



# **Steam Generator Task Force/ Nuclear Regulatory Commission Biannual Meeting**

**February 16, 2012**

# Agenda

8:30 am      **Introductions NRC/SGTF**

**Opening Remarks – NRC/SGTF**

8:45 am      **SGMP Steam Generator Task Force Update - SGTF**

- SGTF Transition from NEI to EPRI SGMP
- Divider Plate Cracking/Tube-to-Tubesheet Weld Cracking
- Noise Monitoring
- Guidance for Auto Analysis
- Eddy Current Essential Variable Tolerances
- AVB Position Verification
- Tube Support Plate Blockage
- Ratio of Industry Efforts for 600MA SGs to Newer Models
- Top of Tubesheet Denting
- Increase in Foreign Object Operating Experience

# Agenda

- 11:30 am **Lunch**
- 12:30 pm **SGMP Steam Generator Task Force Update (Continued)**
- TSTF-510
  - Upcoming Changes to Industry Documents
  - Recent SG Operating Experience
  - NEI 03-08 Deviations since January 1, 2011
- 2:30 pm **NRC Discussion/Items of Interest** (e.g., pre-service inspection requirements, license renewal interim staff guidance)
- 3:00 pm **Address Public Questions/Comments**
- 3:30 pm **Adjourn**

## SGTF Transition from NEI to EPRI SGMP

- In November 2011, NEI recommended disbanding the NEI SG Task Force
- The original purpose of the task force (development of NEI 97-06 and providing input to the Generic License Change Package) has been fulfilled
- The EPRI SGMP and NRC discussed the future of the SGTF
  - Concluded that SGTF and NRC interactions are beneficial to both organizations and should continue
- EPRI SGMP will sponsor the SGTF in place of NEI
  - NEI will still be a member of the SGTF

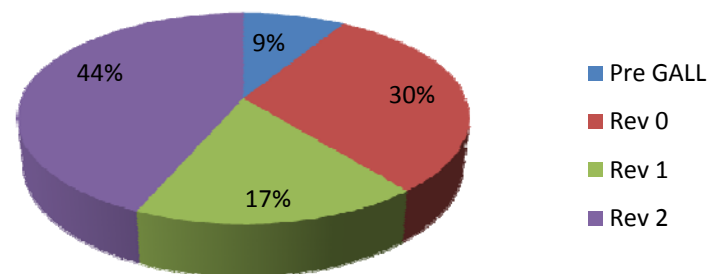
## SGTF Transition from NEI to EPRI SGMP

- The SGTF will be a working group under the SGMP Engineering & Regulatory Technical Advisory Committee and the SGMP Integration Committee will provide oversight and support to the SGTF
- The SGTF will continue to meet with the NRC bi-annually
  - Typically February and August
- The SGTF membership will remain the same
  - Jim Benson is the point of contact for the NRC
  - Helen Cothron will be the SGMP Project Manager
  - Jay Smith will continue to be the Utility SGTF Chair
  - SGTF members will continue to include Industry, vendor and NEI representation
  - SGTF members at-large will continue to be the same as before the transition
- Format and content of SGTF meetings with the NRC will remain unchanged
- End Result - Seamless transition of SGTF from NEI to SGMP

# Divider Plate/Tube-to-Tubesheet Weld Project

- The Generic Aging Lessons Learned Report (GALL), R2 added the divider plate and tube-to-tubesheet weld as items to be evaluated in Aging Management Plans
- Applications reviewed using R2 have required a commitment to inspect these areas once they are in the period of extended operation and the steam generators have been in service more than 20 years
  - Plants whose applications were reviewed using prior revisions have not made these commitments

