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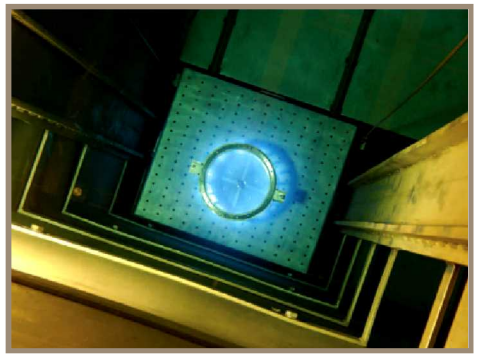

Brief Summary of LWRS Program: Cable Insulation

Sandia National Laboratories

Organic Materials Science Department

U.S. DEPARTMENT OF ENERGY | NNSA Nuclear National Security Administration

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Brief Summary of LWRS Program: Cable Insulation

Robert Bernstein

Gregory V. White II

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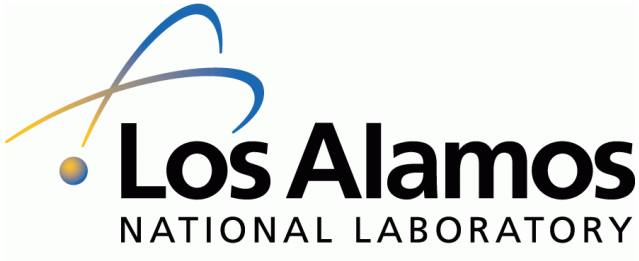
National Nuclear Security Administration

Team

- Robert Bernstein
- John L. Schroeder
- Patricia S. Sawyer
- Derek J. Wichhart
- Guillermo A. Mata
- Amy Garner
- Kenneth T. Gillen (not shown)
- Greg White (‘emeritus’)
- Mathew Celina (not shown)
- Kylen Johns (not shown)

Collaborators



National Defence
Défense nationale

Highlights of Work FY13

CNEA (Argentina) work on silicone

HFIR work

Zion cable/visit

Got some radiation information (THANK YOU DREW!!)

List of potential field materials (THANK YOU DREW!!)

Gillen Spearheading Condition Monitoring Review

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FO-GG-001 r 1

	Gerencia de coordinación de proyectos CNEA NA-SA	IN-CPCN/GE-72 Rev.: 0
		Page: 1 of 6

TITLE: **Report on previous experience on silicone rubber cable.**

1. OBJECTIVE

The objective of this report is to summarize the previous experience in silicone rubber cables installed in NPP in Argentina.

2. SCOPE

This procedure is applicable to silicone rubber cables studies under agreement between CNEA and NA-SA within the scope of CP AI 02-10 contract. This report is issue under the cooperation agreement between Argentinean Secretary of Energy and United State department of Energy.

Preparó		Revisó			Intervino calidad	Aprobó
Jorge Zorrilla		Elvio Antonaccio			Jorge Zorrilla	Juan Manuel Ranalli

REVISIONES

Rev.	Fecha	Modificaciones

FECHA DE VIGENCIA:

US-Argentine BEWG

SILICONE RUBBER

Tensile Data

Figures 8 and 9 show the degradation in tensile elongation with increasing dose and time respectively, for the silicone rubber insulations. The degradation in tensile elongation to ~50% occurs rather quickly (< 3,000 hrs and ~105 kGy) at 100 °C.

