



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

SAND2013-3973P

Salt Progress 2013

**UFD Working Group Meeting
Las Vegas, NV
May 21, 2013**

**Robert J. MacKinnon for Francis D. Hansen
Sandia National Laboratories
SAND 2013-XXXX**

- Reconsolidation of granular salt at elevated temperature
- Thermal conductivity $f(t, \phi)$
- Elevated temperature tests on WIPP salt
- Joint Project benchmarking
- Salt international collaboration

Reconsolidation at of Granular Salt at Elevated Temperature

Level II Deliverable

**COUPLED THERMAL-
HYDROLOGICAL-MECHANICAL
PROCESSES IN SALT: HOT
GRANULAR SALT
CONSOLIDATION, CONSTITUTIVE
MODEL AND MICROMECHANICS**

Fuel Cycle Research & Development

Prepared for
US Department of Energy
UFD Campaign
F.D. Hansen, S.J. Bauer,
S.T. Broome
Sandia National Laboratories
G.D. Callahan
RESPEC
November 15, 2012
FCRD-UFD-2012-000422
SAND2012-9893P



SNL-FCT-TP-11-0001
Revision 1
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Sandia National Laboratories
Fuel Cycle Technology (FCT) Program

**Consolidation of Crushed Salt at Temperatures up to 250°C, under
Hydrostatic and Shear Stresses, Rev. 1**

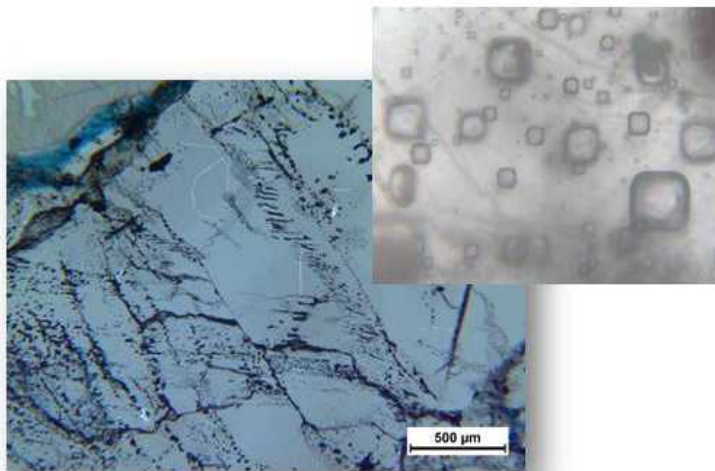
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Stephen Bauer
Geomechanics Department 6914
Sandia National Laboratories

