

# **Current Inspection Practice for Reactor Internals and Future Needs**

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# Internals Failure Mechanisms

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- Stress corrosion cracking
  - PWSCC
  - IASCC
- Wear
- Swelling
- MRP I&E Guideline draft lists and ranks various PWR issues
- BVIP reports list BWR issues

# Observed Component Degradation

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- PWRs

- Baffle bolts
- Fuel alignment pins
- Control rods
- Control rod guide cards

- BWRs

- Core Shrouds
- Internal piping systems
- Jet pump beams

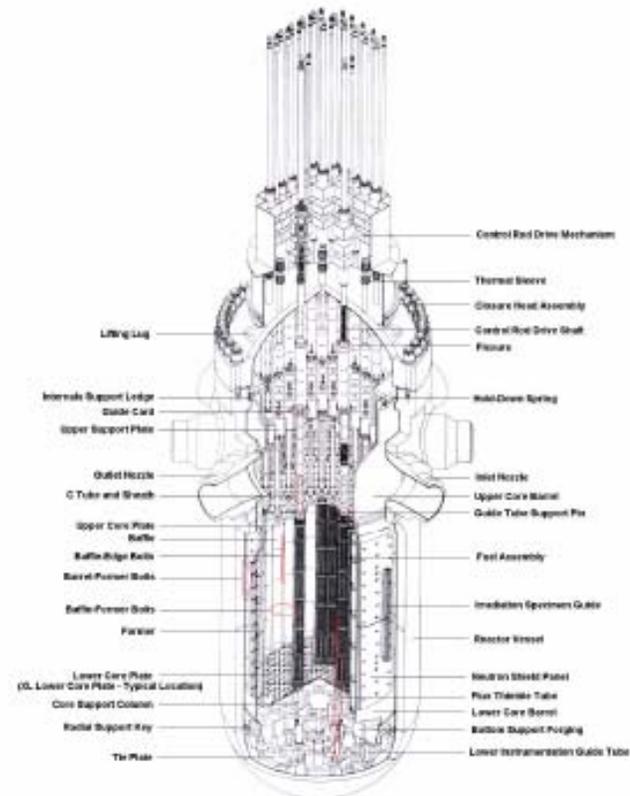
# Inspection Technologies

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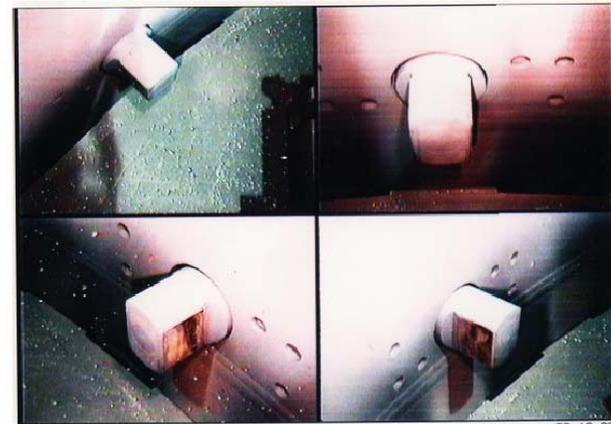
