SMiRT Post-Conference Seminar "Aging Management and Lifetime Assessment for NPPs," Shanghai, China, August 15-17, 2005

NPP License Renewal and Aging Management: An International Perspective

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Office of Nuclear Reactor Regulation (NRR)

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License Renewal Guidance Documents

- NUREG-1801, *Generic Aging Lessons Learned* (GALL) *Report*
- NUREG-1800, *Standard Review Plan for License Renewal Applications for Nuclear Power Plants (SRP-LR)*
- Regulatory Guide (RG) 1.188, *Standard Format and Content for Applications to Renew Nuclear Power Plant Operating Licenses*
- Existing version dated 2001

GALL Report

- Addresses aging management
- Based on:
  - Nuclear Plant Aging Research Reports (NPAR), 153 Reports
  - Licensee Event Reports (LERs)
  - Nuclear Management and Resources Council (NUMARC), 10 Reports on Major Components
  - Generic Communications
  - Previous Safety Evaluation Reports (SERs)

Standard Review Plan (SRP-LR)

- Provides guidance to NRC staff in performing review of license renewal application
- SRP-LR based on GALL report

Regulatory Guide (RG) 1.188

- Provides guidance to industry in preparing application
- Contains standard format of license renewal application
- Endorses Nuclear Energy Institute (NEI) document 95-10

Update License Renewal Guidance Documents

- Incorporate lessons learned from review of license renewal applications to increase efficiency for both applicant and NRC
  - GALL (NUREG 1801)
  - SRP-LR (NUREG 1800)
  - RG 1.188
- Revision scheduled for September 30, 2005

Document Update Effort

- Multi-Office within NRC
  - Office of Nuclear Regulatory Research (RES)
  - Office of Nuclear Reactor Regulation (NRR)
    - Division of Regulatory Improvement Programs (DRIP)
    - Division of Inspection Program Management (DIPM)
    - Division of Systems Safety & Analysis (DSSA)
    - Division of Engineering (DE)
- Contractors
- Nuclear Energy Institute (NEI)
- Public groups

Document Update Process

- Enhanced public participation
  - Sept. 30, 2004 - Preliminary draft posted on public website
  - Frequent public meetings
  - Jan. 31, 2005 – Draft available for a 60-day public comment period
- Expanded explanations and justification
  - Technical basis document (NUREG-1833) for changes from 2001 version available Oct. 30, 2005
  - Public comment NUREG-1832 available Sept. 30, 2005