**GALL Report Revisions Used for Reviewing Plant License Renewal Application**

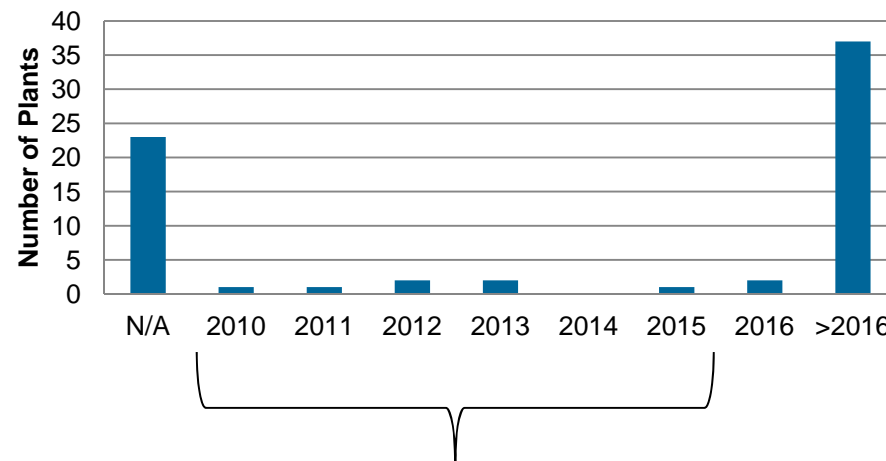


# Divider Plate/Tube-to-Tubesheet Weld Project

- Regulatory Issue Summary (RIS) 2011-05
  - Highlights the addition of divider plate assemblies and tube-to-tubesheet welds to the aging management review line items
  - Changes the priorities of the project

## Date of Extended Period of Operation and SG Life > 20 Years

N/A = Plants with no Alloy 600 material in the channel head assembly



License renewal reviewed under previous revisions of the GALL

# Divider Plate/Tube-to-Tubesheet Weld Project

- SGMP Project Plan
  - The immediate need is for near term inspection relief for the divider plate to the channel head material (carbon steel)
    - Solution for tube-to-tubesheet weld inspection needed in 2013
  - SGMP has accelerated the review of previous research on crack propagation and the development of a technical report that addresses whether cracks will arrest when they come into contact with materials resistant to PWSCC
    - A draft is near completion



# Divider Plate/Tube-to-Tubesheet Weld Project

- SGMP Project Plan
  - The technical report will demonstrate that steam generators will operate safely in the extended period of operation while the industry completes the work outlined in the Aging Management of Alloy 600 in the Steam Generator Channel Head Assembly Roadmap
    - Scheduled to be completed by 2016

# Noise Monitoring

- The industry has developed procedures and protocol for monitoring eddy current noise to ensure an understanding of probability of detection
- Vendors have developed software to implement noise monitoring
- SGMP has funded pilot projects for the last 3 years to demonstrate the procedures, protocol, and software
- Final pilot project completed 2011
  - Alloy 600MA tubing
  - Process and software performed as expected
  - Lessons learned documented in a technical report (1022834)

# Noise Monitoring

- Recommendations for industry guidance will be developed in 2012 and presented to the Examination Guidelines Revision 8 Committee
  - Revision is underway and draft scheduled by end of 2012

# Guidance for Auto Analysis

- Retaking of auto analysis qualification test
  - All auto systems are required to test on SGMPs auto analysis performance demonstration database (AAPDD) and site specific performance database (SSPD)
    - When non conservative changes are made to algorithms the SSPD should be retaken
  - Revision 8 subcommittee is reevaluating circumstances when the AAPDD is to be retaken
  - SGMP is evaluating the need for retaking the test when there are major revisions of the AAPDD

# Guidance for Auto Analysis

- Current Practice for Comparing Auto Analysis Results to Manual Analysis Results
  - Software program does the compare
    - Compare criteria can be adjusted
      - Review 20% and greater
      - Review all “I” Codes
      - Tolerance for variance in location, phase, voltage
  - Resolution analysts determine final calls
  - In addition, there is a data analysis feedback process and an independent oversight process per Examination Guidelines

# Guidance for Auto Analysis

- Ongoing SGMP Auto Analysis Projects
  - Comparing probability of detection for dual party analysis and single pass auto analysis systems
  - Revision 8 of the Examination Guidelines will add Appendix L to better address the latest developments in Auto Analysis, such as single party analysis
    - Subcommittee considered NRC feedback from auto analysis workshop
    - Subcommittee has submitted draft to main committee
  - Continue development of algorithms for other damage mechanisms for auto analysis
  - Plan to incorporate one ANL detection algorithm into the auto analysis toolbox