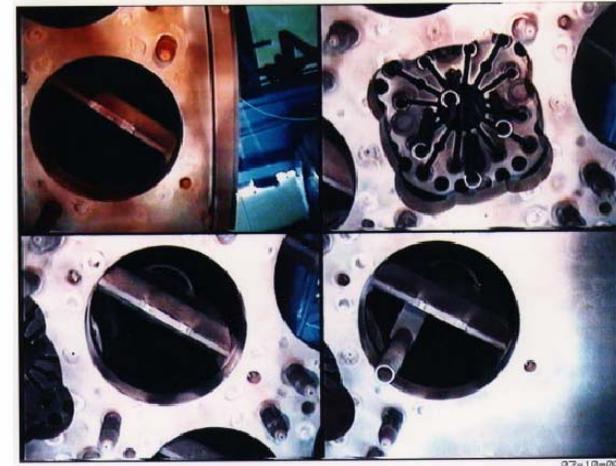
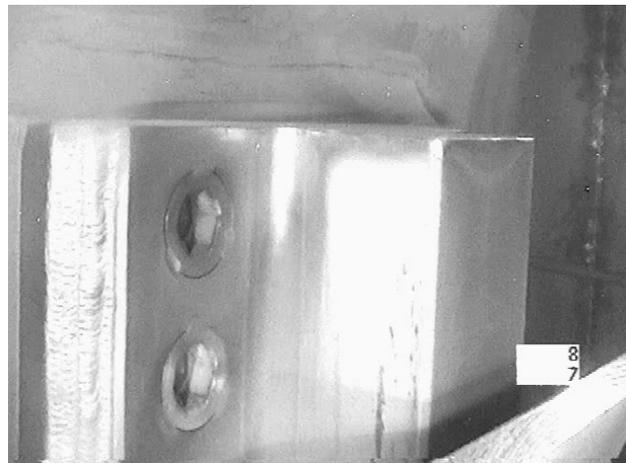
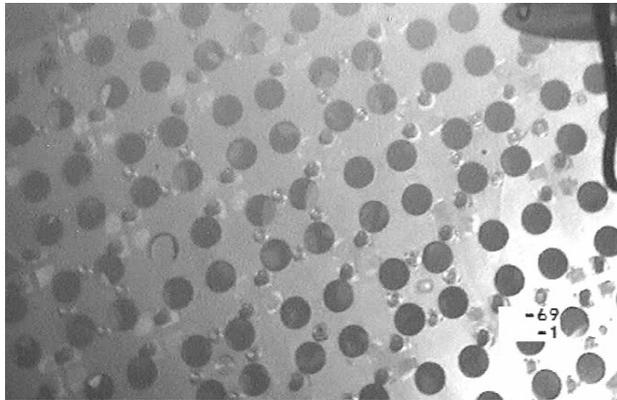
- Visual Inspection
  - VT-3 for general condition assessment
  - VT-1 for crack detection
- Surface Inspection
  - Eddy current testing predominantly
  - Limited used of underwater surface replication
- Volumetric Inspection
  - Ultrasonic testing

# Westinghouse RPV Internals

- Baffle and Former Bolts
  - VT and UT
- Fuel Alignment Pins
  - UT
- Control Rods
  - ET and UT
- Guide Cards
  - VT and LVDT dimensioning



# Conventional Visual Inspection – VT-3



# Enhanced Visual Inspection – VT-1 & Beyond

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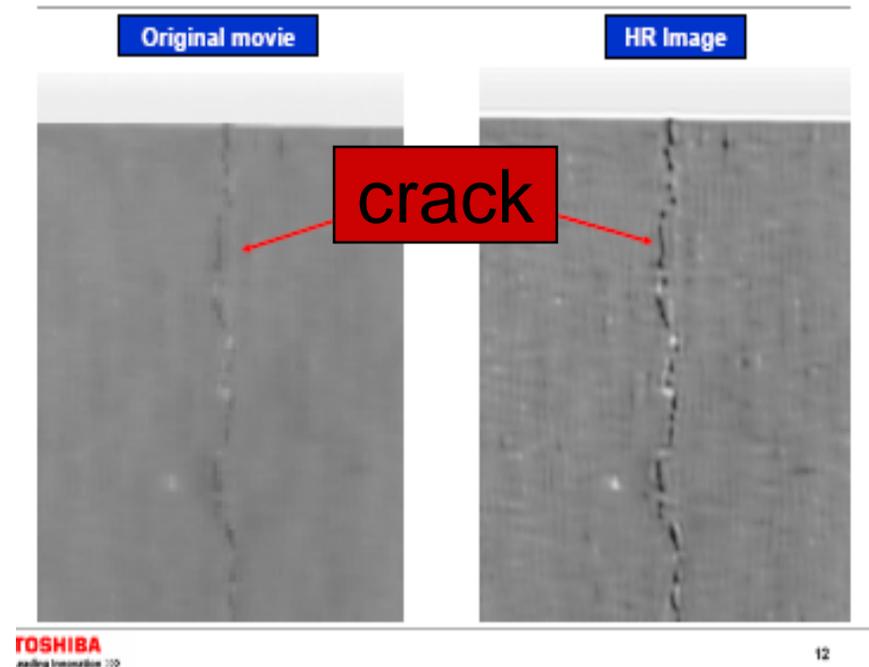
# Visual Inspection Technology

