Presentation to the Nuclear Waste Technical Review Board

OCRWM International Program

Presented by Thomas Isaacs, Director
Office of Strategic Planning and International Programs
July 16, 1991

Presentation to the Nuclear Waste Technical Review Board

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PURPOSE OF BRIEFING

- ***OCRWM's relationships with international nuclear waste management community***
- ***Status of current OCRWM international activities***
- ***International perspectives and progress on:***
  - -- ***Engineered and natural barriers***
  - -- ***Thermal loading***
  - -- ***Selecting and characterizing potential repository sites***

OBJECTIVES OF OCRWM'S INTERNATIONAL PROGRAM

- ***Obtain information that will benefit development and licensing of the U.S. Federal waste management system.***

- ***Promote international understanding and consensus on radioactive waste management issues.***

MECHANISMS FOR PARTICIPATION IN INTERNATIONAL ACTIVITIES

Direct Agreements with Other Countries

- ***Bilateral Agreements***
  - -- *Subsidiary and Project Agreements*
- ***Multinational Agreements***

Membership and/or Participation in Multinational Organizations

- ***Nuclear Energy Agency (NEA)***
- ***International Atomic Energy Agency (IAEA)***
- ***Commission of European Communities (CEC)***

PARTICIPATION IN INTERNATIONAL ACTIVITIES

- ***Bilateral Agreements***
- ***Cooperative Projects***
- ***International Working and Advisory Groups***

OCRWM BILATERAL AGREEMENTS

Bilateral Agreements with Subsidiary or Project Agreements

Canada (AECL)	--	New agreement under review
Switzerland (NAGRA)	--	Agreement extension awaiting approval
Sweden (SKB)	--	Investigating potential work scopes

Other Bilateral Agreements -- Information Exchange

Belgium	France	Japan
Germany	United Kingdom	Commission of European Communities

INTERNATIONAL COOPERATIVE PROJECTS
Performance (Safety) Assessment

INTRAVAL Project (1987 - 1993)

Radionuclide transport model validation

TDB (Thermochemical Data Base) Project (1983 - Present)

Thermochemical data compilations

PSACOIN Exercises (1985 - Present)

Safety code comparison exercises

INTERNATIONAL COOPERATIVE PROJECTS
In Situ / Field / Laboratory Testing

OECD/NEA Stripa Project (1980-1991)

In situ testing and modeling

Switzerland -- NAGRA

In situ / laboratory testing and modeling

Canada -- AECL

Laboratory / field / in situ testing

Swedish Hard Rock Laboratory (Potential)

In situ testing and modeling

INTERNATIONAL COOPERATIVE PROJECTS
Natural Analogue Activities

Pocos De Caldas Project (1986 - 1990) -- Brazil

Alligator Rivers Analogue Project (1987 - 1992) -- Australia

Cigar Lake Analogue Study (1984 - 1992) -- Canada

OCRWM PARTICIPATION IN INTERNATIONAL WORKING AND ADVISORY GROUPS

NEA RADIOACTIVE WASTE MANAGEMENT COMMITTEE (RWMC)

Performance Assessment Advisory Group (PAAG)

Probabilistic System Assessment Group (PSAG)

Coordinating Group on Site Evaluation and Design of Experiments for Radioactive Waste Disposal (SEDE) Group.

OCRWM PARTICIPATION IN INTERNATIONAL WORKING AND ADVISORY GROUPS (Continued)

NEA Working Group on Public Outreach

CEC Natural Analogue Working Group

IAEA Groups on Safeguards and Behavior of Spent Fuel in Storage

IAEA International Nuclear Waste Advisory Committee

INTERNATIONAL INITIATIVES

- ***International Program Working Group (IPWG)***

  -- ***Initiatives Being Pursued***

- ***International Program Documents***

  -- ***Program Plan***
  -- ***Program Description***
  -- ***Procedures***

STATUS, ACTIVITIES AND PLANS FOR HLW/SPENT FUEL DISPOSAL

CANADA

FRANCE

GERMANY

SWEDEN

SWITZERLAND

OVERALL FOREIGN WASTE MANAGEMENT SYSTEMS

Country	Short-Term SF Storage	Extended SF Storage	Spent Fuel Reprocessing	Waste & Age at Disposal
Canada	AR Wet	AR Wet & Dry	No, but decision is not final	SF; $\geq$ 10 years
France	1 year AR; 2-3 years @ reprocessing plant	None	Yes	HLW; ~30 years
Germany	1-10 year AR	2 Dry AFR available, but not in use	Yes, except for 20-50% of SF (under review)	HLW & SF; ~20+ years
Sweden	1-5 year AR	30-40 year Wet AFR	No	SF; ~40 years
Switzerland	~10-year AR	Dry AFR planned	Yes, but option is open	HLW; ~40 years

