CHAPTER IX

UNIQUE IDENTIFIERS AND SELECTED DEFINITIONS OF TERMS USED

FOR

DESCRIBING AND STANDARDIZING

STRUCTURES, COMPONENTS, MATERIALS, ENVIRONMENTS,

AGING EFFECTS, AND AGING MECHANISMS

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A. Structures and Components

The GALL report is a technical basis document to the Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants (SRP-LR, NUREG-1800) which provides the staff with guidance in reviewing a license renewal application. The GALL Report should be treated in the same manner as an approved topical report that is generically applicable. An applicant may reference the GALL Report in a license renewal application to demonstrate that the programs at the applicant's facility correspond to those reviewed and approved in the GALL Report and that no further staff review is required.

The GALL Report does not address scoping of structures and components for license renewal. Scoping is plant specific, and the results depend on the plant design and current licensing basis. The inclusion of a certain structure or component in the GALL Report does not mean that this particular structure or component is within the scope of license renewal for all plants. Conversely, the omission of a certain structure or component in the GALL Report does not mean that this particular structure or component is not within the scope of license renewal for any plants.

The following table IX.A1 provides a listing of the structure and component identifiers utilized in the GALL tables. Each expression is cross-referenced to the specific chapters in the GALL Report where they are found. This table is presented as an interim measure to facilitate expedited completion of the September 30, 2004 draft of the GALL Report update. A final version of the table will be included in the accompanying Bases Document instead of Chapter IX.

IX. Unique Identifiers and Selected Definitions of Terms used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

A1. Unique Identifiers for Structures and Components

Referring Chapters	Standardized Expression
IV	Baffle/former assembly Baffle and former plates
IV	Baffle/former assembly Baffle/former bolts
V, VII, VIII	Bolting
III	Building concrete at locations of expansion and grouted anchors; grout pads for support base plates
VIII	Buried piping, piping components, piping elements, and tanks
VIII	BWR heat exchanger shell side components
VIII	BWR tanks
IV	CEA Shroud Assemblies
IV	CEA shroud assemblies CEA shroud extension shaft guides
IV	CEA Shroud Assemblies CEA shrouds bolts
IV	Class 1 piping, piping components, and piping elements
IV	Class 1 piping, fittings and branch connections < NPS 4
IV	Class 1 piping, fittings and primary nozzles, safe ends, manways, and flanges
IV	Class 1 pump casings and valve bodies
IV	Class 1 pump casings, and valve bodies and bonnets
IV, V, VII, VIII	Closure bolting

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A1. Unique Identifiers for Structures and Components

Referring Chapters	Standardized Expression
IV	Closure head Stud assembly
IV	Closure head Vessel flange leak detection line
II	Concrete Dome; wall; basemat; ring girder; buttresses
II	Concrete: Dome; wall; basemat; ring girders; buttresses; reinforcing steel
II	Concrete: Foundation; subfoundation
III	Concrete: All
III	Concrete: Below-grade exterior; foundation
III	Concrete: Exterior above and below grade; foundation; interior slab
III	Concrete: Interior and above-grade exterior
VI	Conductor insulation for electrical cables and connections
VI	Conductor insulation for electrical cables used in instrumentation circuits that are sensitive to reduction in conductor insulation resistance (IR)
VI	Conductor insulation for inaccessible medium-voltage (2kV to 15kV) cables (e.g., installed in conduit or direct buried)
VI	Connector contacts for electrical connectors exposed to borated water leakage
III	Constant and variable load spring hangers; guides; stops; sliding surfaces; design clearances; vibration isolators
V	Containment isolation piping and components external surfaces
V	Containment isolation piping and components internal surfaces
IV	Control rod drive head penetration Flange bolting
IV	Control rod drive head penetration Nozzle
IV	Control rod drive head penetration Pressure housing
IV	Control rod guide tube (CRGT) assembly CRGT spacer screws Flange-to-upper grid screws
IV	Control rod guide tube (CRGT) assembly CRGT pipe and flange CRGT spacer casting CRGT spacer screws Flange-to-upper grid screws CRGT rod guide tubes CRGT rod guide sectors
IV	Control rod guide tube (CRGT) assembly CRGT spacer casting
IV	Core barrel (CB) CB flange (upper) CB outlet nozzles Thermal shield
IV	Core barrel assembly Baffle/former bolts and screws
IV	Core barrel assembly Core barrel cylinder (top and bottom flange) Baffle

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A1. Unique Identifiers for Structures and Components

Referring Chapters	Standardized Expression
	plates and formers
IV	Core barrel assembly Lower internals assembly-to-core barrel bolts Core barrel-to-thermal shield bolts
IV	Core shroud and core plate Access hole cover (mechanical covers)
IV	Core shroud and core plate Access hole cover (welded covers)
IV	Core shroud and core plate Core plate Core plate bolts (used in early BWRs)
IV	Core shroud and core plate Core shroud (upper, central, lower)
IV	Core shroud and core plate Shroud support structure (shroud support cylinder, shroud support plate, shroud support legs)
IV	Core shroud assembly Core shroud assembly bolts (later plants are welded)
IV	Core shroud assembly Core shroud tie rods (core support plate attached by welds in later plants)
IV	Core spray lines and spargers Core spray lines (headers) Spray rings Spray nozzles Thermal sleeves
IV	Core support barrel Core support barrel upper flange
IV	Core support barrel Core support barrel upper flange Core support barrel alignment keys
IV	Core support pads/core guide lugs
IV	Core support shield assembly Core support shield cylinder (top and bottom flange) Outlet and vent valve (VV) nozzles VV body and retaining ring
IV	Core support shield assembly Core support shield-to-core barrel bolts
IV	Core support shield assembly Core support shield-to-core barrel bolts VV assembly locking device
IV	Core support shield assembly Outlet and vent valve nozzles VV body and retaining ring
VII	Cranes - rails
VII	Cranes – Structural girders
VII	Diesel engine exhaust Piping, piping components, and piping elements
V	Drywell and suppression chamber spray system (internal surfaces: flow orifice spray nozzles)
V	Ducting and components
VII	Ducting and components external surfaces
VII	Ducting and components internal surfaces
V, VII	Ducting, piping and components external surfaces
V, VII	Ducting, piping and components internal surfaces
III	Earthen water-control structures: Dams, embankments, reservoirs, channels, canals
VII	Elastomer lining
V	Elastomer seals

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A1. Unique Identifiers for Structures and Components

Referring Chapters	Standardized Expression
VII	Elastomer seals and components
VI	Electrical equipment subject to 10 CFR 50.49 EQ requirements
IV, V. VII, VIII	External surfaces
VII	Fire barrier penetration seals
VII	Fire-rated doors
IV	Flow distributor assembly Flow distributor head and flange Incore guide support plate Clamping ring
IV	Flow distributor assembly Shell forging-to-flow distributor bolts
IV	Fuel supports and control rod drive assemblies Control rod drive housing
IV	Fuel supports and control rod drive assemblies Orificed fuel support
VI	Fuse Holders (Not Part of a Larger Assembly)
VI	Fuse Holders (Not Part of a Larger Assembly) Metallic Clamp
V, VII, VIII	Heat exchanger shell side components
V, VII	Heat exchanger shell side components including tubes
VII	Heat exchanger tube side components including tubes
V, VII, VIII	Heat exchanger tubes
V	Heat exchanger tubes (serviced by open-cycle cooling water)
III	High strength bolting for NSSS component supports
VI	High voltage insulators
VII	High-pressure pump Casing and closure bolting
IV	Instrument penetrations and primary side nozzles
IV	Instrumentation Intermediate range monitor (IRM) dry tubes Source range monitor (SRM) dry tubes Incore neutron flux monitor guide tubes
IV	Instrumentation support structures Flux thimble guide tubes
IV	Isolation condenser tube side components
IV	Jet pump assemblies Jet pump sensing line
IV	Jet pump assemblies Thermal sleeve Inlet header Riser brace arm Holddown beams Inlet elbow Mixing assembly Diffuser Castings
IV	Lower grid assembly Fuel assembly support pads Guide blocks
IV	Lower grid assembly Incore guide tube spider castings
IV	Lower grid assembly Lower grid rib section Fuel assembly support pads Lower grid flow dist. plate Orifice plugs Lower grid and shell forgings Guide blocks Shock pads Support post pipes Incore guide tube spider castings
IV	Lower grid assembly Lower grid rib section Fuel assembly support pads Lower grid rib-to-shell forging screws Lower grid flow dist. plate Orifice plugs Lower grid and shell forgings Lower internals assembly-to- thermal shield bolts Guide blocks and bolts Shock pads and bolts Support post pipes Incore guide tube spider castings
IV	Lower grid assembly Lower grid rib-to-shell forging screws Lower internals assembly-to- thermal shield bolts Guide blocks and bolts Shock pads and bolts

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A1. Unique Identifiers for Structures and Components