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- Enhanced VT approximately 30x standard VT-3
- Effective scanning limited to ¼"/sec (PNNL report)
  - Lighting and angle are critical
  - Has limited ability for tight cracking (<30 microns)
- Technical issues
  - SPEED, SPEED, SPEED
  - Resolution

# Signal Processing for Enhanced VT

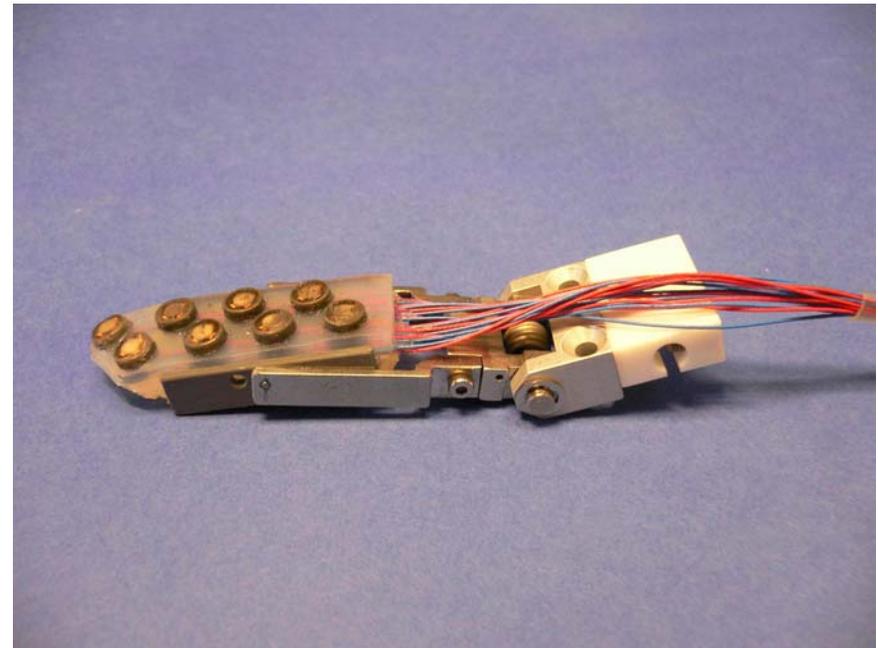
- Super-pixel concept  
combining multiple frames
- Corrects for camera jitter  
from motion
- Allows higher scan rates
  - ¼"/sec now  
recommended