AR = At-Reactor Storage; AFR = Away-From-Reactor Storage; SF = Spent Fuel; HLW = High-Level Waste

OVERALL FOREIGN WASTE MANAGEMENT SYSTEMS (Continued)

Country	Repository Concept	Waste Package	Host Rock	Hydrologic Setting	URL
Canada	Conceptual: 1 canister in drift floor hole	Conceptual: SF in Ti, Cu canisters; glass beads matrix	Plutonic rock; primarily granite	Saturated Zone	OperatingURL
France	Preconceptual: 1-18 canisters in drift floor holes	Glass; rest not defined	Granite, clay, salt, or schist	Saturated Zone	1 operating; 2 ISVLs planned
Germany	Reference: HLW stacked in boreholes; SF in horizontal drifts	Glass; SF in Pollux containers	Salt dome	Salt Dome	Asse operating
Sweden	Reference: 1 canister in drift floor hole	Preliminary: thick Cu canister with Pb or Cu filler	Granite, gneiss, or gabbro	Saturated Zone	Stripa completed; HRL construction started
Switzerland	Reference: Horizontal waste packages in drifts	Glass; thick steel overpack	Granite, or sedimentary rocks	Saturated Zone	Grimsel Pass operating; URL to be located at final site

SF = Spent Fuel; Ti = Titanium; Cu = Copper; ISVL = In-Situ Validation Laboratory (or URL = Underground Research Laboratory)

OVERVIEW OF FUTURE REPOSITORY SCHEDULE

Country	Select & Characterize Final Site(s)	Construct Repository	Start Waste Emplacement
Canada	After concept accepted in 1994	No schedule; ~2015	~2020
France	Select 2 of 4 sites ~1992 - 1995; 2 ISVLs for characterization	No schedule; ~2010	After 2010
Germany	Gorleben selected; site confirmation ~2000	~2003	After 2008
Sweden	3 candidate sites ~1992 - 1995; final site confirmed ~2003	~2010 - 2020	~2020
Switzerland	1 candidate site for evaluation in 1993	2010 - 2025	~2025

ISVL = In-Situ Validation Laboratory (or URL = Underground Research Laboratory)

BARRIERS, THERMAL LOADING, AND SITING ACTIVITIES

CANADA

FRANCE

GERMANY

SWEDEN

SWITZERLAND

ENGINEERED AND NATURAL BARRIERS

FOR LONG-TERM PERFORMANCE:

- ***All countries use a combination of engineered and natural barriers***
- ***Heaviest reliance on EBS in Switzerland and Sweden***
- ***Less reliance on EBS in France and Canada***
- ***Heavy reliance on natural barrier in Germany and the U.S.***

WASTE PACKAGE DESIGN

Other Countries

Waste package designs developed for disposal in the physical, chemical, and hydrologic conditions of emplacement in the saturated zone

U.S.

Waste package configuration reference design intended to meet NRC containment and controlled release requirements, and take advantage of unique features of the unsaturated zone (UZ)

- *DOE is continuing to examine other designs tailored to maximize performance in the UZ.*

THERMAL LOADING

- *Design temperatures not easily compared due to differences in maturity of designs, extent of design analyses, and different geologic media.*

- *Trend observable toward generally lower temperature when greater reliance placed on EBS for long-term performance.*

Design Temperatures in Host Rock Around Emplacement Holes

Lower Temperature	Moderate Temperature	Higher Temperature
Canada < 100°C	France < 125°C	U.S. < 275°C
Sweden < 100°C		Germany < 200°C
Switzerland < 100°C		

RATIONALES BEHIND DESIGN TEMPERATURES

Lower Temperature -- Canada, Sweden, Switzerland

-- maximize EBS performance; reliability of characterization/modeling

Moderate Temperature -- France

-- limit microfracturing in granite/buffer changes

Higher Temperature -- Germany

-- maximize loading and minimize adverse effects

Higher Temperature -- U.S.