GALL Report 2005 : Table of Contents

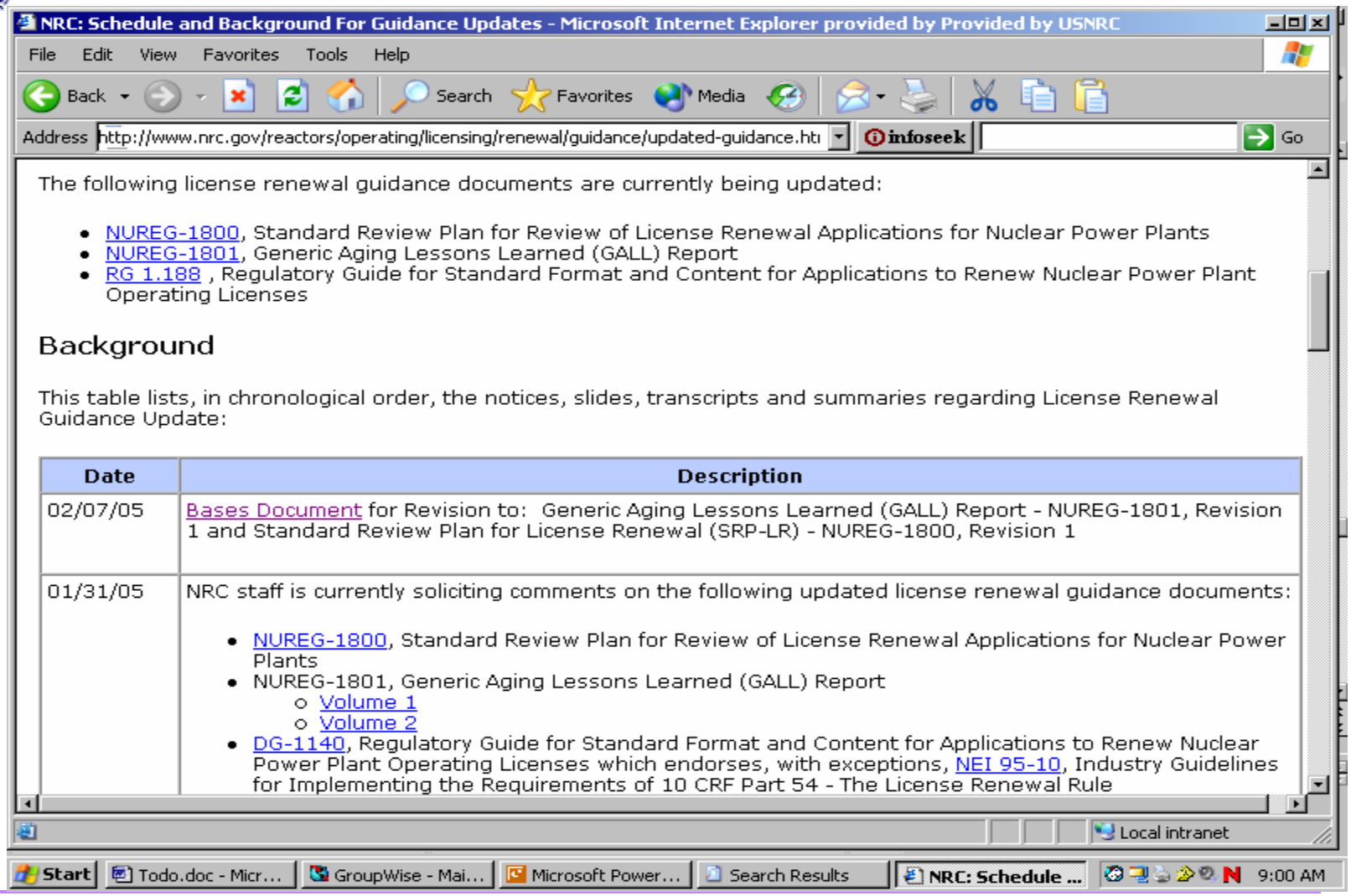
Standard Review Plan: Table of Contents

- I. Administrative Information
- II. Scoping and Screening Methodology
- III. Aging Management Review Results
- IV. Time Limited Aging Analysis
- Appendix A: Branch Technical Positions

License Renewal Guidance Update Website

- Information is available such as relevant correspondence, meeting notices, summaries, NRC public presentations, Sept. 30, 2004 and Jan. 31, 2005 posting, etc.
  - http://www.nrc.gov/reactors/operating/licensing/renewal/guidance/updated-guidance.html

NRC Website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The following license renewal guidance documents are currently being updated:
NUREG-1800, Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants
NUREG-1801, Generic Aging Lessons Learned (GALL) Report
RG 1.188 , Regulatory Guide for Standard Format and Content for Applications to Renew Nuclear Power Plant Operating Licenses
Background
This table lists, in chronological order, the notices, slides, transcripts and summaries regarding License Renewal Guidance Update:
Date
Description
02/07/05
Bases Document for Revision to: Generic Aging Lessons Learned (GALL) Report - NUREG-1801, Revision 1 and Standard Review Plan for License Renewal (SRP-LR) - NUREG-1800, Revision 1
01/31/05
NRC staff is currently soliciting comments on the following updated license renewal guidance documents:
NUREG-1800, Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants
NUREG-1801, Generic Aging Lessons Learned (GALL) Report
Volume 1
Volume 2
DG-1140, Regulatory Guide for Standard Format and Content for Applications to Renew Nuclear Power Plant Operating Licenses which endorses, with exceptions, NEI 95-10, Industry Guidelines for Implementing the Requirements of 10 CRF Part 54 - The License Renewal Rule
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Additions to SRP-LR

