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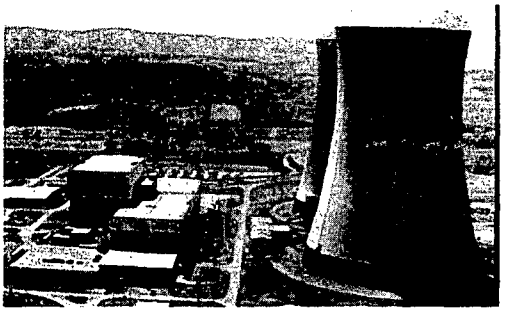
Susquehanna Steam Dryer Replacement

NRC Meeting
June 29, 2007

Rockville, MD



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Steam Dryer Replacement

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Agenda

- Overview of SSES CPPU Steam Dryer Licensing and Design Approach
- Corrective Action Status
- Replacement Dryer Design Overview
- Steam Dryer Instrumentation Plan
- Power Ascension Test Plan/Start-Up Limits

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Overview

- Steam dryer licensing basis is conservative and meets ASME fatigue limit of 13,600 psi
- The as fabricated replacement steam dryer will have reduced stress intensities and increased margins to the ASME fatigue limit
- The revised FEM provides results less that the ASME fatigue limit
- Replacement dryer designed for CPPU conditions
  - [[ ]]
  - Improved dryer joint/weld design and fabrication techniques
  - Design and fabrication conducted under 10CFR50, Appendix B
- Unit 1 steam dryer instrumented for 107% CLTP
  - Demonstrates structural adequacy of new steam dryer design
  - Validates steam dryer analysis tools
- Power ascension test program
  - Slow and deliberate
  - Confirms no acoustic resonances at 114% CLTP
  - Allows validation of analysis and steam dryer design prior to full CPPU operation
  - Confirms acceptability of steam dryer up to full CPPU conditions
  - Provides for communication to NRC

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CPPU Dryer Licensing Approach

- Based on conservative steam dryer design
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  - Stresses benchmarked to 1985 strain gage data
  - Assumes same weld details as used on current dryer
  - Does not include fabrication stress reduction techniques
- Power ascension test plan overview
  - Acceptance criteria based on 13,600 psi ASME fatigue limit
  - MSL start-up limit curves based on submitted stress report
  - Unit 1 steam dryer instrumented (strain, pressure, & acceleration) for operation up to 107% CLTP
  - Unit 1 107% CLTP acceptance criteria (values) based on final fabricated steam dryer and steam dryer instrumentation data
  - MSL start-up limit curves validated by steam dryer instrument data and revised as necessary
  - Unit 1 and Unit 2 full CPPU acceptance criteria based on validated MSL start-up limit curves
- Summary reports provided to NRC
- Post implementation inspections

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CPPU New Dryer Design Approach

- Based on specific Susquehanna plant steam dryer data
- New steam dryer design
  - Improved structural design
  - Designed and fabricated under 10CFR50, Appendix B
  - Fabrication utilizes stress reduction techniques
- Approach will be validated
  - Start-up testing
    - Measure actual dryer stresses and loads
    - Validate ACM load definition
  - Periodic inspections
- Design of Record
  - Revised stress analysis incorporating data from steam dryer instrumentation
  - Incorporate stress reduction fabrication details into revised analysis
  - Updated stress analysis becomes the steam dryer design basis

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GE CORRECTIVE ACTION REPORT

Susquehanna Steam Dryer Finite Element Model Input Condition

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Corrective Action Overview

- Support lug locations misplaced
  - Under lifting rods for most dryers
  - Negligible impact on component mode shapes
  - Minor impact on dryer stresses
- Corrective actions to assure quality
  - Internal GE reverification of FE model
  - PPL/3rd party review of FE model
  - No additional discrepancies found

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Corrective Action Impact – Support Lug Stress Results Impact

- Limiting Component
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- Minimum stress margin at full CPPU
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REPLACEMENT STEAM DRYER OVERVIEW

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Replacement Steam Dryer Overview

- Utilized OE from Quad Cities and Dresden replacement steam dryers
- Overall Design Approach
  - Maintain basic geometry
    - Load definition development remains applicable
      - 1985 instrumented dryer measurements
      - 2006 main steam line measurements
      - MSIV slow closure testing
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Replacement Steam Dryer Overview

- Overall Design Approach
  - Improve fabrication details to reduce or eliminate stress intensities
    - Eliminate surface cold working
    - Weld factor optimization
      - Full penetration welds
      - Minimize plate thickness mismatches
    - Move or eliminate welds from high stress locations
    - Use extruded and preformed sub-components
    - Solution anneal sub-components
    - Design and fabricated under 10CFR50, Appendix B