Referring Chapters	Standardized Expression
IV	Lower internal assembly Core support column
IV	Lower internal assembly Core support plate Fuel alignment pins Lower support structure beam assemblies Core support column Core support column bolts Core support barrel snubber assemblies
IV	Lower internal assembly Core support plate Lower support structure beam assemblies Core support column Core support barrel snubber assemblies
IV	Lower internal assembly Fuel alignment pins Lower support plate column bolts Clevis insert bolts
IV	Lower internal assembly Lower core plate Radial keys and clevis inserts
IV	Lower internal assembly Lower support casting Lower support plate columns
IV	Lower internal assembly Lower support forging Lower support plate columns
III	Masonry walls: All
IV	Nozzle safe ends High pressure core spray Low pressure core spray Control rod drive return line Recirculating water Low pressure coolant injection or RHR injection mode
IV	Nozzle safe ends Inlet Outlet Safety injection
IV	Nozzles Control rod drive return line
IV	Nozzles Feedwater
IV	Nozzles Low pressure coolant injection or RHR injection mode
IV	Nozzles Inlet Outlet Safety injection
V	Orifice (miniflow recirculation)
V	Partially encased tanks with breached moisture barrier
II	Penetration sleeves; penetration bellows
IV	Penetrations Control rod drive stub tubes Instrumentation Jet pump instrument Standby liquid control Flux monitor Drain line
IV	Penetrations Head vent pipe(top head) Instrument tubes (top head)
IV	Penetrations Instrument tubes (bottom head)
II	Personnel airlock; equipment hatch
II	Personnel airlock; equipment hatch: Locks, hinges, and closure mechanisms
VI	Phase bus - Bus/connections
VI	Phase bus - Enclosure assemblies
VI	Phase bus - Insulation/insulators
IV, VII	Piping and components external surfaces and bolting
V	Piping and components internal surfaces
IV, V, VII, VIII	Piping, piping components, and piping elements
V, VII	Piping, piping components, and piping elements and tanks
IV, V	Piping, piping components, and piping elements greater than or equal to 4

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A1. Unique Identifiers for Structures and Components

Referring Chapters	Standardized Expression
	NPS
IV	Plenum cover and plenum cylinder Plenum cover assembly Plenum cylinder Reinforcing plates
IV	Plenum cover and plenum cylinder Top flange-to-cover bolts Bottom flange-to-upper grid screws
IV	Pressure boundary and structural FW and AFW nozzles and safe ends Steam nozzles and safe ends
IV	Pressure vessel support Skirt support
IV	Pressurizer Integral support
IV	Pressurizer Spray head
IV	Pressurizer components
IV	Pressurizer instrumentation penetrations and heater sheaths and sleeves
IV	Pressurizer relief tank Tank shell and heads Flanges and nozzles
II	Prestressing system: Tendons; anchorage components
IV	Pump and valve closure bolting
IV	Pump and valve seal flanges
VIII	PWR heat exchanger shell side components
IV	RCCA guide tube assemblies RCCA guide tube bolts RCCA guide tube support pins
IV	RCCA guide tube assemblies RCCA guide tubes
VII	Reactor coolant pump oil collection system Piping, tubing, valve bodies
VII	Reactor coolant pump oil collection system tank
IV	Reactor coolant system piping and fittings Cold leg Hot leg Surge line Spray line
IV	Reactor vessel internals components
VII	Regenerative heat exchanger tube and shell side components including tubes
V	Safety injection tank (accumulator)
II	Seals, gaskets, and moisture barriers (caulking, flashing, and other sealants)
IV	Secondary manways and handholes (cover only)
III	Sliding support bearings and sliding support surfaces
VII	Spent fuel storage racks Neutron-absorbing sheets - BWR
VII	Spent fuel storage racks Neutron-absorbing sheets - PWR
VII	Spent fuel storage racks Storage racks - BWR
IV	Steam generator closure bolting
IV	Steam generator components
IV	Steam generator components Such as, secondary side nozzles (vent, drain, and instrumentation)

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A1. Unique Identifiers for Structures and Components

Referring Chapters	Standardized Expression
IV	Steam generator components Upper and lower heads Tube sheets
IV	Steam generator feedwater impingement plate and support
IV	Steam generator shell assembly (for OTSG), upper and lower shell, and transition cone (for recirculating steam generator)
III	Steel components: All structural steel
III	Steel components: Fuel pool liner
III	Steel components: Radial beam seats in BWR drywell; RPV support shoes for PWR with nozzle supports; other supports
II	Steel elements: Drywell head; downcomers
II	Steel elements: Drywell; torus; drywell head; embedded shell and sand pocket regions; drywell support skirt; torus ring girder; downcomers; ECCS suction header
II	Steel elements: Liner; liner anchors; integral attachments
II	Steel elements: Suppression chamber shell (interior surface)
II	Steel elements: Torus; vent line; vent header; vent line bellows; downcomers
VII	Structural fire barriers – walls, ceilings and floors
VII	Structural Steel
III	Support members; welds; bolted connections; support anchorage to building structure
IV	Support skirt and attachment welds
VI	Switchyard bus and connections
V, VII, VIII	Tanks
IV	Thermal shield
IV	Top guide

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A1. Unique Identifiers for Structures and Components

Referring Chapters	Standardized Expression
IV	Top head enclosure Closure studs and nuts
IV	Top head enclosure Vessel flange leak detection line
IV	Top head enclosure (without cladding) Top head Nozzles (vent, top head spray or RCIC, and spare)
VI	Transmission conductors and connections
IV	Tube plugs
IV	Tube support lattice bars
IV	Tube support plates
IV	Tubes
IV	Tubes and sleeves
IV	Tubes and sleeves (exposed to phosphate chemistry)
IV	Upper assembly and separators Feedwater inlet ring and support
IV	Upper grid assembly Fuel assembly support pads Plenum rib pads
IV	Upper grid assembly Rib- to-ring screws
IV	Upper grid assembly Upper grid rib section Upper grid ring forging Fuel assembly support pads Plenum rib pads
IV	Upper Internals Assembly Fuel alignment plate Fuel alignment plate guide lugs and their lugs Hold-down ring
IV	Upper internals assembly Hold-down spring
IV	Upper internals assembly Upper core plate alignment pins
IV	Upper Internals Assembly Upper guide structure support plate Fuel alignment plate Fuel alignment plate guide lugs and guide lug inserts
IV	Upper internals assembly Upper support column
IV	Upper internals assembly Upper support column (only cast austenitic stainless steel portions)
IV	Upper internals assembly Upper support column bolts
IV	Upper internals assembly Upper support column bolts Upper core plate alignment pins Fuel alignment pins
IV	Upper internals assembly Upper support plate Upper core plate Hold-down spring
IV	Vessel shell Attachment welds
IV	Vessel shell Intermediate beltline shell Beltline welds
IV	Vessel shell Upper shell Intermediate and lower shell (including beltline welds)
IV	Vessel shell Vessel flange
III	Vibration isolation elements

IX. Unique Identifiers and Selected Definitions of Terms used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

A2. Definition of Selected Consolidated Structures and Components

Term	Definition as used in this document
Closure bolting (in high-pressure or high-temperature systems)	Closure bolting in systems where the pressure exceeds 275 psi or 200ºF (93C) For example, Alloy 718, approved up to 566ºC in ASME Section III, Subsection NH, and types 304 and 316 stainless steels, with allowable stress intensities for bolting up to 704ºC, are considered for high-temperature closure bolting.
Ducting and components	Ducting and components includes Heating, Ventilation, and Air conditioning components. Examples include ductwork, ductwork fittings, access doors, closure bolts, equipment frames and housing
Piping, piping components, and piping elements	This general category includes the designated material surfaces exposed to the designated environments in 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 & bowl, safe ends, spray head, strainers, thermowells, and valve body& bonnet.
Phase bus, switchyard bus and connections	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)
Seals, gaskets, and moisture barriers (calking, flashing, and other sealants)	Elastomer components used as sealant, or as gaskets in flanges, etc.
Steel elements: Liner; liner anchors; integral attachments	Steel liners used in suppression pool or spent fuel pool, and other integral attachments
Vibration isolation elements	Non-steel supports used for supporting components prone to vibration

B. Materials

The following table provides a listing of material identifiers utilized in the GALL tables. Each expression is cross-referenced to the specific chapters in the GALL Report where they are found. This table is presented as an interim measure to facilitate expedited completion of the September 30, 2004 draft of the GALL Report update. A final version of the table will be included in the Bases Document instead of Chapter IX.

IX. Unique Identifiers and Selected Definitions of Terms used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

B1. Unique Identifiers for Materials

Referring Chapters	Standardized Expression
V, VII	Aluminum
VI	Aluminum / Silver-plated aluminum copper / Silver-plated copper; stainless steel, steel
VI	Aluminum, copper, bronze, stainless steel, galvanized steel
VI	Aluminum, steel
VII	Boraflex
VII	Boral, boron steel
IV	CASS, carbon steel with stainless steel cladding
IV, V, VII	Cast austenitic stainless steel (CASS)
II	Concrete
III	Concrete block
II	Concrete, carbon steel
II	Concrete, porous concrete
V, VI, VII, VIII	Copper alloy
V, VII, VIII	Copper alloy <15% Zn
VII	Copper alloy >15% Zn
V, VI, VII	Elastomers
V, VII	Galvanized steel
III	Galvanized steel, aluminum
III	Galvanized steel, aluminum, stainless steel
V, VII, VIII	Glass
VII	Gray cast iron
IV	High strength low alloy steel Maximum tensile strength <1172 MPa (<170 Ksi)
IV	High-strength low-alloy steel SA 193 Gr. B7
V, VII, VIII	High-strength steel
IV	High-strength low-alloy steel, stainless steel
VI	Insulation materials (e.g. bakelite, phenolic melamine or ceramic, molded polycarbonate)
III	Low-alloy steel, yield strength >150 ksi
III	Lubrite
IV, V, VII, VIII	Nickel alloys
IV	Nickel alloys, cast austenitic stainless steel, stainless steel