NEW

NEW

Table 3.2-1. Summary of Aging Management Programs for Engineered Safety Features Evaluated in Chapter V of the GALL Report

ID	Type	Component	Aging Effect/ Mechanism	Aging Management Programs	Further Evaluation Recommended	SRP Ref	Related Item
1	BWR/ PWR	Piping, piping components, and piping elements in emergency core cooling system	Cumulative fatigue damage	TLAA, evaluated in accordance with 10 CFR 54.21(c)	Yes, TLAA	Yes, TLAA (See subsection 3.2.2.2.1)	E-10 E-13 E-16
2	BWR/ PWR	Ducting, piping, piping components, and piping elements internal and external surfaces	Loss of material due to general corrosion	Plant specific	Yes, plant specific	Yes, plant specific (See subsection 3.2.2.2.2)	E-25 E-26 E-29 E-30 E-35 E-44 E-45 E-46
3	BWR/ PWR	Piping, piping components, and piping elements	Loss of material due to pitting and crevice corrosion	Plant specific	Yes, plant specific	Yes, plant specific (See subsection 3.2.2.2.3.1)	EP-32
4	BWR/ PWR	Piping, piping components, and piping elements internal surfaces	Loss of material due to pitting and crevice corrosion	Plant specific	Yes, plant specific	Yes, plant specific (See subsection 3.2.2.2.3.1)	E-33
5	BWR/ PWR	Partially encased tanks with breached moisture barrier	Loss of material due to pitting and crevice corrosion	A plant-specific aging management program is to be evaluated because moisture and water can egress under the tank due to cracking of the perimeter seal from weathering.	Yes, plant specific	Yes, plant specific (See subsection 3.2.2.2.3.2)	E-01
6	BWR/ PWR	Piping, piping components, and piping elements in contact with soil	Loss of material due to pitting and crevice corrosion	Plant specific	Yes, plant specific	Yes, plant specific (See subsection 3.2.2.2.3.2)	EP-31

