Westinghouse/NRC Meeting 3/20/02

Steam Generator Water Level Uncertainty Issues
NRC Meeting Agenda
3/20/02 1:30 PM

• Introduction	Hank Sepp
– Meeting Objectives	
– W Actions to Date	
• Overview of Physical Phenomena	Rick Lee
• Discussion of NSALs 02-3, 02-4 and 02-5	Rick Lee
• Customer Response to NSALs	Dave Lounsbury (WOG)
• Future Actions	
• Open Discussion	

Steam Generator Water Level Uncertainty Issue
Meeting Objectives

- Provide Background of the Mid-Deck Plate Issue
- Discuss Westinghouse On-Going Actions
- Present SG Design and Associated Phenomena
- Describe the Recommended NSAL Actions
- Identify Future Actions

SG MID DECK PLATE DATES

1. 3/87 — Model F SG Instrumented- MDP ΔP Observed
2. 1995/1999 — MDP ΔP Accounted for in RSG Analyses
3. 1996-1999 — Full Scale Testing Performed in Italy
4. 11/16/99 — NR-99-283 Opened by NPD (Pensacola) to Address Original SGs
5. 2000-2001 — Lab Test Comparisons Conducted; Developed Model for Calculating Mid-deck Plate Pressure Loss
6. 8/20/01 — IR 01-002092 Opened to Address Uncertainty Calculations
7. 9/6/01 — PI-01-014 Opened to Assess Reportability
8. 10/1/01 — W Senior Technical Review Team Meeting Held

SG MID DECK PLATE DATES

9. 10/9/01 Part 21 Closed, Not SSH
10. 10/19/01 W/WOG Core Team Telecon Held
11. 12/13/01 Engineering Analyses of Each Plant ΔP Completed
12. 1/2002 MDP NSAL Prepared; Control System NSAL Prepared
13. 2/9/02 DCPP Trip (2/14/02 Identified ΔP Related)
14. 2/15/02 NSAL 02-3 Issued
15. 2/19/02 W/WOG Core Team Telecon Held
16. 2/20/02 NSALs 02-4 and 02-5 Issued (Original Scheduled Issue Date for all three NSALs)

WESTINGHOUSE CORRECTIVE ACTION PROCESS

- Corrective Action Programs (CAPs)
- 10CFR21 Process (Potential Safety Issues, PIs)
  - WOG PI Core Team Receives Summary of Emerging Issues
  - W Determines Part 21 Reportability
- Engineering Evaluation/Analyses Completed
- NSAL Prepared/Sent to Impacted Plants

WESTINGHOUSE ON-GOING ACTIONS

1. WOG PI Core Team Telecon Held 2/19/02	• Reviewed Draft NSALS 02-4 and 02-5
2. CAPS IR Issued - High Priority 2/21/02	• Timeliness of MD Plate ΔP Communication
3. Independent Assessment/ RCA Team - 2/22/02	• R. Osterrieder - Tech Lead/ 4-Person Team
4. SGWL NSAL Workshop Held 2/27/02	• 30 Plant Representatives Attend
5. WOG Executive Committee Briefing 3/7/02	• WOG Plant VPs Provide Feedback for process enhancement
6. NRC Informational Meeting 3/20/02	• Open Meeting, SGWL Issue

Westinghouse Steam Generator
Mid Deck Plate Pressure Losses
and
Void Fraction above Mid Deck