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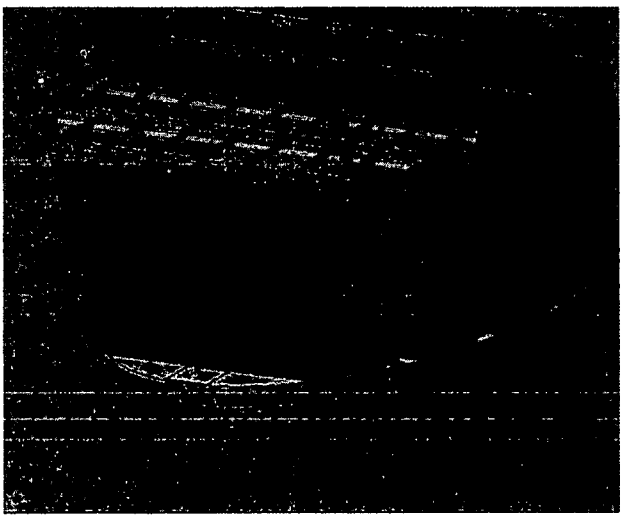
Current Susquehanna Dryer



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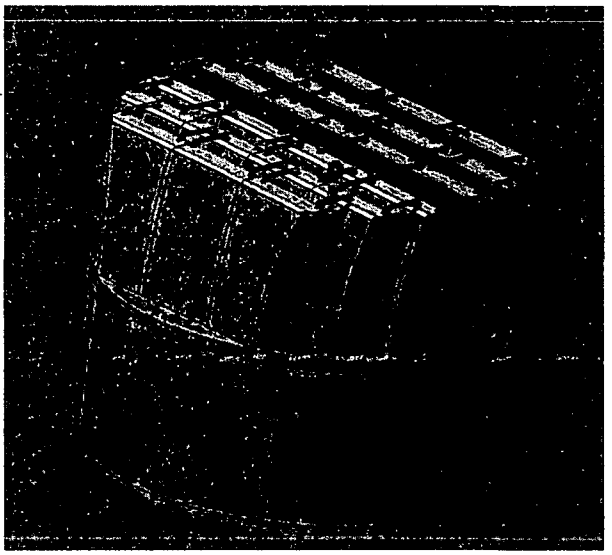
Replacement Susquehanna Steam Dryer



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STEAM DRYER INSTRUMENTATION PLAN

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Steam Dryer Instrumentation Plan (PLA-6176)

Vibration Measurement Program Goals

- Validate the structural adequacy of the replacement steam dryer design under CPPU conditions for first two steps (107% CLTP)
- Validate load definition and structural analysis models used for the full CPPU analysis
- Validate the main steam line strain gage limit curves

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Steam Dryer Instrumentation Plan

- Steam dryer strain gages
  - Primary instrument for monitoring structural response (Unit 1, first two CPPU steps)
- Steam dryer accelerometers
  - Monitor dryer rocking, mechanical vibration from recirculation pump vane passing frequency (Unit 1, first two CPPU steps)
  - Provides backup to strain gages for structural response
- Steam dryer pressure sensors
  - Benchmark pressure load definition (Unit 1, first two CPPU steps)
  - Provides backup to strain gages
- Main steam line strain gages
  - Primary instrument for monitoring structural response (Unit 1, third and fourth CPPU steps and all Unit 2 steps)

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Main Steam Line Sensor Summary

- Two locations monitored per steam line
- Four strain gauges per location
- Total of 32 strain gages installed on four steam lines per unit

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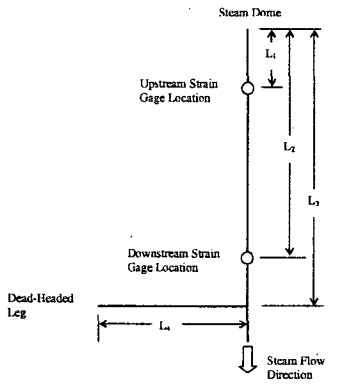
Main Steam Line Strain Gauge Locations



Length	MSL A (ft)	MSL B (ft)	MSL C (ft)	MSL D (ft)
Distance from steam dome to upstream SG location (L_1)	22.8	22.8	22.8	22.8
Distance from steam dome to downstream SG location (L_2)	52.7	49.6	48.3	52.6
Distance from steam dome to dead-headed leg location (L_3)	54.4	NA	NA	54.4
Length of dead-headed leg (L_4)	24.1	NA	NA	24.2

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Main Steam Line Strain Gauge Acceptance Criteria

- Based on 80% CLTP slow MSIV closure data and 100 CLTP data
- Base data is used to develop baseline curves for each MSL location
- Limit curves developed from baseline curves
  - Baseline factored by ratio of ASME endurance limit to peak dryer stress intensity
  - Bias and uncertainty included in calculation of peak stress
  - Assessments based on frequency dependent uncertainty factors
  - The baseline factor is calculated for multiple high stress locations to assure it is limiting

