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# ASME Section XI Preservice and Inservice Inspection Limitations (Non-Proprietary)

May 26, 2016



# Meeting Objective and Agenda

## Objective:

- Engage the NRC Staff in a technical exchange to discuss design for inspectability challenges.
- Inform the NRC Staff of the issue, present the proposed path forward and then receive feedback on the approach.

## Agenda:

- Background
- Problem Statement
- Technical Resolution
- Licensing Resolution
- Discussion



# Background



# Requirements

- 10 CFR 50.55a(g)(3)(i) and (ii) provides the inservice inspection (ISI) program design and accessibility requirements for Class 1, 2, and 3 components and supports as follows:
  - *Components (including supports) that are classified as ASME Code Class 1, 2, and 3 must be designed and be provided with access to enable the performance of inservice examination of these components and must meet the preservice examination requirements set forth in the applicable editions and addenda of Section III or Section XI of the ASME BPV Code*
- ASME BPV Code Section XI requires all Class 1, 2, and 3 welds to be examined via non-destructive examination (NDE). The scope of these examinations is defined as the preservice and inservice inspection program. The preservice inspection (PSI) serves as the baseline examination for the inservice inspection (ISI) program (throughout the life of the plant).
- The AP1000 UFSAR (Section 5.2.4.2) requires both PSI and ISI programs to be developed in accordance with 10CFR50.55a(g) and ASME BPV Code Section XI requirements:
  - *The components and welds requiring Inservice inspection are designed to allow for the application of the required Inservice inspection methods, that is, sufficient clearance for personnel and equipment, maximized examination surface distances, two-sided access, favorable materials, weld joint simplicity, elimination of geometrical interferences, and proper weld surface preparations.*



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# AP1000 PSI Program Plans

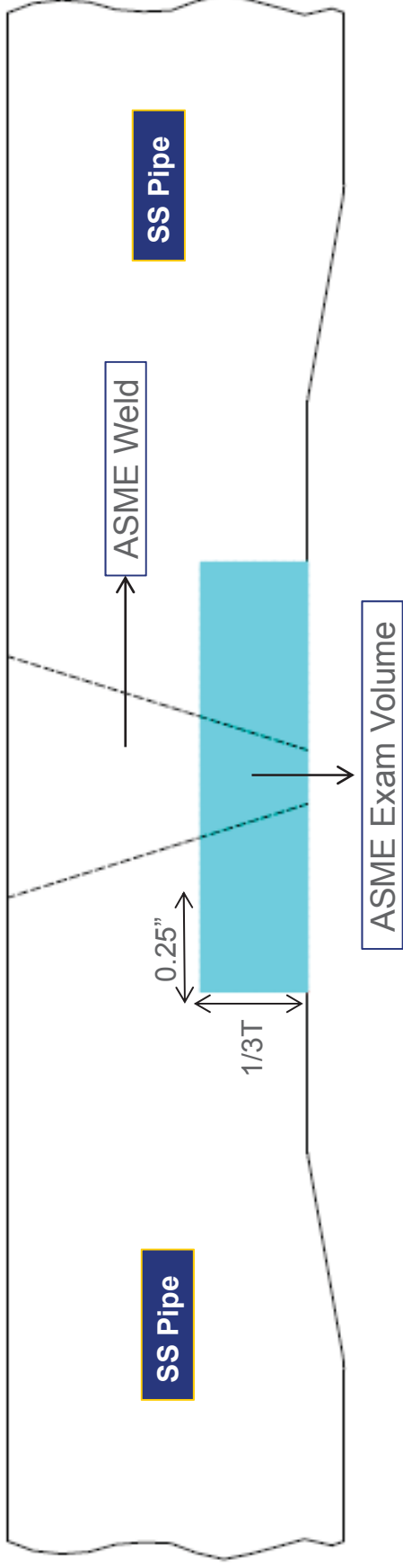
- Westinghouse has developed the PSI programs for both the Vogtle Units 3 & 4 and V.C. Summer Units 2 & 3 Owners.
  - There are approximately 2200 items subject to exam in each of the PSI program plans.
  - Of the 2200 exams there are approximately 600 stainless steel (SS) piping weld exams:
    - 500 Class 1 SS piping welds  $\geq$  4" nominal pipe size (NPS).
    - 28 Class 2 SS piping welds  $>$  4" NPS requiring ultrasonic testing (UT).
    - 20 Class 1 SS piping welds 2" and 3" NPS, requiring exams because they are high pressure CVS welds.
    - 20 SS piping welds, 3" and 4" NPS, requiring exams because they reside within the break exclusion zone (BEZ).

