group received and discussed six papers from member countries on various projects and aspects of planning for subsurface use. Among the projects discussed were major underground commercial facilities, housing, transportation, community facilities, and institution buildings. The planning techniques of several countries were compared, and the conclusions reached that much improvement was needed in relating planning for the subsurface to surface urban conditions.

Working Group on Catalogue of Works In Progress

The working group studied the lists received from Spain, USA, France, Japan, Netherlands and United Kingdom; the target date for the answers is August 14, 1980, and the catalogue will be published just after this date. The future activities of the working group will consist of cataloguing in the following order of priority, interesting tunnels, completed tunnels and tunnels under planning.

Working Group on Maintenance and Repair of Underground Structures

The working group exchanged information about inventory, methods of repair, and of inspection. The collection of data and analysis of information will be continued although only a few countries can answer. Case studies of repair projects will be published and analyzed.

Working Group on Structural Design Models for Tunneling

The working group received 52 answers to its questionnaire from 14 ITA member nations. The group discussed the answers to the synposis which had been prepared by the animateur. Some amendments were proposed; a final draft will be written within a few months for submitting to the approval of the group members and of the Executive Council and for publication.

Working Group on Seismic Effects on Underground Structures

The working group received information provided by the delegates of 13 countries regarding the damage caused to underground structures during earthquakes and the needs for aseismic design procedures; a memorandum will be distributed. The objectives of the group are to continue to develop the bibliography on damages; the state of the art paper prepared in the U.S. will be distributed for comments before the end of the year; the group will prepare for the 1982 meeting a report about the design philosophy for underground structures subject to seismic forces.

Working Group on Safety in Work

The working group submitted a document on the use of safety signs in underground works to the Executive Council with the request that it be published as soon as possible. The group has also embarked on the task of collecting statistics on accidents during construction. It is also the group's intention to compile guidelines on safety during construction; initally, the areas of ventilation, illumination, drilling, blasting and traffic in tunnels will be considered.

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INTERNATIONAL SYMPOSIUM

The Safety of Underground Works

The symposium was organized by the Belgian Tunnelling Association with the objective of promoting safety knowledge for all types of underground works.

There were 4 themes concerning safety of underground works:

- o At the conception stage
- o At the realization stage of the main construction and the associated support facilities
- o At the realization stage for construction personnel in connection with building procedures (chaired by Mr. Lemley, U.S.)
- o At the utilization stage

Additionally, there was a special session on case histories. An open discussion on May 23 concluded the symposium. Principal speakers were the session chairmen and members of the working group on Safety.

CONCLUSIONS

U.S. participation in activities of the International Tunnelling Association continues to be worthwhile. The U.S. has been able to make substantial contributions to the ITA, principally in the areas of planning, contractual sharing of risk, research, and seismic effects.

Several other nations, notably Japan and the European nations, are leaders in tunneling technology. The opportunity to work through the USNC/TT with representatives of these nations in international working groups holds the prospect of introducing the latest and best ideas for possible adoption in the U.S.

For these reasons, U.S. participation in ITA activities and support of the ITA should continue at approximately the present level.

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ASSOCIATION INTERNATIONALE
DES TRAVAUX EN SOUTERRAIN

INTERNATIONAL TUNNELLING
ASSOCIATION

A.I.T.E.S. I.T.A.

3

PARTAGE CONTRACTUEL DES RISQUES
CONTRACTUAL SHARING OF RISKS

Recommandations préparées par le Groupe de Travail

Recommendations prepared by the Working Group

MAI - 1979 - MAY

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CHANGED CONDITIONS CLAUSES

It has long been recognized by knowledgeable people in the industry that the contracting practices employed for the construction of underground works have a material effect upon the efficiency with which such works are constructed. In an effort to improve the contractual climate in which underground works are constructed, the International Tunnelling Association established a working group for Contractual Sharing of Risks which was charged with the responsibility of examining the means by which risks are customarily shared and making recommendations to promote more equitable and efficient sharing of risks.

There follow recommendations entitled:

- Changed Condition Clauses
- Full Disclosure of All Available Subsurface Information
- Elimination of Disclaimers
- Prequalification of Contractors

These recommendations are the result of extensive communication among the members of the working group, and meetings of representatives of the working group in Stockholm in 1977, and in Tokyo in 1978. The draft recommendations were circulated among all of the member nations and their adoption as recommendations by the International Tunnelling Association has been unanimously approved.

It is in the best long term interest of both owners and contractors to incorporate a "Changed Conditions" clause in their contracts. The wording of such a clause differs from one contract form to another but the intention is the same, to require an adjustment in the contract price in the event that unknown conditions, not normally expected, are encountered.

The rationale for including a "Changed Conditions" clause in construction contracts is that contractors are induced no to include large contigency sums in their tenders to cover the risk of encountering adverse underground conditions. Much of the gamble is thereby taken out of underground construction. The owner does not have to pay a windfall price when only normal conditions are encountered and the contractor suffers no disaster when unanticipated conditions arise. The owner only pays as if the true conditions were originally known. Both parties further benefit by the creation of an informal procedure, generally through the Engineer, for resolving disputes by negociation rather than litigation.

