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**DATE OF MEETING**

**09/25/2003**

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Docket Number(s)	<u>50-261</u>
Plant/Facility Name	<u>H. B. Robinson Steam Electric Plant, Unit No. 2</u>
TAC Number(s) (if available)	<u>MC0315</u>
Reference Meeting Notice	<u>September 15, 2003</u>
Purpose of Meeting (copy from meeting notice)	<u>To discuss CP &amp; L request for relaxation from the</u> <u>NRC order for establishing interim inspection</u> <u>requirements for reactor press. vessel heads at PWRs</u>

NAME OF PERSON WHO ISSUED MEETING NOTICE

**Chandu P. Patel**

TITLE

**Project Manager**

OFFICE

**NRR**

DIVISION

**Division of Licensing Project Management**

BRANCH

**Project Directorate II**

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# Meeting With NRC To Discuss Request For Relaxation Of RPV Head Inspection Requirements



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**H. B. Robinson, Unit No. 2**

**September 25, 2003**



# Agenda

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- Introduction
- Historical Perspective And Summary Of Relaxation Request
- Overview Of Technical Basis
- Closing Remarks

# Introduction

Chris Burton

Director - Site Operations



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# Historical Perspective And Summary Of Relaxation Request

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Chuck Baucom  
Licensing Supervisor



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# Historical Perspective

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- Refueling Outage 20 (April 2001)
  - ◆ Performed qualified bare-metal visual (BMV) examination
  - ◆ No vessel head penetration (VHP) or head surface degradation identified
    - ▼ Canopy seal leakage identified and repaired
  - ◆ Reasonable assurance of structural integrity provided until next scheduled inspection
  - ◆ Actions pre-date issuance of NRC Bulletin 2001-01 in August 2001

# Historical Perspective

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- Refueling Outage 21 (November 2002)
  - ◆ Performed qualified BMV examination; no VHP or head surface degradation identified
    - ▼ Canopy seal leakage identified and repaired
  - ◆ Performed NDE of VHP nozzles
    - ▼ Eddy current of 69 J-groove welds and penetration tube outer diameter surfaces
    - ▼ Eddy current and UT of 17 open penetration tubes from inner diameter surfaces
    - ▼ Eddy current of 45 penetration tubes with thermal sleeves and 7 penetration tubes with part length drive shafts from inner diameter surfaces

# Historical Perspective

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- Refueling Outage 21 (Continued)
  - ◆ No evidence of VHP nozzle leakage or PWSCC
    - ◆ One recordable indication (surface anomaly from manufacturing process) away from high stress area
  - ◆ BMV and NDE consistent with NRC Bulletins 2001-01 and 2002-02
  - ◆ Actions pre-date issuance of NRC Order EA-03-009
    - ◆ Examination coverage evaluated against Order requirements



# Summary Of Relaxation Request

- NRC Order EA-03-009 Requires The Following Every Refueling Outage:
  - ◆ BMV examination of 100% of the head surface, AND
  - ◆ Either:
    - ▼ UT of each nozzle and an assessment for leakage into the interference fit zone, OR
    - ▼ Eddy current or dye penetrant testing of wetted surface of each J-groove weld and penetration nozzle base material

# Summary Of Relaxation Request

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- Order Response Dated March 3, 2003
  - ◆ Reviews were in progress to determine if sufficient technical basis existed for relaxation of Order requirements
- Request For Relaxation Of Order Requirements Dated August 15, 2003
  - ◆ Relief requested for NDE of VHP nozzles and J-groove welds only for Refueling Outage 22 (April 2004)

# Summary Of Relaxation Request

- Proposed Alternative Applicable Only For Refueling Outage 22 (April 2004)
  - ◆ BMV examination of visible portions of RPV head surface
  - ◆ NDE from Refueling Outage 21 with detailed technical analyses supporting operation until RPV head replacement
- RPV Head Replacement During Refueling Outage 23 (October 2005)

# Summary Of Relaxation Request

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- Good Cause For Relaxation Is Based Upon
  - ◆ Successful examinations from two prior refueling outages
  - ◆ Detailed probabilistic and deterministic analyses support two cycles of operation with known condition of RPV head
- Pressure Boundary Integrity will be maintained until RPV Head Replacement