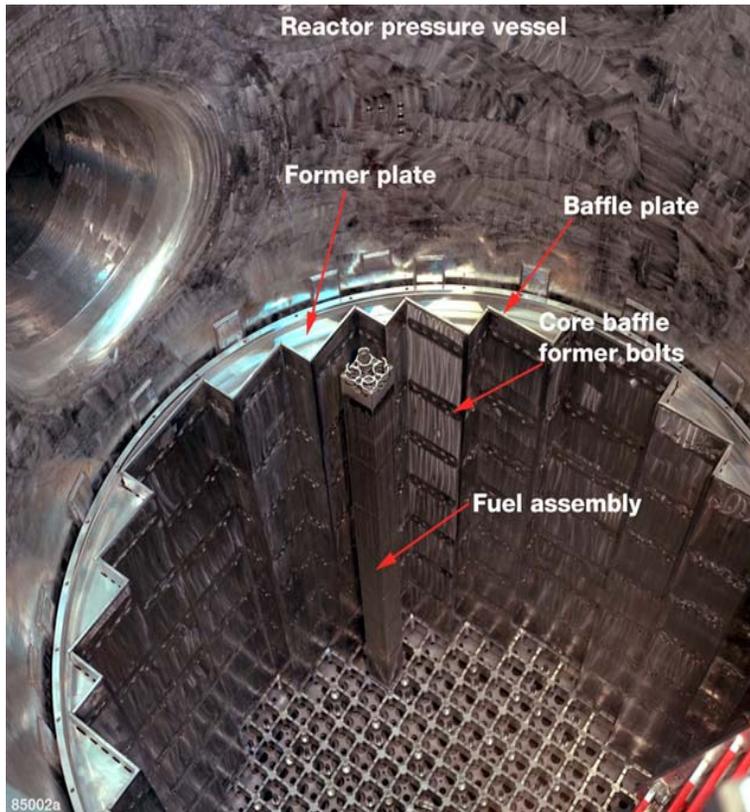
# Surface Inspection

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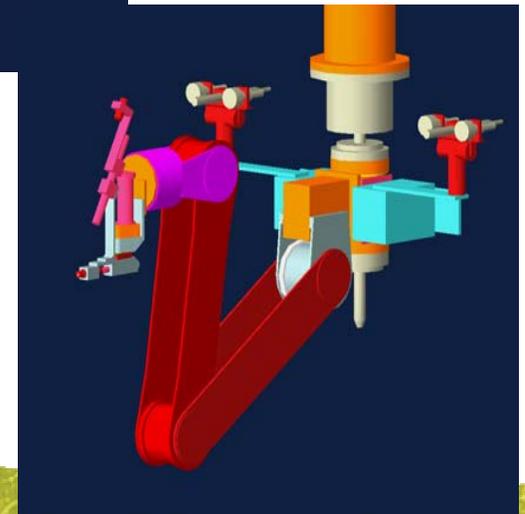
- Eddy Current Arrays
  - Increase speed dramatically
  - Flexible for surface contour following



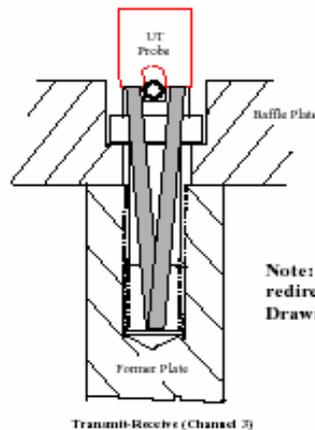
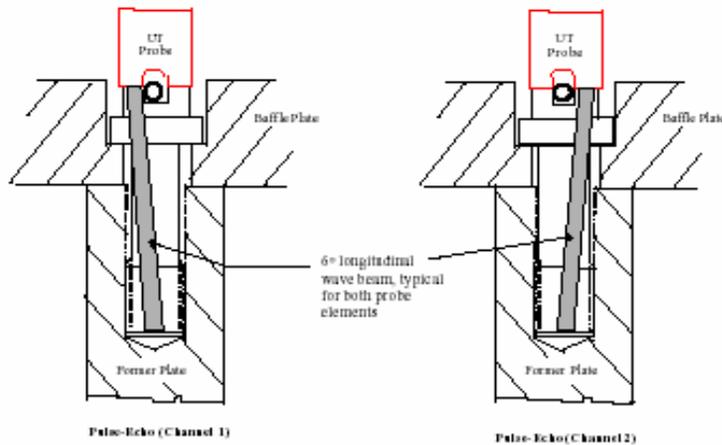
# Ultrasonic Test Applications – Baffle Bolt UT



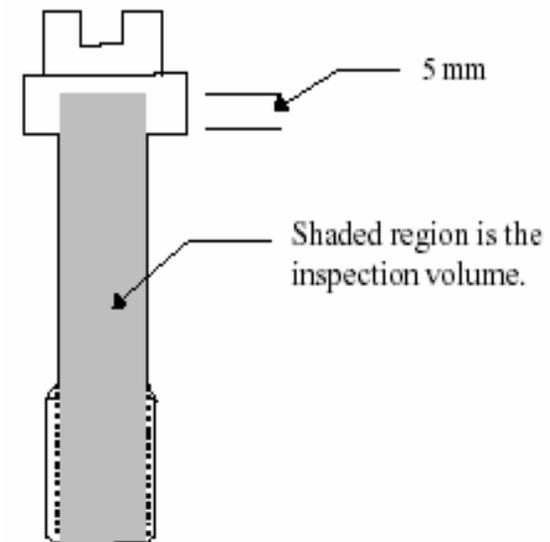
**SUPREEM™**  
**Baffle Bolt UT**  
**Platform**



# Ultrasonic Test Applications – Baffle Bolt UT



Note: Beam spread and beam redirection not depicted. Drawing is illustrative only.