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B1. Unique Identifiers for Materials

Referring Chapters	Standardized Expression
III	Polymer (e.g., Rubber)
VI	Porcelain, malleable iron, aluminum, galvanized steel, cement
VI	Porcelain, xenoy, thermo-plastic organic polymers
III, VII	Reinforced concrete
III	Reinforced concrete, porous concrete
III	Reinforced concrete, grout
IV	SA508-Cl 2 forgings clad with stainless steel using a high-heat-input welding process
II	Seals, elastomers, rubber and other similar materials
II, III, IV, V, VI, VII, VIII	Stainless steel
II	Stainless steel, carbon steel
IV	Stainless steel, cast austenitic stainless steel
IV	Stainless steel, cast austenitic stainless steel, nickel alloy
IV	Stainless steel, cast austenitic stainless steel, nickel alloy and associated welds and buttering
IV	Stainless steel, cast austenitic stainless steel, nickel alloy, PH stainless steel forging
IV	Stainless steel, nickel alloy
IV	Stainless steel, nickel alloy, PH stainless steel forging
IV	Stainless steel, PH stainless steel forging, CASS
IV, VII	Stainless steel, steel
IV, VII	Stainless steel, steel with stainless steel cladding
IV	Stainless steel, steel with stainless steel or nickel alloy cladding, nickel alloys
II	Stainless steel, dissimilar metal welds
II, III, IV, V, VI, VII, VIII	Steel
VII, VIII	Steel (with or without coating or wrapping)
IV, VII	Steel (without lining/coating or with degraded lining/coating)
III	Steel and other materials (e.g., lubrite plates, polymeric vibration isolators, etc.)
VII	Steel with elastomer lining
VII	Steel with elastomer lining or stainless steel cladding
VII	Steel with internal lining or coating
IV, V, VII	Steel with stainless steel cladding
IV	Steel with stainless steel or nickel alloy cladding
IV	Steel with stainless steel or nickel alloy cladding; or stainless steel
VII	Steel, copper alloy

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B1. Unique Identifiers for Materials

Referring Chapters	Standardized Expression
II	Steel, dissimilar metal welds
VI	Steel, galvanized steel
II	Steel, graphite plate
IV	Steel, stainless steel, cast austenitic stainless steel, carbon steel with nickel alloy or stainless steel cladding, nickel alloy
II	Steel, stainless steel, dissimilar metal welds
III	Various
VI	Various metals used for electrical contacts
VI	Various polymers (e.g. EPR, SR, EPDM, XLPE)
VI	Various polymeric and metallic materials

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B2. Selected Descriptions of Materials

Standardized Expression	Description and Technical Justification
Boraflex	Boraflex is a material that is composed of 46 percent of silica, 4 percent of polydimethyl siloxane polymer and 50 percent of boron carbide by weight. It is a neutron absorbing material used as a neutron absorber in spent fuel storage racks; degradation of Boraflex panels under gamma radiation can lead to loss of boron absorber in spent fuel storage pools. The AMP XI.M22 is used as a reference for Boraflex monitoring.
Boral, boron steel	Boron steel is steels with boron content ranging from 1 to a few per cent. Boral is material consisting of boron carbide sandwiched between aluminum. Boron steel absorbs neutrons and thus is often used as a control rod to help control the neutron flux.
Cast austenitic stainless steel (CASS)	Cast stainless steels containing ferrite in an austenitic matrix. Examples of cast austenitic stainless steel (CASS) designations that were specifically referenced in GALL 2001 that comprise this category include CF-3M, CF-8 or CF-8M.
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.
Elastomers	Elastomers include rubber, EPT, EPDM, PTFE, ETFE, viton, vitril, neoprene, silicone elastomer, etc
Galvanized steel	Steel coated with zinc (usually by immersion or electrodeposition); the Zn coating is capable protecting the steel from atmospheric corrosion even when the surface is scratched, since the Zn is preferentially attacked by carbonic acid, forming a protective coat of basic zinc carbonate.
Glass	All glass materials
Gray cast iron	This form of cast iron is the most common of the iron alloys used in nuclear plants. This cast iron is susceptible to selective leaching.
High strength low alloy steel - Maximum tensile strength <1172 MPa (<170 Ksi)	High-strength Fe-Cr-Ni-Mo low alloy steel bolting materials that are subject to stress corrosion cracking. Examples of high strength alloy steel designations that were specifically referenced in GALL 2001 that comprise this category include SA540-Gr. B23/24, SA193-Gr. B8, Grade L43 (AISI4340)

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B2. Selected Descriptions of Materials

Standardized Expression	Description and Technical Justification
High-strength low-alloy steel SA 193 Gr. B7	Bolting fabricated from SA193-Gr. B8 austenitic steel, comparable to AISI 304 (UNS# S30400) is also susceptible to stress corrosion cracking.
High-strength steel	High-strength low-alloy steel as referenced in GALL2001 (such as V.E.2-b, VIII.H.2-b)
Insulation materials (e.g. bakelite, phenolic melamine or ceramic, molded polycarbonate)	Electrical fuse holders are composed of insulation materials (e.g. bakelite, phenolic melamine or ceramic, molded polycarbonate)
Low-alloy steel, yield strength >150 ksi	High strength bolting for NSSS component supports is fabricated from low-alloy steel, yield strength >150 ksi
Lubrite	Lubrite is bronze to ASTM B22 alloy 905 with G 10 lubricant.
Nickel alloys	Nickel alloys are used for a wide variety of applications, the majority of which involve corrosion resistance and/or heat resistance. Nickel and nickel alloys, like the stainless steels, offer a wide range of corrosion resistance. However, nickel can accommodate larger amounts of alloying elements, chiefly chromium, molybdenum, and tungsten, in solid solution than iron. Therefore, nickel-base alloys, in general, can be used in more severe environments than the stainless steels. Nickel-chromium-iron (molybdenum) alloys are those such as the Alloy 600 and 690. Examples of nickel alloy designations that were specifically referenced in GALL 2001 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.
PH stainless steel forging	Precipitation hardened (PH) martensitic stainless steel, Combines excellent corrosion resistance, high strength and hardness, low temperature hardening and good fabricating characteristics, superior transverse ductility and toughness. Examples of steel designations that were specifically referenced in GALL 2001 that comprise this category include Type 15-5PH.
Polymer (e.g., Rubber)	Vibration isolation elements in supports for the emergency diesel generator are fabricated from polymeric materials such as rubber and can be degraded by aging mechanisms such as radiation hardening, temperature, humidity, sustained vibratory loading
SA508-Cl 2 forgings clad with stainless steel using a high-heat-input welding process	Quenched and tempered vacuum treated carbon and alloy steel forgings for pressure vessels. Growth of intergranular separations (underclad cracks) in low-alloy steel forging heat affected zone under austenitic stainless steel cladding is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation for all the SA 508-Cl 2 forgings where the cladding was deposited with a high heat input welding process.

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B2. Selected Descriptions of Materials

Standardized Expression	Description and Technical Justification
Stainless steel	Wrought or forged austenitic, ferritic, martensitic, or duplex stainless steel (Cr content >11%) Examples of stainless steel designations that were specifically referenced in GALL 2001 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, and cast iron exhibit the same aging effects, even though the rates of aging may vary. Consequently, these metal types may be considered the same for aging management reviews. Gray cast iron is also susceptible to selective leaching and high strength low alloy steel is also susceptible to stress corrosion cracking. Therefore, when these aging effects are being considered, these materials are specifically mentioned; otherwise they are considered part of the general category of steel, which does NOT include stainless steel. Galvanized steel – (Zinc coated carbon steel) is also included in this category. Examples of steel designations that were specifically referenced in GALL 2001 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
Various polymers used in electrical applications (e.g. EPR, SR, EPDM, XLPE)	XLPE is cross linked polyethylene (XLPE) in the category of thermoplastic resins as Polyethylene And Polyethylene Copolymers. EPR and EPDM are Ethylene-Propylene Rubbers (EPR, EPDM) in the category of thermosetting elastomers.

C. Environments

The following table IX.C1 provides a listing of the environment identifiers utilized in the GALL tables. Each expression is cross-referenced to the specific chapters in the GALL Report where they are found. This table is presented as an interim measure to facilitate expedited completion of the September 30, 2004 draft of the GALL Report update. A final version of the table will be included in the Bases Document instead of Chapter IX.

