ELECTRIC POWER RESEARCH INSTITUTE

Alternatives for Submittals, Reviews and Decisions on Re-examination Intervals for Alloy 690 PWR Reactor Vessel Top Head Penetration Nozzles

Paul Crooker
Materials Reliability Program (MRP) - EPRI

Glenn White and Kevin Fuhr
Dominion Engineering, Inc.

William Sims
MRP Assessment TAC Chair - Entergy

Public Meeting
NRC Offices - Rockville, MD
August 21, 2014

Purpose

The purpose of the meeting is to provide the Industry need to extend A690 head inspection interval, provide an overview of the technical basis, and to establish the preferred process for Licensee to extend the A690 head inspection interval beyond the 10 years as required in Code Case N-729-1.

© 2014 Electric Power Research Institute, Inc. All rights reserved.

Agenda

- Need for Reexamination Interval Extension
- Technical Basis for Reexamination Interval
- ASME Code Activities
- Utility Relief Requests
- Alternatives for Reexamination Interval
- Generic Relief Request Template
- Discussion

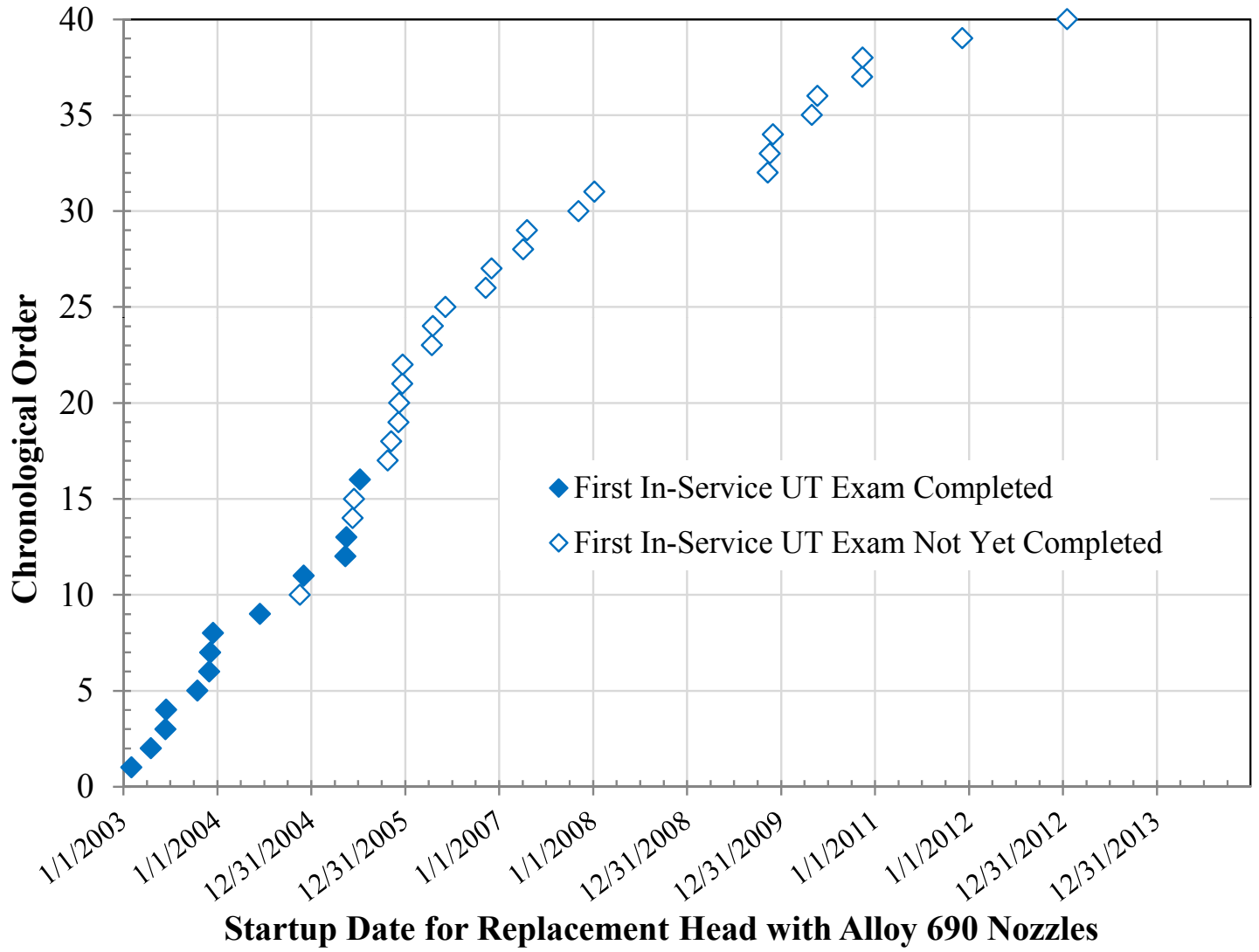
© 2014 Electric Power Research Institute, Inc. All rights reserved.

Need for Reexamination Interval Extension

- Volumetric inspection performed every 10 years includes many unnecessary inspections, with unnecessary dose up to several person-REM per inspection:
  - 13 heads with Alloy 690 nozzles in the U.S. have been inspected volumetrically with no service-induced indications
  - EDF approach to inspect only 3 units in a fleet of 58 units
  - On a conservative basis, MRP-375 supports a 20 year inspection interval, plus an option for alternating schedules for “sister heads”
  - A draft CC revision would implement the intervals supported by MRP-375
- Volumetric inspection performed per proposed alternative interval requirements:
  - Removes excess conservatism while still maintaining a conservative approach
  - Ensures an acceptably small effect of the PWSCC concern on nuclear safety
  - In combination with the visual examination requirements, conservatively addresses the concern for leakage
  - Ensures that information on the status of the U.S. fleet of heads with Alloy 690 nozzles continues to be collected
  - Continues to provide reasonable assurance of structural integrity and thus an acceptable level of quality and safety

© 2014 Electric Power Research Institute, Inc. All rights reserved.