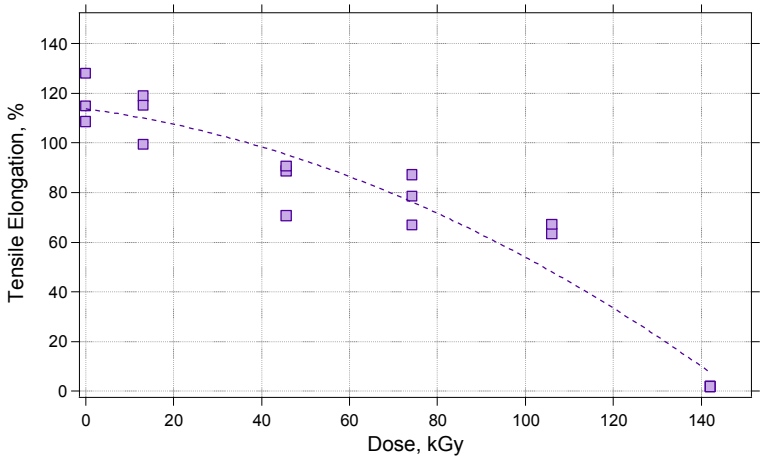

Fig. 8 - Ultimate tensile elongation data for silicone rubber cable insulations aged at 100 °C and ~39 Gy/hr provided by CNEA.

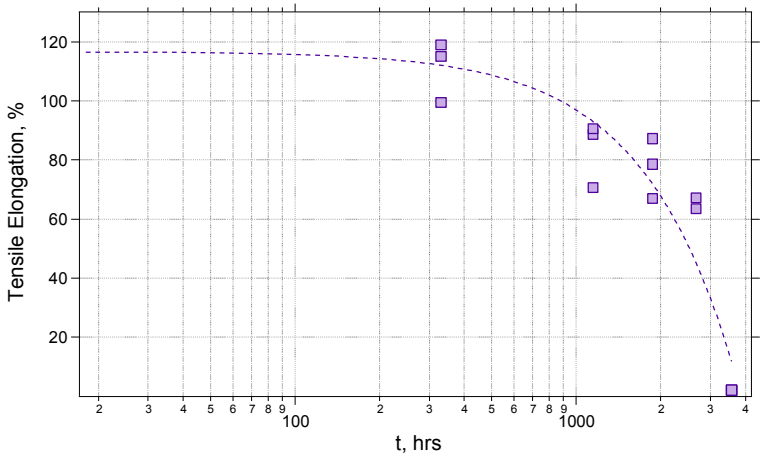

Fig. 9 - Ultimate tensile elongation data for silicone rubber cable insulations aged at 100 °C and ~39 Gy/hr provided by CNEA.

Robert Bernstein, G. V. W. I., Mathew C. Celina, John L. Schroeder, Patricia S. Sawyer, Derek J. Wichhart, Amy Garner, Guillermo A. Mata, and Kenneth T. Gillen "LWRS Year End Report - Cable Aging Research at SNL, Organic Materials Science Department," SAND#2013-7998P, 2013.

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HFIR

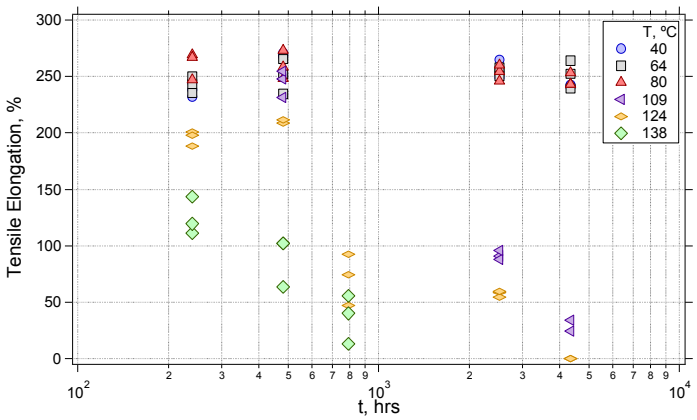

Fig. 1 - Ultimate tensile elongation data for Anaconda Densheath EPR cables returned from HFIR at ORNL (~45 yrs of age, T_{avg} ~27 °C, RH ~70%) which were further aged at varying temperatures.