-- keep water away from waste packages
-- not hot enough to adversely affect natural barrier

REPOSITORY SITING

Canada

- *No site characterization work until the disposal concept approved*
- *Developing methods for characterization, including URL work*
- *Large number of potentially suitable sites in granite*

France

- *4 candidate sites, one each in granite, clay, schist, and salt*
- *3-year program of surface investigations and borehole drilling*
- *Moratorium on site investigations started 2/1990*
- *Detailed investigations at 2 candidate sites, including in-situ validation laboratories*

REPOSITORY SITING (Continued)

Germany

- *Gorleben studied since 1979; deep drilling started in 1980; only candidate site*
- *Confirmation studies started in 1986; to be completed ~2000*

Sweden

- *Investigation of ~10 study sites started in late 1970s*
- *Hard Rock Laboratory: a "dress rehearsal" for characterizing 3 sites*
- *3 candidate sites selected 1992 - 1995*

REPOSITORY SITING
(Continued)

Switzerland

- ***Studies narrowed to clay and basement crystalline sites***
- ***Surface characterization in 1990s***
- ***Final confirmation, exploratory shaft, and URL at candidate site***

CONCLUSION

- ***Value and necessity of international activities.***
- ***Significant benefit and progress to date.***
- ***Proactive pursuit of new initiatives.***

[Backup Overheads]

BRIEFING FOR

THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

ON THE

OCRWM INTERNATIONAL PROGRAM

THOMAS ISAACS, DIRECTOR
OFFICE OF STRATEGIC PLANNING AND INTERNATIONAL PROGRAMS

JULY 16, 1991

PURPOSE OF BRIEFING

- Summarize OCRWM's relationships with the international nuclear waste management community.
- Provide a status report on current OCRWM international activities.
- Discuss international perspectives and progress on:
  - Engineered and natural barriers
  - Thermal loading
  - Selecting and characterizing potential repository sites

OBJECTIVES OF OCRWM'S INTERNATIONAL PROGRAM

- Obtain information that will benefit development and licensing of the U.S. Federal waste management system.

- Promote international understanding and consensus on radioactive waste management issues.

MECHANISMS FOR PARTICIPATION IN INTERNATIONAL ACTIVITIES

Direct Agreements with Other Countries

- Bilateral Agreements
  - -- Subsidiary and Project agreements
- Multinational Agreements
  - -- Joint projects and studies

Membership and/or Participation in Multinational Organizations

- Nuclear Energy Agency (NEA)
- International Atomic Energy Agency (IAEA)
- Commission of European Communities (CEC)

PARTICIPATION IN INTERNATIONAL ACTIVITIES

Bilateral Agreements

- Access to information/technology from other programs.
- Opportunity to identify areas for cooperative projects.
- Mechanism for arranging personnel exchange, peer review, site visits, etc.

Cooperative Projects

- Develop technology on a cost-sharing basis.
- Conduct experiments at unique test facilities in foreign countries.
- Develop expertise within the OCRWM program.

International Working and Advisory Groups

- Develop international consensus on common issues in waste management.
- Broaden the information and experience base for management and decision making.

OCRWM BILATERAL AGREEMENTS

Bilateral Agreements with Subsidiary or Project Agreements

Canada – AECL

Proposed Subsidiary Agreement 2 is being reviewed within DOE.

Switzerland – NAGRA

Project Agreement 3 is awaiting final DOE approval.

Sweden – SKB

Developing workscopes for cooperative studies in the Hard Rock Laboratory.

Other Bilateral Agreements -- Information Exchange

Belgium	France	Japan
Germany	United Kingdom	Commission of European Communities

AECL SUBSIDIARY AGREEMENT 2 TASKS

Sealing Materials -- Thermodynamic data / modeling / testing

In Situ Stress Determination

Spent Fuel Dissolution Modeling

Large Block Tracer Test

In Situ Hydrochemical Tool

Cigar Lake Analogue Study

Performance Assessment Code Verification

Field Tracer Test

NAGRA PROJECT AGREEMENT 3 TASKS

Fluid Transport Characterization

Multi-Phase Flow in Fractured Rock

Seismic Tomographic Imaging

Mechanisms Controlling Sorption

Borehole Fluid Logging

HARD ROCK LABORATORY
COOPERATIVE PROGRAM

POTENTIAL TASKS

Flow and Transport Characterization in Fractured Rock

Excavation Effects and Two-Phase Flow

Geochemical Investigations Using Radiogenic Isotopic Methods

Geochemical Modeling

Underground Construction / Testing Integration

INTERNATIONAL COOPERATIVE PROJECTS
Performance (Safety) Assessment

INTRAVAL Project (1987 - 1993) -- Managed by SKI.