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POWER ASCENSION TEST PLAN

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Power Ascension Test Plan (PLA-6176)

- 3 Main Elements
  - Slow and deliberate power ascension
    - Defined hold points
    - Time allowed for monitoring and analysis
  - Monitoring, analysis, and trending program
    - Steam dryer instrumentation
    - Main steam line strain gages
    - Piping accelerometers
    - Moisture carryover
  - Post CPPU monitoring and inspection program to verify dryer and piping performance above CLTP conditions

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Power Ascension Test Plan

Slow Deliberate Power Ascension

- Obtain baseline observations at 100% CLTP
- Maximum hourly power increase restriction ~1 % CLTP per hour (~34.8 MWt)
- During power increases, obtain steam dryer instrument (Unit 1 only), main steam line strain, and piping vibration data at each 3.5% power ascension step.
- Each 3.5% power ascension step (~122 MWt)
  - Compare strain and vibration data to acceptance criteria
  - Obtain/ evaluate moisture carryover data
  - Perform plant walk downs
  - Review data evaluation and walk down results

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Power Ascension Test Plan

Steam Dryer Monitoring and Analysis

- Level 1: Allowable Stress Exceeded (13,600 psi)
  - Action – Reduce power level to previous acceptable level
- Level 2: Low Margin to Allowable Stresses (11,000 psi)
  - Action – Hold at current power and re-evaluate
- Steam dryer pressures and MSL strain measurements used to validate and benchmark analytical tools
- Unit 1, 3rd and 4th steps and all Unit 2 steps monitored using MSL strain measurements
  - MSL limit curves updated after benchmark against steam dryer instrument data

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Power Ascension Test Plan

Steam Dryer Monitoring and Analysis

- MSIV Slow Closure Test
  - Measurements taken at ~80% CLTP to simulate 107% CLTP
    - Benchmark composite pressure load definition used in FEA
  - Measurements taken at ~85.5% CLTP to simulate 114% CLTP
    - Confirm the "no acoustic resonance" prediction
    - Confirm power scaling factor used to calculate full CPPU stresses
- Increased Core Flow
  - Measurements taken at 107% CLTP power, increased core flow range

    100 - 108 Mlb/hr
    - 1 or 2 Mlb/hr steps
    - Benchmark and evaluate recirculation vibration load definition used in FEA
    - Moisture Carryover
  - Moisture carryover measurements taken at each 3.5% power ascension step over 100% CLTP
    - Acceptance criterion ≤ 0.1% by weight
    - Action – Hold at current power level and re-evaluate

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Power Ascension Test Plan

Steam Dryer Monitoring and Analysis

Unit 1 at 107% CLTP

- Validate, benchmark load definition and structural analysis analytical tools
- Validate, benchmark CPPU scaling factor
- Limit curves will be validated on Unit 1 measurements at 107% CLTP
- Validated MSL power ascension limit curves will be used for ascension to 114% CLTP for Unit 1 3rd and 4th steps, and all Unit 2 steps
- Monitored using MSL strain measurements

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Power Ascension Test Plan

Post CPPU Monitoring and Inspection Program

- Moisture Carryover and Plant Parameters
  - Per station operating procedures
- Strain gage/Accelerometer Monitoring
  - Dryer, MSL data collection as appropriate during remainder of operating cycle as long as instrumentation remains operable
- Steam Dryer Monitoring and Inspection
  - Plant parameter monitoring during operation
  - Dryer inspections during refueling outages per BWRVIP-139
  - Inspections and Walk Downs

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Power Ascension Test Plan

NRC Communication

- Written reports on steam dryer upon completion of test program for each CPPU fuel cycle will be forwarded to NRC staff
  - Relevant data collected at each power step
  - Comparisons to performance criteria (design predictions)
  - Steam dryer structural integrity monitoring evaluations
  - Evaluations or corrective actions required to obtain satisfactory dryer performance
- Reports will be provided for
  - Unit 1 at 107% CLTP
  - Unit 2 at 114% CLTP
  - Unit 1 at 114% CLTP

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Power Ascension Test Plan Summary

Slow and deliberate power ascension

- New Steam Dryers
- Dryer on Unit 1 instrumented for 107% CLTP uprate
- Steam dryer strain gages used for Unit 1 107% CLTP acceptance criteria
- MSLs on both units instrumented
- Methods benchmarked to in-plant measurements before proceeding to full CPPU
- Main steam line strain gages used for Unit 1 114% CLTP and Unit 2 114% acceptance criteria
- Provides feedback to the NRC

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Additional Questions?

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