# Eddy Current Essential Variable Tolerances

- Development of standardized process for determining examination technique equivalency
  - **Objective:** Develop a consistent and cost effective method to evaluate system performance, evaluate technique performance and to demonstrate substitute component equivalency
    - Draw an equivalency between existing Examination Technique Specification Sheets (ETSS) to plant specific conditions
  - **Approach:** Develop a process that will test for an equivalent magnetic field within the tubing as a basis for establishing equivalency between two similar yet differing acquisition setups.
    - Compare essential variables of EPRI ETSSs to site specific ETSSs

# Eddy Current Essential Variable Tolerances

- Technical Reports Issued
  - March 2008: Technical update report, “Development of a Process for Determining Examination Technique Equivalency” 1015126.
    - Designed and produced a master set of flawed samples that could be used to perform examination technique equivalency checks
    - Practical demonstration showing that the modified techniques can generate signals from selected calibration tube flaw equivalent to those generated by the qualified techniques



# Eddy Current Essential Variable Tolerances

- Technical Reports Issued
  - March 2009: Technical update report, “Steam Generator Management Program: Development of Standardized Process for Determining Examination Technique Equivalency”1018557
    - Review various EPRI qualified techniques compared to field techniques with modified essential variables
    - Engineering technical justification – a study based on eddy current theory to justify equivalency
    - Document the effect that changes in essential variables tolerances have on the resulting eddy current signal
    - Allowable tolerances were established for master set of flaws

# Eddy Current Essential Variable Tolerances

- Acceptable Ranges Established for Master Set of Flaws
  - Bobbin:
    - Raw voltage from the (4) x 20% FBHs must be  $\geq 80\%$  of qualified technique
    - FBH normalized voltages within  $\pm 40\%$  of qualified technique
    - FBH phase within  $\pm 20^\circ$  of qualified technique
  - MRPC:
    - Raw voltage 100% Axial EDM  $\geq 80\%$  of qualified technique
    - Normalized voltages within  $\pm 20\%$  of qualified technique
    - EDM notch phase within  $\pm 10^\circ$  of qualified technique

# Eddy Current Essential Variable Tolerances

- Technical Reports Issued
  - September 2010: Final report, “Steam Generator Management Program: Development of Documentation for Examination Technique Equivalencies”1020992.
    - Additional field data were compared to the EPRI ETSS data
    - Additional data were collected using the master set of calibration standards produced in the first phase
    - Additional data documenting the effect that changes in essential variables tolerances have on the resulting eddy-current signal

# Eddy Current Essential Variable Tolerances

- Acceptance Ranges
  - Methodology
    - Technique should be considered equivalent if all compared flaws are within the acceptance range
    - Technique is NOT equivalent if only the normalization flaw is within range; resolution is required
    - If some compared indications are outside the acceptance range, evaluate those flaw responses and document the reason for the difference

# Eddy Current Essential Variable Tolerances

- Revision 8 of the PWR SG Examination Guidelines
  - Alternate Method for Bobbin Probe and Rotating Probe Techniques for drawing equivalency
    - Appendix “H” will include acceptable ranges
    - Include a reference to the three Technical Reports
    - Contractors responsible for the three Technical Reports will be asked to participate in the effort to incorporate the findings of this project into the new guidelines

## AVB Position Verification

- Meeting February 14, 2012
  - Westinghouse
  - AREVA
  - MHI
  - Babcock and Wilcox
  - EPRI
  - Utility representatives
- Reviewed North Anna and Mihama events and causal factors
- Discussed position verification techniques and manufacturing improvements in the mid 80's
- Results from the meeting will be evaluated by the E&R TAC

# Tube Support Plate Blockage

- During the June 2011 Executive Materials Meeting it was requested that SGTF provide status of tube fouling projects to the NRC technical staff
- SGMP Project “Dynamic Analysis of a Steam Generator” (2009-2013)
  - Develop a steam generator dynamic simulation model to evaluate the effect of deposit accumulation at tube support plates on steam generator water level stability
  - Benefits
    - Assessment of tube support plate deposit loading on operational parameters (water level oscillations) for several steam generator designs