Radionuclide transport model validation exercises using field and laboratory data.

OCRWM participates in this multilateral project -- Phase I completed; Phase II beginning.

Phase II includes validation efforts for field studies and natural analogue efforts.

TDB (Thermochemical Data Base) Project (1983 - Present) -- Managed by NEA.

Compilations of peer-reviewed, internally consistent thermodynamic data for selected elements.

OCRWM contributes specialist experts to review teams.

PSACOIN Exercises (1985 - Present) -- Managed by NEA.

Verification and code comparison exercises on probabilistic safety assessment codes.

OCRWM monitors this project.

INTERNATIONAL COOPERATIVE PROJECTS
In Situ / Field / Laboratory Testing

OECD/NEA Stripa Project (1980-1991) -- Managed by SKB

In situ testing:
- testing completed
- rock mass characterization, fracture flow, sealing, geophysical technique development.

Switzerland -- NAGRA

In situ testing:
- Grimsel Pass facility
- testing and modeling fractured flow
- geophysical technique development
- mechanistic sorption testing

Canada -- AECL

Field and laboratory testing:
- Underground Research Laboratory
- instrumentation development
- safety assessment, and materials testing

Swedish Hard Rock Laboratory (Potential) -- Managed by SKB

In situ testing:
- facility under construction
- modeling and confirmatory testing of rock mass behavior, integration of construction and testing, flow and transport, geochemical modeling, and isotopic studies.

ADVANTAGES OF COOPERATIVE TESTING

- Use experience and technology in other countries.
- Use unique facilities not otherwise available to OCRWM.

<u>EXAMPLES</u>

Fracture flow testing in saturated zone hard rock sites (e.g. Stripa, Grimsel, HRL, etc.).
-- no similar testing in U.S.

Thermochemical Data Base Project (NEA)
-- compilation of data for Uranium, Neptunium, Americium, Plutonium, and Technetium

Tracer testing -- laboratory and field scale combination (AECL)
-- complements C-Well tests at Yucca Mountain site.

INTERNATIONAL COOPERATIVE PROJECTS
Natural Analogue Activities

Pocos De Caldas Project (1986 - 1990) -- multinational

Uranium mobilization in a fractured rock deposit under humid conditions (Brazil)

Alligator Rivers Analogue Project (1987 - 1992) -- multinational

Uranium mobilization in a fractured rock flow regime (Australia)

Data being modeled in Phase II of the INTRAVAL Project.

Effects of climate on hydrology and transport.

Cigar Lake Analogue Study -- Canada (1984 - 1992) -- multinational

Uranium deposit in Saskatchewan -- geochemical modeling of uranium concentrations and radionuclide transport in ground water.

U.S. participation as part of bilateral agreement with Canada.

PARTICIPATION IN INTERNATIONAL WORKING AND ADVISORY GROUPS

NEA RADIOACTIVE WASTE MANAGEMENT COMMITTEE (RWMC)

Senior-level forum for discussion of common nuclear waste management issues.

Performance Assessment Advisory Group (PAAG)

Safety assessment issues, approaches, and technology; scenario development; human intrusion; and biosphere modeling.

Probabilistic Systems Assessment Group (PSAG)

Code comparison exercises and exchange of system performance assessment codes.

Coordinating Group on Site Evaluation and Design of Experiments for Radioactive Waste Disposal (SEDE) Group.

Information and experience-sharing on problems in site characterization testing and modeling.

PARTICIPATION IN INTERNATIONAL WORKING AND ADVISORY GROUPS (Continued)

NEA WORKING GROUP ON PUBLIC OUTREACH

Develops educational approaches and materials on nuclear waste management.

CEC NATURAL ANALOGUE WORKING GROUP

Forum to discuss, evaluate, and review natural analogue studies.

IAEA GROUPS ON SAFEGUARDS AND BEHAVIOR OF SPENT FUEL IN STORAGE

Forums for information exchange and development of R&D prioritization.

IAEA INTERNATIONAL NUCLEAR WASTE ADVISORY COMMITTEE

Considers a wide range of nuclear waste management issues.

INTERNATIONAL INITIATIVES

International Program Working Group (IPWG)

- Consists of representatives from all OCRWM offices.
- Facilitates communication, coordination, and planning of OCRWM efforts.

