Code Case N-XXX Risk-Informed Classification And Treatment Requirements

Applicability: 1980 Edition with Winter 1981 Addenda through the 2001 Edition

Inquiry: What alternative requirements may be used for inservice examination, pre-service examination and repair/replacement activities[1] on items and their associated supports (exclusive of core support structures, and Class CC and MC items)?

Reply: It is the opinion of the Committee that, as an alternative to IWX-2500 for inservice examination, IWX-2200 for pre-service examination and/or IWA-1320, IWA-1400(n), IWA-4000, and IWA-6210(e) for repair/replacement, the examinations and/or activities may be performed in accordance with the following requirements (exclusive of core support structures, and Class CC and MC items).

(1) **GENERAL REQUIREMENTS**

(a) Items shall be assigned a category (category A or B) that shall be used to determine the treatment requirements of this Case. Category A items shall consist of items that are Class 1 and > 1NPS (i.e. reactor coolant pressure boundary), portions of RHR, ECC and CHR that support the decay heat removal pressure boundary function (i.e. items consisting of the reactor pressure vessel to the first component located outside containment that is capable of remote isolation (e.g. trip pump, close valve)), in the feedwater system (> 4 NPS) of PWRs from the steam generator to the outer containment isolation valve/boundary restraint, or items that are within the break exclusion region (> 4 NPS) for high energy piping systems. Category B items shall include all other items within the scope of the Section XI program not classified as Category A.

(b) The owner shall have in place programs that meet the intent of Generic Letter 88-01 (NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping), Generic Letter 89-08 (Erosion/Corrosion Induced Pipe Wall Thinning) and Generic Letter 89-13 (Service Water System Problems Affecting Safety-Related Equipment), as applicable.

(c) The owner shall have in place an operating experience review program that meets the intent of NUREG-0737 (Clarification of TMI Action Plan Requirements) as it pertains to pressure boundary component reliability.

(d) The owner shall have conducted a plant-specific evaluation that meets the intent of Generic Letter 88-20 (Individual Plant Examination for Severe Accident Vulnerabilities – 10CFR50.54(f)) and implemented changes, as applicable.

(e) The owner shall have in place a change control process that meets the intent of 10CFR50.59 (Changes, Tests and Experiments).

(f) Repair/replacement activities shall meet the following requirements, in accordance with the Edition and Addenda of Section XI specified in the Repair/Replacement Program, or in accordance with later Editions and Addenda of Section

XI as provided by IWA-4150(b). The references used in this Case refer to the 2001 Edition of Section XI. For use with other Editions and Addenda of Section XI, refer to Table 1.

(2) INSERVICE INSPECTION REQUIRMENTS

Items categorized as Category A shall meet the inspection requirements of IWB or IWC, as applicable, with the exception of examination categories B-F, B-J, C-F-1 and C-F-2.

Ten percent of the Category A items that belong to examination categories B-F, B-J, C-F-1 and C-F-2 shall be subjected to inservice inspection. The examination requirements for these locations are defined in Table 2. The ten percent sample shall be determined by evaluating each item's susceptibility to the degradation mechanisms listed in Table 3 and include the following:

- Each item selected, shall be subjected to non-destructive (i.e. volumetric and/or surface) examination,
- Ultrasonic and radiographic are two acceptable methods of conducting volumetric examination,
- Inspections shall be allocated equally among systems to the extent practical, and each system shall individually meet the following requirements:
  - Inspections shall be required for each degradation mechanism and degradation mechanism combination (e.g. thermal fatigue and IGSCC) identified,
  - For the reactor coolant pressure boundary, at least two thirds of the inspections shall be located between the first isolation valve and the reactor pressure vessel,
  - For that portion of the reactor coolant pressure boundary that penetrates containment, if applicable, a representative inspection size shall be conducted,
  - Inspections shall be repeated in subsequent inspection intervals to the extent practical,
  - Inspections may be selected and scheduled to minimize worker exposure, scaffolding and other practical concerns provided the above requirements are met.
  - Augmented inspections may be credited towards the inspection population. No more than one half of the inspection population may be augmented inspections.