# Tube Support Plate Blockage

- SGMP Project “Prediction of SG TSP Flow Blockages” (2010-2012)
  - Develop a model to predict the blockage of broached-hole openings in topmost SG TSPs
  - Benefits
    - Quantify the probability that a plant will experience a certain level of TSP blockage during future operation
    - Reduce the uncertainty in the estimated time necessary to reach utility-defined TSP blockage levels



## Ratio of SGMP Projects for Alloy 600MA Tubing to More Advanced Materials

- During the June 2011 Executive Materials Meeting it was requested that SGTF provide the ratio of industry effort for Alloy 600MA SGs to that for the newer/replacement SGs to the NRC technical staff
  - Approximately 90% of SGMP effort is applicable to both original Alloy 600MA SGs and newer/replacement SGs with Alloy 600TT and Alloy 690TT tubing
  - About 10% of effort is focused on newer/replacement SGs only

# Top of Tubesheet Denting

- Plant Experience
  - Denting at the top of the tubesheet has occurred in 1 domestic (Alloy 690) and 10 foreign plants (worldwide)
  - 3 (Alloy 800 and Alloy 600TT) of the 11 plants have SCC indications at dents
  - Denting is associated with a hard sludge pile
- SGMP Project “Top of Tubesheet Denting” (2010-2014)
  - Review plant experience, materials of construction, chemistry
  - Literature review of low alloy steel corrosion
  - Finite element analysis using typical dent 3-D profile

# Top of Tubesheet Denting

- Benefits
  - Identify plant operating conditions and maintenance practices that lead to top of tubesheet denting
  - Investigate the extent to which potential mitigation methods would be expected to reduce the risk of SCC
  - If needed, update secondary water chemistry guidelines

# Foreign Object Task Force Update

- During the December 2011 EPRI Drop in Meeting it was requested that SGTF provide status of foreign object trends
  - A small industry group was formed June 2011 to update foreign object trend data that was first published in 2005
  - The 2005 report was the result of an industry effort to study what was considered an adverse trend in foreign object events between 2002 and 2005 and resulted in the following SGMP actions
    - Several SGMP projects were funded for foreign object detection, sizing, and analysis
    - Additional guidance was added to the Integrity Assessment Guidelines
    - Foreign Object Handbook was published

# Foreign Object Task Force Update

- The objectives of the current task force is to determine:
  - If there is an increasing trend in tube wear caused by foreign objects since 2005
  - The specific causes of the loose parts wear events that have occurred since 2005.
    - Have the causes changed
  - If there is a correlation between plants that skip inspection and plants that have problems with foreign objects (frequency and severity)
  - If there is a correlation between the plant design and the number of foreign object events
  - The status of projects that were recommended by the 2005 task force.

# Foreign Object Task Force - 2005 Report

## Conclusions are Unchanged

- No leakage caused by foreign objects since 2005
- No tube wear caused by foreign objects have exceeded performance criteria
- Quantity of reported foreign objects increased 2002 to 2005 and remains steady
  - Plants performing exams in areas that have never been inspected before (preheater inspections)
  - Heightened awareness

# TSTF-510 Planned Submittals

- From the 2011 survey

	Plan to Submit ASAP	Plan to Submit Within 3 Months of NOA	Plan to Submit Within 6 Months of NOA	Plan to Submit Within 1 year of NOA	Plan to Submit More than 1 year of NOA	No Plan to Submit
Number of Plants	1	6	3	33	18	1
Number of LAR's*	1	2	2	16	11	1
* Assumes dual unit and sister plants have common Tech Specs Notice of availability was issued October 2011						

# TSTF-510 Planned Submittals

- Update
  - Byron/Braidwood-1/2 – March 30, 2012
  - TMI-1 – March 30, 2012
  - Wolf Creek – April 26, 2012
  - Turkey Point 3/4 – Spring 2012
  - Prairie Island-1/2 – Summer 2012
  - North Anna 1/2 – Summer 2012
  - ANO-1/2 – before October 2012



## TSTF-510 Issue

- Paragraph d.2 for all the material types, the Traveler states:

"If a degradation assessment indicates the potential for a type of degradation to occur at a location not previously inspected with a technique capable of detecting this type of degradation at this location and that may satisfy the applicable **tube repair criteria**, the minimum number of locations inspected with such a capable inspection technique during the remainder of the inspection period may be prorated."