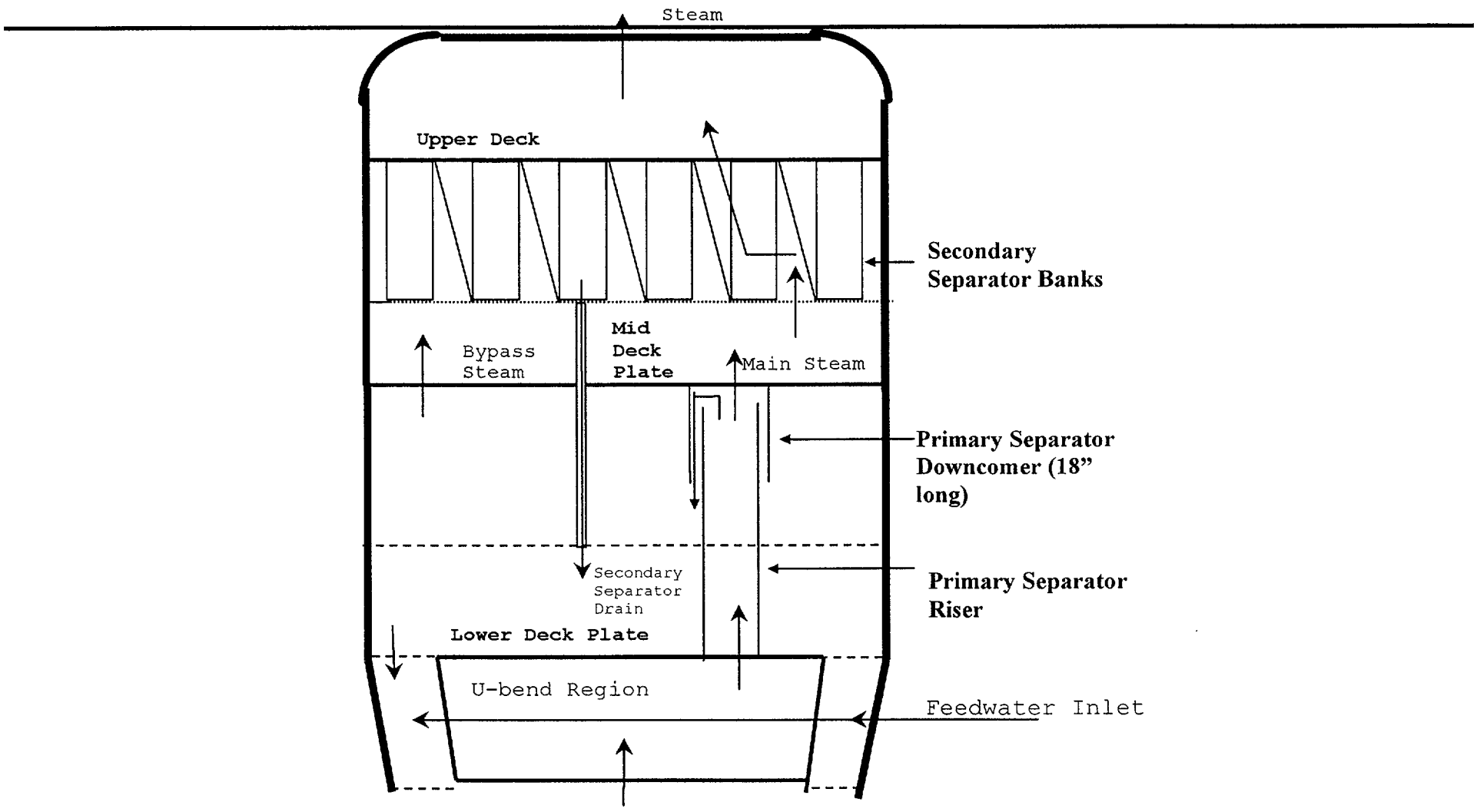
By

Rick Lee

March 20, 2002

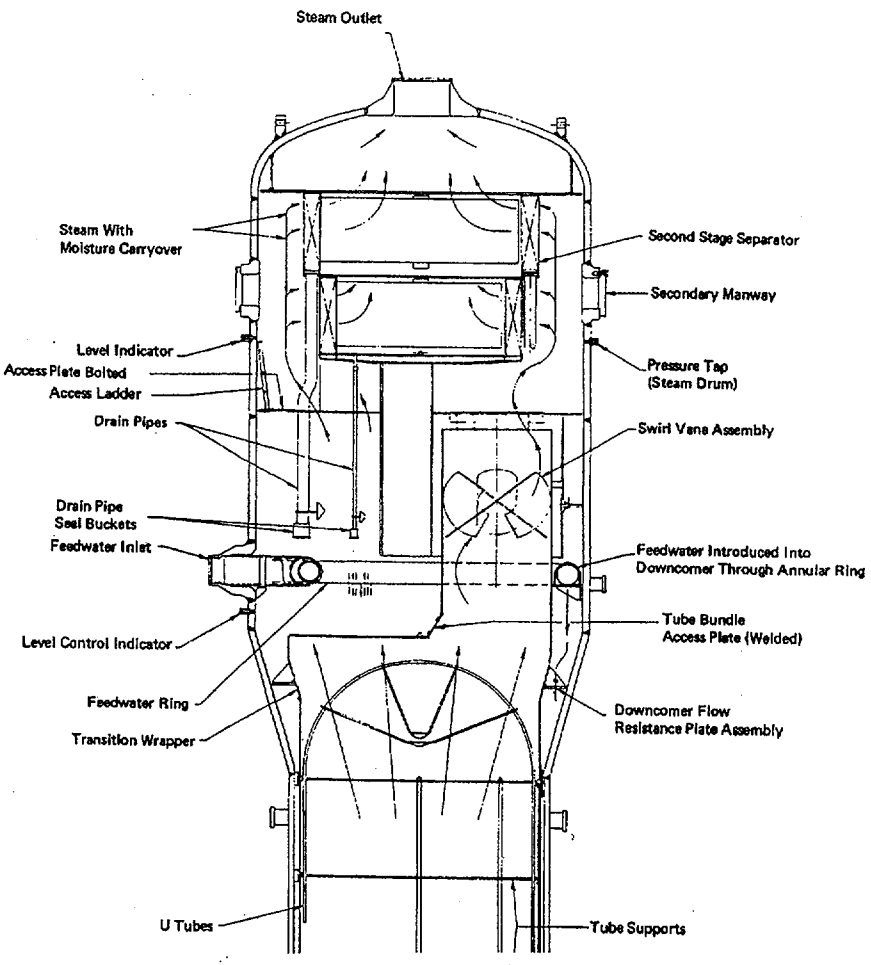
Type 1 - Primary Separators with Short Downcomers

- Modular primary separators (7 inch diameter risers) and (20 inch diameter risers)
- 18-inch long downcomers, which are not submerged under the normal water level


Steam
Upper Deck
Secondary
Separator Banks
Bypass
Steam
Mid
Deck
Plate
Main Steam
Primary Separator
Downcomer (18"
long)
Secondary
Separator
Drain
Primary Separator
Riser
Lower Deck Plate
U-bend Region
Feedwater Inlet

Type 2 - Primary Separators with Submerged Downcomers

- 20 inch diameter primaries, such as Model D's, E's and F's
- Three large diameter primaries, such as Model 24, 44 and 51's
- These have tangential nozzles just below the mid deck


Steam Outlet
Steam With
Moisture Carryover
Second Stage Separator
Secondary Manway
Level Indicator
Access Plate Bolted
Access Ladder
Pressure Tap
(Steam Drum)
Drain Pipes
Swirl Vane Assembly
Drain Pipe
Seal Buckets
Feedwater Inlet
Feedwater Introduced Into
Downcomer Through Annular Ring
Tube Bundle
Access Plate (Welded)
Level Control Indicator
Feedwater Ring
Transition Wrapper
Downcomer Flow
Resistance Plate Assembly
U Tubes
Tube Supports

Basic Operation of Primary Separators

- The fixed swirl vane (located below the top of the separator riser) separates most of the water from the upward flow, directs it to the inside wall of the riser.
- This water is channeled through perforations in the riser in many cases and/or a gap between the top of the riser and the bottom of the Mid Deck Plate.