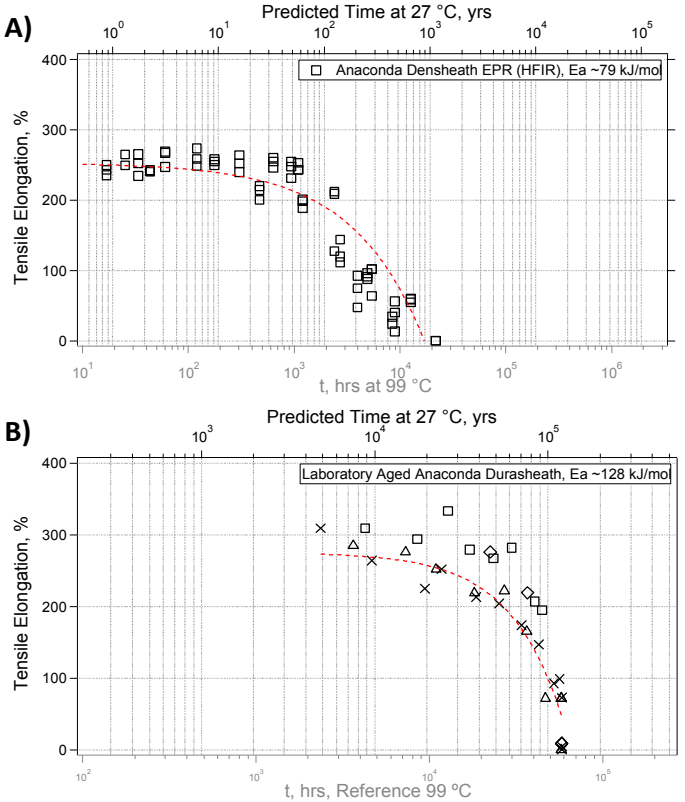

Fig. 3 - Ultimate tensile elongation data for A) Anaconda Densheath EPR cables returned from HFIR at ORNL (~45 yrs of age, T_{avg} ~27 °C, RH ~70%) and B) accelerated aging data for Anaconda Durasheeth EPR cable data [4].

Robert Bernstein, G. V. W. I., Mathew C. Celina, John L. Schroeder, Patricia S. Sawyer, Derek J. Wichhart, Amy Garner, Guillermo A. Mata, and Kenneth T. Gillen "LWRS Year End Report - Cable Aging Research at SNL, Organic Materials Science Department," SAND#2013-7998P, 2013.

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Zion

3.3 Cable from Zion Nuclear Power Station

A short length of suspected Okonite Hypalon/EPR cable was obtained from the decommissioning Zion Nuclear Power Station. The tensile elongation and density were measured to be approximately 240 % and 1.45 g/cm^3, respectively. It is important to note that the tensile and density measurements were performed on the bonded jacket and insulation at the same time as they could not be separated; this complicates any comparison to other data sets. Regardless of this testing configuration, significant tensile elongation remains in the materials.

Not having any environmental history of the cable makes it difficult to perform an aging assessment. Furthermore, knowledge that the cable was in a submerged environment adds an extra layer of complexity to the issue that is outside the work scope of this program. Future SNL effort may involve revisiting this particular cable, but under a revised work scope or alternative funding source.

Robert Bernstein, G. V. W. I., Mathew C. Celina, John L. Schroeder, Patricia S. Sawyer, Derek J. Wichhart, Amy Garner, Guillermo A. Mata, and Kenneth T. Gillen "LWRS Year End Report - Cable Aging Research at SNL, Organic Materials Science Department," SAND#2013-7998P, 2013.

1) Given that NRC is obtaining numerous cables from the Zion plant, I don't think it is the best use of taxpayer money to reproduce the work they are doing. Sheila and Stephanie are on the right path and more than capable of testing those cables. I would be happy to be involved (advice/counsel discussion about data/how to further age/etc.), but don't see the point in also obtaining samples and reproducing their work. What is most important is that the work is done, not who does it. In the unlikely case that things drop out for NRC (funding cut), let me know and I will try to convince Jeremy (probably an easy sell) that we would want to take those samples and continue that work.