# ASME Section XI PS/ISI Requirements

- Performance demonstration of equipment, procedures, and personnel in compliance with Section XI Appendix VIII Supplement 2 (Wrought Austenitic Stainless Steel Piping Welds) and Supplement 3 (Ferritic Piping Welds)
  - PDI-UT-2 Qualified Procedure for Wrought Austenitic SS Piping Welds
    - Where dual-sided access is not possible, single-sided examinations are not qualified for full coverage. However, supplemental examination of the far side is required.
  - PDI-UT-1 Qualified Procedure for Wrought Ferritic Piping Welds
    - Where dual-sided access is not possible, single-sided examinations are qualified to demonstrate full coverage.

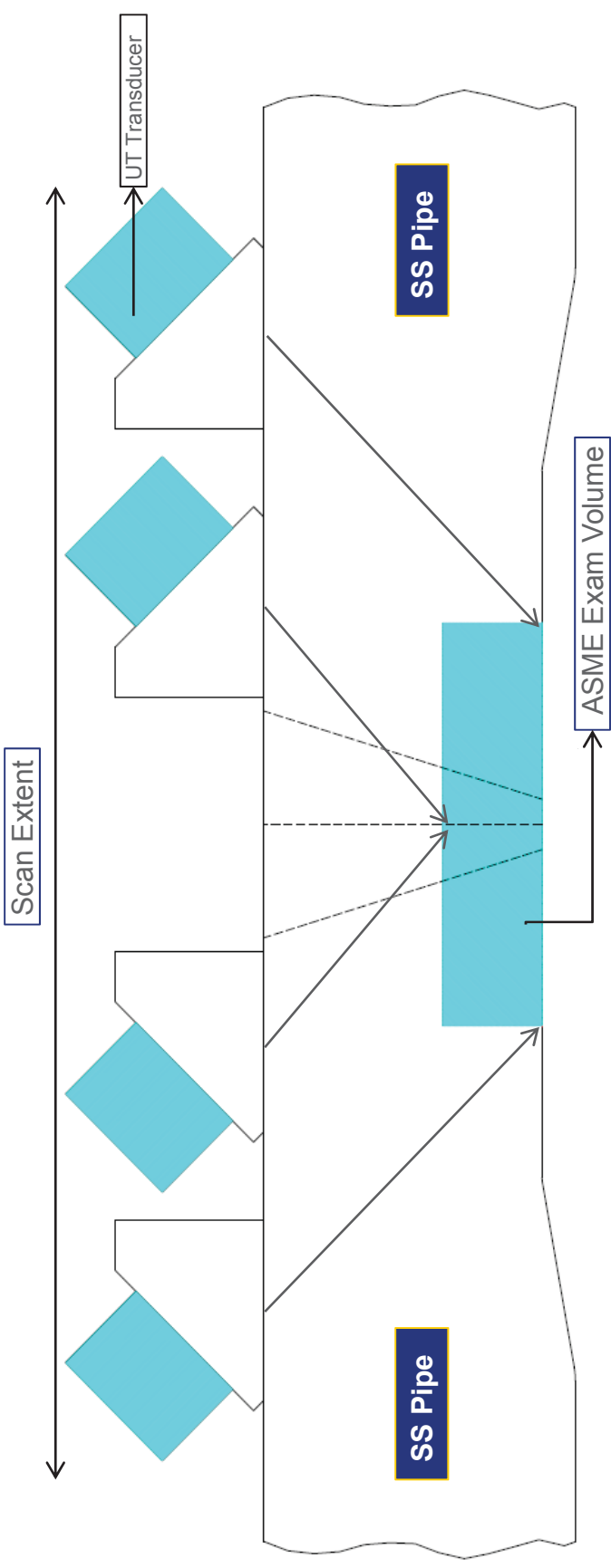


# Examination Requirements



**ASME Code Section XI requires the inner 1/3T of the weld and 0.25" of adjacent base metal, on both sides of the weld toe, be examined for axial and circumferential flaws.**