# Overview Of Technical Basis

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Chris Church  
Engineering Manager



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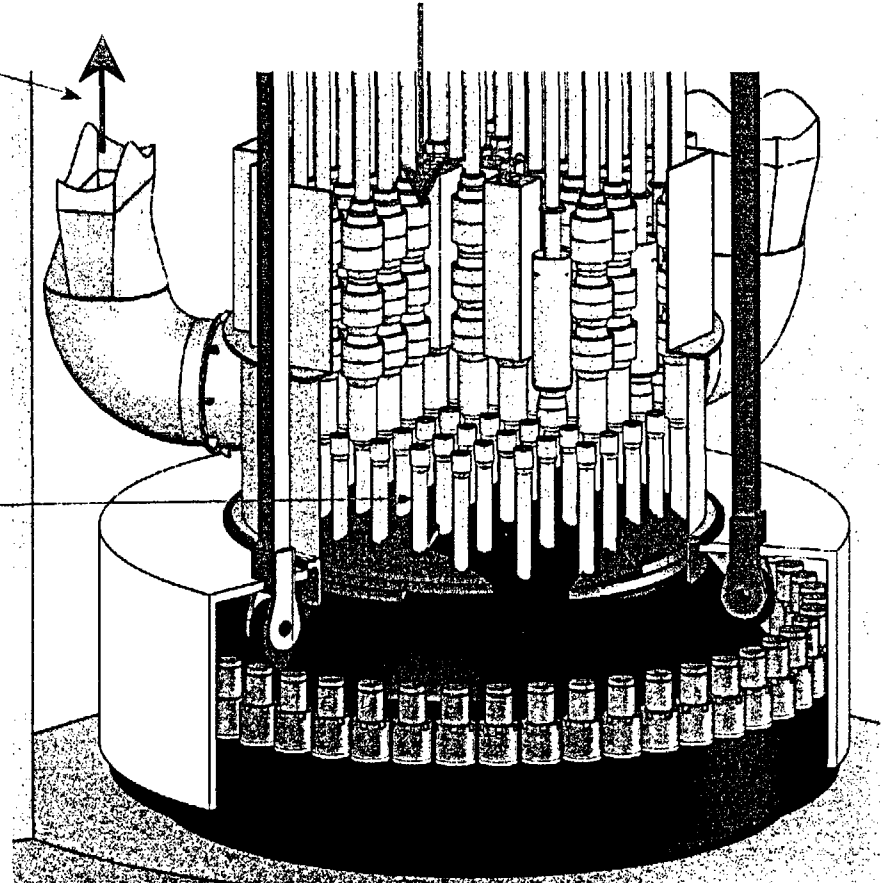


# Technical Basis

- H. B. Robinson Reactor Pressure Vessel Head
- H. B. Robinson Materials and Fabrication
- Industry Experience
- Statistical Analysis of Differential Susceptibility
- Deterministic Evaluations
- Probabilistic Evaluations
- H. B. Robinson Leak Detection Capability
- Conclusions

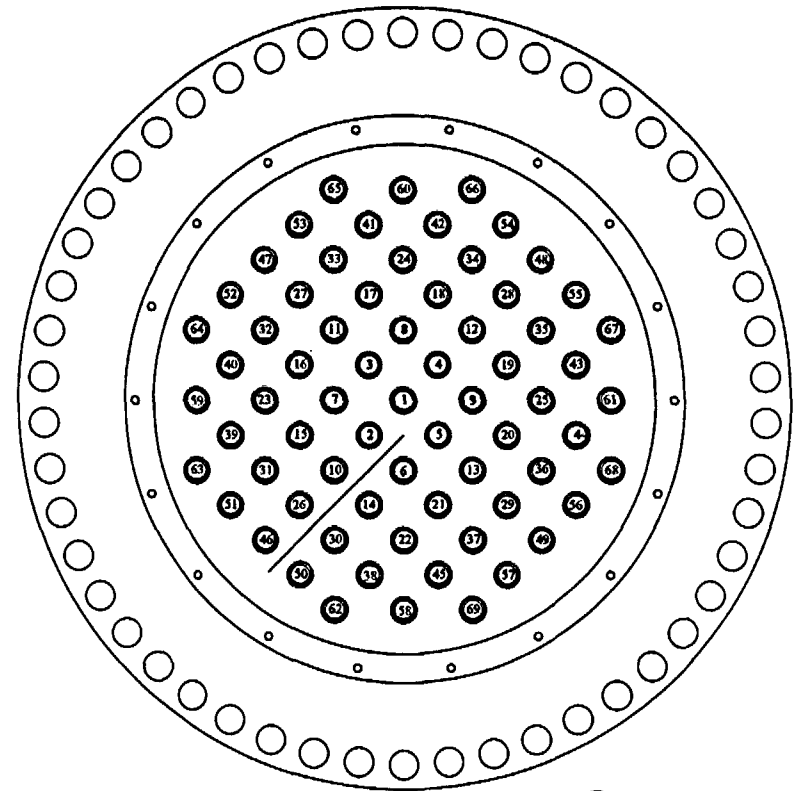
# H. B. Robinson Reactor Pressure Vessel Head