- The issue is that "tube repair criteria" should have been changed to "tube plugging [or repair] criteria" to match the rest of the wording in TSTF-510.
- The NEI TSTF and NRC met on Feb 15 and the following was discussed as resolution:
  - NEI TSTF to send letter to NRC stating that paragraph d.2 is in error and the "fix" is an administrative change to change the wording
  - NRC will respond with an acceptance letter stating that the change is not a technical change and TSTF 510 will still fall under CLIP process

# SGMP Industry Document Status and Revision Schedule

Guideline Title	Current Rev #	Report #	Last Pub Date	Implementation Date(s)	Interim Guidance	Review Date	Comments
Steam Generator Integrity Assessment Guidelines	3	1019038	Nov 2009	9/1/10	SGMP-IG-10-01	2012	
EPRI Steam Generator In Situ Pressure Test Guidelines	3	1014983	Aug 2007	3/14/08 6/14/08	None		Rev 4 in progress
PWR Steam Generator Examination Guidelines	7	1013706	Oct 2007	9/1/08	SGMP-IG-08-04		Rev 8 in progress
PWR Steam Generator Primary-to-Secondary Leakage Guidelines	4	1022832	Sept. 2011	4/11/2012 7/11/2012	None	2013	

# SGMP Industry Document Status and Revision Schedule

Guideline Title	Current Rev #	Report #	Last Pub Date	Implementation Date(s)	Interim Guidance	Review Date	Comments
PWR Primary Water Chemistry Guidelines	6	1014986	Dec 2007	6/17/08 9/17/08	SGMP-IG-09-01 SGMP-IG-11-02		Review Board Interpretation CHEM 18 issued Rev 7 will begin 2012
PWR Secondary Water Chemistry Guidelines	7	1016555	Feb 2009	8/20/09 11/20/09	None	2012	
Steam Generator Management Program Administrative Procedures	3	1022343	Dec 2010	9/1/11 12/31/11	None	N/A	
Steam Generator Degradation Specific Flaw Handbook	1	1019037	Dec 2009	N/A	None	N/A	

## Operating Experience – Alloy 690TT Tubing

- 46 units in the US with 690TT tubing
  - 43 have conducted the first in-service inspection
  - Date of first in-service inspection 1990 – 2011
- Some plants have experienced a large number of indications in the first inservice inspection
- Some have experienced a large growth in numbers of indications in subsequent inspection

## 690TT Units Affected by Wear

MECHANISM	NUMBER OF DOMESTIC UNITS AFFECTED
Foreign Object Wear	12
U-Bend Support Wear	20
Support Structure Wear	31
Tube-to-Tube Wear	2

Data from Steam Generator Degradation Database as of December 2011

## 690TT Plants Affected by Wear

- Because of the large number of indications and/or growth rates, some plants are not able to skip primary inspections
- Diagnostic examinations have been performed to verify the characteristics of wear indications
  - Wear can be flat or tapered, single or double sided

## Increase in U-Bend Support Wear in Replacement SGs

- A plant with replacement SGs with A690TT tubing experienced an increase in U-Bend support tube wear during a recent SG inspection
- During the previous inspection in 2006, ~50 indications of U-Bend support tube wear were detected with a 50% inspection
- During the 2011 SG inspection, the number of indications increased to ~2000 indications during a 100% inspection
- Condition Monitoring performance criteria were met
- Utility conducting root cause

# Tube-to-Tube Wear

- Tube-to-tube wear reported by two plants during fall 2011 SG inspections
- Details were presented to the NRC January 26, 2012 (ADAMS Accession No. ML120270416)
- SGMP initiated project 2012 to develop tube-to-tube wear ETSSs
- Root cause in progress
- SGMP committees reviewed the initial OE and determined that no immediate changes to guidance is necessary
- When root cause information is provided to SGMP, committees will reevaluate the need to enhance guidance



## Operating Experience – Alloy 600TT Tubing

- Plants are still using temporary alternate repair criteria to limit inspections in the tubesheet
- Cracking continues to be identified in Alloy 600TT tubing

Location	ODSCC		PWSCC	
	Axial	Circ	Axial	Circ
U-Bend			X	
TSP/FDB	X			
TTS/Exp Trans	X	X	X	X
Tubesheet			X	X
Tube End			X	X