# Qualified Method for SS Welds



- For austenitic pipe welds, current procedure PDI-UT-2, qualified per Section XI, Appendix VIII, Supplement 2, requires dual sided access to claim full examination coverage for circumferential and axial flaw detection and length sizing of the examination volume.
- PDI-UT-2 requires “best effort” examinations of the far side of the weld but does not allow inclusion of the far side examinations in the coverage calculations when exams can only be performed from a single side.

# Problem Statement



## ASME Section III Design Requirements

- AP1000 valve designs meet the requirements of ASME B16.34 and ASME Section III NB/NC-4000 for minimum wall thickness ( $t_M$ )
- A flat end weld transition would allow for better inspectability, however, the ASME boundary (i.e.,  $t_M$ ) and pipe nozzle loading would not be met

**Section III requirements are met but cannot be inspected as required by Section XI**

## ASME Section XI Examination Categories & Coverage

- Three categories of welds with examination coverage concerns have been identified:
  - Category 1: forged pipe to cast austenitic SS (CASS) valve welds
    - Qualified examination coverage will be approximately 50%
  - Category 2: forged pipe to forged austenitic SS valve welds
    - Qualified examination coverage will be approximately 50%
  - Category 3: forged pipe to forged austenitic SS fitting welds
    - UT coverage exams were performed to confirm that this is not a global concern, there may be minimal situations where > 90% coverage cannot be achieved



**Additional information about each category will be presented on the following slides**

# Category 1: Pipe to CASS Valve Welds

Fifty-two (52) of the impacted valves have a weld between a CASS (SA351 CF3M) valve body and a forged austenitic stainless steel pipe.

- Section XI, Appendix VIII Supplement 2 qualified procedures addresses austenitic stainless steel materials except for CASS.
- Section XI, Appendix VIII Supplement 9 addresses qualification requirements for CASS piping welds.
  - As of the current published version of the code, this supplement is still listed as “In the course of preparation”.
  - No other published guidance available to qualify procedures for examining CASS.
- The examination limitations are driven by both the lack of a qualified method to perform the exams from the valve body side of the weld (dual sided exams are required for SS) and the geometry of the valve body.
- These examination limitations are consistent with those that exist in current operating plants