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C1. Unique Identifiers for Environments

Referring Chapters	Standardized Expression
VI	Adverse localized environment caused by exposure to moisture and voltage
VI	Adverse localized environment caused by heat, radiation, or moisture in the presence of oxygen
VI	Adverse localized environment caused by heat, radiation, or moisture in the presence of oxygen or > 60-year service limiting temperature
VI	Adverse localized environment caused by heat, radiation, oxygen, moisture, or voltage
II, III	Aggressive environment
V, VII, VIII	Air – high temperature
VI	Air – indoor
VI	Air – indoor and outdoor
V, VII, VIII	Air – indoor controlled (External)
II, III, IV, V, VI, VII, VIII	Air – indoor uncontrolled
III, IV, V, VII, VIII	Air – indoor uncontrolled (External)
V, VII	Air – indoor uncontrolled (Internal)
V, VI	Air – indoor uncontrolled (Internal/External)
VII	Air – indoor uncontrolled >35°C (>95°F) (Internal)
V	Air – indoor uncontrolled >35°C (>95°F) (Internal/External)
II, III	Air – indoor uncontrolled or air - outdoor
II, III, VI, VII	Air – outdoor
V, VII, VIII	Air – outdoor (External)
V	Air and steam
III, IV, V, VI, VII, VIII	Air with borated water leakage
IV	Air with leaking secondary-side water and/or steam
IV	Air with metal temperature up to 288°C (550°F)
IV	Air with reactor coolant leakage
V, VII, VIII	Air with steam or water leakage
II, III	Any
V, VII, VIII	Closed cycle cooling water
VII	Closed cycle cooling water >60°C (>140°F)
IV, V, VII, VIII	Concrete
V, VII	Condensation (External)
V	Condensation (Internal/External)

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C1. Unique Identifiers for Environments

Referring Chapters	Standardized Expression
V, VII	Condensation (Internal)
VII	Diesel Exhaust
VII	Dried Air
VII	Fuel oil
IV, V, VII, VIII	Gas
V, VII, VIII	Lubricating oil
V, VII, VIII	Lubricating oil (no water pooling)
VII	Moist air
V, VII, VIII	Raw water
IV	Reactor coolant
IV	Reactor coolant >250°C (>482°F) and neutron flux
IV	Reactor coolant >250°C (>482°F)
IV	Reactor coolant and high fluence (>1 x 10E21 n/cm2 E >0.1 MeV)
IV	Reactor coolant and neutron flux
IV	Reactor coolant and secondary feedwater/steam
VII	Saturated air
IV	Secondary feedwater
IV	Secondary feedwater/steam
VII	Sodium pentaborate solution
II, III, VII, VIII	Soil
VIII	Steam
IV	System temperature up to 288°C (550°F)
IV	System temperature up to 340°C (644°F)
IV, V, VII	Treated borated water
IV, V, VII	Treated borated water >60°C (>140°F)
V	Treated borated water >250°C (>482°F)
V, VII, VIII	Treated water
V, VII	Treated water >60°C (>140°F)
V, VIII	Untreated water
V	Untreated water or raw water
II	Water
II, III	Water - flowing
III	Water – flowing Water – standing
III	Water – standing

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
VI	Adverse localized environment caused by exposure to moisture and voltage	The conductor insulation used for electrical cables in instrumentation circuits can be subjected to an adverse localized environment caused by exposure to moisture and voltage (GALL 2001, VI.A1-c)
VI	Adverse localized environment caused by heat, radiation, or moisture in the presence of oxygen	The conductor insulation used for electrical cables in instrumentation circuits can be subjected to an adverse localized environment caused by heat, radiation, or moisture in the presence of oxygen (GALL 2001, VI.A1-b)
VI	Adverse localized environment caused by heat, radiation, or moisture in the presence of oxygen or > 60-year service limiting temperature	The term ">60-year service limiting temperature" refers to that which exceeds the temperature below which the material has a 60-year or greater service lifetime.
VI	Adverse localized environment caused by heat, radiation, oxygen, moisture, or voltage	Electrical components subject to 10CFR50.49 EQ requirements can be subjected to an adverse localized environment caused by caused by heat, radiation, oxygen, moisture, or voltage (GALL 2001, VI.B1-a)
II, III	Aggressive environment	For steel in concrete. As described in NUREG-1557, this is defined as that occurring when concrete pH <11.5 or chlorides concentration >500 ppm). Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Inside or outside containment
V, VII, VIII	Air – indoor controlled (External)	The environment to which the external surface of the component or structure is exposed - - Indoor air in a humidity controlled (e.g., air conditioned) environment
II, III, IV, V, VI, VII, VIII	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. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Ambient température air • Ambient environment inside buildings • Inside or outside containment

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		• Indoors: exposed to variable temperature and humidity inside the auxiliary building or fuel handling building • Air, moisture, and humidity < 100°C (212°F)
V	Air – indoor uncontrolled >35°C (>95°F) (Internal/External)	The environment to which the internal or external surface of the component or structure is exposed. Indoor air above thermal stress threshold for elastomers. If ambient is <95°F, then any resultant thermal aging of organic materials can be considered insignificant over the 60-yr period of interest [1, 2] Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: Internal: occasional exposure to moist air; external: ambient plant air environment
II, III	Air – indoor uncontrolled or air - outdoor	Indoor air on systems with temperatures higher than the dew point – Condensation can occur but only rarely – equipment surfaces are normally dry. Alternatively, the aging effect could occur outdoors. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Inside or outside containment
II, III, VI, VII	Air – outdoor	The outdoor environment consists of moist, possibly salt-laden atmospheric air, ambient temperatures and humidity, and exposure to weather, including precipitation and wind. The component is exposed to air and local weather conditions including salt spray where applicable. A component is considered susceptible to a wetted environment when it is submerged, has the potential to pool water, or is subject to external condensation. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Weather exposed • Outside containment
V	Air and steam	Exposed normally to air and periodically to steam. Since this is for FAC, there is no temperature threshold and thus the temperature parameters of environment need not be defined

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Air and steam up to 320°C (608°F)
III, IV, V, VI, VII, VIII	Air with borated water leakage	Air and untreated borated water leakage on indoor or outdoor systems with temperatures above or below the dew point. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Inside PWR containment • Air, leaking and dripping chemically treated borated water up to 340°C (644°F) Air, leaking chemically treated borated water
IV	Air with leaking secondary-side water and/or steam	Steel secondary manways and handhole covers in the pressure boundary and structural parts of the once-through steam generator may be exposed to an environment consisting of air with leaking secondary-side water and/or steam (revised from IV.D2.1-l)
IV	Air with metal temperature up to 288°C (550°F)	Synonymous with system temperature up to 288°C (550°F). Used in GALL update to describe environment to which the steel and stainless steel pressurizer integral support in the PWR reactor coolant system are exposed (revised from GALL 2001 IV.C2.5-v)
IV	Air with reactor coolant leakage	Air and reactor coolant or steam leakage on high temperature systems. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Air, leaking reactor coolant water and/or steam at 288°C (550°F)
VII, VIII	Air with steam or water leakage	Air and untreated steam or water leakage on indoor or outdoor systems with temperatures above or below the dew point Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Air, moisture, humidity, and leaking fluid
II, III	Any	Could be any environment indoors or outdoor, aging effect not dependent on environment. Examples of environment descriptors that were

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		specifically referenced in GALL 2001 that comprise this category include: • Inside or outside containment
V, VII, VIII	Closed cycle cooling water	Treated water subject to the closed cycle cooling water chemistry program Examples of environment descriptors that were specifically referenced in GALL 2001 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
VII	Closed cycle cooling water >60°C (>140°F)	Closed cycle cooling water >60°C (>140°F) thus allowing the possibility of stainless steel SCC. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • In the BWR reactor water cleanup system, the nonregenerative heat exchanger reactor coolant water at 288°C (550°F) and 10MPa max. pressure. (VII.E3.4-a)
IV, V, VII, VIII	Concrete	Components embedded in concrete
V, VII	Condensation (Internal/External)	The environment to which the internal or external surface of the component or structure is exposed Air and condensation with the potential for boric acid leakage on surfaces of indoor systems with temperatures below the dew point – condensation is considered untreated water due to potential for surface contamination Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Saturated air(internal environment as in compressed air)
VII	Diesel Exhaust	Gases, fluids, particulates present in a diesel engine exhaust Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Hot diesel engine exhaust gases containing

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		moisture and particulates
VII	Dried Air	Air that has been treated to reduce the dew point well below the system operating temperature
VII	Fuel oil	Fuel oil used for combustion engines with possible water contamination
IV, V, VII, VIII	Gas	Inert gases such as carbon dioxide, freon, halon, nitrogen
V, VII, VIII	Lubricating oil	Lubricating oils within the scope of license renewal are low to medium viscosity hydrocarbons used for bearing, gear, and engine lubrication. This lubricating oil used for plant equipment has the possibility of water contamination. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Lubricating oil (with contaminants and/or moisture
V, VII, VIII	Lubricating oil (no water pooling)	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.
VII	Moist air	In the emergency diesel generator system, the steel diesel engine starting air subsystem and the diesel engine combustion air intake subsystem can be exposed to moist air resulting in loss of material caused by general, pitting, and crevice corrosion.
V, VII, VIII	Raw water	Raw untreated fresh, salt, or ground water Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Flowing water • open-cycle cooling water (raw water)
IV	Reactor coolant	Water in the reactor coolant system and connected systems at or near full operating temperature – includes steam for BWRs. For aging effect of cumulative fatigue damage, no temperature threshold of concern. In context of PWR reactor vessel, reactor coolant was more appropriate description of environment. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include:

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		• Chemically treated borated water or steam up to 340°C (644°F) • Up to 288°C (550°F), reactor coolant water
IV	Reactor coolant >250°C (>482°F) and neutron flux	Water in the reactor coolant system and connected systems above thermal embrittlement threshold for CASS. Since CASS and the AMP XI.M13 are referenced, both environments are listed in single cell as well as the temperature threshold. Wherever there is thermal aging of CASS, 482 applies. Wherever there is neutron irradiation, Neutron Flux applies. If components other than CASS are included, then the limitations do not apply for the other components. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: Chemically treated borated water up to 340°C (644°F) fluence $>10^{17}$ n/cm^2 (E >1 MeV)
IV	Reactor coolant >250°C (>482°F)	Treated water above thermal embrittlement threshold for CASS. Address environment specifications of concern for specific aging effect. Here thermal embrittlement of CASS is addressed. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: 25–288°C (77-550°F) demineralized water
IV	Reactor coolant and high fluence (>1 x 10E21 n/cm2 E >0.1 MeV)	The PWR reactor vessel internals (such as baffle/former assembly and associated baffle/former bolts) will be subjected to a reactor coolant environment and also a high fluence (>1 x 10E21 n/cm2 E >0.1 MeV). Subsequently, SCC and IASCC aging mechanisms can cause cracking.
IV	Reactor coolant and neutron flux	Reactor core environment for ferritic materials that will result in a neutron fluence exceeding 10^{17} n/cm^2 (E >1 MeV) at the end of the license renewal term. Since the material is steel and the aging effect/mechanism is loss of fracture toughness/ neutron irradiation embrittlement, the only environment of concern in this context is the neutron flux. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		this category include: • 288°C (550°F) reactor coolant water $5x10^8$ - $5x10^9$ n/cm^2·s Chemically treated borated water up to 340°C (644°F) neutron fluence greater than 10^{17} n/cm^2 (E >1 MeV)
IV	Reactor coolant and secondary feedwater/steam	For PWR systems, it is reasonable to combine these environments into one cell. Water in the reactor coolant system and connected systems at or near full operating temperature and the PWR feedwater or steam at or near full operating temperature subject to the secondary water chemistry program. Nickel-alloy tubes and sleeves are subject to cumulative fatigue damage and managed by TLAA. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • ID chemically treated borated water up to 340°C (644°F); OD up to 300°C (572°F) secondary-side water chemistry
VII	Saturated air	This environment is not used. Instead, replaced with condensation.
IV	Secondary feedwater	In the recirculating steam generator, the steel pressure boundary and structural feedwater impingement plate and support are exposed to secondary feedwater environment and can experience loss of section thickness due to erosion.
IV	Secondary feedwater/steam	PWR feedwater or steam at or near full operating temperature subject to the secondary water chemistry program. In IV, this is the descriptor for SCC of secondary side nozzles in pressure boundary and structural components of steam generator (once-through) constructed of Alloy 600 Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Up to 300°C (572°F) secondary-side water chemistry at 5.3-7.2 MPa
VII	Sodium pentaborate solution	Although it has been referenced that sodium pentaborate approximates basic treated water in aggressivity, this is a fairly concentrated solution.

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (≈24,500 ppm B)
II, III, VII, VIII	Soil	External environment for components buried in the soil, including groundwater in the soil. Environment where settlement could occur – includes changes in groundwater condition. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Soft soil; changes in groundwater conditions (III) • Soil (VII) • Soil and ground water (VIII)
VIII	Steam	Steam, subject to BWR water chemistry program or PWR secondary plant water chemistry program. Defining temperature of steam is not considered necessary for analysis Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • 288°C (550°F) steam • Up to 300°C (572°F) steam
IV	System temperature up to 288°C (550°F)	Metal temperature outside the recirculation pump and valves associated with BWR reactor coolant pressure boundary Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Air with metal temperature up to 288°C (550°F)
IV	System temperature up to 340°C (644°F)	Maximum metal temperature associated with either reactor coolant pump, valves, or pressurizer integral support for PWR reactor coolant or PWR steam generators. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Air • Air with metal temperature up to 340°C (644°F)

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
IV, V, VII	Treated borated water	Borated (PWR) water. Since material of concern is Boraflex, no need to specify temperature threshold. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Chemically treated oxygenated (BWR) or borated (PWR) water
IV, V, VII	Treated borated water >60°C (>140°F)	Treated water with boric acid above SCC threshold for stainless steel. [2,3] borated (PWR) water, when dealing with SCC of stainless steel, then list > 140°F Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Chemically treated borated water at temperature <93°C (200°F) • Chemically treated oxygenated (BWR) or borated (PWR) water
V	Treated borated water >250°C (>482°F)	Treated water with boric acid above thermal embrittlement threshold for CASS. Only environmental temperature of concern is that above the embrittlement threshold – specifying full temp range is counterproductive. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Chemically treated borated water at temperature 25–340°C (77-644°F)
V, VII, VIII	Treated water	Treated or demineralized water – This environment is used where the context of the MEAP combination makes the type of treated water apparent; e.g., if the program is for PWR secondary water chemistry, the treated water is from the PWR secondary system. When the aging effect is not temperature dependent, it is counterproductive to define environment temp Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • <90°C (<194°F) treated water • 25–288°C (77-550°F) demineralized water • Chemically treated oxygenated (BWR) or borated (PWR) water

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		• Secondary side treated water • Treated water side (condensate side) • Treated water (BWRs: reactor coolant; PWRs: secondary side water) • Treated water side (other side of steam generator blowdown)
V, VII	Treated water >60°C (>140°F)	Treated water above SCC threshold for stainless steel. This is Chemically treated oxygenated (BWR) water, when dealing with stress corrosion cracking (SCC) of stainless steel, then include temperature threshold > 140°F. Treated water in the reactor coolant system and connected systems above SCC threshold for stainless steel. [2,3] In context of SCC of SS components in PWR reactor vessel, then list >140°F Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Chemically treated oxygenated (BWR) or borated (PWR) water • Chemically treated borated water up to 340°C (644°F)
V	Untreated water or raw water	Water that may contain contaminants including oil and boric acid depending on the location – includes originally treated water that is not monitored by a chemistry program. Untreated is a very broad term that overlaps with raw water in that leaking groundwater can be included. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Moisture, water
II, III	Water - flowing	Water that is refreshed, thus having larger impact on leaching – this can be raw water, groundwater, or flowing water under a foundation. Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: include: • Flowing water under foundation
III	Water – standing	Water that is stagnant and unrefreshed, thus possibly resulting in increased ionic strength of solution up to saturation.

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C2. Selected Descriptions of Environments

Referring Chapters	Standardized Expression	Description and Technical Justification
		Examples of environment descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Exposed to water

IX. Unique Identifiers and Selected Definitions used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

C3. Temperature Thresholds Expressed in Environmental Descriptors

Temperature	Threshold	Description and Technical Justification
95°F	Thermal stresses for elastomers	In general, if the ambient temperature is less than about 95°F, then thermal aging may be considered not significant for rubber, butyl rubber, neoprene, nitrile rubber, silicone elastomer, fluoroelastomer, EPR, and EPDM. [1]
140°F	SCC for stainless steel	In general, SCC very rarely occurs in austenitic stainless steels below 140°F. Although SCC has been observed in stagnant, oxygenated borated water systems at lower temperatures than this 140°F threshold, all of these instances have identified a significant presence of contaminants (halogens, specifically chlorides) in the failed components. With a harsh enough environment (significant contamination), SCC can occur in austenitic stainless steel at ambient temperature. However, these conditions are considered event driven, resulting from a breakdown of chemistry controls. [2,3]
482°F	Thermal embrittlement for CASS	CASS materials subjected to sustained temperatures below 250°C (482°F) will not result in a reduction of room temperature Charpy impact energy below 50 ft-lb for exposure times of approximately 300,000 hours (for CASS with ferrite content of 40%) and approximately 2,500,000 hours for CASS with ferrite content of 14%) [Figure 2; Reference 4]. For a maximum exposure time of approximately 420,000 hours (48 EFPY), a screening temperature of 482°F is conservatively chosen because (1) the majority of nuclear grade materials are expected to contain a ferrite content well below 40%, and (2) the 50 ft-lb limit is very conservative when applied to cast austenitic materials. It is typically applied to ferritic materials (e.g., 10 CFR 50 Appendix G). For CASS components in the reactor coolant pressure boundary, this threshold is supported by NUREG-1801 XI.M12, with the exception of niobium-containing steels which require evaluation on a case-by-case basis.

D. Aging Effects

IX. Unique Identifiers and Selected Definitions of Terms used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

D. Aging Effects

Referring Chapters	Standardized Expression	Description and Technical Justification
IV	Changes in dimensions	Changes in dimension can result from void swelling
VII	Concrete cracking and spalling	Concrete cracking and spalling can result from freeze-thaw, aggressive chemical attack, and reaction with aggregates.
VI	Corrosion of connector contact surfaces	Corrosion of connector contact surfaces can be caused by borated water intrusion.
IV	Crack growth	The Vessel shell (including beltline welds) fabricated of SA508-Cl 2 forgings clad with stainless steel using a high-heat-input welding process when subjected to a reactor coolant environment can experience a crack growth aging effect caused by cyclic loading.
II, IV, VII	Cracking	This term is used in this document to be synonymous with the phrase “crack initiation and growth” where used in reference to metallic substrates. Nonductile failure of a component due to stress corrosion, fatigue, or embrittlement. Aging mechanisms that can result in cracking include: Cyclic loading Stress corrosion cracking Intergranular attack Outer diameter stress corrosion cracking Primary water stress corrosion cracking Intergranular stress corrosion cracking Irradiation-assisted stress corrosion cracking Thermal and mechanical loading Examples of aging effect descriptors that were specifically referenced in GALL 2001 that comprise this category include: • Crack initiation and growth Cracking in concrete can be caused by restraint shrinkage, creep, and aggressive environment.
II	Cracking, loss of bond, and loss of material (spalling, scaling)	Cracking, loss of bond, and loss of material (spalling, scaling) can be caused by Corrosion of embedded steel
II	Cracks; distortion; increase in component stress level	Within concrete structures, Cracks, distortion, and increase in component stress level can be caused by settlement.
IV, V, VII, VIII	Cumulative fatigue	Cumulative fatigue damage is due to fatigue