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IAEA meeting and the CRP

Westinghouse PWR Environmental Data

Sandia National Laboratories

PWR At-Power Dose Survey: Summary and Conclusions

Presented at: ASTM D33 Committee Meeting
West Conshohocken, PA

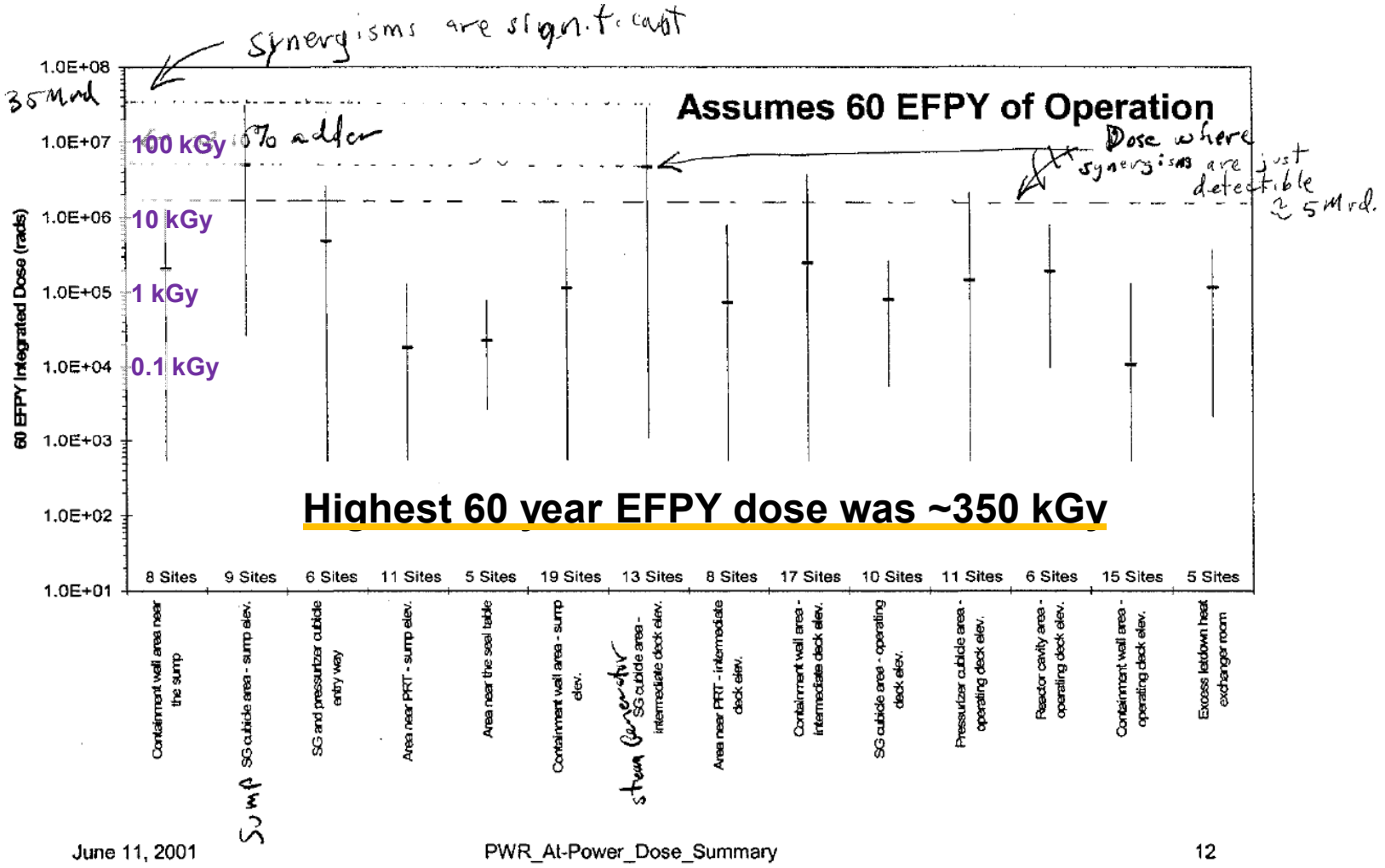
Presented by: Tim Andreychek
Westinghouse Electric Co., LLC
andreyts@westinghouse.com
(412) - 374 - 6246

Date: June 11, 2001

Thank you Drew Mantey and EPRI for passing this information onto our team!