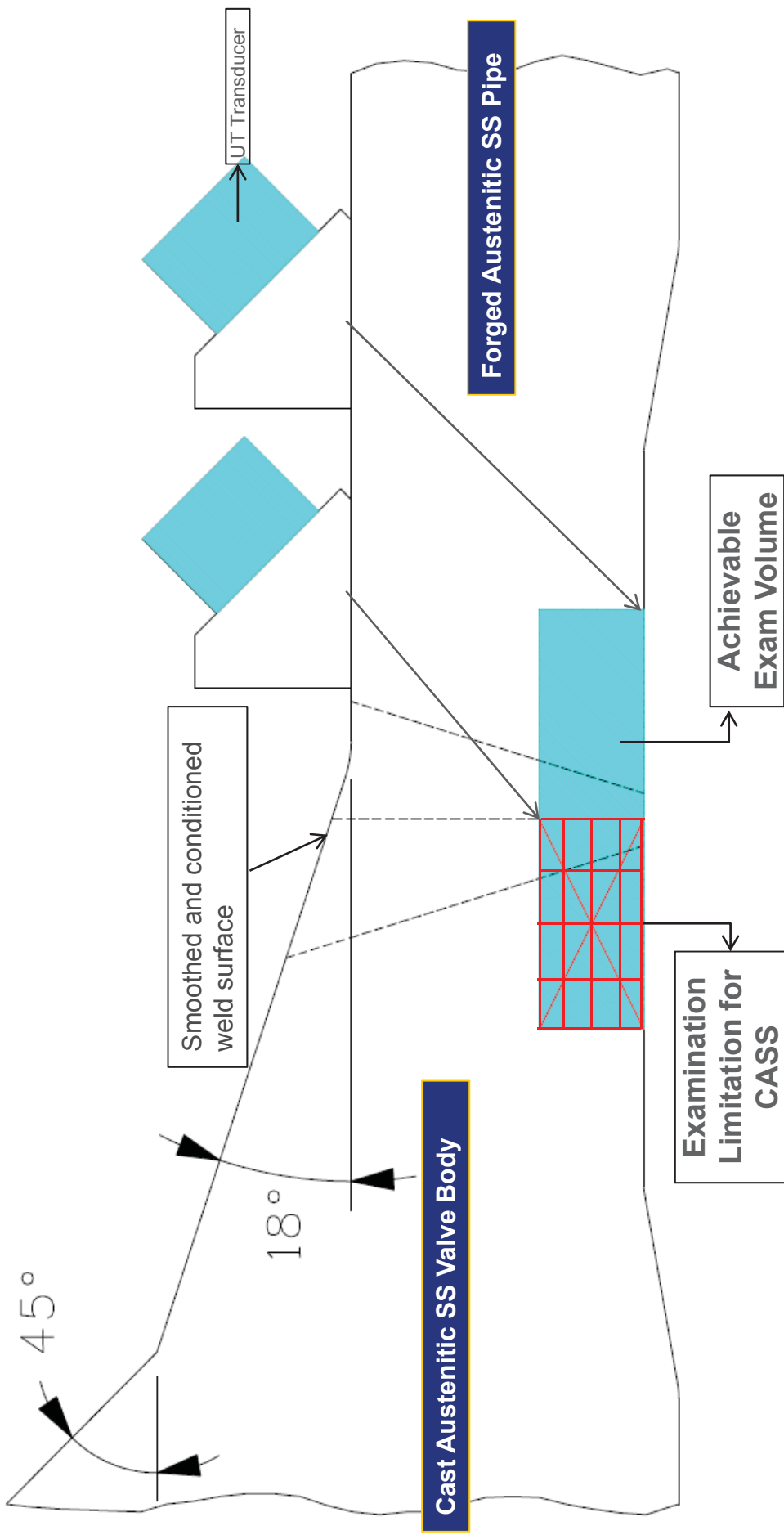


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APP-GW-GLY-106 Revision 0

**Qualified examination coverage will be approximately 50% for Category 1 welds**

# Category 1: Examination Limitation



# Category 1: Summary of Impacted Valves

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(a,c)



## Category 2: Pipe to Forged Valve Welds

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] (a,c)

- The limitations associated with this category are driven by the geometry of the valves.
- Sufficient access on the OD surface of the valve is not available.
- These examination limitations are consistent with those that exist in current operating plants



## Category 3: Fitting Welds

There are fifteen (15) distinct fitting configurations within the AP1000 PSI Program made from forged austenitic stainless steel.

- ASME B16.9 tightly controls the pressure class of the fittings. However, the outside dimensions (OD) of standard fittings are not tightly controlled. The outside dimension is critical to determine the inspectability of the pipe fitting welds.
- This situation results in minor variation in OD configuration which may impact inspection code required volume (CRV).
- The fittings used in the AP1000 design are standard fitting designs used throughout the industry.
- Industry experience has not shown significant issues with limitations on fittings.