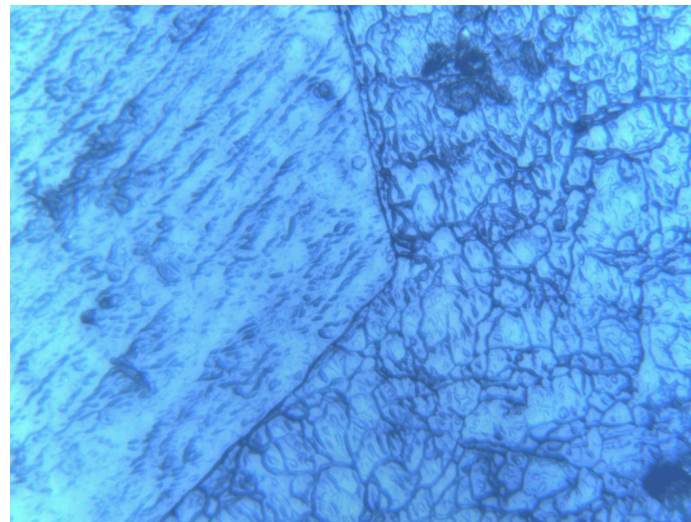
Work Underway

Reconsolidation of Granular Salt at Elevated Temperature

Natural Fluid
Inclusions



Migrating Inclusions
during Consolidation



Recrystallization during
Reconsolidation

Thermal Conductivity as a Function of Temperature and Porosity

SNL-FCT-TP-12-0001
Revision 0
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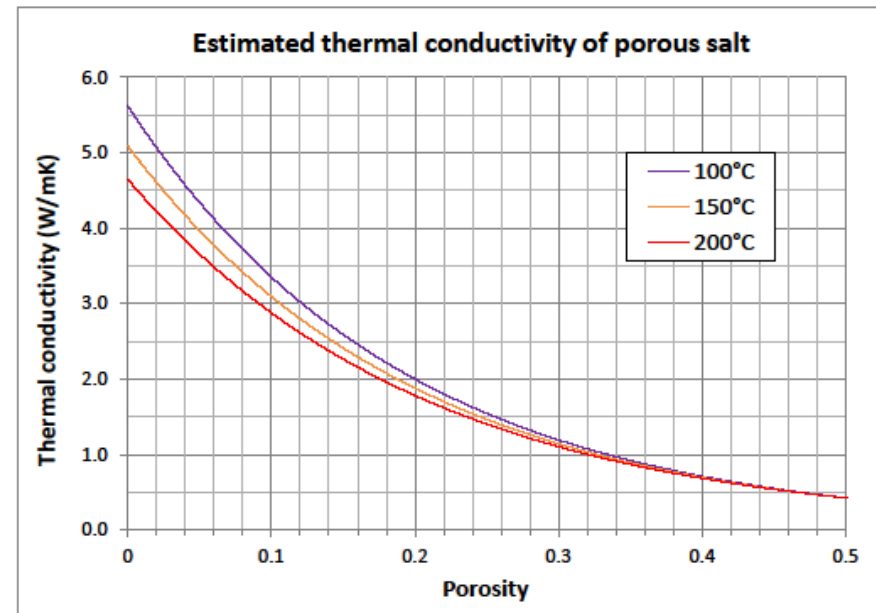
Sandia National Laboratories
Fuel Cycle Technology (FCT) Program

Thermal Conductivity of Crushed Salt
Rev. 0

Effective Date: _____

Stephen Bauer
Geomechanics Department 6914
Sandia National Laboratories

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Work Underway

Used Fuel Disposition

Elevated Temperature Tests on WIPP Salt

SNL-FCT-TP-xx-000x
Initial Issue
Page 1 of 1

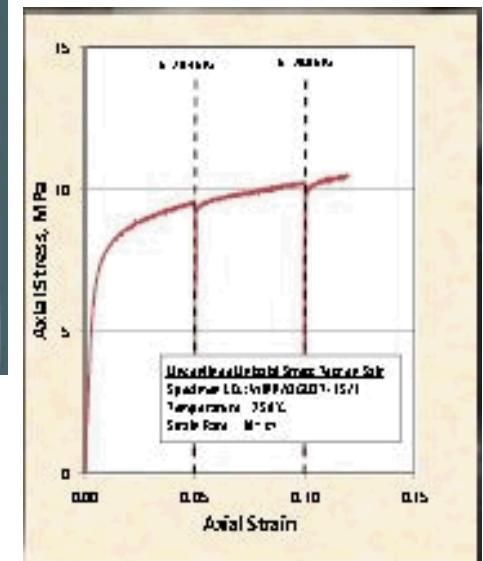
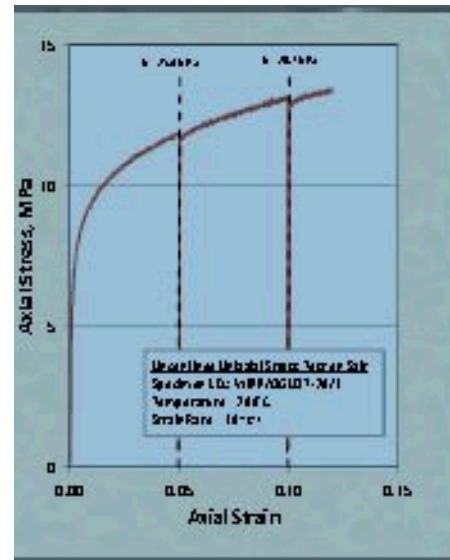
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Sandia National Laboratories
Fuel Cycle Technology (FCT) Program

Elevated Temperature Unconfined Compression Tests on Salt

Effective Date: February 14, 2013

Kirby D. Mellegard, Principal Investigator
Manager, Materials Testing
RESPEC
P.O. Box 725
Rapid City, SD 57709



Work Underway

Typical Test Results



Decrepitation at 275C



Plastic flow at 250C

Joint Project Benchmarking

10/2010 Start of Joint Project III

- Asse Benchmark Study on Temperature Influence and Healing

10/2012 Today

- Simulations of a Drift with a Bulkhead in the Asse Mine
- German Testing of WIPP Salt

9/2013 Current End of Subprojects

10/2013 Intended Start of Extension

- WIPP Benchmark Study

Used
Fuel
Disposition

WIPP Salt Sent to Germany Researchers



Sieved Run-of-Mine WIPP Salt used in Testing.



300 mm Diameter WIPP Core.

