

March 6, 2008

MEMORANDUM TO: Jennifer L. Uhle, Director
Division of Engineering
Office of Nuclear Regulatory Research

FROM: C. E. Carpenter, Group Lead */RA/*
Division of Engineering
Office of Nuclear Regulatory Research

SUBJECT: MEETING SUMMARY - FEBRUARY 19-21, 2008, JOINT NRC/DOE
WORKSHOP ON U.S. NUCLEAR POWER PLANT LIFE EXTENSION
RESEARCH AND DEVELOPMENT ("LIFE BEYOND 60")

The U.S. Nuclear Regulatory Commission (NRC), in collaboration with the U.S. Department of Energy (DOE), held a public Workshop on February 19-21, 2008, in Bethesda, MD, to discuss potential research and development issues related to ensuring that, if licensees elect to pursue subsequent license renewal periods, continued long-term operation can be conducted safely. Participants included representatives from the NRC, DOE, industry, national laboratories, academia, IAEA, the public and international organizations (see Enclosure1).

The sessions, which included panel and public discussions, were:

Opening Plenary

Session 1a: Industry Discussion on Historical License Renewal Efforts

Session 1b: Industry Perspective on Future Industry Needs for Continued
Operation Beyond 60 Years

Session 2: Long-term Reliability of Systems, Structures, and Components;

Session 3: Management of Age-Related Materials Degradation Issues;

Session 4: Determination of New Technologies, Tools, and Applications for Diagnostics
and Monitoring

Wrap-Up Plenary

These Sessions are described briefly in Enclosure 2. The Wrap-Up Plenary was an overview of what was discussed during the Workshop.

The Workshop identified several areas that may require additional research to ensure that continued long-term operation can be safely achieved, including identifying "sentinel samples" (e.g., limiting materials) that could provide predictions of long-term serviceability of systems, structures and components; performing combined effects testing on reactor materials; improved concrete damage models and mitigation and inspection technologies; developing improved welding and weld repairs methods and inspection technologies; and, improvements to on-line monitoring and diagnostics. A final report on the outcomes from this Workshop is expected to be published in April 2008.

The NRC's role is to establish the regulatory requirements with which licensees must comply to ensure adequate protection of public health and safety. It is important to note that the industry is responsible for developing the technical basis to demonstrate that these requirements are met. Demonstrating that the age-related degradation associated with operation into subsequent license renewal periods is adequately addressed, including conducting the necessary research, is the responsibility of licensees. The NRC often performs confirmatory research to independently assess the conclusions provided by the industry. The NRC and industry have developed cooperative research agreements in the past to jointly obtain raw data for independent assessments. Such agreements may be useful for research associated with age-related degradation.

The next steps include focused discussions with DOE, the domestic industry, and potential international partners to begin development of an integrated research plan, and additional public outreach to ensure appropriate stakeholder participation (this includes a session on this topic during the NRC's 2008 Regulatory Information Conference, and a session during the June 8-12, 2008, American Nuclear Society Annual Meeting).

Enclosures:
As stated

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Enclosures:
As stated

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DATE	03/6/08	03/6/08	03/6/08	