Total Integrated Dose to 60 years

Reported dose rates were extrapolated to total integrated dose after 60 Effective Full Power Years.



Andreychek, T. "PWR At-Power Dose Survey: Summary and Conclusions" ASTM D33 Committee Meeting, June 11, 2001

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Field Aged Cables

Participating Utilities, Placement Dates, and Withdrawals

Code	Utility	Plant Name	Placement Date	Number of With-drawals
A	American Electric	DC Cook #1	O: 9/20/85	8
B	Exelon (formerly Commonwealth Edison)	LaSalle #2	O: 2/12/85 S: 10/88, B1	8 2
C	Maine Yankee Atomic Power	Maine Yankee (Being Decommissioned)	O: 10/15/85 S: 11/88, C1 S: 11/88, C3	8 2 2
D	Dominion Resources (formerly Northeast Utilities)	Millstone 2	O: 6/21/85 P: (not placed)	5 0
E	Exelon (formerly Philadelphia Electric)	Peach Bottom 3	O: 9/25/85	13
F	Nuclear Management Company (formerly Wisconsin Electric)	Point Beach 2	O: 11/04/85	12
G	Portland General Electric	Trojan (Being Decommissioned)	O: 6/18/85 S: 6/89, G3	30 12
H	Energy Northwest (formerly Washington Public Power Supply System)	Columbia River (formerly WNP-2)	O: 5/26/85 S: 6/89, H1	12 2
J	Dominion Resources (formerly Virginia Power)	Surry	O: 6/88	7
K	Public Service Electric and Gas of NJ	Salem	P: 8/95	0

O = Original bundles, S = Sandia bundles, P = Pace cable bundles

Table 1: Data Table from EPRI (courtesy Andrew Mantey)

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Gillen Spearheading Condition Monitoring Review

IAEA meeting and the CRP

Gillen Review –Condition Monitoring

a substantial effort was devoted over the past year to put together a literature review with the tentative title "Review of Important Issues that must be considered when Condition Monitoring Techniques are Applied to Nuclear Power Plant Safety Cables". This document is nearing completion (the current version contains more than 70 Figures) and is expected to be finished in the early part of FY14.

The first issue has to do with the potential importance of diffusion-limited oxidation (DLO) when accelerated aging exposures are utilized to correlate CM measurements with mechanical deterioration. Very few of the CM documents have focused on the effects of DLO on the correlations between CM parameters and mechanical degradation (e.g., elongation). With this in mind, we intend to show how DLO can alter such correlations and offer some guidance on how one can estimate and, if necessary, confirm which experimental aging conditions are likely to cause DLO effects for several important generic cable insulation and jacketing materials (chloroprene and CSPE jackets, EPR/EPDM and XLPE/XLPO insulations).

Robert Bernstein, G. V. W. I., Mathew C. Celina, John L. Schroeder, Patricia S. Sawyer, Derek J. Wichhart, Amy Garner, Guillermo A. Mata, and Kenneth T. Gillen "LWRS Year End Report - Cable Aging Research at SNL, Organic Materials Science Department," SAND#2013-7998P, 2013.

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Highlights of Work FY14

Finish work with Argentina

Finish HFIR work

Complete Gillen Condition Monitoring Review

Work to –SIMPLY- document conditions in plant

Work with ‘others’ to understand concerns

Work to retrieve field aged cables (aside from Zion)

New thought process: cable systems as opposed to cable insulation?

