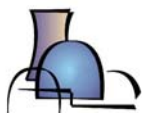


Inspection Plan

PWR Reactor Pressure Vessel Head Penetrations

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Purpose

- Provide guidance and the basis for a long-term management program for RPV Head penetrations.
- Preserve structural integrity thereby ensuring safe operation.
 - GL 88-05 program remains the primary defense against boric acid wastage.
 - Inspection frequencies have been conservatively established relative to the structural integrity of the RPV Head.
- Provide a graduated approach to inspections to allow early detection of leakage or through-wall cracking prior to challenging structural integrity or significant wastage.
 - Structural integrity is defined as maintaining an acceptably low probability of developing cracking that could lead to nozzle ejection.

Scope

- Applies to the pressure boundary of the RPV head penetrations fabricated from Alloy 600 with Alloy 82/182 weld material.
- Does NOT apply to RPV head replacements and nozzle repairs with Alloy 690 and Alloy 52/152
- Assumes that a GL 88-05 walk down of the plant is effectively performed each refueling outage.

Effective Degradation Years - EDY

- Based on years of operation, normalized to 600F (as of 2/28/01)
- Effective Degradation Years (EDY) may be a more appropriate way to rank for wastage potential
 - Leaking crack as important as large circ flaw
 - Independent of ONS 3
- Although similar to old way, rank for some units changes
 - Old rank - combination of head temperature, operating time to date, and time left to ONS3 equivalence.
 - EDY rank - just time and temperature at current (2/28/01) time

Risk Informed Basis

Probabilistic fracture mechanic (PFM) analyses using a Monte-Carlo simulation algorithm

- Included experience-based time to leakage correlations
 - used a Weibull model of plant inspections to date,
 - fracture mechanics analyses of various nozzle configurations containing axial and circumferential cracks, and
 - MRP developed crack growth rate data for Alloy 600.
- Performed to determine the probability of leakage and failure versus time for a set of input parameters:
 - head operating temperature,
 - benchmarked against experience to date
- Sensitivity studies were performed for various:
 - inspection types (visual or NDE) and
 - inspection intervals.

Risk Based Susceptibility

- Moderate susceptibility boundary:
 - The number of EDYs at which a plant reaches
 - probability of one leaking nozzle = 20% (approximately equal to the probability of net section collapse (NSC i.e. nozzle ejection) = 1×10^{-4})
- High susceptibility boundary:
 - The number of EDYs at which a plant reaches:
 - probability of nozzle ejection = 1×10^{-3} (approximately equal to the probability of one leaking nozzle = 75%)
 - consistent with NRC RG 1.174 guidance for change in Core Damage Frequency.

Plant Categories

- **Low Susceptibility:**
 - less than 10 Effective Degradation Years, EDY (defined as Effective Full Power Years @ 600F), without a leak or identified crack
- **Moderate Susceptibility:**
 - greater than or equal to 10 EDY and less than 18 EDY without a leak or identified through-wall crack
- **High Susceptibility:**
 - greater than or equal to 18 EDY or units that have identified leaks or through-wall cracks.

CRDM/CEDM J-Groove Weld Inspection Bases

- Circumferential cracks in the J-groove weld do not pose a significant risk of nozzle ejection.
- Lack-of-fusion: extent to still maintain structural integrity is similar to the acceptable extent of through-wall circumferential cracking (i.e. >75% of the circumference).

CRDM/CEDM Head Penetration Flaw Acceptance Criteria

- Visual evaluation criteria
 - EPRI Technical Report 1006899, Visual Examination for Leakage of PWR Reactor Head Penetrations on Top of the RPV Head: Revision 1, March 2002.
- Non-visual evaluation criteria
 - MRP and ASME Section XI Code are working to develop final criteria, and until those criteria are issued, NRC-proposed criteria may be used.

Inspection Schedule – Low Susceptibility

For low susceptibility plants (< 10 EDY):

- Perform a Bare Metal Visual (BMV) examination of 100% of the CRDM/CEDM penetrations once per 10 years, beginning no later than the third ISI interval.
- Or, perform NDE (i.e., non-visual examination) of 100% of the CRDM/CEDM penetrations and associated J-groove welds once per 10 years, beginning no later than the third ISI interval.

Inspection Schedule – Moderate Susceptibility

For moderate susceptibility plants ($10 \text{ EDY} \leq X < 18 \text{ EDY}$):

- Perform a BMV examination of 100% of the CRDM/CEDM penetrations at the 1st RFO upon entering this category and once every 2 EDY not to exceed 5 EFPYs.
- Or, perform NDE (i.e., non-visual examination) of 100% of the CRDM/CEDM penetrations and associated J-groove welds at the 1st RFO upon entering this category and once every 4 EDY not to exceed 10 EFPYs.

Inspection Schedule – High Susceptibility

For high susceptibility plants (≥ 18 EDY):

- Perform a BMV examination of 100% of the CRDM/CEDM penetrations at every RFO upon entering this category, **AND**
- Perform NDE (i.e., non-visual examination) of 100% of the CRDM/CEDM penetrations and associated J-groove welds within 4 EDY upon entering this category or issuance of this Plan, whichever is later
 - Exceptions to 100% NDE for undue hardship.