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Workshop Attendees

<u>Name</u>	<u>Company</u>
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Norio Nakagawa	Ames Laboratory
Hash Hashemian	AMS
Massoud Tafazzoli	AREVA
Apostolos (Paul) Raptis	Argonne National
Sasan Bakhtiari	Argonne National Lab
Ihor Bodnar	Argonne National Lab
Ron Faibish	Argonne National Laboratory
Hussein Khalil	Argonne National Laboratory
Ken Natesan	Argonne National Laboratory
Richard Schaller	Arizona Public Service Co.
Jack Lance	Battelle Energy Alliance
Kevin Kamps	Beyond Nuclear
Tina Seeley	Bloomberg News
Mike Melton	BNL
Charles Hofmayer	Brookhaven National Laboratory
Robert Lofaro	Brookhaven National Laboratory
Myra Torres	CALCE, Univ of Maryland
Lawrence Makovich	Cambridge Energy Research Associates, Inc.
Barry Krebs	CC Technologies
Hiroshi Yoshida	Chubu Electric Power Co., Inc.
Mike Fallin	Constellation
Oliver Moghissi	DNV/CC Technologies
Chris Abernathy	Duke Energy
Michael Semmler	Duke Energy
Erol Ozan	East Carolina University
Gary Toman	Electric Power Research Institute
Michel Vidard	Electricite de France INA
Robert Falk	Enercon Services, Inc.
Matthew Ahlers	Energetics Incorporated
Carl Berger	Energetics Incorporated
Marylee Blackwood	Energetics Incorporated
Marty Martinez	Energetics Incorporated
Jenna Thompson	Energetics Incorporated
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Dan Keuter	Entergy Nuclear
Garry G. Young	Entergy Nuclear
Mohamad Behravesh	EPRI
John Gaertner	EPRI
Kenneth Huffman	EPRI
Greg Selby	EPRI
Jack Spanner	EPRI
Thomas Tebrush	EPRI
Gary Vine	EPRI
Andy Winter	Exelon

Workshop Attendees

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Frederick Polaski	Exelon Corporation
Dennis Weakland	First Energy
Charles Wirtz	First Energy
Hoa Hoang	GE Hitachi Nuclear Energy
Rosemary Greene	Greene R&D International
David Greene	Greene R&D International
Ron Victor	Greene R&D International
Ki Sig Kang	IAEA
Donald Dudenhoeffer	Idaho National Laboratory
Bruce Hallbert	Idaho National Laboratory
Timothy Leahy	Idaho National Laboratory
Mitchell Meyer	Idaho National Laboratory
Cheryl O'Brien	Idaho National Laboratory
Peter Planchon	Idaho National Laboratory
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Tim Roney	Idaho National Laboratory
Ronaldo Szilard	Idaho National Laboratory
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Michael Chinworth	Japan Nuclear Energy Safety Organization (JNES)
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Brandon Rasmussen	Kurz Technical Services
Richard Kester	Lockheed Martin
Thomas Marcille	Los Alamos National Lab
Ted Marston	Marston Consulting
Mauri Lemoncelli	Morgan Lewis
Julie Keys	NEI
Michael Becker	Northrop Grumman
Roman Mychajliw	NTEC
Doug Walters	Nuclear Energy Institute
Rebecca Cooper	Nuclear Fuel Cycle Monitor
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Richard Wood	Oak Ridge National Lab
Jeremy Busby	Oak Ridge National Laboratory
Randy Nanstad	Oak Ridge National Laboratory
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Mike Watkins	Pacific Northwest National Laboratory
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Leonard Bond	PNNL
Roger Stewart	Progress Energy
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Jason Petti	Sandia National Laboratories
Charles Morrow	Sandia National Labs
Ben Cross	Savannah River National Laboratory
Karthik Subramanian	Savannah River National Laboratory
Chalmer Myer	Southern Nuclear
Charles Pierce	Southern Nuclear
Jeff Gasser	Southern Nuclear Operating Co., Inc.
James Sheppard	STP Nuclear Operating Company
Tim Gilman	Structural Integrity Associates, Inc.
Herbert Garrett	Tennessee Valley Authority
Francis Cameron	The Zero Gravity Group, LLC
Rory Sweeney	Times Leader
Dennis McCloud	TVA
Gary Was	University of Michigan
Yesim Sireli	University of North Carolina at Charlotte
Wes Hines	University of Tennessee
Todd Allen	University of Wisconsin
Dick Seif	URS Washington Division
John Lareau	WesDyne International, Inc.
Cheryl Boggess	Westinghouse
Mike Burke	Westinghouse
John Goossen	Westinghouse
Patricia Paesano	Westinghouse
Randy Lott	Westinghouse Electric
Charles Meyer	Westinghouse Electric
Patrick Burke	Xcel Energy