Removed X from Tubesheet ODSCC based on SGDD December 2011

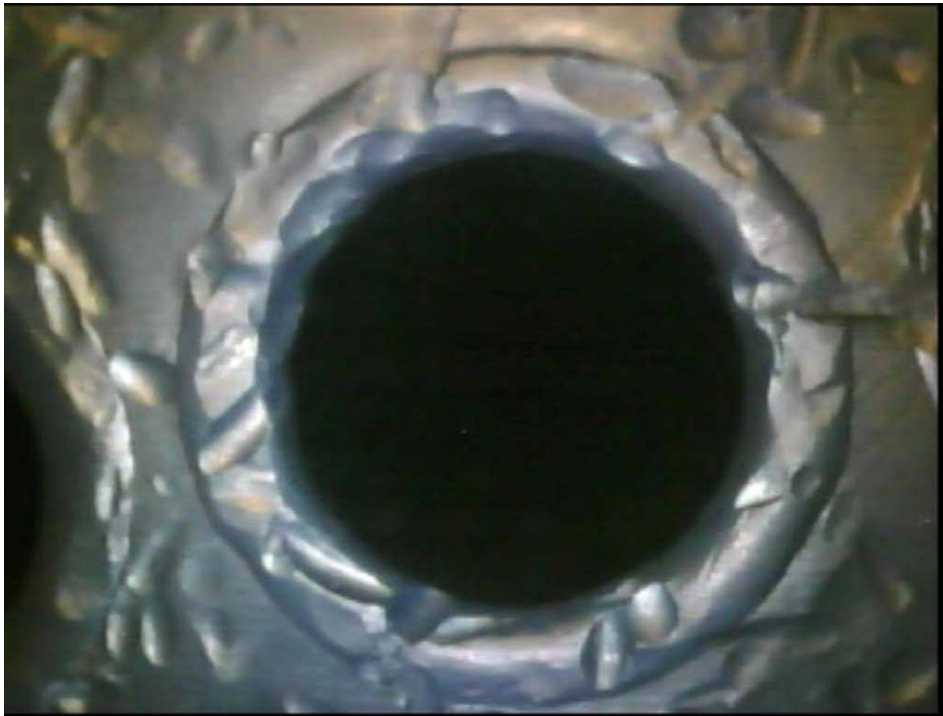
# Tube End Welds

- Impact marks identified on tube-to-tubesheet welds with bowl camera
- Marks have been there since 1989/91 time frame



# Tube End Welds

- High resolution and H\* cameras were used to evaluate the condition of the welds



# Tube End Welds

- Acceptance criteria was developed by OEM
  - Based on ASME Section III, design specification, NSSS design transients for extended power uprate, and stress report
  - Structural criteria based on number of impacts to weld
  - Leakage criteria based on loss of continuity at weld interface
  - A team of OEM engineers evaluated every tube to tubesheet weld in SG B hot leg
- All tube to tubesheet welds passed, no tubes required plugging

# August 2011 Earthquake

- US utility experienced an earthquake greater than operating basis earthquake
- Both units required to perform steam generator inspections by Section 3.10 of Examination Guidelines
  - Requirement to perform inspections during plant shutdown subsequent to any of the following conditions:
    - SG Primary-to-secondary leakage leading to plant shutdown
    - Seismic occurrence greater than the Operating Basis Earthquake
    - Loss-of-coolant accident requiring actuation of the engineered safeguards
    - Main steam line or feedwater line break

## August 2011 Earthquake

- Steam generator eddy current and visual inspections were performed on both units
- No damage identified
- Both units back on line

## August 2011 Earthquake - Basis for the Requirement

- The forced outage guidance in the current revision of the Examination Guideline was based on item 6.e. of Regulatory Guide 1.83, Revision 1, July 1975
- Typical plant Tech Specs (TS 5.5.9) also had these requirements until they were deleted as part of implementation of performance based inspection requirements in TSTF-449 Revision 4 (or equivalent)
- The change of Tech Specs was required by NRC Generic Letter 2006-01, and the NRC subsequently withdrew Regulatory Guide 1.83
- The steam generator Tech Specs are now performance based with a requirement to maintain tube integrity and meet structural and leakage performance criteria