- Cooling air is drawn down through mechanisms and out through ducts
- Head is low-alloy steel
  - ◆ 148.9" ID
  - ◆ 7.75" base metal thickness
  - ◆ 0.218" clad thickness
- 69 VHP nozzles
  - ◆ Alloy 600 (SB-167)
  - ◆ Alloy 182 Welds
  - ◆ 4.00" OD
  - ◆ 2.75" ID



# H. B. Robinson Reactor Pressure Vessel Head

- 69 VHP nozzles
  - ◆ 45 CRDM
  - ◆ 7 Part length CRDM
  - ◆ 1 Part length removed & capped
  - ◆ 11 Capped dummy can assemblies
  - ◆ 5 Thermocouple columns
- 52 full and part length CRDMs have thermal sleeves
- Remaining 17 nozzles are open
- Head vent nozzle design



- CRDM Nozzles
- Part Length Nozzles
- Capped Nozzles
- Thermocouple Nozzles

# H. B. Robinson Materials and Fabrication

- Review of materials and fabrication processes was performed by Westinghouse and DEI
- Purpose was to identify differences in the materials and fabrication processes that could explain why Robinson has not seen PWSCC even though it is categorized as “high susceptibility” based on EDY
- λ The materials processing and fabrication reviews showed no unusual processes or repairs that would be expected to increase PWSCC susceptibility of the RPV head penetrations or welds

# H. B. Robinson Materials and Fabrication

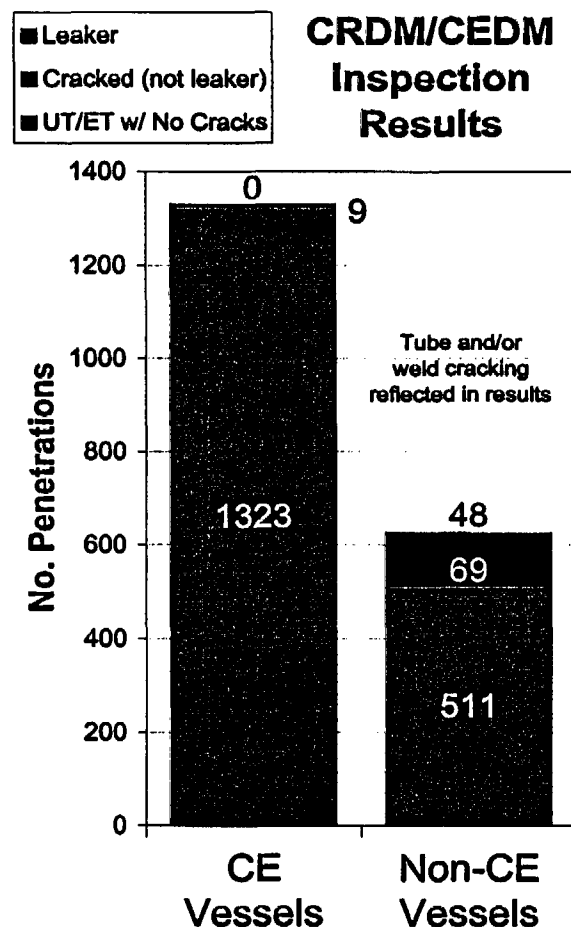
- Some material and fabrication processes used in the construction of the H. B. Robinson RPV head allows good ability to detect leakage during BMV exam, may contribute to lower residual stresses, and lower PWSCC susceptibility
  - ◆ Use of a minimum interference fit, individual nozzle/bore size matching, and acetone/dry ice bath shrink fit techniques
  - ◆ Smaller weld sizes in Robinson head relative to some other heads
  - ◆ Thicker nozzle tube walls compared to some other PWR closure heads
  - ◆ Tubes were produced using a process that is expected to produce large grain size and predominantly intergranular carbides. This material would be expected to have lower PWSCC susceptibility than material with small grain size and predominantly intragranular carbides