In lieu of the above inspection requirements, an approved risk-informed inservice inspection program (i.e. number and type of inspections) may be used for Category A items, provided Category B items that were used to justify a reduction in Category A inspections below 10 percent, if applicable, continue to be inspected.

Category B items do not require inservice inspection other than pressure testing at a frequency of at least once per inspection period.

Any inservice inspections specifically implemented in response to the evaluation defined in 1(d) shall continue to be conducted, regardless of the item's category.

(3) PRESERVICE EXAMINATION REQUIRMENTS

Items classified as category A shall be subjected to pre-service inspection. The inspection volumes, techniques and procedures shall be in accordance with Table 2. As an alternative, pre-service inspections may be conducted to the requirements of IWX, as applicable.

Items classified as Category B do not required pre-service inspection

(4) REPAIR/REPLACEMENT REQUIREMENTS

All requirements of IWA-1400(n), IWA-4000, and IWA-6210(e), shall be met.

I. ITEMS CLASSIFIED AS CATEGORY A:

All requirements of IWA-1400(n), IWA-4000, and IWA-6210(e), shall be met.

II. ITEMS CLASSIFIED AS CATEGORY B:

Pressure retaining or component support items shall meet the following requirements.

(a) The provisions of IWA-1400(n) shall be applied to a degree consistent with the category assigned to the item.

(b) IWA-4110 Scope

(c) IWA-4120 Applicability, except the provisions of IWA-4120(a) are not applicable.

(d) Repair/Replacement Activities involving piping, tubing (except heat exchanger tubing, and sleeves and welded plugs used for heat exchanger tubing and Class 1 piping $\leq$ 1 NPS), valves, and fittings, NPS 1 and smaller, and associated supports, are exempt from all requirements, except that the item shall meet the technical requirements of the Construction Code selected for use in accordance with this Case.

(e) As an alternative to IWA-4140 Responsibilities and IWA-4150 Repair/Replacement Program and Plan, a plan shall be developed for each repair/replacement activity. This plan may be contained in the normal work control documents for the site, as long as the following are specified:

(i) Owner's Requirements, including a Construction Code Edition and Addenda, if specified, used for the following:

(a) construction of the item to be affected by the repair/replacement activity

(b) construction of the item to be installed by the repair/replacement activity

(c) performance of the repair/replacement activity

(ii) The following items, when applicable to the specific repair/replacement activity, shall be documented.

(a) a description of any defects and nondestructive examination methods used to detect those defects

(b) the defect removal method

(c) the applicable weld procedure, heat treatment, nondestructive examination, tests, and material requirements

(d) the applicable examination, test, and acceptance criteria to be used to verify acceptability

(iii) An evaluation, in accordance with the criteria provided in Table 3, shall be conducted to confirm that the repair/replacement activity does not increase the unit's susceptibility to the identified degradation mechanisms. This may include a confirmation (e.g. evaluation) that the repair/replacement activity does not increase the unit's susceptibility to the identified degradation mechanism, implementation of a new or existing monitoring program or a combination of both.

(f) If the repair/replacement activity is being performed due to the item failing to satisfy structural integrity requirements, an evaluation shall be performed as follows:

(i) Prior to returning the item to service, the suitability of the item shall be determined. This evaluation shall include an assessment of the effect of this failure mechanism on the item's reliability in performing its pressure retaining function. If the requirements for the original item are determined to be deficient (e.g., improper material for the service, inadequate provisions for erosion, inadequate fatigue provisions), appropriate corrective provisions shall be included in the Owner's Requirements. Owner's Requirements shall be revised or updated in accordance with IWA-4180(c).

(ii) An evaluation shall be performed to determine if other items susceptible to the same failure mechanism require corrective actions performed to preclude a similar failure.

(iii) The evaluations in (i) and (ii) above shall be documented and retained by the Owner.

(g) IWA-4170 Inspection. The ANII shall document acceptance of the repair/replacement activity. The specific documentation to be used shall be designated in the Repair/Replacement Program, which is subject to acceptance by the Authorized Inspection Agency.

(h) Completion of Form NIS-2 is not required.

(i) Items used for repair/replacement activities shall meet (i), (ii), or (iii), and (iv) and (v), below.