The long term advantage of the inclusion of a "Changed Conditions" clause in construction contracts is, therefore, in lowered construction costs (1) by the existence of more contractors willing and financially able to engage in such work, and (2) by the elimination of underground risk contingency costs from tenders. The owner pays less for the completed project and receives actual money value for what he contracted to have constructed.

The International Tunnelling Association recommends that a "Changed Conditions" clause be incorporated in all tunnelling contracts.

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2

FULL DISCLOSURE OF AVAILABLE SUBSURFACE INFORMATION

It is consistent with the incorporation of a "Changed Conditions" clause in construction contracts to recommend the full disclosure to tenderers of all available subsurface information, including both factual and interpretive data. The reason is that the owner alone has the adequate and necessary time to explore, analyze and study available sources of information as to underground conditions. It is not economically feasible or practical for contractors to do so for every project on which a tender is submitted. Moreover, contractors generally do not have the means of access or the time to carry out meaningful subsurface investigations during the relatively short tender period. If contractors were actually to make their own explorations, their tenders would have to include this cost, resulting in a increasing of expense to the owner, without a corresponding benefit to the owner.

While it is recognized that often there is no clear distinction between factual data and interpretive data, to the extent possible, opinions of the owner's specialists should be clearly identified. Those opinions which are significantly relied upon by the designer should also be identified.

It is believed that full disclosure of all available subsurface information will result in better, more competitive tenders, and in the long run will result in lower contract prices. Similarly, there will be fewer disputes because such disclosure will provide a better basis for determining whether a "Changed Condition" has been encountered during construction.

The International Tunnelling Association recommends that a full disclosure of all available subsurface information, including both factual and interpretative data, be made to tenderers for all tunnelling contracts.

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3

ELIMINATION OF DISCLAIMERS

It is consistent with the inclusion of a "Changed Conditions" clause in construction contracts and the full disclosure of all available subsurface information, to eliminate so-called "disclaimers", clauses purporting to relieve the owner of responsibility for the accuracy of the underground information furnished. Otherwise, a conflict is created between the "Changed Conditions" clause and the disclaimer clause, mitigating the intended elimination by contractors of contingency sums from their tenders to cover the uncertainty created by the disclaimer.

For contractual purposes a distinction should be made between data the accuracy of which the owner is prepared to guarantee and that which is provided for the information of the tenderer. The former should be binding on the owner. While the accuracy of the latter is not guaranteed it should not be expressly disclaimed and should no be regarded as binding for the purposes of a "Changed Conditions" determination but it should be considered as one factor with all the other evidence.

The practice of the owner making the interpretation of the ground is recommended.

By the elimination of disclaimers, owners should be encouraged to engage in well conceived and executed underground investigations, sufficient both for design and construction purposes. This will benefit owners by reducing the margin of uncertainty, enabling better design and planning, leading to more economic construction. It is believed that the added time and expense of a thorough site investigation, in the long run, is much less costly than the lost time and extra expenses incurred during construction in overcoming the consequences of incorrect underground information. The better the underground information, the less need there will be to disclaim responsibility for it, and the less frequently the owner will be faced with claims for "Changed Conditions".

The International Tunnelling Association recommends that adequate resources be employed on ground investigations at the pretender stage and that disclaimer clauses be eliminated from all tunnelling contracts.

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4

PREQUALIFICATION OF CONTRACTORS

It is in the best interest of owners to seek bids only from contractors who have satisfied a rigorous technical and financial prequalification procedure.

Works of underground construction are carried out in an uncertain and frequently hostile environment and require the application of considerable specialized skills, and resources for their successful completion. The preparation of realistic bids requires experience in the particular form of underground construction envisaged. Conditions may change rapidly and if construction is to proceed without undue delay and in safety, both to persons within the works and to third parties in the vicinity of the works, the contractors involved must have substantial resources available, both of technical ability, experience of similar situations and of financial strength to enable an immediate response to be made to changing conditions.

It is the practice among some owners in some parts of the world to accept tenders for underground work from all contractors choosing to submit them. All too often tenders will be received from firms which have limited or no background in underground construction. It is extremely difficult if not impossible for the owner in these circumstances, particularly if it is a public body, to refuse to accept the tender of such a firm. Unfortunately, the acceptance of such a tender is often the first step down the road to physical and economic disaster for both the owner and the contractor.

A far better procedure requires that tenders only be received from those contracting organizations which have demonstrated in advance in a formal fashion that they have available adequate financial resources and personal well qualified and experienced in the type of work to be performed. They should also be required to demonstrate that they have previously properly completed similar work within the allowed time.

By the use of prequalification procedures, the owner can ensure that all the bids received have been made by contractors with the experience essential to prepare a realistic bid and who have the resources required and which may possibly be required to complete the works safely and expeditiously.

The International Tunnelling Association recommends that owners seek bids only form contractors who have satisfied a rigorous technical and financial prequalification procedure.

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