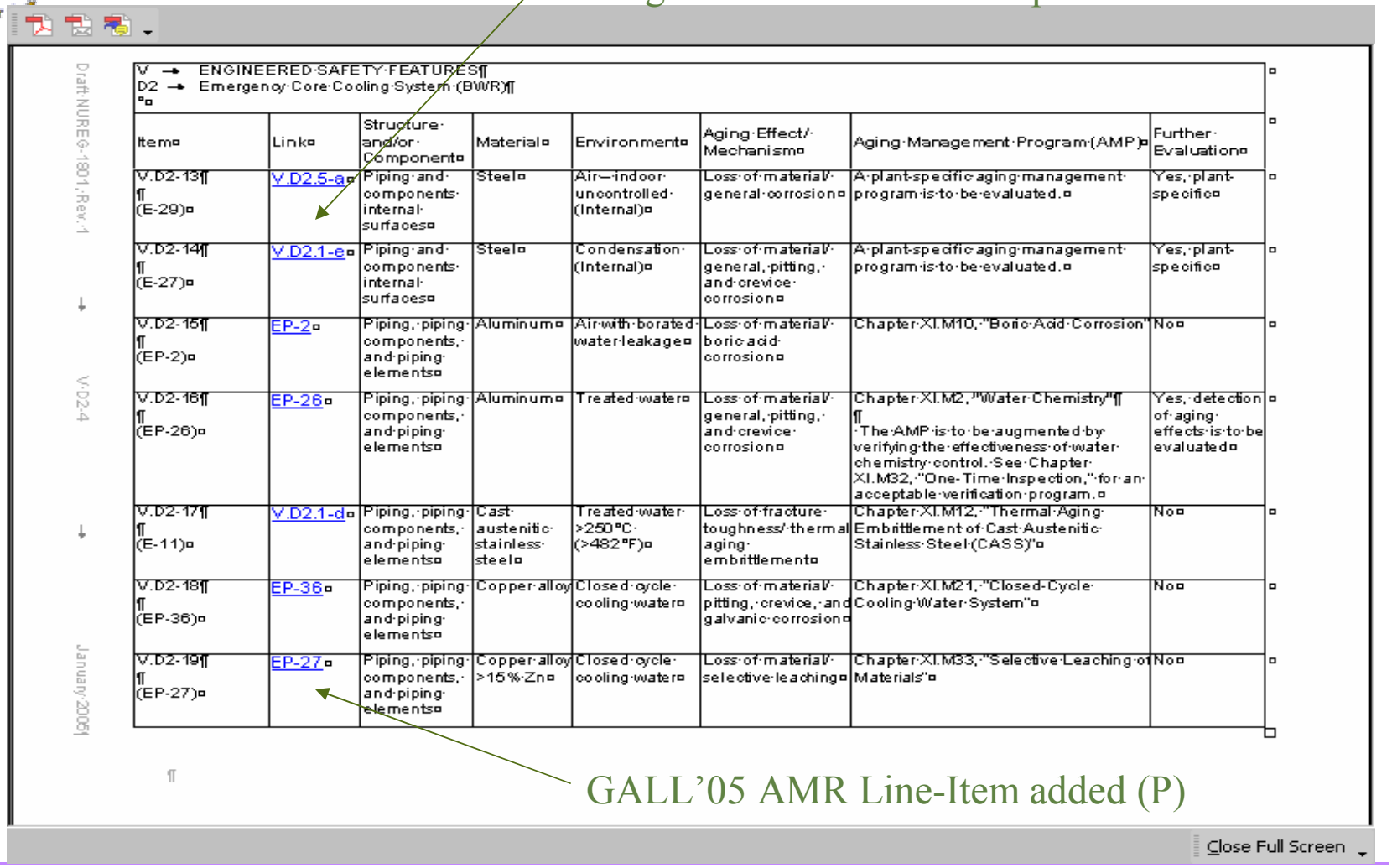
Close Full Screen

GALL Report: Examples of Enhancements

- Aging Management Program (AMP) revisions
- Generalization and standardization of aging management review (AMR) line-items to make less prescriptive
- Primary focus on approved precedents, interim staff guidance, extensive NRC review, and lessons learned resulted in new subchapters
  - Common miscellaneous material environment combinations
  - External surfaces of components and miscellaneous bolting
- Accompanying Bases Document explains technical changes since the 2001 versions of guidance documents
- Analysis of comments generated during 60-day public comment period are documented in NUREG-1832

New Configuration of GALL'05

Link gives GALL'01Counterpart



V → ENGINEERED SAFETY FEATURES
D2 → Emergency Core Cooling System (BWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
V.D2-13 (E-29)	V.D2.5-a	Piping and components internal surfaces	Steel	Air—indoor uncontrolled (Internal)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant-specific
V.D2-14 (E-27)	V.D2.1-e	Piping and components internal surfaces	Steel	Condensation (Internal)	Loss of material/ general, pitting, and crevice corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant-specific
V.D2-15 (EP-2)	EP-2	Piping, piping components, and piping elements	Aluminum	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
V.D2-16 (EP-26)	EP-26	Piping, piping components, and piping elements	Aluminum	Treated water	Loss of material/ general, pitting, and crevice corrosion	Chapter XI.M2, "Water Chemistry" The AMP is to be augmented by verifying the effectiveness of water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program.	Yes, detection of aging effects is to be evaluated
V.D2-17 (E-11)	V.D2.1-d	Piping, piping components, and piping elements	Cast austenitic stainless steel	Treated water >250°C (>482°F)	Loss of fracture toughness/ thermal aging embrittlement	Chapter XI.M12, "Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)"	No
V.D2-18 (EP-36)	EP-36	Piping, piping components, and piping elements	Copper alloy	Closed cycle cooling water	Loss of material/ pitting, crevice, and galvanic corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
V.D2-19 (EP-27)	EP-27	Piping, piping components, and piping elements	Copper alloy >15% Zn	Closed cycle cooling water	Loss of material/ selective leaching	Chapter XI.M33, "Selective Leaching of Materials"	No