(i) The requirements of the Construction Code and Owner's Requirements shall be met as required by IWA-4220.

(ii) In lieu of the Construction Code requirements of IWA-4220, the item shall meet the requirements of other nationally-recognized codes or standards applicable to that item[6]. Except for components, the material, fabrication, and examination requirements of the repair/replacement activity shall be reconciled against the design of the item on which the repair/replacement activity is being performed. When installing a piping subassembly to alternative codes or standards, the reconciliation shall be performed from piping anchor to piping anchor, encompassing the subassembly.

(iii) In lieu of the Construction Code requirements of IWA-4220, material, parts, piping subassemblies, appurtenances, complete valves or pumps, and component supports, used for repair/replacement activities, shall meet the technical requirements of the Construction Code for the item being replaced. Administrative requirements of the Construction Code need not be met.

(iv) Regardless of the above selected option, the fracture toughness requirements of the original Construction Code, or later Edition or Addenda of the Construction Code, of the item being replaced shall be met.

(v) Owner's Requirements may be revised by reconciliation in accordance with IWA-4220.

(j) IWA-4300 Design, except that the evaluation or reanalysis, review, and certification shall be performed to the requirements of the Construction Code selected for the item in accordance with this Case.

(k) IWA-4400 Welding, Brazing, Defect Removal, and Installation. As an alternative to meeting the Construction Code of the item as required in IWA-4411, (i) or (ii) below shall be met:

(i) The requirements of other nationally-recognized codes or standards applicable to that item.

(ii) Alternative design and materials may be used for repair/replacement activities performed on non-class items as long as the as-left (i.e., returned-to-service) configuration provides reasonable assurance that the affected item will perform its intended function and is accepted by analysis, evaluation, or testing, and documented in accordance with IWA-4300, except for the requirement to meet the Construction Code or Owner's Requirements. Use of this option is subject to the following limitations:

(a) The repair/replacement activity may remove and install material, parts, components, and piping subassemblies, subject to the following limitations.

(1) The repair/replacement activity may not install a component (i.e., vessel, pump, valve, storage tank, or piping system), unless the component meets the requirements of (3)(i).

(2) The repair/replacement activity may not install a piping subassembly (i.e., a section of piping system consisting of fittings and pipes or tubes fabricated as subassemblies in a shop or in the field before being installed in a nuclear power system), unless the piping subassembly meets the requirements of (3)(i).

(b) It is not practical to perform the repair/replacement activity in accordance with IWA-4400 or an alternative nationally-recognized code or standard due to the fact that the repair/replacement activity would result in one of the following

(1) the unit being shut down

(2) significantly increasing daily or cumulative plant risk, as determined and documented by the Owner, based on analysis of the maintenance to be performed during the repair/replacement activity (e.g., 10CFR 50.65(a)(4))

(c) The item shall meet its original Construction Code or (3)(k)(i), prior to returning the item to service following the next refueling outage or system outage of sufficient duration to allow the repair/replacement activity to be performed.

(l) IWA-4500 Examination and Testing, except as follows:

(i) Examination and testing shall be performed in accordance with the Construction Code selected in accordance with this Case and the Owner's Requirements.

(ii) Preservice examinations shall be performed in accordance with the requirements applicable to inservice inspection of the item selected for examination (e.g., use of risk-informed inservice inspection Code Cases). Preservice examinations shall be performed prior to return of the system to service and may be performed prior to or following any required pressure tests.

(iii) Unless exempted by IWA-4540, a system leakage test shall be performed in accordance with IWA-5000 (1991 Addenda or later) prior to, or as part of, returning the item to service.

Footnotes

[1] The term Repair/Replacement Activities contained in this Case includes those terms previously know as Repair (IWA-4000), Replacement (IWA-7000), and Modification (IWA-7000), in earlier Editions and Addenda of Section XI.

[2] Administrative requirements are those requirements that do not affect the pressure boundary or component support function. Examples include quality assurance, certification, Code Symbol Stamping, Data Reports, and Authorized Inspection. Technical requirements are distinguished from administrative requirements and those requirements related to materials, design, fabrication, examination, or testing that affect the pressure boundary or component support function.