Basic Operation of Primary Separators

- The water is channeled to a downcomer annulus thereby returning it to the recirculating water pool
- Most of the steam passes out the top of the riser through an orifice in the mid deck plate before continuing through the gravity separation space into the secondary separator (dryer) banks

Primary Separator Bypass Steam

- Phenomenon identified in water/steam Unit Cell tests
- Some steam (called bypass steam) is vented through the tangential nozzles if used
- Some bypass steam is carried through the downcomer with the separated water

Primary Separator Bypass Steam

This bypass steam must then rise through steam vents or open areas in the mid-deck plate before going into the dryer banks

Primary Separator Bypass Steam

Further evaluations have shown that steam flow through the mid deck vent area will result in a measurable pressure drop, except for:

- 35F design with primary separators with 20 inch diameter risers and the 44F/47F designs with seven inch diameter modular primary separators
- Both have a very large mid deck plate vent area, and a large annulus between deck and shell

Importance of Mid Deck Plate in Reducing Moisture Carryover

- The original Delta 75 replacement steam generators had no real mid deck plate, resulting in MCO greater than the limit of 0.10%
- The addition of separator downcomer restrictors and the addition of a mid deck plate brought the MCO to less than 0.10%

Summary of variables that impact the loss

Based on evaluation of:

- Full-scale steam/water separator tests
- Computer code evaluations
- Comparison to plant data

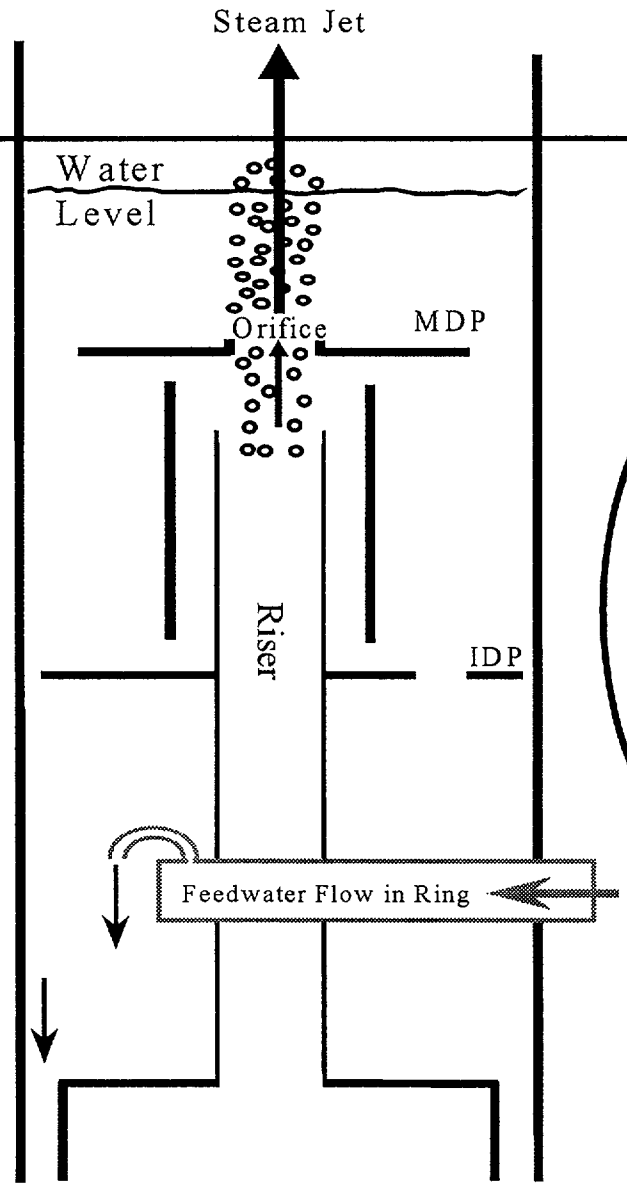
Summary of variables that impact the loss