**4th US/German Workshop on Salt Repository Research,
Design and Operations**

Suggested Topics

- German Program (VSG, DAEF)
- Salt Club Meeting Report
- FEP-Catalogue
- Uncertainties in Safety Case
- Scenario Development
- Contributions of Analogues
- Operational Phase Safety
- Plugging and Sealing
- Rock/Salt Mechanics (THM-Modelling)
- Geochemical Issues
- Repository Design and Operations
- Miscellaneous Topics
- Technical Tours: ERAM, ASSE, Staßfurt
- Sept 2013 Berlin

*Proceedings of 3rd
US/German Workshop
on Salt Repository
Research, Design and
Operation*

Fuel Cycle Research & Development

Prepared for
U.S. Department of Energy
Used Fuel Disposition Campaign
Francis D. Hansen, Kristopher L. Kuhlman
Sandia National Laboratories
Walter Steininger
Karlsruhe Institute of Technology
Enrique Biurrun
DBE Technology
February 14, 2013
FCRD-UFD-2013-000100
SAND 2013-1231P



- ## Level II Milestone
- Safety Case
 - Benchmarking
 - Reconsolidation

A core group (Steering Committee) was nominated for the member nations of the Salt Club:

- Germany (E. Biurrun/DBE TEC and J. Mönig/GRS/Chair)
- United States (F. Hansen/Sandia/Co-Chair and A. van Luik/DOE)
- Poland (Andrzej Chwas)
- Netherlands (Erika Neeft, Jacques Grupa, Ewoud Verhoef)

Salt Club undertakings are responsive to the NEA/IGSC goals and therefore reach a wider distribution and more extensive applicability.

Used Fuel Disposition

3rd US/German Workshop on Salt Repository Research, Design and Operations



Name	Org	Name	Org	Name	Org	Name	Org	Name	Org
21 Arguello, J. Guadalupe	SNL	22 Fehland, Sandra	BGR	30 Jobmann, Michael	DBETEC	3 Nair, Pressed	DOE-NE	20 Stahlmann, Joachim	TUBS
4 Bauer, Steve	SNL	43 Freeze, Geoff	SNL	17 Klein, Tom	URS-RES	8 Orrell, Andrew	SNL	44 Steudmeister, Kurt	IUB Hannover
23 Bean, Jim	SNL	31 Gährlen, Andreas	TUBS	7 Lux, Kai-Heinz	TUC	36 Plischke, Elmer	TUC	11 Steininger, Walter	KIT-PTKA
38 Becker, Dirk-Alexander	GRS	24 Gardner, W. Peyton	SNL	12 Kuhlman, Kris	SNL	49 Popp, Tili	IFG	61 Thompson, Bill	Golden
10 Blumun, Enrique	DBETEC	32 Glöck, Amelvia	CNWR/SWR	37 Kuhlmann, Sebastian	TUC	16 Pudewill, Alexandra	KIT-NE	Missing Weng, Yifeng	SNL
46 Bollinger-Rehr, Wilhelm	DBETEC	33 Gröbe, Werner	SGR	37 Lee, Joon	SNL	50 Robinson, Bruce	LBNL	28 Wileczorek, Klaus	GRS
14 Broom, Scott	SNL	33 Guerin, David	LBNL	39 Leigh, Christi	SNL	41 Rosell, Gregory	SNL	47 Wolf, Jens	GRS
34 Bühner, Michael	KIT, PTKA	40 Günther, Ralf/Michael	IFS	23 Leuter, Bastian	IUB Hannover	23 Sallaberry, Cedric	SNL	36 Yıldırım, Savas	IUB Hannover
2 Buschman, Nancy	US DOE-EM	33 Gunter, Tim	DOE-NE	26 MacKinnon, Robert	SNL	5 Sambeek, Leo Van	RESPEC	53 Zapf, Dirk	IUB Hannover
1 Callahan, Gary	RESPEC	42 Hampel, Andreas	Hampel Consulting	34 Mauke, Ralf	BFS	48 Schuen, Michael	SNL		
Missing Camphouse, Chris	SNL	9 Hansen, Frank	SNL	39 Melleghand, Kirby	RESPEC	29 Self, Stephen	US-HRC		
Missing Colon, Carlos F. Jove	SNL	52 Hardin, Ernest	SNL	13 Miller, Andy	SNL	6 Sevouglan, S. David	SNL		
43 Dunagan, Sean	SNL	31 Hierchen, Kai	TUC	19 Missel, Christian	TUBS	Missing Shoemaker, Paul E.	SNL		
13 Düsterloh, Uwe	TUC	60 Houseworth, James	LBNL	27 Müller, Christian	DBETEC	18 Sobolik, Steven	SNL		



US/GERMAN WORKSHOP
Salt Repository Research,
Design, & Operation
ALBUQUERQUE, NM • USA