OR

- Perform NDE (i.e., non-visual examination) of 100 % of the CRDM/CEDM penetrations and associated J-groove welds at the 1st RFO upon entering this category and once every 4 EDY not to exceed 6 EFPYs.

Inspection Plan

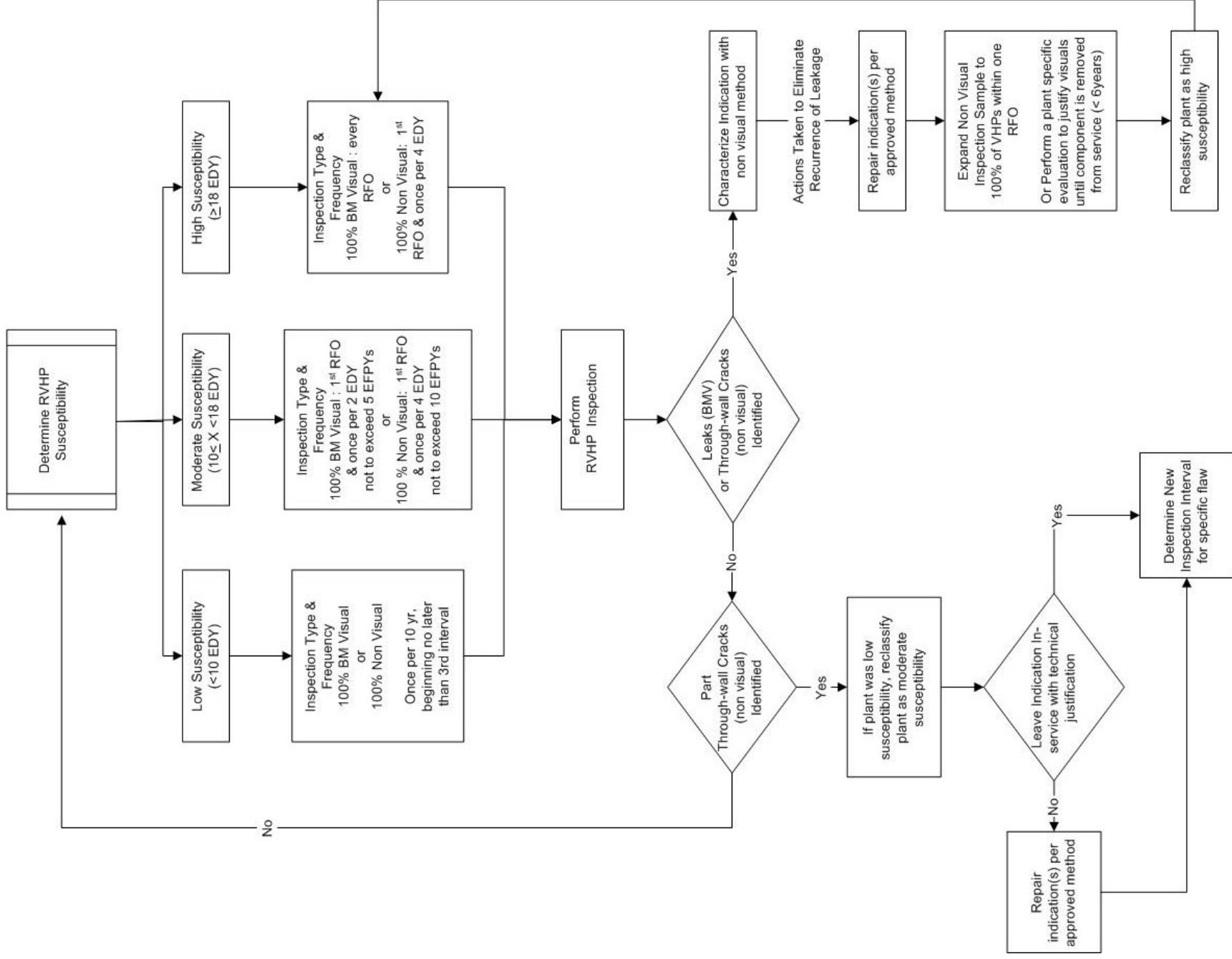
- **Plants with leak(s) or through wall cracks identified:**
 - *Discovery Inspection*
 - Perform a non-visual examination of the CRDM/CEDM penetrations and associated J-groove welds to characterize the crack or leak identified.
 - Indications are evaluated or repaired in accordance with flaw evaluation guidelines.

Plants with leak(s) or through wall cracks

Expansion of Inspection (to be implemented no later than next RFO)

- Perform NDE (i.e., non-visual examination) of 100% of the CRDM/CEDM penetrations and associated J-groove welds.
 - Indications are evaluated or repaired in accordance with flaw evaluation guidelines (Reference 4).
- Or, perform an evaluation to justify continued visual examination until the RVH component is removed from service.
- Or, perform NDE at a frequency to be determined such that the 3x safety margin of a hypothetical circumferential crack growing above the weld is not exceeded prior to the next inspection.

RVHP Inspection Flowchart



- [Inspection Chart.ppt](#)