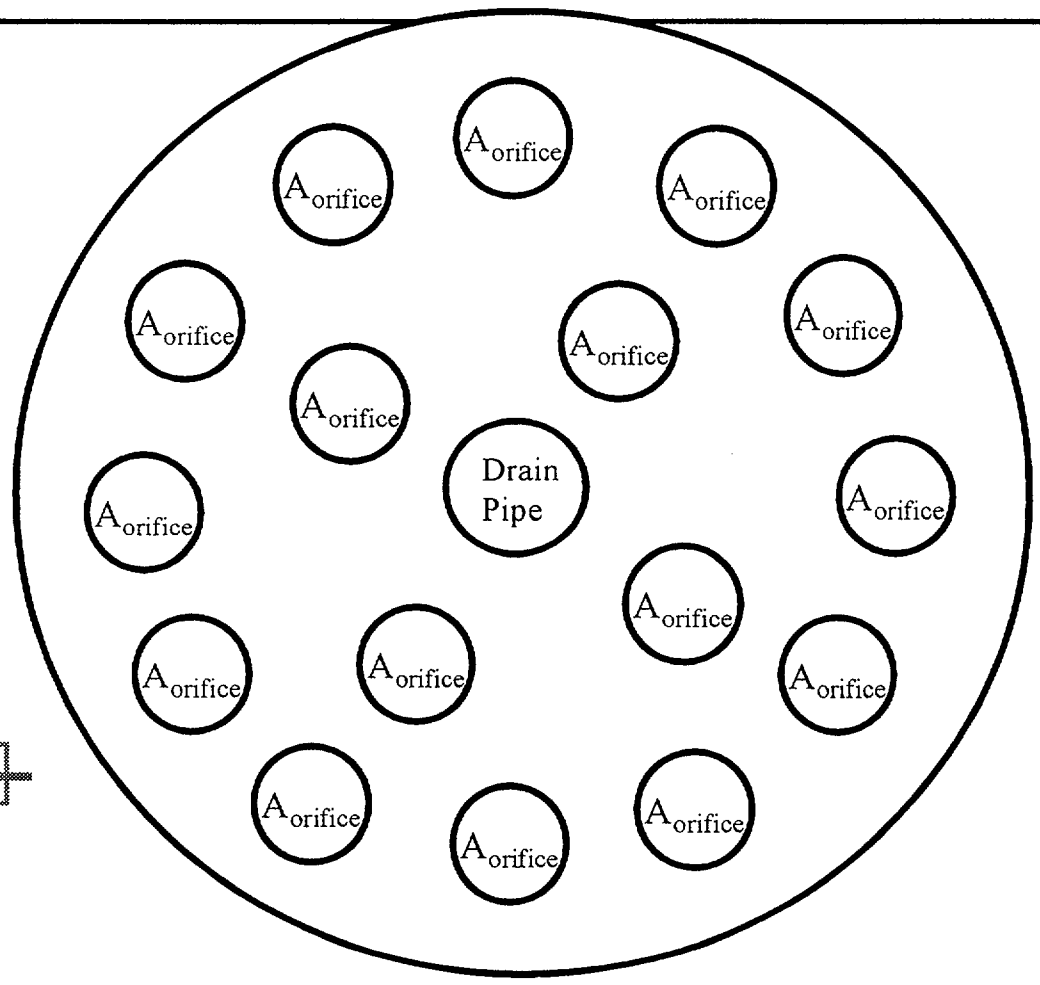
- Mid Deck Plate pressure losses correlate well with steam flow rate
- Mid Deck Plate open area variations have a significant impact (area corrections developed by computer code evaluations)

Summary of variables that impact the loss

- Circulation ratio has a negligible impact
- Steam pressure has a negligible impact
- Mid deck plate pressure loss remains constant as water level decreases below nominal