  Initiatives Being Pursued

  -- OCRWM International Program review

  -- OCRWM International Program journal

  -- international meetings list

  -- possible new bilateral agreements (e.g. Spain)

  -- mechanisms for increasing opportunities for international peer review

  -- fact-finding visits to other programs

International Program Documents

- International Program Plan (Available)
- International Program Description
- Revised International Procedures

STATUS, ACTIVITIES AND PLANS FOR HLW/SPENT FUEL DISPOSAL

CANADA

FRANCE

GERMANY

SWEDEN

SWITZERLAND

OVERALL FOREIGN WASTE MANAGEMENT SYSTEMS

Country	*Short-Term SF Storage*	*Extended SF Storage*	*Spent Fuel Reprocessing*	*Waste & Age at Disposal*
Canada	*AR Wet*	*AR Wet & Dry*	*No, but decision is not final*	*SF; ≥ 10 years*
France	*1 year AR; 2-3 years @ reprocessing plant*	*None*	*Yes*	*HLW; ~30 years*
Germany	*1-10 year AR*	*2 Dry AFR available, but not in use*	*Yes, except for 20-50% of SF (under review)*	*HLW & SF; ~20+ years*
Sweden	*1-5 year AR*	*30-40 year Wet AFR*	*No*	*SF; ~40 years*
Switzerland	*~10-year AR*	*Dry AFR planned*	*Yes, but option is open*	*HLW; ~40 years*

AR = At-Reactor Storage; AFR = Away-From-Reactor Storage; SF = Spent Fuel; HLW = High-Level Waste

OVERALL FOREIGN WASTE MANAGEMENT SYSTEMS (Continued)

Country	Repository Concept	Waste Package	Host Rock	Hydrologic Setting	URL
Canada	Conceptual: 1 canister in drift floor hole	Conceptual: SF in Ti, Cu canisters; glass beads matrix	Plutonic rock; primarily granite	Saturated Zone	OperatingURL
France	Preconceptual: 1-18 canisters in drift floor holes	Glass; rest not defined	Granite, clay, salt, or schist	Saturated Zone	1 operating; 2 ISVLs planned
Germany	Reference: HLW stacked in boreholes; SF in horizontal drifts	Glass; SF in Pollux containers	Salt dome	Salt Dome	Asse operating
Sweden	Reference: 1 canister in drift floor hole	Preliminary: thick Cu canister with Pb or Cu filler	Granite, gneiss, or gabbro	Saturated Zone	Stripa completed; HRL construction started
Switzerland	Reference: Horizontal waste packages in drifts	Glass; thick steel overpack	Granite, or sedimentary rocks	Saturated Zone	Grimsel Pass operating; URL to be located at final site

SF = Spent Fuel; Ti = Titanium; Cu = Copper; ISVL = In-Situ Validation Laboratory (or URL = Underground Research Laboratory)

OVERVIEW OF FUTURE REPOSITORY SCHEDULE

Country	*Select & Characterize Final Site(s)*	*Construct Repository*	*Start Waste Emplacement*
Canada	*After concept accepted in 1994*	*No schedule; ~2015*	*~2020*
France	*Select 2 of 4 sites ~1992 - 1995; 2 ISVLs for characterization*	*No schedule; ~2010*	*After 2010*
Germany	*Gorleben selected; site confirmation ~2000*	*~2003*	*After 2008*
Sweden	*3 candidate sites ~1992 - 1995; final site confirmed ~2003*	*~2010 - 2020*	*~2020*
Switzerland	*1 candidate site for evaluation in 1993*	*2010 - 2025*	*~2025*

ISVL = In-Situ Validation Laboratory (or URL = Underground Research Laboratory)

BARRIERS, THERMAL LOADING, AND SITING ACTIVITIES

CANADA

FRANCE

GERMANY

SWEDEN

SWITZERLAND

ENGINEERED AND NATURAL BARRIERS

FOR LONG-TERM PERFORMANCE:

- **All countries use a combination of engineered and natural barriers.**
- **Heaviest reliance on EBS in Switzerland and Sweden.**
- **Less reliance on EBS in France and Canada.**
- **Heavy reliance on natural barrier in Germany and the U.S.**

ENGINEERED AND NATURAL BARRIERS
(Continued)

Sweden

- EBS: long-term isolation of wastes from ground water.
- Natural barriers: stabilize EBS environment & retard radionuclides reaching groundwater

Switzerland

- Robust EBS: $\geq$ 1000 years for container; $\geq$ 100,000 years for buffer.
- Natural barriers: retard and dilute radionuclide release; provide redundancy to EBS.

