

International Perspectives on Technical Data Gaps Associated with Long Term Storage and Transportation of Used Nuclear Fuel

PSAM11 Probabilistic Safety Assessment and Management Conference

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**Helsinki, Finland
June 2012**



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Overview of Electric Power Research Institute (EPRI) Extended Storage Collaboration Program (ESCP)

The first meeting was held in November 2009 in Washington DC

Vision: Provide the technical bases to ensure safe, long-term used fuel storage and future transportability.

Objectives:

- Evaluate what we already know
- Identify the open items for even longer storage (gap analysis)
- Suggestions for what needs to be done (and how, if possible)
- Form standing groups to continue pursuing additional, appropriate R&D

Standing Subcommittees:

- Fuel/Internals
- Marine Environments
- Concrete
- Nondestructive Examination
- International

Participants:

- Industry (EPRI/NEI/fuel & cask vendors/utilities)
- U.S. Nuclear Regulatory Commission
- U.S. Department of Energy (DOE)
- DOE laboratories
- Universities
- International organizations

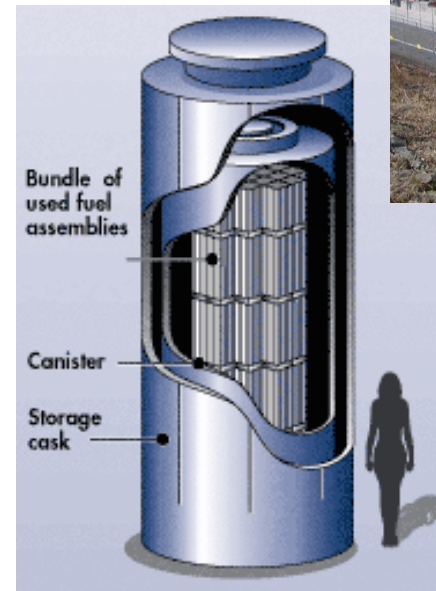
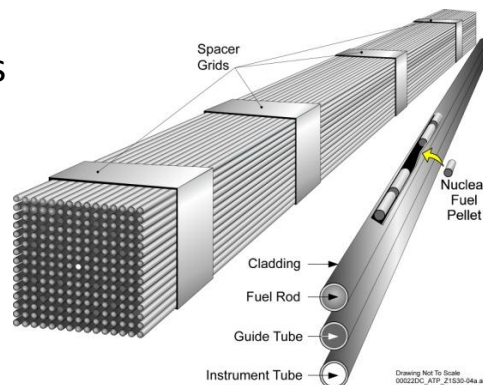
EPRI/ESCP International Subcommittee Overview

■ Objectives

- Conduct a technical data gap survey (Phase 1)
- Assess opportunities to leverage specific research to benefit the larger international group (Phase 2)
- Integrate our work with relevant International Atomic Energy Agency (IAEA) committee work

■ Terms of Reference

- Dry storage
- LWR UO₂
- Storage system includes:
 - Fuel
 - Canister/internals
 - Neutron poisons
 - Overpack
 - Pad
- Timeframe up to 300 years



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www.nrc.gov/waste/spent-fuel-storage/

EPRI/ESCP International Subcommittee Overview

1. Vienna – June 2010

- Meeting held in conjunction with IAEA Long Term Spent Fuel Storage Conference
- Initial discussions to engage a broader international community in a working group environment
- Initial Terms of Reference and Objectives were discussed

2. London – October 2010

- Meeting held in conjunction with PATRAM 2010
- Broader participation
- Initial assessment of individual country gaps

3. Charlotte – December 2010

- Relative comparison of country gaps
- Presentation of NRC technical gap analysis
- Presentation of Nuclear Waste Technical Review Board (NWTRB tech gap analysis)

4. Berlin – June 2011

- Expanded country participation
- Review of technical gap commonalities and differences
- Path Forward

5. Charlotte – December 2011

- Laid out schedule for completing the international data gap report
- Discussed potential integration potential with IAEA meetings
- Initiated discussion on potential topics for collaboration