# August 2011 Earthquake - Future Modification of Requirement

- Revision 8 of the Examination Guidelines will delete this prescriptive requirement
- Interim guidance will be developed to add a performance based requirement to the Integrity Assessment Guidelines for the following events:
  - SG Primary-to-secondary leakage leading to plant shutdown
  - Seismic occurrence
  - Loss-of-coolant accident requiring actuation of the engineered safeguards
  - Main steam line or feedwater line break



# Tie Rod Bowing

- Once through steam generator identified new tie rod bowing
  - SGA tie rod bowing remained the same (12)
  - Identified tie rod bowing in SGB for the first time (7)
  - No tube wear associated with tie rod bowing



# In Situ Pressure Tests Since Last Meeting

- One US plant performed 3 full tube in situ pressure tests May 2011
  - One indication exceeded leakage screen
    - PWSCC U-Bend axial indication at H07+10.4, 1.37 volts
  - Two tubes were tested preventively due to permeability variation
  - Tests were run up to and including 3dP
  - No leakage during tests

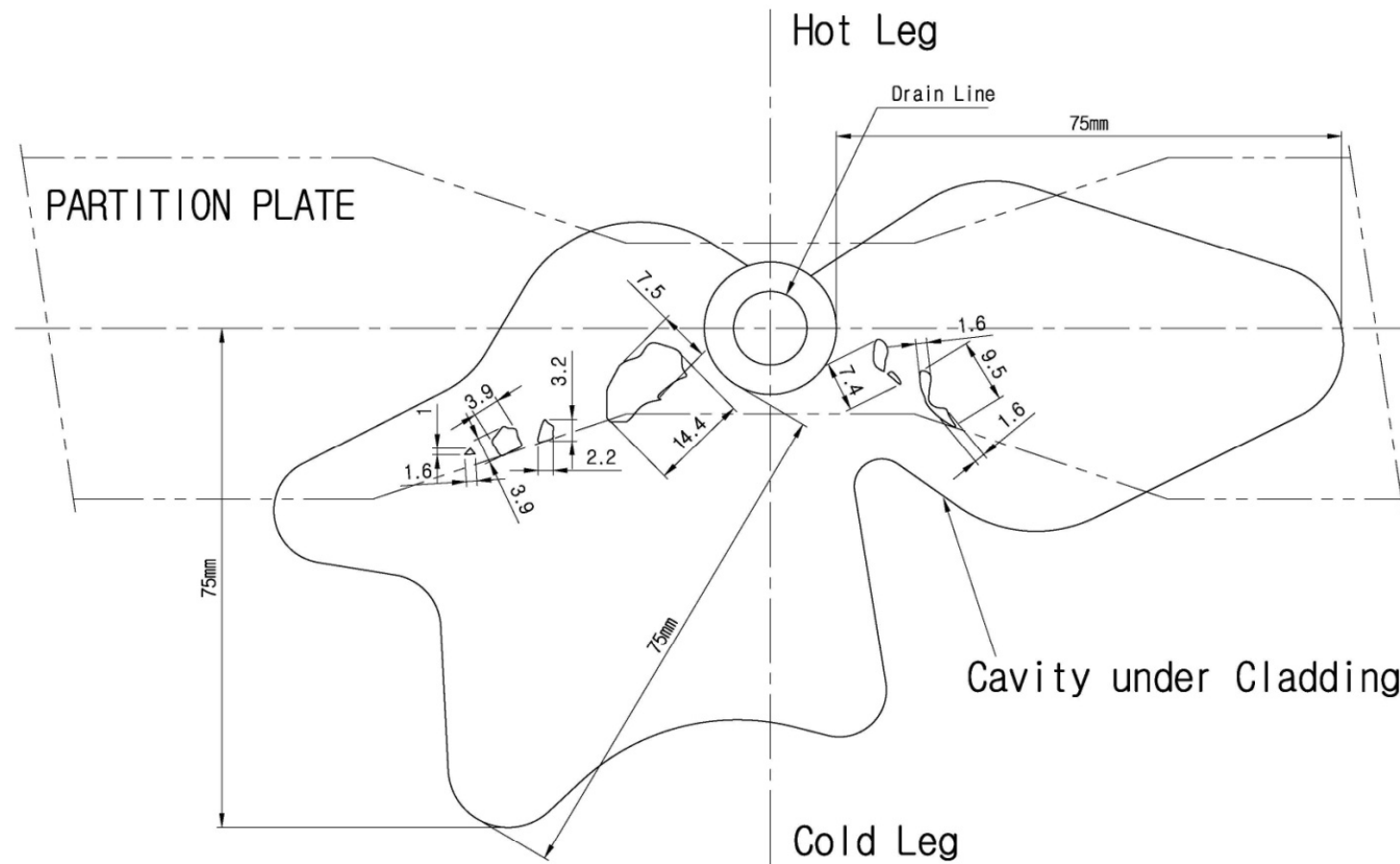
# Westinghouse Nuclear Safety Advisory Letter (NSAL-12-01)