France

- EBS: 1000-year waste package desired.
- Clay buffers and possibly overpack being considered.

Canada

- Natural barriers have long-term role; EBS has near-term role (container $\geq$ 500 years).
- Focus on overall system performance, not components.
- "Equivalent" reliance on natural and engineered barriers.

Germany

- Only natural barriers have long-term function.
  - For HLW, EBS needed only until emplacement.
  - For SF, Pollux cask effectiveness ~500 years.

United States

- Natural and engineered barriers required to implement defense-in-depth approach.
- Natural barriers provide long-term function.
- EBS designed to satisfy containment and controlled release functions.

WASTE PACKAGE DESIGN

Other countries

Waste package designs are to be developed for disposal in the physical, chemical, and hydrologic conditions of emplacement in the saturated zone.

U.S.

The configuration of the waste package reference design is aimed at meeting NRC containment and controlled release requirements, and taking advantage of the unique features of the unsaturated zone.

- DOE is continuing to examine designs tailored to maximize performance in the unsaturated zone setting.

WASTE PACKAGE DESIGN IN THE U.S.
(Continued)

Components of the SCP conceptual engineered barrier system are:

- corrosion-resistant container (thin-walled)
- air gap between the container and the borehole wall

Container design takes advantage of:

- unsaturated zone (container is not submerged in water)
- absence of hydrostatic and lithostatic pressures
- thin-wall design allows higher-quality closure

Extended life waste packages being evaluated as alternatives to the SCP conceptual design.

THERMAL LOADING

- Design temperatures not easily compared due to differences in maturity of designs, extent of design analyses, and different geologic media.
- Trend observable toward generally lower temperature when greater reliance placed on EBS for long-term performance.

Design Temperatures in Host Rock Around Emplacement Holes

Lower Temperature	Moderate Temperature	Higher Temperature
Canada < 100°C	France < 125°C	U.S. < 275°C
Sweden < 100°C		Germany < 200°C
Switzerland < 100°C		

RATIONALES AND DESIGN TEMPERATURES

Lower Temperature – Canada, Sweden, Switzerland

- Minimize disturbance in the near-field natural barrier.
- Maximize long-term EBS performance.
- Reliability of characterizing and modeling conditions and performance.

Moderate Temperature – France

- Limit microfracturing in granite and mineralogical changes in backfill.

Higher Temperature – Germany

- Minimizes stress and buckling in salt and maintain glass stability.

Higher Temperature – U.S.

- Use heat to keep water away from the waste package, but not enough to adversely affect the natural barrier (Calico Hills) performance.

REPOSITORY SITING

Canada

- No site characterization work is allowed to select or characterize sites until the disposal concept is approved -- expected in 1994.
- Work has concentrated on developing methods for characterization, including URL work.
- Research indicates a large number of potentially suitable sites in granite.

France

- Sites screened in 1987 to 4 candidate sites, one each in granite, shale, schist, and salt.
- 3-year program of surface investigations and borehole drilling was started.
- 1-year moratorium on site investigations started 2/1990 and is still in effect.
- 2 candidate sites will be selected for detailed investigations, including an in-situ validation laboratory at each site.

REPOSITORY SITING
(Continued)

Germany

- Gorleben site studied since 1979, deep drilling started in 1980.
- Gorleben site identified as only candidate site in 1983.
- Confirmation studies started in 1986 (construction of two exploratory shafts).
- Confirmation studies to be completed at Gorleben by ~2000.

Sweden

- Investigations of about 10 study sites started in the late 1970s.
  -- surface investigations and about 15 boreholes per site.
- 3 candidate sites to be selected 1992 - 1995.
- 3 candidate sites to be characterized for final site license application in 2003.
- Hard Rock Laboratory (now under construction) will be "dress rehearsal" for characterizing 3 sites.

REPOSITORY ON SITING
(Continued)

Switzerland

- Studies in late 1970s narrowed to shale and basement crystalline rocks.
- Crystalline bedrock investigated (7 boreholes through 1989).
- Recent emphasis on sedimentary rock investigations.
- In the 1990s, specific sites to be selected for surface characterization.
- Final confirmation, including exploratory shaft and Underground Research Laboratory, to be carried out on final candidate site.

CONCLUSION

- Value and necessity of international activities.
- Significant benefit and progress to date.
- Proactive pursuit of new initiatives.