FY14 Thoughts -Pseudo Detail

1. Work toward model validation via field returned cable materials.
    1. Visit Zion with NRC/DOE to identify, and work to retrieve field cables -Completed. Decision made NOT to pursue Zion cables, letting NIST take lead here
    2. Receive Control rod drive mechanism (CRDM) cables (after health physics approval at SNL) and perform baseline testing and propose path forward on an assessment of the service cables -Need to follow up when find the time
    3. Work with EPRI (Drew Mantey) to receive some of their field aged cables -Need to follow up and keep trying to get any cables he can provide
    4. Work with University of Connecticut and Drew Mantey to retrieve reactor aged samples -These might not be the opportunity originally thought. Reports sent by Drew, SNL needs to follow up

2. Continue/Finalize HFIR Anaconda Durasheath Cable Aging for service cables (current data is aged out to 125 days) and put out final report (UUR peer reviewed publication, with their blessing) –Personal milestone for FY14; need to finish the work

3. Finalize collaboration with CNEA (Argentina) on SiR cables. Perform some limited testing (gel analysis, possibly radiation studies, and IR studies) and publish paper jointly under the US-Argentine BEWG (UUR Peer review publication) (This data is applicable to US SiR Cables) –Personal milestone for FY14; need to finish the work

4. Because of success with CNEA and IAEA meeting, explore possible collaboration with Koreans, and Canadians to broaden the US network -Submitted proposal with Koreans, need to follow up with them. Need to talk to with Canadians because of their indenter work. Will try to make time for this, but not sure high enough on priority list given other tasks.

5. Contribute minor support to the IAEA CRP on Cable Aging, possibly attend next meeting

6. Continue restoration/ modernization of radiation facilities (LICA) and then age XLPO, EPR, and SiR cables in LICA which relate to cables in rad environments -LICA has a thermal "event". Some samples were lost. Working to have independent over-temperature control.

7. Work with EPRI (Drew Mantey) to translate existing data to applicable knowledge for US utilities for rad/thermal environments (this activity may take into FY15 depending upon when EPRI publishes their data). –Really need to find the time to make this a priority in FY14.

8. Participate in professional meetings when can attend (e.g., EPRI Cable Users Group, American Nuclear Society, IEEE ICC, etc.)

9. Host regular DOE/NRC/EPRI meetings to discuss detailed cable data (radiation/thermal/and submerged) and areas of interest/overlap between the various groups/programs

10. Attend Joint LWRS-EPRI LTO Cable R&D Meeting

11. Release memo/report on the radiation testing concerns with regard to location in LICA facility (a concern raised in FY13) –Personal milestone for FY14

12. Continue development of potential new oxygen consumption methodology (equipment purchased in FY13)

13. Explore possibility of research areas with Mat Celina (SNL) –meeting setup for mid October

14. Work closer with Kevin Simmons at PNNL to asset with his rejuvenation project; provide insight learned from the NRC program
    –Initiated that collaboration. Providing aging expertise.

Asking for frank feedback….

From an operator or regulator perspective….

(keeping in mind DOE as funding source)

What is the next big thing we can/should tackle?

What would we need to address to 'end' concerns on cable insulation?

Where are there still concerns with regard to cable insulation?

Are there *significant* areas that are lacking work?

Who cares and is going to use this information….and how are they going to use it?

Acknowledgements

- Jeremy T. Busby (ORNL)
- Kathryn A. McCarthy (INL)
- Andrew Mantey (EPRI)
- Gary Toman (EPRI)
- Sherry Bernhoft (EPRI)
- Stephanie Watson (NIST)
- Sheila Ray (NRC)
- Darrell Murdock (NRC)
- Kevin Simmons (PNNL)
- Jorge Zorrilla (CNEA)
- Maryla Wasiolek (SNL)
- Don Hanson (SNL)

Lots of help…

Dora Derzon, Brad Hance, Don Bradley, Roger Assink, David Lo,

--AWE--Mark Read, David Plant, Mogon Patel, Niaz Khan

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John Schroeder, Patti Sawyer, Ray Boucher, Christina Lucero, Derek Wichhart, Amy Garner, Guillermo Mata, Roger Clough, Ken Gillen