IX. Unique Identifiers and Selected Definitions of Terms used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

D. Aging Effects

Referring Chapters	Standardized Expression	Description and Technical Justification
	damage	
VI	Degradation of insulator quality	Degradation of insulator quality can result from the presence of any salt deposits, surface contamination
IV.	Denting	Denting can result from corrosion of carbon steel tube support plates.
VI	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance (IR); electrical failure	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance, electrical failure can have as its root cause Thermal or thermoxidative degradation of organics, Radiation-induced oxidation, Radiolysis and photolysis (UV sensitive materials only) of organics Moisture intrusion Ohmic heating
II	Expansion and cracking	Within concrete structures, expansion and cracking can result from reaction with aggregates
VI	Fatigue	Fatigue in copper fuse holder clamps can result from ohmic heating, thermal cycling, electrical transients, frequent manipulation, vibration, chemical contamination, corrosion, oxidation.
IV	Fretting or lockup	Fretting is an aging effect due to accelerated deterioration at the interface between contacting surfaces as the result of corrosion and slight oscillatory movement between the two surfaces. In essence both fretting and lockup are due to mechanical wear.
V, VII	Hardening and loss of strength	Hardening and loss of strength can result from elastomer degradation of seals and other elastomeric components.
II	Increase in porosity and permeability, cracking, loss of material (spalling, scaling)	Concrete can increase in porosity and permeability, cracking, loss of material (spalling, scaling) due to aggressive chemical attack.
II	Increase in porosity and permeability, loss of strength	Concrete can increase in porosity and permeability, with resulting loss of strength due to leaching of calcium hydroxide
	Increase in porosity, permeability	Concrete can increase in porosity and permeability due to leaching of calcium hydroxide
VII	Increased hardness, shrinkage and loss of strength	Elastomers can experience increased hardness, shrinkage and loss of strength due to weathering.

IX. Unique Identifiers and Selected Definitions of Terms used for Describing and Standardizing Structures, Components, Materials, Environments, Aging Effects, and Aging Mechanisms

D. Aging Effects

Referring Chapters	Standardized Expression	Description and Technical Justification
VI	Increased resistance of connection	Increased resistance of connection in electrical transmission conductors and connections can be caused by oxidation or loss of preload.
VI	Increased resistance of connection	Increased resistance of connection can result from oxidation or loss of pre-load
IV	Ligament cracking	Steel tube support plates can experience ligament cracking due to corrosion.
VI	Localized damage and breakdown of insulation leading to electrical failure	Localized damage in polymeric electrical conductor insulation leading to electrical failure is due to moisture intrusion, and the formation of water trees.
II	Lock-up	Lock-up of steel elements in the drywell head downcomers can be attributed to mechanical wear.
VI	Loosening of bolted connections	The loosening of bolted bus duct connections due to thermal cycling can result from ohmic heating
VI	Loss of conductor strength	Loss of conductor strength in electrical transmission lines can result from corrosion
IV	Loss of fracture toughness	Loss of fracture toughness can result from various aging mechanisms including thermal aging, thermal aging embrittlement, neutron irradiation embrittlement, void swelling,
II	Loss of leak tightness	Steel airlocks can experience loss of leak tightness in closed position resulting from mechanical wear of locks, hinges and closure mechanisms.
II, III, IV, V, VI, VII, VIII	Loss of material	Loss of material may be due to general corrosion, boric acid corrosion, pitting corrosion, galvanic corrosion, crevice corrosion, erosion, fretting, flow-accelerated corrosion, MIC, selective leaching, wastage, wear, and aggressive chemical attack. In concrete structures, loss of material can also be caused by abrasion or cavitation or corrosion of embedded steel. For high voltage insulators, loss of material can be attributed to mechanical wear or wind-induced abrasion and fatigue due to wind blowing on transmission conductors. Loss of material due to general corrosion is an aging effect requiring management for low alloy steel, carbon steel, and cast iron in outdoor environments
II	Loss of material (spalling, scaling) and cracking	In concrete, loss of material (spalling, scaling) and cracking can result from freeze-thaw processes.

D. Aging Effects

Referring Chapters	Standardized Expression	Description and Technical Justification
III	Loss of material, loss of form	In earthen water-control structures, the loss of material, and loss of form can result from erosion, settlement, sedimentation, frost action, waves, currents, surface runoff, and seepage.
III	Loss of mechanical function	Loss of mechanical function in ASME Class 1 piping and components (such as constant and variable load spring hangers, guides, stops, sliding surfaces, design clearances, vibration isolators) fabricated from steel or other materials such as lubrite can experience loss of mechanical function due to corrosion, distortion, dirt, overload, fatigue due to vibratory and cyclic thermal loads, or elastomer hardening.
IV	Loss of preload	Loss of preload in closure bolting is due to stress relaxation.
II	Loss of prestress	Loss of prestress in structural steel anchorage components can result from relaxation, shrinkage, creep, or elevated temperatures.
II, VI	Loss of sealing; leakage through containment	Loss of sealing and leakage through containment in materials such as seals, elastomers, rubber and other similar materials can result from deterioration of seals, gaskets, and moisture barriers (caulking, flashing, and other sealants) Loss of seal in elastomeric phase bus enclosure assemblies can result from moisture intrusion
VII	Macrofouling	Macrofouling can result from biofouling.
VII, VIII	Macrofouling and loss of material	Biofouling listed in NUREG-1801 as aging mechanism is assumed to be the plugging of components due to biological growth or material. Although plugging of a component affects only flow, an active intended function outside the purview of license renewal, the term macrofouling is used to address fouling that causes plugging as opposed to fouling that causes loss of heat transfer, and includes plugging from any source, including biological. Macrofouling and loss of material can result from biofouling and general, pitting, crevice,& microbiologically influenced corrosion (MIC)
VII	None	Certain structures and components made of corrosion-resistant materials may in certain environments be subject to no aging mechanisms and thus there are also no relevant aging effects.

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D. Aging Effects

Referring Chapters	Standardized Expression	Description and Technical Justification
III	Reduction in concrete anchor capacity due to local concrete degradation	Reduction in concrete anchor capacity due to local concrete degradation can result from a service-induced cracking or other concrete aging mechanisms
III	Reduction in foundation strength, cracking, differential settlement	Reduction in foundation strength, cracking, and differential settlement can result from erosion of porous concrete subfoundation.
V, VII, VIII	Reduction of heat transfer	Reduction of heat transfer from fouling by the buildup (from whatever source) on the heat transfer surface. Biofouling listed in NUREG-1801 as aging mechanism is assumed to be the plugging of components due to biological growth or material. Although plugging of a component affects only flow, an active intended function outside the purview of license renewal, the term macrofouling is used to address fouling that causes plugging as opposed to fouling that causes loss of heat transfer, and includes plugging from any source, including biological
VII	Reduction of neutron-absorbing capacity	Reduction of neutron-absorbing capacity can result from Boraflex degradation.
VII	Reduction of neutron-absorbing capacity and loss of material	Reduction of neutron-absorbing capacity can result from Boraflex degradation.
VI	Reduction of strength and modulus	In concrete, reduction of strength and modulus can be attributed to elevated temperatures (>150°F general; >200°F local)
III	Reduction or loss of isolation function	Reduction or loss of isolation function in polymeric vibration isolation elements can result from Radiation hardening, temperature, humidity, sustained vibratory loading.
VI	Various degradation effects	Electrical equipment subjected to adverse localized environment can be subject to various degradation effects due to various mechanisms.
IV, V, VIII	Wall thinning	This is the term used throughout GALL'05 to describe the specific version of loss of material due to flow-accelerated corrosion.

E. Significant Aging Mechanisms

An aging mechanism is considered to be significant when it may result in aging effects that produce a loss of functionality of a component or structure during the current or license renewal period if allowed to continue without mitigation.

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Referring Chapters	Standardized Expression	Description and Technical Justification
III, VI	Abrasion	As water migrates over a concrete surface it may transport material that can abrade the concrete. The passage of water may also create a negative pressure at the water - air to concrete interface that can result in abrasion and cavitation degradation of the concrete. This may result in pitting or aggregate exposure due to loss of cement paste. [16]
II, III, VII	Aggressive chemical attack	Concrete, being highly alkaline (pH> 12.5) is degraded by strong acids. Chlorides and sulfates of potassium, sodium, and magnesium may attack concrete depending concentration in soil/ground water. Exposed surfaces of Class 1 structures may be subject to sulfur-based acid-rain degradation. Minimum degradation thresholds are 500 ppm chlorides and 1500 ppm sulfates. [16]
V, VII, VIII	Biofouling	Reduction of heat transfer from fouling by the buildup (from whatever source) on the heat transfer surface. Biofouling listed in NUREG-1801 as aging mechanism is assumed to be the plugging of components due to biological growth or material. Although plugging of a component affects only flow, an active intended function outside the purview of license renewal, the term macrofouling is used to address fouling that causes plugging as opposed to fouling that causes loss of heat transfer, and includes plugging from any source, including biological
VII	Boraflex Degradation	Boraflex degradation may involve gamma radiation-induced shrinkage of Boraflex and the potential to develop tears or gaps in the material. A more significant potential degradation is the gradual release of silica and the depletion of boron carbide from Boraflex following gamma irradiation and long-term exposure to the wet pool environment. The loss of boron carbide from Boraflex is characterized by slow dissolution of the