Void Fraction Above Mid Deck





Orifice and central drain pipe in upper shell

OVERVIEW

NSAL-02-4

NSAL-02-3

NSAL-02-5

March 20, 2002

R. H. Lee

Safety Systems Operations

Westinghouse Electric Company, LLC

NSAL-02-4: Maximum Reliable Indicated Steam Generator Water Level

Phenomenon: When water level is above the mid-deck plate, it is also above the exit of the swirl vane separators. This results in a significant two-phase mixture of water and steam above the mid-deck plate.

Impact: The voids (steam) in the water reduce the density of the water that is above the mid-deck plate. This results in an error in the direction of indicated level lower than actual level. Thus, a Maximum Reliable Indicated Level (MRIL) exists which is less than 100% narrow range span.

NSAL-02-4: Maximum Reliable Indicated Steam Generator Water Level

Applicability:

1. All Westinghouse designed steam generators
2. Not applicable to CE designed steam generators.

NSAL-02-4: Maximum Reliable Indicated Steam Generator Water Level

Evaluation:

1. Determine the MRIL using the void fraction in Attachment 1.
2. If the SAL for the high-high trip is lower than the MRIL, no action is required.
3. If the SAL is above the MRIL, determine if the NTS is acceptable using the MRIL. If adequate margin exists, no action is required. If there is insufficient margin, the NTS must be lowered.

NSAL-02-4: Maximum Reliable Indicated Steam Generator Water Level

Results:

All plants for which Westinghouse maintains the current calculation of record can maintain current NTS.

NSAL-02-3: Steam Generator Mid-deck Plate Pressure Loss

Phenomenon: Flow of steam through the vent area in the mid-deck plate results in a pressure drop across the plate

Impact: A bias in the uncertainty of the steam generator low-low level trip. Direction is indicated level is higher than actual.

NSAL-02-3: Steam Generator Mid-deck Plate Pressure Loss

Applicability:

1. All Westinghouse designed steam generators
2. The mid-deck plate d/p must be considered for the Loss of Normal Feed (LONF) and Loss of Offsite Power (LOOP) transients.
3. The mid-deck plate d/p does not need to be considered for Feedline Break (FLB) transient when the break occurs between the steam generator and the check valve.
4. Not applicable to CE designed steam generators.

NSAL-02-3: Steam Generator Mid-deck Plate Pressure Loss

Evaluation/Recommendations:

1. Add the new bias to the existing uncertainty for low-low level trip
2. Is there sufficient margin between the current NTS and SAL?
3. If yes, no modifications to NTS or SAL are necessary, but the low-level trip uncertainty calculation should be updated.
4. If no, evaluate if the SAL can be lowered. Reevaluation of transients will be required.
5. If SAL cannot be lowered, NTS should be raised.
6. Review the allowable value calculation for possible impact.

NSAL-02-3: Steam Generator Mid-deck Plate Pressure Loss

Revision: A revision to this NSAL will be issued to:

1. **Remove vague statement regarding lower tap elevation relative to the lower deck plate.**
2. **Provide guidance relative to AMSAC setpoint.**
3. **Include a discussion on steamline breaks outside containment.**
4. **Change two plants from Category 2 to Category 1 plants.**
5. **Clarify feedline break location (between S/G and check valve).**

NSAL-02-5: Steam Generator Water Level Control System Uncertainty Issue

Situation: The steam generator water level uncertainties at normal operating level which are used in initial condition assumptions for various safety analyses may not be bounding.

Background: Westinghouse recently completed calculations for two plants which resulted in large uncertainties; +11% for a Model 54F S/G, and -19.5% for a Model D5 S/G. The -19.5% uncertainty occurred at 20% power. The +11% uncertainty was at 100% power.