GALL'05 AMR Line-Item added (P)

Benign Material/ Environment Combinations

Excerpted from GALL '05

V F	ENGINEERED SAFETY FEATURES Common Miscellaneous Material Environment Combinations						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
V.F-4 (EP-10)	V.F.	Piping, piping components, and piping elements	Copper alloy	Air – indoor uncontrolled (External)	None	None	No
V.F-5 (EP-9)	V.F.	Piping, piping components, and piping elements	Copper alloy	Gas	None	None	No
V.F-6 (EP-11)	V.F.	Piping, piping components, and piping elements	Copper alloy	Lubricating oil (no water pooling)	None	None	No
V.F-7 (EP-12)	V.F.	Piping, piping components, and piping elements	Copper alloy <15% Zn	Air with borated water leakage	None	None	No

GALL 2005 (Added Definitions and Usage of Terms)

- New Definition section (Chapter IX) provided for **M**aterials, **E**nvironments, **A**ging effects/mechanisms, and selected components as relevant to different aging management **P**rograms (MEAPs)
- Standardization of terms used for MEA parameters to make the AMR line-items more generic
  - Traceability to GALL'01 retained
  - Guidance applicability enhanced without compromising relicensing rigor and safety

Chpt. IX: Standardized SSC Terms

IX.B Selected Definitions of Terms Used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

Definition of Selected Terms for Structures and Components

Term	Definition as used in this document
Metal enclosed bus (MEB)	Metal enclosed buses (sometimes referred to as bus ducts) are those electrical buses installed on electrically insulated supports and are constructed with all phase conductors enclosed in a separate metal enclosure or a common metal enclosure.
Phase bus	Bus that is enclosed [either within its own enclosure (duct or inside a vault) that is not part of an active component such as a switchgear, load center, or motor control center]
Piping, piping components, and piping elements	This general category includes various features of the piping system that are within the scope of license renewal. Examples include piping, fittings, tubing, flow elements/indicators, demineralizer, nozzles, orifices, flex hoses, pump casing and bowl, safe ends, sight glasses, spray head, strainers, thermowells, and valve body and bonnet.
Switchyard bus	Switchyard bus is uninsulated, unenclosed, rigid electrical conductor used in switchyards and switching stations to connect two or more elements of an electrical power circuit such as active disconnect switches and passive transmission conductors.
Transmission conductors	Transmission conductors are uninsulated, stranded electrical cables used in switchyards, switching stations and transmission lines to connect two or more elements of an electrical power circuit such as active disconnect switches, power circuit breakers, and transformers and passive switchyard bus.

Chpt. IX: Standardized Materials Terms

Excerpted from GALL Vol. 2, Table IX.C

Selected Descriptions of Materials

Standardized Expression	**Description and Technical Justification**
Copper alloy <15% Zn	Copper, copper nickel, brass, bronze <15% Zn, Aluminum bronze < 8% Al – These materials are resistant to stress corrosion cracking, selective leaching and pitting and crevice corrosion. May be identified simply as copper alloy when these aging mechanisms are not at issue.
Copper alloy >15% Zn	Copper, brass and other alloys >15% Zn, Aluminum bronze > 8% Al – These materials are susceptible to stress corrosion cracking, selective leaching (except for inhibited brass) and pitting and crevice corrosion. May be identified simply as copper alloy when these aging mechanisms are not at issue.
Nickel alloys	Nickel-chromium-iron (molybdenum) alloys are those such as the Alloy 600 and 690. Examples of nickel alloy designations that were earlier referenced in NUREG-1801 that comprise this category include Alloy 182, Alloy 600, Alloy 690, Gr. 688 (X-750), Inconel 182, Inconel 82, NiCrFe, SB-166, SB-167, SB-168, X-750.
Stainless steel	Wrought or forged austenitic, ferritic, martensitic, or duplex stainless steel (Cr content >11%) Examples of stainless steel designations that were earlier referenced in NUREG-1801 that comprise this category include A-286, SA193-Gr. B8, SA193-Gr. B8M, Gr. 660 (A-286), SA193-6, SA193-Gr. B8 or B-8M, SA453, Type 304, Type 304NG, Type 308, Type 308L, Type 309, Type 309L, Type 316, Type 347, Type 403, Type 416.
Steel	For a given environment, carbon steel, alloy steel, gray cast iron, high strength low alloy steel, and cast iron are vulnerable to general, pitting, and crevice corrosion even though the rates of aging may vary. Consequently, these metal types are generally grouped for AMRs under the broad term steel. Note that this does not include stainless steel. However, gray cast iron is also susceptible to selective leaching and high strength low alloy steel is susceptible to stress corrosion cracking. Therefore, when these aging effects are being considered, these materials are specifically called out. Galvanized steel – (zinc-coated carbon steel) is also included in this category of 'steel' when there is moisture. Examples of steel designations that were earlier referenced in NUREG-1801 that comprise this category include ASTM A 36, ASTM A 285, ASTM A759, SA36, SA106-GrB, SA155-Gr KCF70, SA193-Gr. B7, SA194 -Gr. 7, SA302-Gr B, SA320-Gr. L43 (AISI 4340), SA333-Gr6, SA336, SA508-64, class 2, SA508-Cl 2 or Cl 3, SA516-Gr70, SA533-Gr B, SA540-Gr. B23/24, SA582.