Examination Volume

# Ultrasonic Test Applications – Baffle Bolt UT

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**Conditions Impacting Inspection  
Approach**

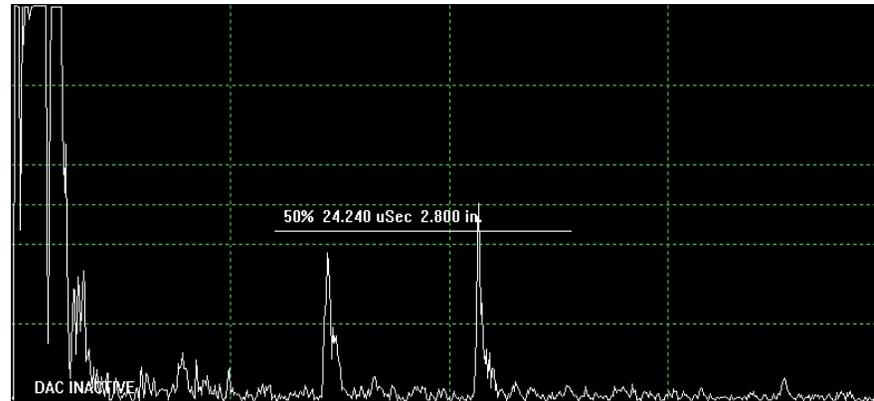
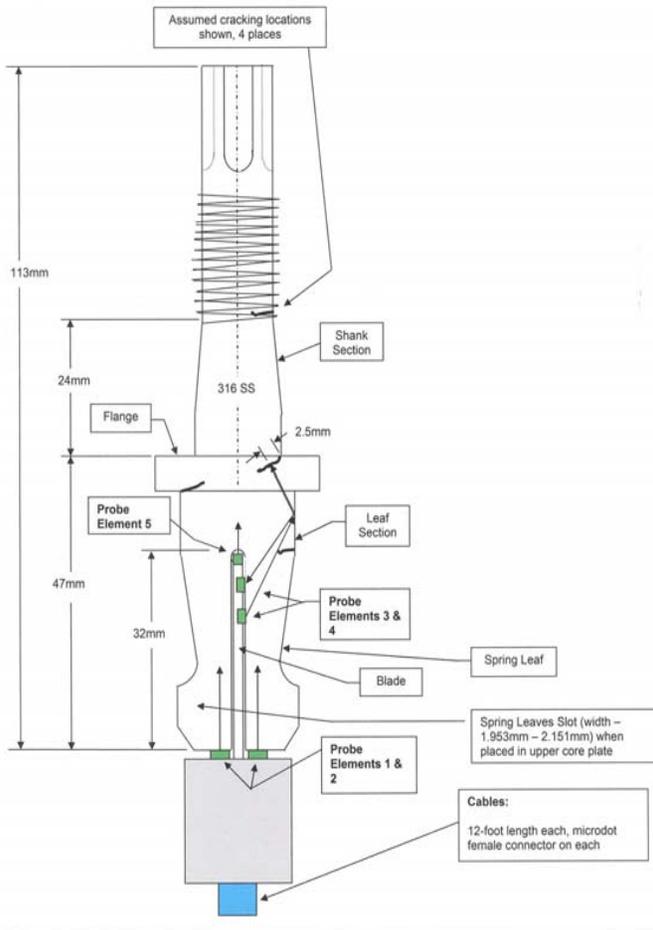
# Baffle Bolt with PWSCC

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- Removed bolts confirmed UT results
- No false positives