**UT coverage exams were performed to confirm that this is not a global concern, there may be minimal situations where > 90% coverage cannot be achieved**

# Category 3: Summary of Impacted Fittings

|  | (a,c) |
|--|-------|
|  |       |

# Technical Resolution



# Technical Resolution

- A report with proposed alternative will cover all three categories of welds discussed and include:
  - Examination coverage summary
  - Technical basis and justification for proposed alternative
- Technical Basis for Proposed Alternative
  - Austenitic SS (cast and forged) is highly resistant to cracking and corrosion in PWRs
  - No known degradation mechanisms beyond fatigue
    - Per Section III NB-3000, the identified design locations are required to be checked for fatigue
  - Thickness and section modulus of the valves are required to be 10% greater than associated piping

# Bases for Proposed Alternative

Proposed alternative will have a similar technical basis to the following code cases:

- Code Case N-481, for pump casings
  - Accepted as a Code Case by ASME in 1989
  - Accepted by NRC in RG 1.147, Rev. 9 (April 1992)
  - Code incorporation of N-481, into Table IWB-2500
    - 2000 Addenda of Section XI (Action BC-00-028)
    - 2000 Addenda endorsed by NRC September 2002
- Code Case N-770, for the stainless steel side of dissimilar metal (DM) welds
  - Code Case N-770-1 endorsed and made mandatory by NRC through 10 CFR 50.55a, June 2011



## Code Case N-481

- Technical justification developed for code case N-481 will be used to resolve inspectability issues:
  - Volumetric examinations (i.e., UT) of CASS welds replaced with a visual examination (VT) for pump casing welds
  - Flaw tolerance evaluation was required
- ASME Section XI Table IWB-2500-1 incorporated the NRC staff endorsed code case in 2000 Addendum, with two changes:
  - Flaw tolerance evaluation requirement was removed (based on successful calculational demonstration of flaw tolerances)
  - Valve bodies added due to similar design requirements to pumps

# Code Implementation of N-481 (2000 - 2007)

TABLE IWB-2500-1  
EXAMINATION CATEGORIES (CONT'D)

| Item No. | Parts Examined   | Examination Requirements/<br>Fig. No. | Examination Method | Acceptance Standard | Extent and Frequency of Examination                          |                                 | Deferral of Examination to End of Interval |
|----------|--|---------------------------------------|--------------------|---------------------|--|---------------------------------|--|
|          |  |                                       |                    |                     | First Inspection Interval                                    | Successive Inspection Intervals |  |
| B12.10   | Pumps<br>Pump casing welds (B-L-1)                                     | IWB-2500-16<br>Internal surfaces      | Visual, VT-1       | IWB-3518            | All welds [Notes (1) and (4)]<br>Internal surface [Note (1)] | Same as for first interval      | Permissible                                |
| B12.20   | Pump casing (B-L-2)  |                                       | Visual, VT-3       | IWB-3519            | Internal surface [Note (1)]                                  | Same as for first interval      | See Note (2)                               |
| B12.30   | Valves<br>Valves, less than NPS 4 (DN 100)<br>valve body welds (B-M-1) | IWB-2500-17                           | Surface            | IWB-3518            | All welds [Notes (3) and (4)]                                | Same as for first interval      | Permissible                                |
| B12.40   | Valves, NPS 4 (DN 100) or larger<br>valve body welds (B-M-1)           | IWB-2500-17                           | Volumetric         | IWB-3518            | All welds [Notes (3) and (4)]                                | Same as for first interval      | Permissible                                |
| B12.50   | Valve body, exceeding NPS 4 (DN 100)<br>(B-M-2)                        | IWB-2500-17<br>Internal surfaces      | Visual, VT-3       | IWB-3519            | Internal surface [Note (3)]                                  | Same as for first interval      | See Note (2)                               |

NOTES:

- (1) Examinations are limited to at least one pump in each group of pumps performing similar functions in the system, e.g., recirculating coolant pumps.
- (2) Examination is required only when a pump or valve is disassembled for maintenance, repair, or volumetric examination. Examination of the internal pressure boundary shall include the internal pressure retaining surfaces made accessible for examination by disassembly. If a partial examination is performed and a subsequent disassembly of that pump or valve allows a more extensive examination, an examination shall be performed during the subsequent disassembly. A complete examination is required only once during the interval.
- (3) Examinations are limited to at least one valve within each group of valves that are of the same size, construction design (such as globe, gate, or check valves), and manufacturing method, and that perform similar functions in the system (such as containment isolation and system overpressure protection).