6. St. Petersburg, FL – May 2012

- Finalized and approved final draft International Data Gap Report (completion of Phase 1)
- Discussed next series of meetings to initiate Phase 2

International Data Gap Identification and Prioritization

- Organizations from seven countries participated:
 - Germany – Bundesanstalt für Materialforschung und –prüfung (BAM)
 - Hungary – Radioaktív Hulladékokat Kezelő Közhasznú (PURAM)
Som System Kft.
 - Japan – Central Research Institute of Electric Power Industry (CRIEPI)
 - Korea – Korea Radioactive Waste Management Corporation (KRMCM)
Korea Atomic Energy Research Institute (KAERI)
 - Spain – ENRESA Empresa Nacional de Residuos Radiactivos
Consejo de Seguridad Nuclear (CSN)
ENUSA Industrias Avanzadas, S.A.
 - United Kingdom – EDF Energy
National Nuclear Laboratory Ltd
 - United States – Sandia National Laboratories
Pacific Northwest National Laboratories
- Individuals contributing to this data gap analysis participate as subject matter experts. The data gaps and prioritization presented do not represent any official country or regulatory position.

International Data Gap Identification and Prioritization

Extended Storage Technical Gaps / Needs Summary of "Importance to R&D" Assessments								
Structure, System, Component	Degradation Mechanism	BAM (Germany)	PURAM (Hungary)	CRIEPI (Japan)	KAERI (Korea)	CSN (Spain)	EDF- Energy (UK)	DOE (USA)
Cladding	Annealing		Medium	High	Medium	Medium	High	Medium
	H ₂ embrittlement		High		High	High	High	High
	H ₂ hydride cracking		Medium		High	Medium	High	High
	Oxidation	Medium	Medium		Medium	High (Spalling)	High	Medium
	Creep	Medium	Medium		Medium	Medium	High	Medium
	High Burn-up Fuel MOX Fuel	Medium						
Pellet	Cracking, bonding			High	Low	Medium		
Assembly hardware	Corrosion		Medium		High			Medium

International Data Gap Identification and Prioritization

Extended Storage Technical Gaps / Needs Summary of “Importance to R&D” Assessments								
Structure, System, Component	Degradation Mechanism	BAM (Germany)	PURAM (Hungary)	CRIEPI (Japan)	KAERI (Korea)	CSN (Spain)	EDF- Energy (UK)	DOE (USA)
Basket	Corrosion, irradiation	Medium						
Neutron poisons/ shielding	Thermal aging	Medium			Medium	Medium		Medium
	Creep					Medium		Medium
	Embrittlement					Medium		Medium
	Corrosion					Medium		Medium
Welded canister	Atmospheric corrosion		High	High	High	Low	High	High
	Aqueous corrosion		High	High			High	High
Moisture absorber	Irradiation, thermal	Medium						

International Data Gap Identification and Prioritization

Extended Storage Technical Gaps / Needs Summary of “Importance to R&D” Assessments								
Structure, System, Component	Degradation Mechanism	BAM (Germany)	PURAM (Hungary)	CRIEPI (Japan)	KAERI (Korea)	CSN (Spain)	EDF- Energy (UK)	DOE (USA)
Bolted cask	Fatigue of seals, bolts	High		High	High			Medium
	Atmospheric corrosion	Medium						High
	Aqueous corrosion							High
Metal gasket	Creep	High						
Overpack / Cask	Freeze-thaw	Low	Medium		Medium	Low	High	Medium
	Corrosion	Low	Medium					Medium

International Data Gap Identification and Prioritization

Cross-cutting Needs	BAM (Germany)	PURAM (Hungary)	CRIEPI (Japan)	KAERI (Korea)	CSN (Spain)	EDF- Energy (UK)	DOE (USA)
Monitoring	Medium	High	High			High	High - Medium
Temperature profiles	Medium	High		High	Medium	High	High
Drying issues	Medium	High			Medium (Pressure profile in cask)	High	High
Subcriticality, burnup credit		High					High
Fuel transfer options		High		Medium	Medium		High
Verification of fuel conditions			High		Medium	High	
Examination		High				High	
Canister weld SCC			High			High	
Fuel classification				High	High		
"Damage" definition				High	High	High	