NSAL-02-5: Steam Generator Water Level Control System Uncertainty Issue

Evaluation/Recommendations:

1. Calculate the steam generator water level uncertainty at normal operating level, including the impact, if any, of the mid-deck plate d/p.
2. Compare these results to the water level uncertainties used in the safety analyses, to determine if the uncertainties used are bounding.
3. If the uncertainties are not bounding, determine the potential impact on the results of the analyses, and if any safety analyses need to be redone.

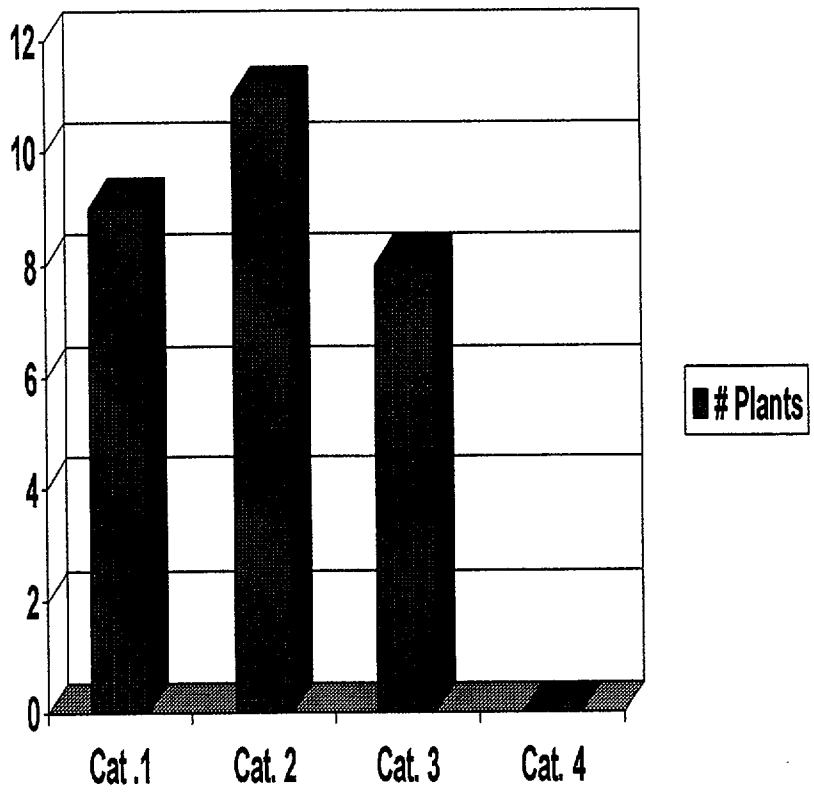
NSAL-02-5: Steam Generator Water Level Control System Uncertainty Issue

Evaluation/Recommendations (continued):

4. **Determine which, if any, safety analyses need to be considered at part-power (0%< Power <100%)**
   a. **Westinghouse is determining which safety analyses, if any, must be considered at part-power.**
   b. **For safety analyses that Westinghouse does not hold for the plant, the responsible group must determine which analyses, if any, must consider part power conditions.**
5. **Calculate the water level control uncertainty for part- power condition, as required.**
6. **Perform safety analyses at part-power condition, as required.**

WOG Interim Survey Results - Response to SG Mid-deck Plate NSAL

- Category 1 - Reviewed the NSAL - No action needed
- Category 2 - Reviewed Analysis - No setpoint changes needed
- Category 3 - Reviewed the NSAL - Setpoint changes made
- Category 4 - Reviewed the NSAL - Still in evaluation



Westinghouse Future Actions

- Issue revision to NSAL 02-3 - 3/2002
- Complete Westinghouse Assessment (RCA) - 5/2002
- Implement recommendations from the Westinghouse Assessment (RCA)
- Continue to address SG WL NSAL Workshop action items, as appropriate
- Planned revision to NSAL-02-5 , "SG Water Level Control System Uncertainty" in progress

Open Discussion