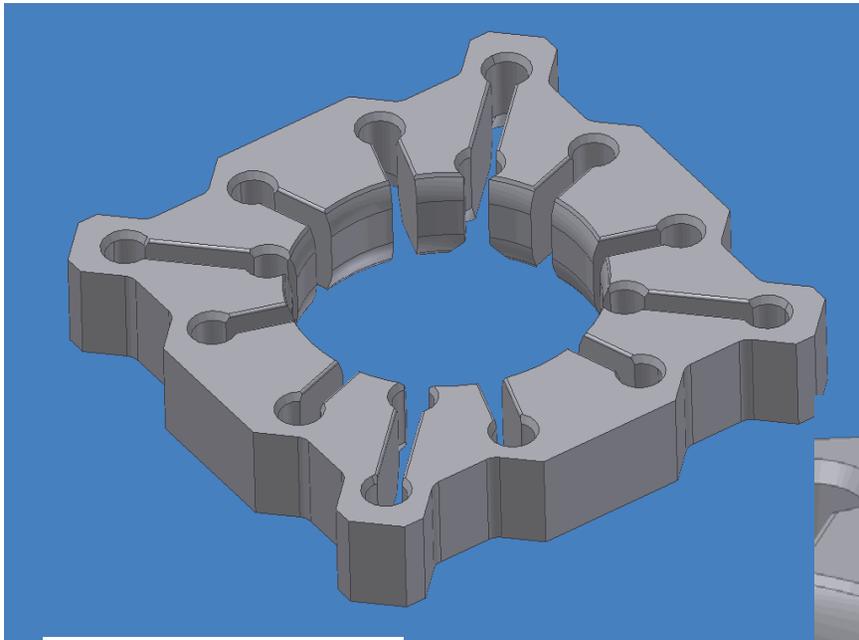


# Ultrasonic Test Applications – Guide Tube Support Pin UT

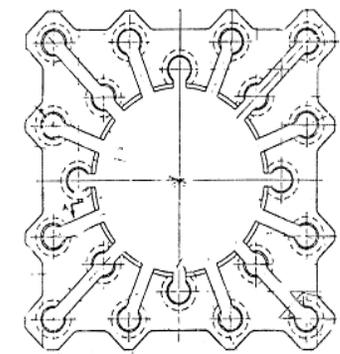
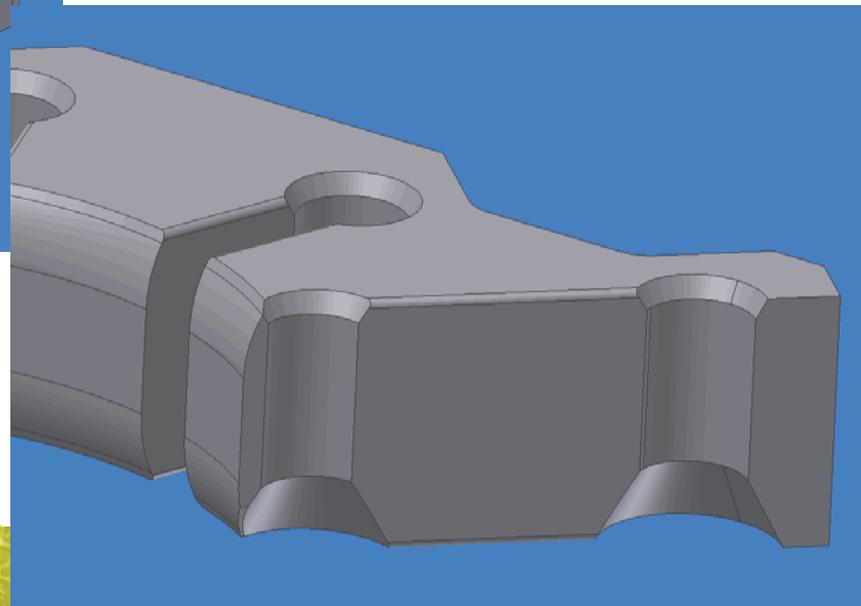