[3] Examples of other nationally-recognized codes or standards are Section VIII for vessels, B31 series for piping, B16.34 for valves, API 620 for 0 -15 psi storage tanks, and API 650 for atmospheric storage tanks.

TABLE 1

References for Alternative Editions and Addenda of Section XI

1995 Addenda through 2001 Edition	1991 Addenda through 1995 Edition	1988 Addenda through 1990 Addenda	Winter 1983 Addenda through 1987 Addenda	Winter 1981 Addenda through Summer 1983 Addenda
4110 Scope	4110	4110 & 7110	4110 & 7110	4110 &7110
4120 Applicability	4120 91A to 92E or 4111 92A to 95E	7400	7400	7400
4140 Responsibilities	4130 & 4920	4130 & 7120	4130 & 7120	4130 & 7120
4150 R/R Program and Plan	4140 & 4170	4120 & 4130, 7130	4130 & 7120, and 7130 added W85A	4130
4160 Verification of Acceptability	4150	7220 & 4130	7220 & 4130	7220 & 4130
4170 Inspection	4160	4140 & 7140	4140, & 7140 added W85A	4140
4180 Documentation	4910	4800 &7520	4700 & 7520	4700 & 7520
4220 Code Applicability	4170	4120 & 7210	4120 &7210	4120 & 7210
4300 Design	4300 was added in the 95A			
4400 Welding, Brazing, Metal Removal, and Installation	4200 & 4300 through 93A, & 4170	4120, 4200,4300, & 4400, and IWB-4200 88A to 89A	4120, 4200,4300 & 4400, and IWB-4200	4120, 4200 & 4300, and IWB-4200
4411 (2001 Edition) 4421 (97A to 2000A) 4410 (95A to 96A)	4170	4120	4120	4120
4500 Examination and Testing	4700 &4800	4600 & 4700	4400 & 4500	4400 & 4500
4530 Preservice Inspection and Testing	4820	4600 & 7530	4500 & 7530	4500 & 7530
4540 Pressure Testing	4700	4700	4400	4400
4600 Alternative Welding Methods	4500	4500	IWB-4300	IWB-4300
4700 Heat Exchanger Tubing	4400	IWB-4200, and IWB-4300 90A	IWB-4400	IWB-4400

Note: All Subarticle or Subsubarticle references are to IWA, unless otherwise noted.

TABLE 2
EXAMINATION CATEGORIES

EXAMINATION CATEGORY R-A, RISK-INFORMED PIPING EXAMINATIONS							
					Extent and Frequency [Note (3)]		
Item No.	Parts Examined	Examination Requirement/ Fig. No. [Note (2)]	Examination Method	Acceptance Standard	1st Interval	Successive Intervals	Defer to End of Interval
R1.10	High Safety Significant Piping Structural Elements						
R1.11	Elements Subject to Thermal Fatigue	IWB-2500-8(c) [Note (1)] IWB-2500-9, 10, 11	Volumetric [Notes (8), (9)]	IWB-3514	Element [Notes (2), (4)]	Same as 1st	Not Permissible
R1.12	Not Used						
R1.13	Elements Subject to Erosion Cavitation	[Note (6)]	Volumetric [Notes (7)]	IWB-3514 [Note (6)]	Element [Note (2)]	Same as 1st	Not Permissible
R1.14	Elements Subject to Crevice Corrosion Cracking	[Note (5)]	Volumetric [Notes (8), (9)]	IWB-3514	Element [Note (2)]	Same as 1st	Not Permissible
R1.15	Elements Subject to Primary Water Stress Corrosion Cracking (PWSCC)	IWB-2500-8(c) [Note (1)] IWB-2500-9, 10, 11	Volumetric [Notes (8), (9)]	IWB-3514	Element [Note (2), (4)]	Same as 1st	Not Permissible
R1.16	Elements Subject to Intergranular or Transgranular Stress Corrosion Cracking (IGSCC or TGSCC)	IWB-2500-8(c) [Note (1)] IWB-2500-9, 10, 11	Volumetric [Notes (7), (8), (9)]	IWB-3514	Element [Note (2), (4)]	Same as 1st	Not Permissible
R1.17	Elements Subject to localized corrosion [Microbiologically Influenced Corrosion (MIC) or Pitting]	IWB-2500-8(a), IWB-2500-8(b), IWB-2500-8(c), IWB-2500-9, 10, 11	Visual, VT-3 Internal Surfaces or Volumetric [Note (6) or (7)]	[Note (6)]	Element [Note (2)]	Same as 1st	Not Permissible
R1.18	Elements Subject to Flow Accelerated Corrosion (FAC)	[Note (7)]	[Note (7)]	[Note (7)]	[Note (7)]	[Note (7)]	[Note (7)]
R1.19	Elements Subject to External Chloride Stress Corrosion Cracking (ECSCC)	IWB-2500-8(a), IWB-2500-8(b), IWB-2500-8(c), IWB-2500-9, 10, 11	Surface	IWB-3514	Element [Note (2)]	Same as 1st	Not Permissible
R1.20	Elements not Subject to a Degradation Mechanism	IWB-2500-8(c) IWB-2500-9, 10, 11	Volumetric [Notes (8), (9)]	IWB-3514	Element [Notes (2), (4)]	Same as 1st	Not Permissible