Workshop Attendees

<u>Name</u>	<u>Company</u>
Richard Burrow	DOE
Robert Jordan	DOE
Shane McLean	DOE NE
Tom Miller	DOE
Charles Ramsey	DOE Office of Environment, Safety and Health
Martha Shields	DOE
Dennis Spurgeon	DOE
Mekonen Bayssie	NRC
Mario Bonaca	NRC
C. E. (Gene) Carpenter	NRC
John Flack	NRC
Amy Hull	NRC
Erickson Kirk	NRC
Shah Malik	NRC
Carol Nove	NRC
Jeffrey Poehler	NRC
Luis Reyes	NRC
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J.S. Armijo	NRC
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Daniel Santos	NRC
Robert Hardies	NRC
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Samson Lee	NRC
Louise Lund	NRC
Matthew Mitchell	NRC
Iouri Prokofiev	NRC
Simon Sheng	NRC
Ted Sullivan	NRC
John Tsao	NRC
Luisette Candelario-Quintana	NRC

Workshop Session Overview

Opening Plenary

<u>Presenter and Presentation Title</u>	<u>ADAMS #</u>
Tom Miller, Deputy Director, DOE C.E. Carpenter, Group Lead, NRC, “Introductory Remarks”	ML080530099
Dennis Spurgeon, Assistant Secretary for Nuclear Energy, DOE “Life Beyond 60”	ML080590295
Luis Reyes, Executive Director for Operations, NRC “Chairman Klein’s Comments on Subsequent License Renewal Terms”	Website
Joe Sheppard, President and CEO, South Texas Project “Life Beyond 60”	ML080590283
Lawrence J. Makovich, Vice President - Global Power Cambridge Energy Research Associates “Nuclear Power Landscape and Outlook”	N/A
Ki Sig Kang, IAEA Plant Life Management Team Leader “International Perspective on Plant Life Management (PLiM)”	ML080570431
Samson Lee, Deputy Director, Division of License Renewal, NRC “Regulatory Overview of License Renewal Process”	ML080601308

The Workshop’s co-chairs, Mr. Tom Miller, Deputy Director, DOE, and Mr. Carpenter, Group Lead, NRC, provided introductory remarks, including the purpose of the Workshop and the expected outcomes. Specifically, the attendees were requested to consider, and provide suggestions for, areas where research may be needed to ensure long-term safe operation of the existing fleet of licensed commercial nuclear power plants, and potential partners that may have capabilities not presently in use, or under-utilized, by the nuclear industry.

Mr. Dennis Spurgeon, Assistant Secretary for Nuclear Energy, DOE, provided his comments on the need for “Life Beyond 60,” which included energy security and carbon abatement concerns. Mr. Luis Reyes, Executive Director for Operations, NRC, then gave NRC’s Chairman Klein’s Comments on “Subsequent License Renewal Terms,” which included the need to begin any needed research in a timely manner. Mr. Joe Sheppard, President and Chief Executive Officer for the South Texas Project, provided an industry perspective on the business case for keeping the existing reactors operating as long as they safely can. Dr. Lawrence J. Makovich, Vice President, Global Power, Cambridge Energy Research Associates, then spoke on the economic perspective of long-term operation of nuclear power plants, including the rising costs of needed construction materials. Dr. Ki Sig Kang, the Plant Life Management Team Leader for the International Atomic Energy Agency (IAEA) discussed the “International Perspective on Plant Life Management (PLiM)”, including that most countries do not have the same regulatory structure as the U.S., and thus do not have license renewal, per se.

Finally, Dr. Samson Lee, Deputy Director, Division of License Renewal, Office of Nuclear Reactor Regulation (NRR) NRC, presented an overview of the License Renewal Process (10 CFR Part 54), including that the NRC considers Part 54 to be sufficient and not requiring any revisions at this time.