**3.7mm deep notch at 1<sup>st</sup> thread with Probe Element #1**

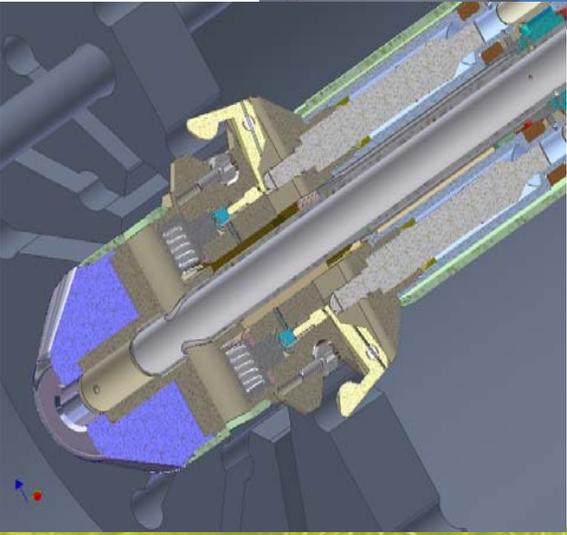
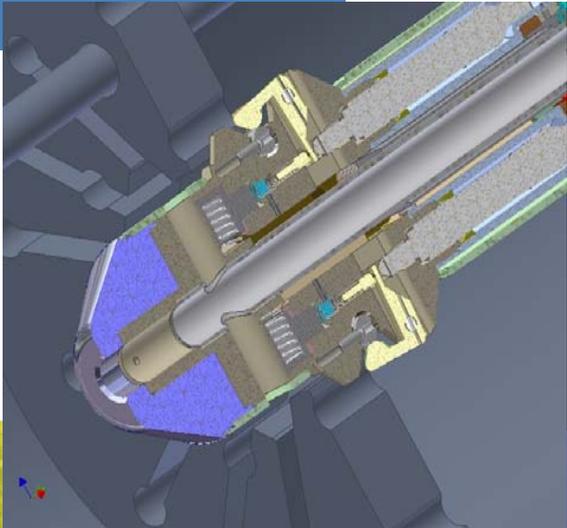
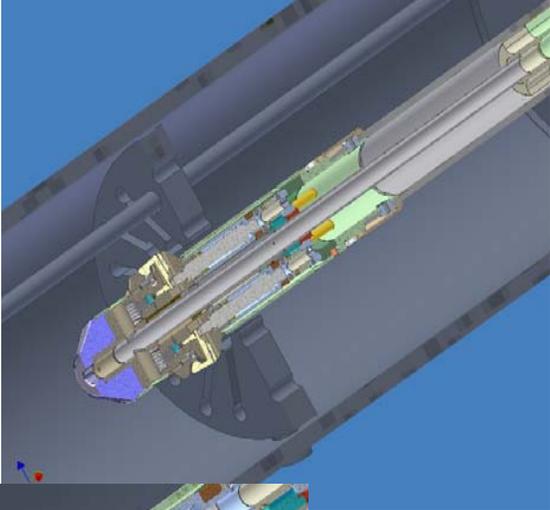
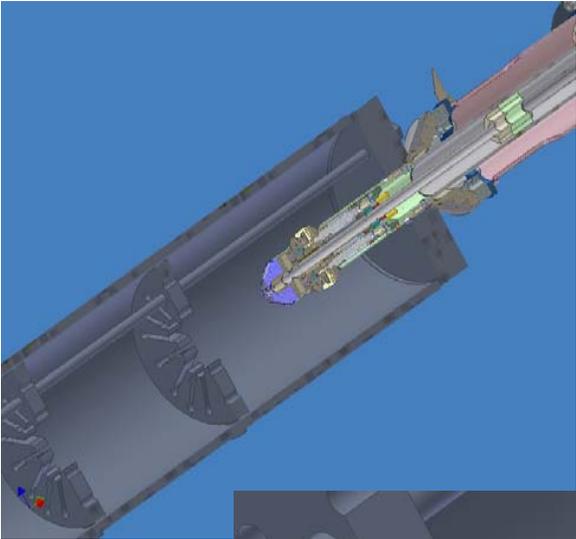
# Guide Tube Wear



**Guide Card**



# Guide Card Ligament Measurement Tool



# RCCA Inspection System

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Westinghouse System Inspects Rod Control Cluster Assemblies for:

1. Rod Cladding Wear
2. Tip Cracking
3. Tip Swelling
4. Rod Diameter Measurements
5. Rod Cladding Wall Thickness

Measurement