NOTES:

(1) The length of the examination volume shown in Figure IWB-2500-8(c) shall be increased by enough distance [approximately ½ in. (13mm)] to include each side of the base metal thickness transition or counterbore.

(2) Includes examination locations and Class 1 weld examination requirement figures that typically apply to Class 1, 2, 3, or Non-Class welds.

(3) Includes 100% of the examination location. When the required examination volume or area cannot be examined due to interference by another component or part geometry, limited examinations shall be evaluated for acceptability. Acceptance of limited examinations or volumes shall not invalidate the results of the risk-informed evaluation. Areas with acceptable limited examinations, and their bases, shall be documented.

(4) The examination shall include any longitudinal welds at the location selected for examination in [Note 2]. The longitudinal weld examination requirements shall be met for both transverse and parallel flaws within the examination volume defined in [Note 2] for the intersecting circumferential welds.

(5) The examination volume shall include the volume surrounding the weld, weld HAZ, and base metal, where applicable, in the crevice region. Examination should focus on detection of cracks initiating and propagating from the inner surface.

(6) The examination volume shall include base metal, welds, and weld HAZ in the affected regions of carbon and low alloy steel, and the welds and weld HAZ of austenitic steel. Examinations shall verify the minimum wall thickness required. Acceptance criteria for localized thinning is in course of preparation. The examination method and examination region shall be sufficient to characterize the extent of the element degradation.

(7) In accordance with the Owner's existing programs such as IGSCC, MIC, or FAC programs as applicable.

(8) Socket welds of any size and branch pipe connection welds [NPS 2 (DN 50) and smaller] require a volumetric examination of the piping base metal within ½ inch of the toe of the weld and the fitting itself shall receive a visual examination.

(9) VT-2 examinations may be conducted during a system pressure test or a pressure test specific to that element or segment and shall be performed each refueling outage or at a frequency that is consistent with the time frame (i.e., 18 to 24 months) established by the refueling outage cycle.