- Issued January 5, 2012
- A foreign utility reported base metal degradation in the primary channel head in one of three steam generators
- Unit has been in operation since 1987 and the condition was noticed in Fall 2011
- The area of degradation was in bottom of the channel head near the center bowl drain and divider plate
- The visually observed degradation is located only in one SG, and only on the cold leg side of the channel head in the vicinity of the central drain line

# Westinghouse Nuclear Safety Advisory Letter (NSAL-12-01)

- The largest defect in the cladding is 7.7 mm (0.3 inch) x 14.4 mm (0.6 inch) by ultrasonic examination
- There are five other smaller observed defects in the cladding in the region of the drain line
- The degradation in the channel head base metal is a volumetric loss in the form of one large cavity which extends to a maximum depth of 28 mm (1.1 inches)
- The area of the degradation in the base metal is irregular in shape and extends a maximum of 75 mm (3.0 inches) from the edge of the drain line, with a maximum azimuthal extent of 285° about the central drain

## Sketch of the Channel Head Base Metal Cavity Geometry and Size



# Westinghouse Nuclear Safety Advisory Letter (NSAL-12-01)

- The cause of the cladding degradation is not currently known and may have been an isolated occurrence
- There has been no other reported degradation or cladding issues in this part of the SG in other SGs
- Recommendations
  - Perform a visual inspection using bowl cameras with dry SG condition the next time primary manways are open
    - Inspect the channel head cladding, divider plate-to-channel head weld, and when accessible, the weld at the top of the channel head bowl drain tube within the mouse hole
    - The inspection can be limited to the approximate area included within a 914 mm (36 inch) radius centered on the very bottom of the channel head bowl.
    - Inspecting for gross defects

# Westinghouse Nuclear Safety Advisory Letter (NSAL-12-01)

- If no degradation is detected during the initial visual inspections, document the inspection results and continue this inspection each time primary manways are open
- If degradation is detected
  - If the inside surface of the channel head has been machined smooth, use dye penetrant test to establish extent of degradation
  - Use UT from outside of the steam generator to determine if any wastage of the channel head base material has occurred
  - Perform engineering assessment

# Westinghouse Nuclear Safety Advisory Letter (NSAL-12-01)

- Westinghouse analysis justified another cycle of operation for the foreign plant as there was sufficient base metal remaining
- An E&R TAC/Westinghouse phone call took place on 1/11/2012
  - SGMP has disseminated the NSAL to all utilities regardless of SG manufacturer
  - Bowl cameras that are currently used for bowl scans should be adequate to look for similar issues
  - Utilities should treat the NSAL as Operating Experience and address it in either their corrective action program or their Degradation Assessments



## NEI 03-08 Deviations

- Two permanent deviations
  - Steam Generator Examination Guidelines, R7
    - Single pass auto analysis
  - Steam Generator Secondary Water Chemistry Guidelines, R7
    - Wet lay up steam generator sample frequency
- Two short term deviations
  - Steam Generator Examination Guidelines, R7
    - PSI prior to hydro
  - Steam Generator Secondary Water Chemistry Guidelines, R7
    - Wet lay up steam generator sample frequency



# NRC Slides



## **Address Public Questions/Comments**



# ADJOURN



# **Together...Shaping the Future of Electricity**