# Industry Experience

- Evaluation of nozzle inspection results compiled by the MRP shows that there is a significant difference in frequency of PWSCC for different fabrication and material categories
  - ◆ Reactor vessels fabricated by CE with CRDM nozzles fabricated from material supplied by Huntington Alloys showed best performance against other reactor vessels and nozzle materials
- H. B. Robinson RPV head fabricated by CE with Huntington CRDM nozzle material
  - ◆ Good industry performance in this category is consistent with lack of PWSCC detected by RO-21 nozzle and weld inspection
  - ◆ There has been only 1 plant (Millstone 2) with PWSCC reported in a vessel fabricated by CE with Huntington Alloys material
  - ◆ Three operating plants have Robinson heats of Huntington material with no reported problems (Salem 1, Indian Point 2, Diablo Canyon 1). Note that Millstone 2 has a different heat than Robinson

# Industry Experience

- Only 0.7% of CE penetrations have shown reportable indications
- 18.72% of non-CE penetrations have shown reportable indications
- Only 9 of 1332 penetrations in CE-fabricated vessels inspected by UT/ET have shown reportable indications
- No detected leaks or weld cracks in CE vessels

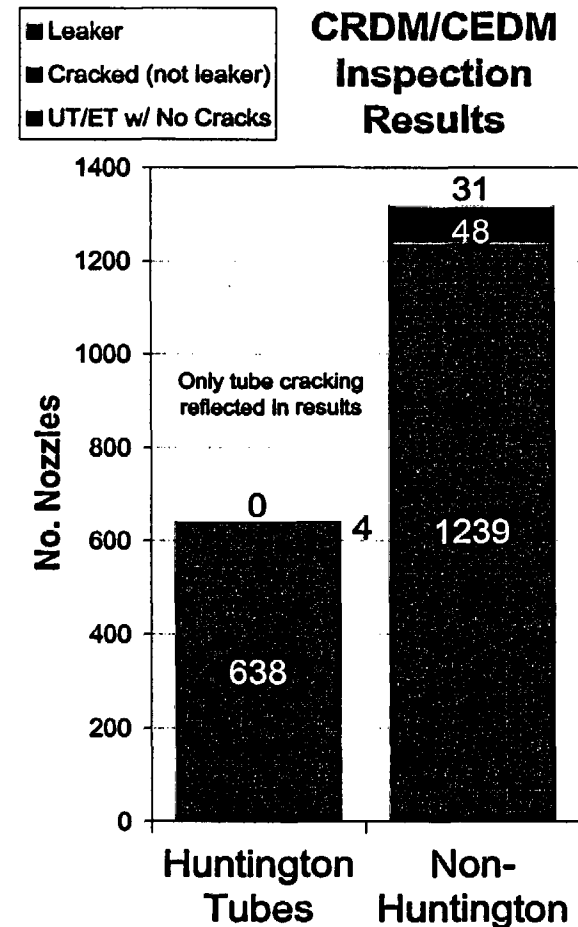


Inspection results through Spring 2003



# Industry Experience

- Only 0.6% of Huntington nozzles have shown reportable indications
- 6.0% of non-Huntington nozzles have shown reportable indications
- Only 4 of 642 Huntington material nozzles inspected by UT/ET have shown reportable indications
- No detected leaks from Huntington material nozzles