<u>Presenter and Presentation Title</u>	<u>ADAMS #</u>
Ted Marston, Principal, Marston Consulting "The Road to License Renewal - The Early Years"	ML080590297
Doug Walters, Senior Director - Operations Support, NEI "Early License Renewal Challenges"	ML080590310
Chuck Pierce, Manager, Nuclear Deployment, Southern Company "Eighty is the New Sixty - Lessons from the Past"	ML080590312

Session 1b, Industry Perspective on Future Industry Needs for Continued
Operation Beyond 60 Years

<u>Presenter and Presentation Title</u>	<u>ADAMS #</u>
Ken Huffman, Technical Executive, EPRI "Long-Term Operation of Nuclear Power Plants: Executive Interviews"	ML080600377
Fred Polaski, License Renewal Manager, Exelon Garry Young, Manager, License Renewal, Entergy Nuclear "License Renewal - The Second Time"	ML080600346
Jeff Gasser, Executive Vice President and Chief Nuclear Officer, Southern Nuclear Operating Company, "License Renewal Factors Outside of Part 54"	ML080600352
Dan Keuter, Vice President - Planning & Innovation, Entergy Nuclear "LWR R&D Strategic Plan"	ML080600341

Mr. Miller, DOE, was the management lead for these sessions, and Ms Julie Keys, Senior Project Manager, Nuclear Energy Institute (NEI), was the technical lead.

In Session 1a, Messrs. Marston, Walters, and Pierce discussed how the lessons learned from the initial license renewal period could be applied to subsequent ones.

In Session 1b, Mr. Huffman, gave an overview of a recent survey that the Electric Power Research Institute (EPRI) conducted which provides an indication that senior industry officials are seriously considering subsequent license renewal terms. Messrs. Polaski and Young discussed how Exelon and Entergy are beginning to consider a second round of license renewals, and what is being looked at to facilitate this. Finally, Mr. Keuter presented an overview of the R&D needed for nuclear energy to expand to a 25% share of electricity generation in 2030, and about 40% by mid-century.

Session 2, Long-term Reliability of Systems, Structures, and Components

<u>Presenter and Presentation Title</u>	<u>ADAMS#</u>
Randy Lott, Westinghouse “Vessel Internals - the Functional Impact of Age-Related Degradation”	ML080600704
Charlie Hofmayer, Group Leader, Engineering Mechanics and Infrastructure Group, Brookhaven National Laboratory “Concrete Structures”	ML080600487
Gary Toman, Senior Project Manager, EPRI “Aging Management of Cable and Buried Piping”	ML080600460 ML080600465
Andy Winter, Manager, Equipment Reliability, Exelon “Exelon Long Term Asset Management (LTAM) Process”	ML080600470
Mike Fallin, Principal Engineer, Constellation “License Renewal Perspective”	ML080600480
Jeff Spilker, Supervisor Nuclear Projects, OPPD “Fort Calhoun Experience with Large Component Replacement”	ML080600456

Dr. Samson Lee, NRC, was the management lead for this session, and Mr. Ken Huffman, EPRI, was the technical lead. For sessions 2 - 4, the individual presentations and the Workshop’s final report should be consulted for details of the individual presentations. What follows is an overview of the sessions.

The panel members did not identify any obvious or absolute barriers (i.e., “show stoppers”) to long-term operation; however, several challenges were discussed, and some areas for additional research were suggested. The potential challenges identified included the need to ensure that the operating experience for passive components, both those currently in service and any replacements, be systematically captured and trended in order to determine potential lessons learned. A recurring recommendation, which applies directly to Session 4, was the need for better inspection capabilities and predictive diagnostic tools, as well as designing for inspection. It was also suggested that a better understanding of the limitations that is inherent in any analysis was needed in order to better determine the service life of plant equipment; particular examples included fatigue and environmental qualification.

It was noted that systematic component replacement and long term asset management (LTAM) are important to maintaining long-term reliability, as well as better environmental protection of equipment such as cables and buried piping. Optimizing replacement designs (e.g., corrosion resistant materials, pre-sized for future power up rates) will also improve long-term operability.

The suggested areas for additional research included developing an industry-wide operating experience database of the operability of passive systems, structures and components (SSC); expanding the utilization of information from retired SSCs; developing “sentinel samples” (i.e., test coupons); proactively developing innovative repair methods and capabilities for hard-to-access components like cables and buried pipes; improved integration of technical contributors (e.g., “silo elimination”); and, increased use of risk-informed analyses to address aging issues.