TABLE 3
DEGRADATION MECHANISMS

Mechanisms [1]		Attributes	Susceptible Regions
TF	*TASCS*	– piping > NPS 1; and – pipe segment has a slope < 45° from horizontal (includes elbow or tee into a vertical pipe), and – potential exists for low flow in a pipe section connected to a component allowing mixing of hot and cold fluids, or potential exists for leakage flow past a valve (i.e., in-leakage, out-leakage, cross-leakage) allowing mixing of hot and cold fluids, or potential exists for convection heating in dead-ended pipe sections connected to a source of hot fluid, or potential exists for two phase (steam / water) flow, or potential exists for turbulent penetration in branch pipe connected to header piping containing hot fluid with high turbulent flow, and – calculated or measured $\Delta T > 50°F$, and – Richardson number > 4.0	nozzles, branch pipe connections, safe ends, welds, heat affected zones (HAZ), base metal, and regions of stress concentration
	TT	– operating temperature > 270°F for stainless steel, or operating temperature > 220°F for carbon steel, and – potential for relatively rapid temperature changes including cold fluid injection into hot pipe segment, or hot fluid injection into cold pipe segment, and – $\lvert\Delta T\rvert > 200°F$ for stainless steel, or $\lvert\Delta T\rvert > 150°F$ for carbon steel, or $\lvert\Delta T\rvert >$ ΔT allowable (applicable to both stainless and carbon)	
SCC	*IGSCC (BWR)*	– evaluated in accordance with existing plant IGSCC program per NRC Generic Letter 88-01, or alternative (e.g. BWRVIP-075)	austenitic stainless steel welds and HAZ
	IGSCC (PWR)	– operating temperature > 200°F, and – susceptible material (carbon content ≥ 0.035%), and – tensile stress (including residual stress) is present, and – oxygen or oxidizing species are present OR – operating temperature < 200°F, the attributes above apply, and – initiating contaminants (e.g., thiosulfate, fluoride, chloride) are also required to be present	
	TGSCC	– operating temperature > 150°F, and – tensile stress (including residual stress) is present, and – halides (e.g., fluoride, chloride) are present, or caustic (NaOH) is present, and – oxygen or oxidizing species are present (only required to be present in conjunction w/halides, not required w/caustic)	austenitic stainless steel base metal, welds, and HAZ

TABLE 3 (Cont'd)
DEGRADATION MECHANISMS

Mechanisms		Attributes	*Susceptible Regions*
SCC	*ECSCC*	– operating temperature > 150°F, and – an outside piping surface is within five diameters of a probable leak path (e.g., valve stems) and is covered with non-metallic insulation that is not in compliance with Reg. Guide 1.36, or an outside piping surface is exposed to wetting from concentrated chloride-bearing environments (e.g., seawater, brackish water, brine)	austenitic stainless steel base metal, welds, and HAZ
	PWSCC	– piping or weld material is Inconel (Alloy 600,182,82), and – exposed to primary water at T > 570°F, and – the material is mill-annealed and cold worked, or cold worked and welded without stress relief	nozzles, welds, and HAZ without stress relief
LC	*MIC*	– operating temperature < 150°F, and – low or intermittent flow, and – pH < 10, and – presence/intrusion of organic material (e.g., raw water system), or water source is not treated w/biocides (e.g., refueling water tank)	fittings, welds, HAZ, base metal, dissimilar metal joints (e.g., welds, flanges), and regions containing crevices
	PIT	– potential exists for low flow, and – oxygen or oxidizing species are present, and – initiating contaminants (e.g., fluoride, chloride) are present	
	CC	– crevice condition exists (i.e. thermal sleeves), and – operating temperature > 150°F, and – oxygen or oxidizing species are present	
FS	*E-C*	– existence of cavitation source (i.e., throttling or pressure reducing valves or orifices) – operating temperature < 250°F, and – flow present > 100 hrs/yr, and – velocity > 30 ft/s, and – $(P_d - P_v) / \Delta P < 5$	fittings, welds, HAZ, and base metal
	FAC	– evaluated in accordance with existing plant FAC program	per plant FAC program
VF[2]	*VF*	– vibration source present, and – susceptible location in vicinity of vibration source	Small bore socket welded connections

Notes:

(1) Thermal Fatigue (TF)
- Thermal Stratification, Cycling, and Striping (TASCS)
- Thermal Transients (TT)

Stress Corrosion Cracking (SCC)
- Intergranular Stress Corrosion Cracking (IGSCC)
- Transgranular Stress Corrosion Cracking (TGSCC)
- External Chloride Stress Corrosion Cracking (ECSCC)
- Primary Water Stress Corrosion Cracking (PWSCC)

Localized Corrosion (LC)
- Microbiologically Influenced Corrosion (MIC)
- Pitting (PIT)
- Crevice Corrosion (CC)

Flow Sensitive (FS)
- Erosion-Cavitation (E-C)
- Flow Accelerated Corrosion (FAC)

Vibratory Fatigue (VF)

(2) This mechanism is not applicable to preservice and inservice examination requirements.