Inspection results through Spring 2003



# Statistical Analysis of Differential Susceptibility

- The fact that RPVs manufactured by CE with Huntington Alloys nozzle material appear less prone to PWSCC than other vessel heads with similar operating history was statistically assessed
- B&W designs, CE fabricated non-B&W designs, and plants that have neither, in addition to EDY, were analyzed
- The results indicate the H. B. Robinson head at current EDY is 10% less likely to leak than the “neither” category and 35% less likely to leak than B&W designs
- This analysis shows that ignoring other factors beyond EDY may lead to substantially overestimating the likelihood of PWSCC in plants with H. B. Robinson-like attributes

# Deterministic Evaluations

- Westinghouse and DEI performed deterministic evaluations of flaw propagation and crack growth in H. B. Robinson VHPs and associated J-groove welds
- Conservative cases analyzed demonstrate incipient leakage is not predicted to occur in less than 3 years
  - ◆ Exception was DEI analysis of J-groove welds
  - ◆ Probability of leak remains low
- Deterministic evaluations for boric acid wastage also concluded that BMV examinations performed every refueling outage preclude rapid boric acid wastage of the low-alloy steel material of the RPV head

# Probabilistic Evaluations

- Both Westinghouse and DEI evaluations utilize conservative assumptions for probability of detection, pre-existing flaws, and flaw propagation
- Westinghouse concluded that the probabilistic analysis provides quantitative confidence that;
  - ◆ Leaks and critical flaws will not be generated
  - ◆ Projected plant risk increase will be within acceptable limits over the proposed interval between inspections
- DEI concluded the analytical resulting maximum increment to core damage frequency (CDF) of  $1\text{E-}7$  per year is an order of magnitude lower than the  $1\text{E-}6$  criterion recommend by Regulatory Guide 1.174 for risk-informed decision making

# Probabilistic Evaluations

- The resultant estimates for leakage show there is a low probability (on the order of 5% per year) that a leak will occur
- Additionally, a probabilistic head wastage model shows that the potential for boric acid corrosion of the low-alloy steel head material, given the BMV examination to be performed in RO-22, has an insignificant effect on CDF
- In summary, two independent probabilistic analyses conclude the proposed relaxation is within regulatory guidelines for ensuring no undue risk to the health and safety of the public

# H. B. Robinson Leak Detection Capability

- H. B. Robinson has several programs to detect leaks
  - ◆ Boric Acid Control Program
  - ◆ RCS inspections at the start and end of each refueling outage
  - ◆ RCS leakage surveillance every 72 hours
    - ▼ Indication of leakage is provided by several factors, including reactor coolant drain tank level, pressurizer relief tank, containment air particulate and noble gas monitors, and containment sump level
    - ▼ Investigation commences if the identified leak rate exceeds 0.3 gpm or the unidentified leak rate exceeds 0.1 gpm
  - ◆ Heightened sensitivity to leaks by maintaining the rate of unidentified leakage very low
    - ▼ The average unidentified leak rate after RO-21 (Fall 2002) was 0.03 gpm and it is currently negligible



# Conclusions

- Two successive qualified bare metal visual examinations showed no evidence of penetration leakage
- Comprehensive NDE exams of CRDM penetrations and J-groove welds performed in RO-21 identified no reportable indications due to PWSCC
- A review of H. B Robinson's materials and fabrication techniques indicate several factors which may provide a lower susceptibility to PWSCC
- Experience to date with vessels fabricated by CE and with Huntington Alloys nozzle material has been excellent

# Conclusions

- Statistical analysis demonstrates that factors in addition to time and temperature significantly influence the likelihood of PWSCC
- Deterministic and probabilistic analyses indicate the likelihood of any PWSCC-induced damage to the RPV head during the extended inspection interval is extremely low, and well within the bounds of Reg. Guide 1.174
- RCS leak rates are currently very small. Any change in leak rate is carefully evaluated and actions are taken to resolve these changes
- Bare metal visual examination during the next refueling outage (RO-22) will detect through wall leaks before head wastage can occur

# Conclusions

- RPV head replacement is scheduled for RO-23
- Taken together, these complementary approaches support the conclusion that the one-time extension of the non-visual NDE inspection will not result in any measurable impact to operational safety
- Based upon the above, good cause is demonstrated for relaxation of Order requirements

# Closing Remarks

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Chris Burton

Director - Site Operations



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