Session 3. Management of Age-Related Materials Degradation Issues

<u>Presenter and Presentation Title</u>	<u>ADAMS #</u>
Todd Allen, Professor, University of Wisconsin "Radiation Resiliency for 80 Year Cores"	ML080601196
Mike Burke, Westinghouse "PWR issues for LWR Life Extension"	ML080601210
Robin Dyle, Principal Engineer, Southern Nuclear "Primary System Corrosion"	ML080601221
Steve Gosselin, Chief Engineer, Pacific Northwest National Laboratory (PNNL) "Fatigue"	ML080600852
Mike Melton, Senior Project Manager, NEI "Material Degradation Matrix, Inconel issues"	ML080600974
Dan Naus, Distinguished Research Staff Member, Oak Ridge National Laboratory (ORNL) "Concrete Materials and Structures - Aging and Life Beyond 60 Years"	ML080601105
Jack Spanner, Program Manager, EPRI "Coatings"	ML080601164

Jennifer Uhle, Director, Division of Engineering, Office of Nuclear Regulatory Research (RES), NRC, was the management lead for this session, and Mr. Jack Lance, Director, Idaho National Laboratory (INL), was the technical lead.

The suggested areas for additional research identified in this session included developing tools such as a Materials Degradation Matrix to help better target materials research into areas like the environmental effects on fracture resistance/fatigue, stress corrosion cracking (SCC) of Nickel-base alloys and stainless steels, and the effect of fluence on SCC and crack growth. It was suggested that since coatings have been shown to be important in protecting structural materials and piping, that additional research into better coating materials, including the potential applications of nanotechnology, could be beneficial. Another area was improved models, experiments, and probes to better understand degradation mechanisms and radiation response of safety-related materials. Combined effects testing of reactor materials, wherein the synergetic effects of heat, pressure, radiation, and chemistry, was strongly encouraged. This could included a more fundamental understanding of the aging effects of complex alloys, how the material's microstructure effects its bulk properties, and any "late blooming" effects.

Also suggested was research into the long-term sustainability of aging mitigation processes; improved concrete damage models and the development of mitigation technologies; improved inspection capabilities of cast-austenitic stainless steels (CASS) and concrete; development of alternates to existing coating technologies, and to welding and weld repairs; and, developing a damage tolerant approach to fatigue.

Session 4, Determination of New Technologies, Tools, and Applications
for Diagnostics and Monitoring

<u>Presenter and Presentation Title</u>	<u>ADAMS #</u>
Leonard Bond, Laboratory Fellow, PNNL "From NDE to Prognostics: A Review"	ML080601227
Greg Selby, Senior Program Manager, EPRI "NDE Research Needs for Long Term Operation of LWRs"	ML080601254
John Lareau, Chief Engineer, WesDyne International, Inc. "Current Inspection Practice for Reactor Internals and Future Needs"	ML080660545
Hash Hashemian, AMS Corp. "Diagnostic Techniques to Be Developed for Aging Nuclear Power Plants"	ML080601232
Sasan Bakhtiari, Argonne National Laboratory (ANL) "Research on Advanced ISI Technologies"	ML080601305
Brandon Rasmussen, Consultant "On-line Monitoring System Diagnostics"	ML080601302
J. Wesley Hines, Professor, University of Tennessee "Prognostic Method Requirements: Planning for the Future"	ML080601300

Mr. Matthew Mitchell, Chief, Vessels and Internals Integrity Branch, Division of Component Integrity, NRR, NRC, was the management lead for this session, and Dr. Leonard Bond, Laboratory Fellow, Pacific Northwest National Laboratory (PNNL) was the technical lead.

The potential challenges identified in this session included establishing the technical and regulatory basis for new inspection technologies; being able to better manage the uncertainty in monitoring and prediction; and, demonstrating the reliability and cost-effectiveness of new inspection technologies and prognostic tools.

The suggested areas for additional research identified in this session included developing a non-destructive examination (NDE) measurements matrix analogue to material degradation matrix (MDM); developing enhanced NDE techniques; management and trend-analysis of large quantities of data (including historical data); establishing a failure signature database; and, determining future instrument needs.