Chpt. IX: Standardized Environment Terms

Excerpted from GALL Vol. 2, Table IX.D

Selected Descriptions of Environment

Standardized Expression	Description and Technical Justification
Air – indoor controlled	The environment to which the specified internal or external surface of the component or structure is exposed – Indoor air in a humidity controlled (e.g., air conditioned) environment
Air – indoor uncontrolled	Indoor air on systems with temperatures higher than the dew point – Condensation can occur but only rarely – equipment surfaces are normally dry.
Air with borated water leakage	Air and untreated borated water leakage on indoor or outdoor systems with temperatures above or below the dew point. The water from leakage is considered to be untreated due to the potential for water contamination at the surface. This is germane to PWRs.
Closed cycle cooling water	Treated water subject to the closed cycle cooling water chemistry program. Closed cycle cooling water >60°C (>140°F) allows the possibility of stainless steel SCC. Examples of environment descriptors that comprise this category include: • Chemically treated borated water; and treated component cooling water • Demineralized water on one side; closed-cycle cooling water (treated water) on the other side • Chemically treated borated water on tube side and closed-cycle cooling water on shell side
Gas	Internal gas environments from air [both at atmospheric pressure in ventilation systems and compressed air used as a working fluid, (e.g. instrument air)], nitrogen, carbon dioxide, freon, and halon. This category assumes absence of corrosion species such as chlorine.
Lubricating oil	Lubricating oils are low to medium viscosity hydrocarbons, with possibility of water contamination, used for bearing, gear, and engine lubrication. Piping, piping components, and piping elements (whether copper, stainless steel, or steel) when exposed to lubricating oil that does not have water pooling will not be subject to aging degradation because there are no relevant aging mechanisms
Reactor coolant	Water in the reactor coolant system and connected systems at or near full operating temperature – includes steam for BWRs.

Technical Basis Document

A.3.2 Technical Justification for inclusion of new 'MEAP' combinations

Item	Material	Environment	Aging Effect/ Mechanisms	AMP	Technical Justification for Acceptance of Precedent
AP-35	Aluminum	Fuel oil	Loss of material/ Pitting and crevice corrosion	XI.M30 Fuel Oil Chemistry. The AMP is to be augmented by verifying the effectiveness of water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program.	An approved precedent exists for adding this material, environment, aging effect and program combination item to the GALL Report. As shown in Ft. Calhoun Unit 1 SER 3.3.2.4.5, the staff has accepted the position that loss of material exhibited by aluminum in a fuel oil environment is properly managed by the Fuel Oil Chemistry AMP which monitors fuel oil quality and the levels of water and microbiological organisms in the fuel oil. This program provides reasonable assurance that the component's intended functions will be maintained within the CLB for the extended period of operation.
AP-36	Aluminum	Air – indoor controlled (Ext)	None	None	An approved precedent exists for adding this material, environment, aging effect and program combination item to the GALL Report. As shown in Ft. Calhoun Unit 1 SER 3.3.2.4.5, the staff has accepted the position that aluminum in an indoor, controlled air environment exhibits no aging effect and that the component or structure will therefore remain capable of performing its intended functions consistent with the CLB for the period of extended operation. This conclusion is based on the fact that aluminum is highly resistant to corrosion in an indoor air environment in the absence of corrosive species, as cited in Metals Handbook, Volume 13 (p. 597), Ninth Edition, American Society for Metals International, 1987