UT Inspection Status vs. Head Replacement Date for U.S. PWRs



© 2014 Electric Power Research Institute, Inc. All rights reserved.

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Technical Basis for Reexamination Interval
- MRP-375

- Detailed technical basis in MRP-375, February 2014
  - Briefed to ASME Code in February 2014
  - Briefed to NRC at public Tech Update meeting in June 2014
- Deterministic and probabilistic calculations based on standard approaches for heads with Alloy 600 nozzles
- Conservatively small credit for improved PWSCC performance through factors of improvement (FOI) applied to crack growth rates and crack initiation times
- Taking conservatively small credit for reduced crack growth rate of Alloy 690 (FOIs of 5 to 20) supports extending volumetric/surface reexamination interval to 40 years on basis of the nuclear safety concern of nozzle ejection
  - Effect on nuclear safety is acceptably small
  - Safety risk is substantially reduced compared to Alloy 600
- Taking conservatively small credit for improved resistance to initiation results in a low probability of leakage
- Taking more realistic credit for improved resistance to initiation results in a very low probability of leakage

© 2014 Electric Power Research Institute, Inc. All rights reserved.

ASME Code Activities

- ASME Code process is in progress:
  - October 28, 2013 meeting in Atlanta of Section XI Task Group High Strength Nickel Alloys Issues (TGHSNAI)
    - Introduced approach and technical basis work
  - February 10, 2014 meeting in San Diego of TGHSNAI
    - Presented results and conclusions of MRP-375 technical basis report
  - May 12, 2014 meeting in Bellevue, Washington of TGHSNAI
    - Initiated revision to N-729
  - August 18, 2014 meeting in Washington, DC of TGHSNAI
    - Revision N-729-5 will include Alloy 690 revisions (only)
    - "Sister head" definitions need to be completed
      - Owners with multiple heads at different plants
  - November 17, 2014 (anticipated)
    - TG vote on revisions
  - 2015 – February, May and August Meetings (anticipated)
    - TG, WG, SG and Standards - Reviews, Comments, Resolution and Approvals

© 2014 Electric Power Research Institute, Inc. All rights reserved.

Utility Relief Requests
- Submitted and in Preparation

- Relief Request process per 10CFR50.55a:
  - Submitted & Under NRC Review
    - Entergy, ANO 1 - 2-1/2 years extension, decision needed Sept 30, 2014
    - FPL, St. Lucie 1 – 3 years extension, decision needed in 2015, sister head approach possibly later

      (both intend to request the full 10 years extension once the ASME Code is revised)
  - In Preparation
    - Licensee A – 10 year extension, decision needed in 2015
    - Licensee B – 10 year extension, decision needed in 2015
    - Licensee C – 10 year extension, decision needed in 2015
    - Licensee D – 10 year extension, decision needed in 2015, 2 heads, sister head approach possibly later
    - Licensee E – 3 year extension (*initially*), decision needed in 2015, sister head approach possibly later

© 2014 Electric Power Research Institute, Inc. All rights reserved.

Alternatives

- Topical report SE
- NRC change 10CFR50.55a invocation of CC N-729-1 to reflect an exception to Alloy 690 resistant heads?
- Relief requests
    - Interim relief request (less than 20 years)
    - Full interval inspection relief (20 years)
    - Sister plant relief request
- Other relief option or alternative?

© 2014 Electric Power Research Institute, Inc. All rights reserved.

Generic Relief Request Template

- Template can be configured to request different alternative examination intervals
  - Less than 10 year extension
  - 10 year extension to a nominal 20 year interval
  - “Sister head” approach alternates inspections between two heads
- Opportunity to cite past inspection results for similar heads
- Opportunity to describe head-specific features that further reduce the PWSCC concern
- Summarizes key aspects of MRP-375
- A volumetric inspection interval of 20 years is justified by the simplified FOI approach that is not dependent on the detailed calculations in MRP-375
  - Plants have option to provide a head-specific “implied FOI” for the relief request, described on the next slide

© 2014 Electric Power Research Institute, Inc. All rights reserved.

Factor of Improvement Calculation

- Calculation for a example plant to determine what minimum FOI for Alloy 690 is needed to justify the inspection interval based on the required Alloy 600 interval of RIY = 2.25
  - Current testing shows that it is reasonable to apply the accepted activation energy for crack growth of Alloy 600 to make predictions for Alloy 690
- Implied FOI is equivalent to the ratio of RIY accumulated during the requested interval to RIY = 2.25
  - For a head operating at 605°F, the RIY after 20 years with a capacity factor of 98% is 22.2 and the needed FOI is 9.9
  - For a head operating at 613°F, the RIY after 20 years with a capacity factor of 98% is 27.0 and the needed FOI is 12.0
- An FOI of 12 represents a level of reduction in PWSCC crack growth rate versus that for Alloys 600/82/182 that is virtually bounded on a statistical basis by the laboratory data compiled in Figures 3-2, 3-4, and 3-6 of MRP-375

© 2014 Electric Power Research Institute, Inc. All rights reserved.

Discussion

© 2014 Electric Power Research Institute, Inc. All rights reserved.

Together…Shaping the Future of Electricity

© 2014 Electric Power Research Institute, Inc. All rights reserved.