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		Boraflex matrix from the surface of the Boraflex and a gradual thinning of the material. The boron carbide loss, of course, can result in a significant increase in the reactivity of the storage racks. An additional consideration is the potential for silica transfer through the fuel transfer canal into the reactor core during refueling operations and its effect on the fuel clad heat transfer capability. [19]
VI	Borated Water Intrusion	Influx of borated water.
III, IV, V, VII, VIII	Boric acid corrosion	Corrosion by Boric acid. See also Corrosion.
III	Cavitation	Formation and instantaneous collapse of innumerable tiny voids or cavities within a liquid subjected to rapid and intense pressure changes. Cavitation caused by severe turbulent flow often leads to cavitation damage.
VI	Chemical contamination	Degradation due to presence of chemical constituents.
VII	Cladding degradation	This refers to the degradation of the stainless steel cladding (via any applicable degradation process for stainless steel/applicable environment described in NUREG 1801). The specific component/material/ environment item is described in A4.2.1 in VII A4-3 of NUREG 1801. It is not a special process.
II, III, IV, V, VI, VII, VIII	Corrosion	Chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties.
IV	Corrosion of carbon steel tube support plate	Corrosion (as defined above) of the carbon steel tube support plates which are plate-type component providing tube-tube mechanical support for the tubes in the tube bundle of the steam generator (recirculating) system of a PWR. The tubes pass through drill holes in the plate. The secondary coolant flows through the tube supports via flow holes between the tubes. [13, 14]
II, III, VII	Corrosion of embedded steel	If pH of the concrete in which steel is embedded is reduced (pH< 11.5) by intrusion of aggressive ions (e.g., chlorides > 500 ppm) in the presence of oxygen, embedded steel corrosion may occur. A reduction in pH may be caused by the leaching of

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		alkaline products through cracks, entry of acidic materials, or carbonation. Chlorides may also be present in the constituents of the original concrete mix. The severity of the corrosion is affected by the properties and types of cement, aggregates, and moisture content. [9]
II, III	Creep	Creep for a metallic material refers to a time-dependent continuous deformation process under constant stress. It is an elevated temperature process and is not a concern for low alloy steel below 700 ^{0} F, for austenitic alloys below 1000 ^{0} F, and Ni-based alloy below 1800 ^{0} F. [11,12] Creep in concrete is related to the loss of absorbed water from the hydrated cement paste. It is a function of modulus of elasticity of the aggregate. It may result in loss of prestress in the tendons used in prestressed concrete containment. [13]
III, IV, V, VII, VIII	Crevice Corrosion	Localized corrosion of a metal surface at, or immediately adjacent to, an area that is shielded from full exposure to the environment because of close proximity between the metal and the surface of another material. Crevice corrosion occurs in a wetted or buried environment when a crevice or area of stagnant or low flow exists that allows a corrosive environment to develop in a component. It occurs most frequently in joints and connections, or points of contact between metals and non-metals, such as gasket surfaces, lap joints, and under bolt heads. Carbon steel, cast iron, low alloy steels, stainless steel, copper, and nickel base alloys are all susceptible to crevice corrosion.
VII	Crevice Corrosion (only for steel after lining/cladding degradation)	Same as crevice corrosion in above.
II, IV, V, VII, VIII	Cyclic loading	One source of cyclic loading is due to periodic application of pressure loads and forces due to thermal movement of piping transmitted through penetrations and structures to which penetrations are connected. The typical results of cyclic loads on metal components is fatigue cracking and failure, however the cyclic loads may also cause deformation that results in functional failure.

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II	Deterioration of seals, gaskets, and moisture barriers (caulking, flashing, and other sealants)	Seals, gaskets, and moisture barriers (caulking, flashing, and other sealants) are subject to loss of sealing and leakage through containment caused by aging degradation of these components. (GALL2001 II.A3.3-a, IIB4.3-b)
II, III	Distortion	The aging mechanism of distortion can be caused by time-dependent strain, or gradual elastic and plastic deformation, of metal that is under constant stress at a value lower than its normal yield strength
V, VI, VII	Elastomer degradation	Elastomer materials are substances whose elastic properties similar to that of natural rubber. The term elastomer sometimes is used technically to distinguish synthetic rubbers and rubber like plastics from natural rubber. Degradation may include cracking, crazing, fatigue breakdown, abrasion, chemical attacks, and weathering. [17,18]
III, V, VI, VII	Elastomer hardening	Degradation in elastic properties of the elastomer.
VI	Electrical transients	Electrical transients are one of the aging mechanisms that can cause fatigue in copper fuse holder clamps.
II, III	Elevated temperature	In concrete, reduction of strength and modulus can be attributed to elevated temperatures (>150°F general; >200°F local)
II, III, IV, V	Erosion	Progressive loss of material from a solid surface due to mechanical interaction between that surface and a fluid, a multicomponent fluid, or solid particles carried with the fluid.
III	Erosion of porous concrete subfoundation	Erosion (as defined above) of the concrete subfoundation
III	Erosion settlement	Erosion (as defined above). Settlement of containment structure may occur during the design life due to changes in the site conditions (e.g., due to erosion or changes in the water table). The amount of settlement depends on the foundation material and is generally determined by survey. [9]
II, III, IV, V, VI, VII, VIII	Fatigue	Phenomenon leading to fracture under repeated or fluctuating stresses having a maximum value less than the tensile strength of the material. Fatigue fractures are progressive and grow under the action of the fluctuating stress.
III	Fatigue due to vibratory	Fatigue is defined as the structural degradation

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	and cyclic thermal loads	that can occur as a result of repeated stress/strain cycles caused by fluctuating loads (e.g., from vibratory loads) and temperatures (giving rise to thermal loads). After repeated cyclic loading of sufficient magnitude, microstructural damage may accumulate, leading to macroscopic crack initiation at the most vulnerable regions. Subsequent mechanical or thermal cyclic loading may lead to growth of the initiated crack. Crack initiation and growth resistance is governed by factors including stress range, mean stress, loading frequency, surface condition and the presence of deleterious chemical species. [15]
IV, V, VIII	Flow-accelerated corrosion (FAC)	Also termed erosion-corrosion. A co-joint activity involving corrosion and erosion in the presence of a moving corrosive fluid, leading to the accelerated loss of material.
II, III, VII	Freeze-Thaw, Frost action	Repeated freezing and thawing is known to be capable of causing severe degradation to the concrete characterized by scaling, cracking, and spalling. The cause of this phenomenon is water freezing within the pores of the concrete, creating hydraulic pressure which if unrelieved will lead to freeze-thaw degradation. Factors that enhance the resistance of concrete to freeze-thaw degradation are a) adequate air content (e.g., within ranges specified in ACI 301-84), b) low permeability, c) protection until adequate strength has developed, and surface coating applied to frequently wet-dry surfaces. [9,10]
II, IV	Fretting	Aging effect due to accelerated deterioration at the interface between contacting surfaces as the result of corrosion and slight oscillatory movement between the two surfaces.
III, V, VII	Galvanic Corrosion	Accelerated corrosion of a metal because of an electrical contact with a more noble metal or nonmetallic conductor in a corrosive electrolyte. Also called bimetallic corrosion, contact corrosion, dissimilar metal corrosion, and two-metal corrosion.
III, IV, V, VII, VIII	General corrosion	Also known as uniform corrosion, corrosion proceeds at approximately the same rate over a

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		metal surface. Loss of material due to general corrosion is an aging effect requiring management for low alloy steel, carbon steel, and cast iron in outdoor environments.
IV	Intergranular attack (IGA)	In austenitic stainless steels, the precipitation of Cr carbides, usually at grain boundaries, on exposure to temperatures of about 550-850degC, leaving the grain boundaries depleted of Cr and therefore susceptible to preferential attack (intergranular attack) by a corroding (oxidizing) medium.
IV, V, VII	Intergranular Stress Corrosion Cracking (IGSCC)	Stress corrosion cracking in which the cracking occurs along grain boundaries.
IV	Irradiation-assisted stress corrosion cracking (IASCC)	Failure by intergranular cracking in aqueous environments of stressed materials exposed to ionizing radiation has been termed irradiation assisted stress corrosion cracking (IASCC). Irradiation by high-energy neutrons can promote stress corrosion cracking by affecting material microchemistry (e.g., radiation-induced segregation of elements such as P, S, Si, and Ni to the grain boundaries), material composition and microstructure (e.g., radiation hardening), as well as water chemistry (e.g., radiolysis of the reactor water to make it more aggressive).
II, III	Leaching of calcium hydroxide	Water passing through cracks, inadequately prepared construction joints, or areas that are not sufficiently consolidated during placing may dissolve some calcium-containing products (of which calcium hydroxide is the most-readily soluble) in the concrete. Once the calcium hydroxide has been leached away, other cementatious constituents become vulnerable to chemical decomposition, finally leaving only the silica and alumina gels behind with little strength. The water's aggressiveness in the leaching of calcium hydroxide depends on its salt content and temperature. This leaching action is effective only if the water passes through the concrete. [9]
IV	Mechanical loading	Applied loads of mechanical origins rather than from other sources such as thermal.
II, VI	Mechanical wear	Fatigue of copper clamps in fuse holders can be partially attributed to frequent manipulation, which