Status of NPP License Renewal Applications (7/25/05)

Applicant	Plant Name & Units	Plant Type	Date LRA Received	Date of SER	Date Licensed
Baltimore Gas & Electric Co.	Calvert Cliffs 1 & 2	PWR	Apr'98	Nov'99	Mar'00
Duke Energy	Oconee 1, 2, & 3	PWR	July'98	Feb'00	May'00
Entergy Operations	Arkansas Nucl. 1	PWR	Feb'00	Apr'01	June'01
Southern Nucl. Operating Co. Inc.	Edwin I. Hatch 1 & 2	BWR	Mar'00	Oct'01	Jan'02
Florida Power & Light Co.	Turkey Point 3 & 4	PWR	Sept'00	Feb'02	June'02
Virginia Electric & Power	Surry 1 & 2 North Anna 1 & 2	PWR	May'01	Nov'02	Mar'03
Duke Energy	McGuire 1&2 Catawba 1 & 2	PWR	June'01	Jan'03	Dec'03
Exelon	Peach Bottom 2&3	BWR	July'01	Feb'03	May'03
Florida Power & Light Co.	St. Lucie 1 & 2	PWR	Nov'01	July'03	Oct'03
Omaha Public Power District	Fort Calhoun	PWR	Jan'02	Sept'03	Nov'03
Carolina Pwr. & Light	Robinson 2	PWR	June'02	Jan'04	Apr'04
Rochester Gas & Elec. Corp.	Ginna	PWR	Aug'02	Mar'04	May'04

Status of NPP License Renewal Applications (7/25/05)

SCE&G	Summer	PWR	Aug'02	Jan'04	Apr'04
Exelon	Dresden 2 & 3 Quad Cities 1 & 2	BWR	Jan'03	July'04	Oct'04
Southern Nuclear Operating Co.	Farley 1&2	PWR	Sept'03	Mar'05	May'05
Entergy Operations	Arkansas Nuclear One 2	PWR	Oct'03	Apr'05	July'05
Indiana & Michigan Power Co.	DC Cook 1&2	PWR	Nov'03	May'05	
Tennessee Valley Authority	Browns Ferry 1, 2 &3	BWR	Jan'04		
Dominion Nuclear Connecticut, Inc.	Millstone 2&3	PWR	Jan'04		
Nuclear Management Co.	Point Beach 1 & 2	PWR	Feb'04		
Constellation Energy	Nine Mile Pt 1 & 2	BWR	May'04		
Carolina Pwr. & Light	Brunswick 1 & 2	BWR	Oct'04		
Nuclear Management Co.	Monticello	BWR	Mar'05		
Nuclear Management Co	Palisades	PWR	Mar'05		
AmerGen Energy Co.	Oyster Creek	BWR	July'05		

International Activities

- IAEA extra budgetary program on safety aspects of long-term operation for water-moderated reactors
  - Steering Committee and 4 working groups
  - Recommendation for pre-conditions and adequate aging management for long-term operation

Further Information

- Overview of Reactor License Renewal Process
  http://www.nrc.gov/reactors/operating/licensing/renewal.html
- Introduction to License Renewal Tutorial
  http://www.nrc.gov/reactors/operating/licensing/renewal/introduction.html
- Revisions to License Renewal Guidance Documents
  http://www.nrc.gov/reactors/operating/licensing/renewal/guidance.html
- Background on Reactor License Renewal
  http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/license-renewal-bg.html