# Code Implementation of N-481 (2008A)

TABLE IWB-2500-1  
EXAMINATION CATEGORIES (CONT'D)

| Item No. | Parts Examined   | Examination Requirements/ Fig. No. | Examination Method | Acceptance Standard | EXAMINATION CATEGORY                     |                            |                                 | Deferral of Examination to End of Interval |
|----------|--|------------------------------------|--------------------|---------------------|--|----------------------------|---------------------------------|--|
|          |  |                                    |                    |                     | B-L-2, PUMP CASINGS; B-M-2, VALVE BODIES |                            |                                 |  |
|          |  |                                    |                    |                     | Extent and Frequency of Examination      | First Inspection Interval  | Successive Inspection Intervals |  |
| B12.20   | Pumps<br>Pump casing (B-L-2)                           | Internal surfaces                  | Visual, VT-3       | IWB-3519            | Internal surface [Note (1)]              | Same as for first interval | See Note (2)                    |  |
| B12.50   | Valves<br>Valve body, exceeding NPS 4 (DN 100) (B-M-2) | Internal surfaces                  | Visual, VT-3       | IWB-3519            | Internal surface [Note (3)]              | Same as for first interval | See Note (2)                    |  |

NOTES:

- (1) Examinations are limited to at least one pump in each group of pumps performing similar functions in the system, e.g., recirculating coolant pumps.
- (2) Examination is required only when a pump or valve is disassembled for maintenance, or repair. Examination of the internal pressure boundary shall include the internal pressure retaining surfaces made accessible for examination by disassembly. If a partial examination is performed and a subsequent disassembly of that pump or valve allows a more extensive examination, an examination shall be performed during the subsequent disassembly. A complete examination is required only once during the interval.
- (3) Examinations are limited to at least one valve within each group of valves that are of the same size, structural design (such as globe, gate, or check valves), and manufacturing method, and that perform similar functions in the system (such as containment isolation and system overpressure protection).



# Code Implementation of N-481 (2008A)

## Explanation for the 2008 Revision:

### Code Revisions

XI-1-A08 (05-1226)

IWB-2411(a)(3), IWB-2500(b), Table IWB-2500-1 + Notes 2 & 4, Fig. IWB-2500-16, Fig.

IWB-2500-17, Table IWB-3410-1, IWB-3516.2(a), IWB-3518, IWC-2500(b), Table IWC-2500-1, Fig.

IWC-2500-8, Table IWC-3410-1, IWC-3515

Pump Casing and Valve Body Welds, Category B-L-1, Category B-M-1, Category C-G

### TECHNICAL

### SIGNIFICANT

This revision deletes the examination requirements for Pump Casing and Valve Body Welds, Categories B-L-1, B-M-1, and C-G, because experience has not identified any failures in pump casing or valve body welds. Further, risk informed evaluations have not identified any degradation mechanism specifically associated with these welds. However, the requirement for performing these examinations results in unnecessary radiation exposure for NDE personnel. Any degradation of the pump or valve interior will be detected by the Category B-L-2 and B-M-2 VT-1 examinations or by the mechanic working on the component internals, and through wall leakage will be detected by the VT-2 examinations during system pressure tests.

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## Code Case N-770

Code Case N-770 (Another example for reduced requirements on SS Welds):

- Provides enhanced examination requirements for susceptible DM welds
- Mandatory through 10 CFR 50.55a, but does ***not*** require volumetric examinations of cast stainless steel portions of susceptible welds
- Similar basis to N-481, materials are reliable and not susceptible to age-related degradation

# Overview: Licensing Resolution Path

- A proposed alternative, following the guidance of 10 CFR 50.55a will be submitted to the NRC staff for review and approval
- A subsequent non-LAR departure to review UFSAR subsection 5.2.4.2 will be implemented

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](a,c)

# Discussion