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		is really a subset of mechanical wear. Other examples include mechanical wear of electrical lines due to wind blowing on transmission conductors. Another is the mechanical wear of locks, hinges and closure mechanisms.
V, VII, VIII	Microbiologically influenced corrosion (MIC)	Corrosion that is affected by the action of microorganisms in the environment.
VI	Moisture Intrusion	Influx of moisture through any viable process.
IV	Neutron irradiation embrittlement	Irradiation by neutrons results in embrittlement of carbon and low alloy steels. It may produce changes in mechanical properties by increasing tensile and yield strengths with corresponding decrease in fracture toughness and ductility. The extent of embrittlement depends on neutron fluence, temperature, and trace material chemistry. [12]
VI	Ohmic heating	Ohmic heating is a thermal stressor that may be induced via conductors passing through electrical penetrations. Ohmic heating is generally significant only for power circuit penetrations.[5]
IV	Outer Diameter Stress Corrosion Cracking (ODSCC)	Stress corrosion cracking initiating in the outer diameter (secondary side) surface of steam generator tubes. This differs from PWSCC which describes inner diameter (primary side) initiated cracking. [14]
III	Overload	Overload is one of the aging mechanisms that can cause loss of mechanical function in ASME Class 1 piping and components (such as constant and variable load spring hangers, guides, stops, sliding surfaces, design clearances, vibration isolators) fabricated from steel or other materials such as lubrite.
VI	Oxidation	Two types of reactions: a) reaction in which there is an increase in valence resulting from a loss of electrons, or b) a corrosion reaction in which the corroded metal forms an oxide. [17]
VI	Photolysis	Chemical reactions induced or assisted by light.
III, IV, V, VII, VIII	Pitting corrosion	Localized corrosion of a metal surface, confined to a point or small area, which takes the form of cavities called pits.
	Plastic deformation	Time-dependent strain, or gradual elastic and

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		plastic deformation, of metal that is under constant stress at a value lower than its normal yield strength.
VI	Presence of any salt deposits	The degradation resulting from the aggressive environment associated with the presence of any salt deposits can be an aging mechanism causing the aging effect of degradation of insulator quality
IV	Primary water stress corrosion cracking (PWSCC	PWSCC is an intergranular cracking mechanism which requires the presence of high applied and/or residual stress, susceptible tubing microstructures (few intergranular carbides), and high temperature. See PWSCC. [13]
III	Radiation hardening	See Radiation hardening, temperature, humidity, sustained vibratory loading.
III, VI	Radiation hardening, temperature, humidity, sustained vibratory loading.	Reduction or loss of isolation function in polymeric vibration isolation elements can result from a combination of radiation hardening, temperature, humidity, sustained vibratory loading.
VI	Radiation-Induced oxidation	Two types of reactions that are affected by radiation: a) reaction in which there is an increase in valence resulting from a loss of electrons, or a corrosion reaction in which the corroded metal forms an oxide. [17]
VI	Radiolysis	Chemical reactions induced or assisted by radiation.
VI	Radiolysis and photolysis (UV sensitive materials only) of organics	See Radiolysis, and Photolysis.
II, III, VII	Reaction With Aggregate	For concrete reactions with aggregates are possible due to the presence in the concretes of alkalis. These alkalis are introduced mainly by cement, but also may come from admixtures, salt-contamination, seawater penetration or solutions of deicing salts. These reactions include alkali-silica reactions, cement-aggregate reactions, and aggregate-carbonate reactions. These reactions may lead to expansion and cracking. [16]
II	Relaxation	Relaxation in structural steel anchorage components can be an aging mechanism contributing to the aging effect of loss of prestress.
III	Restraint shrinkage	Restraint shrinkage can cause cracking in concrete transverse to the longitudinal construction joint.

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V, VII	Selective leaching	Also known as dealloying (dezincification or graphitic corrosion are examples). Selective corrosion of one or more components of a solid solution alloy.
III	Service-induced cracking or other concrete aging mechanisms	Cracking of concrete under load over time of service (e.g., from shrinkage or creep) or other concrete aging mechanisms which may include freeze-thaw, leaching, aggressive chemicals, reaction with aggregates, corrosion of embedded steels, elevated temperatures, irradiation, abrasion and cavitations. [16]
II, III	Settlement	Settlement of containment structure may occur during the design life due to changes in the site conditions (e.g., the water table). The amount of settlement depends on the foundation material and is generally determined by survey. [9]
II, III, IV, V, VII, VIII	Stress corrosion cracking (SCC)	Cracking of a metal produced by the combined action of corrosion and tensile stress (applied or residual).
IV, V, VII, VIII	Stress relaxation	Many of the bolts in reactor internals are stressed to a cold initial preload. When subject to high operating temperatures over time, These bolts may loosen and the preload may be lost. Radiation can also cause stress relaxation in highly stressed members such as bolts. [13]
VI	Surface contamination	Contamination of the surfaces by corrosive constituents.
III	Sustained vibratory loading	Vibratory loading over time.
IV	Thermal Aging	See Thermal aging embrittlement.
IV, V	Thermal aging embrittlement	At operating temperatures of 500 to 650^{0}F cast austenitic stainless steels (CASS) exhibit a spinoidal decomposition of the ferrite phase into ferrite-rich and chromium-rich phases. This may give rise to significant embrittlement (i.e., reduction in fracture toughness) depending on the amount, morphology, and distribution of the ferrite phase and the composition of the steel. Thermal aging of materials other than CASS is a time and temperature-dependent degradation mechanism that decreases material toughness. It includes temper embrittlement and strain aging embrittlement. Ferritic and low alloy steels are

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		subject to both of these embrittlement but wrought stainless steel are not affected by either of the processes. [12]
IV	Thermal and mechanical loading	Loads (stress) due to mechanical or thermal (temperature) sources.
VI	Thermal cycling	Cycling of the thermal (temperature) loads.
VI	Thermal degradation of organic materials	This category includes both short-term thermal degradation and long-term thermal degradation. Thermal energy absorbed by polymers can result in crosslinking and chain scission. Crosslinking will generally result in increased tensile strength and hardening of material, with some loss of flexibility and eventual decrease in elongation-at-break (and increased compression set). Scission generally reduces tensile strength. Other reactions that may occur include crystallization and chain depolymerization.
IV, V	Thermal Embrittlement	See thermal aging embrittlement.
III, VI	Thermal loading	Loading due to thermal sources.
VI	Thermoxidative degradation of organics/thermoplastics	Degradation of organics/thermoplastics via oxidation reactions (loss of electrons by a constituent of a chemical reaction) and thermal means. See Thermal degradation of organic materials. [11]
VI	Various mechanisms	
VI	Vibration	Vibration may result in component cyclic fatigue as well as cutting, wear, and abrasion if left unabated. Vibration is generally induced by external equipment operation. It may also result from flow resonance or movement of pumps or valves in fluid systems.
IV	Void Swelling	Vacancies created in reactor (metallic) materials as a result of irradiation may accumulate into voids which may, in turn lead to dimensional changes (swelling) of the material. Void swelling may occur after an extended incubation period.
IV	Wastage and pitting corrosion	Wastage is thinning of component walls due to general corrosion. For pitting corrosion see pitting corrosion. [13]
VI	Water trees	The predominant cause of failures in underground polymeric cables is water treeing. The water tree is a diffuse structure of microvoids (generally unconnected, Swiss cheese-like holes) in the

Referring Chapters	Standardized Expression	Description and Technical Justification
		polymer. As the cable nears the end of its reliable life, electrical trees begin to grow from this water tree. Once an electrical tree starts growing, the cable will fail.
III	Erosion, settlement, sedimentation, frost action, waves, currents, surface runoff, seepage	In earthen water-control structures, the loss of material, and loss of form can result from erosion, settlement, sedimentation, frost action, waves, currents, surface runoff, and seepage.
II, III, IV, VI, VII	Wear	Wear is defined as the removal of surface layers due to relative motion between two surfaces or under the influence of hard abrasive particles. Wear occurs in parts that experience intermittent relative motion or in clamped joints where relative motion is not intended but may occur due to a loss of the clamping force. [12]
VII	Weathering	Degradation of external surfaces of materials when exposed to outside environment.
VI	Wind induced abrasion	See abrasion. Carrier of abrading particles is wind rather than water/liquids.

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Acronyms and other Miscellaneous Information:

Acronym	Explanation
A	ASTM nomenclature
Ext/Int	External or internal surfaces of a structure or component. Separate environments seen by internal surfaces and external surfaces of components or structures
L	Low carbon content in stainless steels, nominal 0.03%C maximum
NG	Nuclear grade, maximum carbon content of.02% C
PH	Precipitation-hardened stainless steels are divided into three groups on the dual basis of characteristic alloying additions, particularly the elements added to promote precipitation hardening (PH), and the matrix structures of the steels in the solution-annealed and aged condition. Differences among the steels have a direct bearing on the behavior of the steels in welding.
SA	ASME manufacturing specifications referring to product form and heat treatment
Type	AISI nomenclature
Type 304 forging	Some secondary fabrication processes, such as forging and ring rolling, do impart sufficient reduction to play the major role in establishing material properties. In fact, forgings usually recrystallize more uniformly because forging is an efficient method of introducing large amounts of stored energy in the material.
Wrought structure	Wrought Structure and Ductility. Another aspect of material control ensures that the final forging has undergone sufficient plastic deformation to achieve the wrought structure necessary for development of the mechanical properties on which the design was based.