International Data Gap Identification and Prioritization

Roll-up of consensus high priority data gaps:

1. Cladding

- Hydride effects

2. Canisters

- General corrosion
- Stress corrosion cracking

3. Cross-cutting gaps

- Monitoring
- Temperature profiles

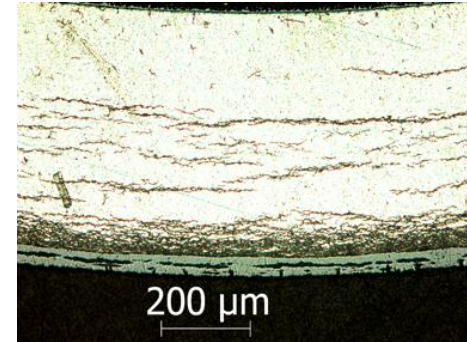


Image courtesy of Mike Billone,
Argonne National Laboratory
High burnup cladding

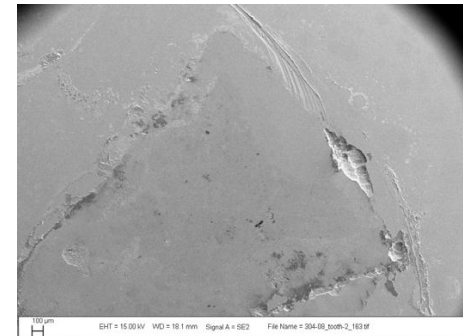


Image courtesy of David Enos,
Sandia National Laboratories
304 SS 100μg/cm² corrosion test

Next Steps

- **Transition from Phase 1 to Phase 2 of the objectives:**
 - **The data gap report has been submitted to EPRI for final editing and distribution**
 - **Work will begin on Phase 2 to assess opportunities to leverage specific research to benefit the larger international group**
- **Set tentative meeting schedule for initiating Phase 2 of the objectives**

Tentative Meeting Schedule

Meetings timeline

2012

2013

June	Oct	Nov	Dec	Mar	May	Nov
• PSAM11 Helsinki	• IAEA ?	• INER Taiwan	• ESCP Charlotte	• IAEA Argentina	• NEA Munich	• Int'l Comm. Mutsu
						

- Helsinki: Ad hoc meeting of subcommittee members to discuss technical presentations for the Charlotte ESCP meeting.
- Charlotte: Technical presentations of on-going research by subcommittee members and discussion of potential topic areas for collaborations
- Munich: Separate Int'l Subcommittee meeting plus collaborative meeting with NEA
- Mutsu: Technical Int'l Subcommittee meeting with associated emphasis on Mutsu consolidated storage facility

Conclusions

- The report, International Perspectives on Technical Data Gaps Associated with Extended Storage and Transportation of Used Nuclear Fuel provides a comprehensive assessment of:
 - current status of used fuel storage,
 - current regulatory frameworks around the world, and
 - data gaps that need to be addressed to provide the technical justification for extended storage and subsequent transportation of used fuel.
- The EPRI/ESCP International Subcommittee will focus addressing these gaps through information exchanges, as well as collaborations with on-going R&D programs.
- The EPRI/ESCP International Subcommittee will continue to coordinate our efforts with similar efforts being conducted by the IAEA and OECD/NEA.

Acknowledgements

The following individuals were the principal Points-of-Contact in writing the international technical data gap report:

- BAM (Germany): Holger Völzke (Co-Chair, International Subcommittee)
- SOM System Kft (Hungary): Miklos Ordogh
- CRIEPI (Japan): Koji Shirai (Co-Chair, International Subcommittee)
- KAERI (Korea): Dong-Hak Kook
- CSN and ENUSA (Spain): Jose Conde and Miriam Lloret
- EDF-Energy (U.K.): Peter Ross
- SNL and PNNL (U.S.): Ken Sorenson (Chair, International Subcommittee), Paul McConnell and Brady Hanson