NEI Gas/Void Workshop

Palo Verde Nuclear Generating Station
Optira
Unit 1 SI Pipe Insulation ON/OFF Study

Savannah, GA

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Palo Verde Nuclear Generating Station (PVNGS) Optira (Omaha, NE)

Laser Scanning Insulation ON/OFF Study

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PVNGS – CE System 80

- 2 Identical Emergency Core Cooling System (ECCS) Trains
- Separate suction feed from the Refueling Water Tank (RWT)
- Separate suction feed from the Containment Recirculation Sump
- 1 High Pressure Safety Injection (HPSI) pump per train
- 1 Low Pressure Safety Injection (LPSI) pump per train
- 1 Containment Spray (CS) pump per train

Resulting Actions from Generic Letter 2008-01

- Extensive laser scanning of the SI piping to determine pipe slope and high points

- To minimize subsequent cost, Unit 1 was completely laser scanned with insulation on and then off (insulation removed on horizontal piping only)

Resulting Actions from Generic Letter 2008-01

- PVNGS uses 3 types of insulation on the SI system.
  - Aluminum clad Calcium Silicate (CalSil) in the Auxiliary Building
  - Stainless Steel Reflective Mirror (RMI) in the Containment Building
  - Aluminum clad Formed Fiberglass (FFG) in the Essential Pipe Tunnel

Resulting Actions from Generic Letter 2008-01

- Laser Scanned approximately 4800 feet of SI piping
  - 3300’ Auxiliary Building (CalSil)
  - 1300’ Containment (RMI)
  - 200’ Essential Pipe Tunnel (FFG)
- Comparison performed on approximately 3500 feet of SI piping
  - 2200’ Auxiliary Building (CalSil)
  - 1100’ Containment (RMI)
  - 200’ Essential Pipe Tunnel (FFG)

Resulting Actions from Generic Letter 2008-01

- Pipe Diameters Scanned
  - Aux
    - Suction - 24” (Sump), 20” (RWT), 18”, 16”, 14”, 10”
    - Discharge – 20”, 12”, 10”, 6”, 4”, 3”, 2”
  - CNTMT
    - Suction - 24” (Sump), 16” (SDC)
    - Discharge – 14”, 12”, 10”, 3”
  - Essential Pipe Tunnel
    - Suction - 20” (RWT)

Resulting Actions from Generic Letter 2008-01

- Optira performed a statistical (least squared linear regression test) comparison for the 3 individual types of insulation (Al clad Calcium Silicate (CalSil), Al clad formed fiberglass (FFG) and Reflective Mirror (RMI))

Data Collection

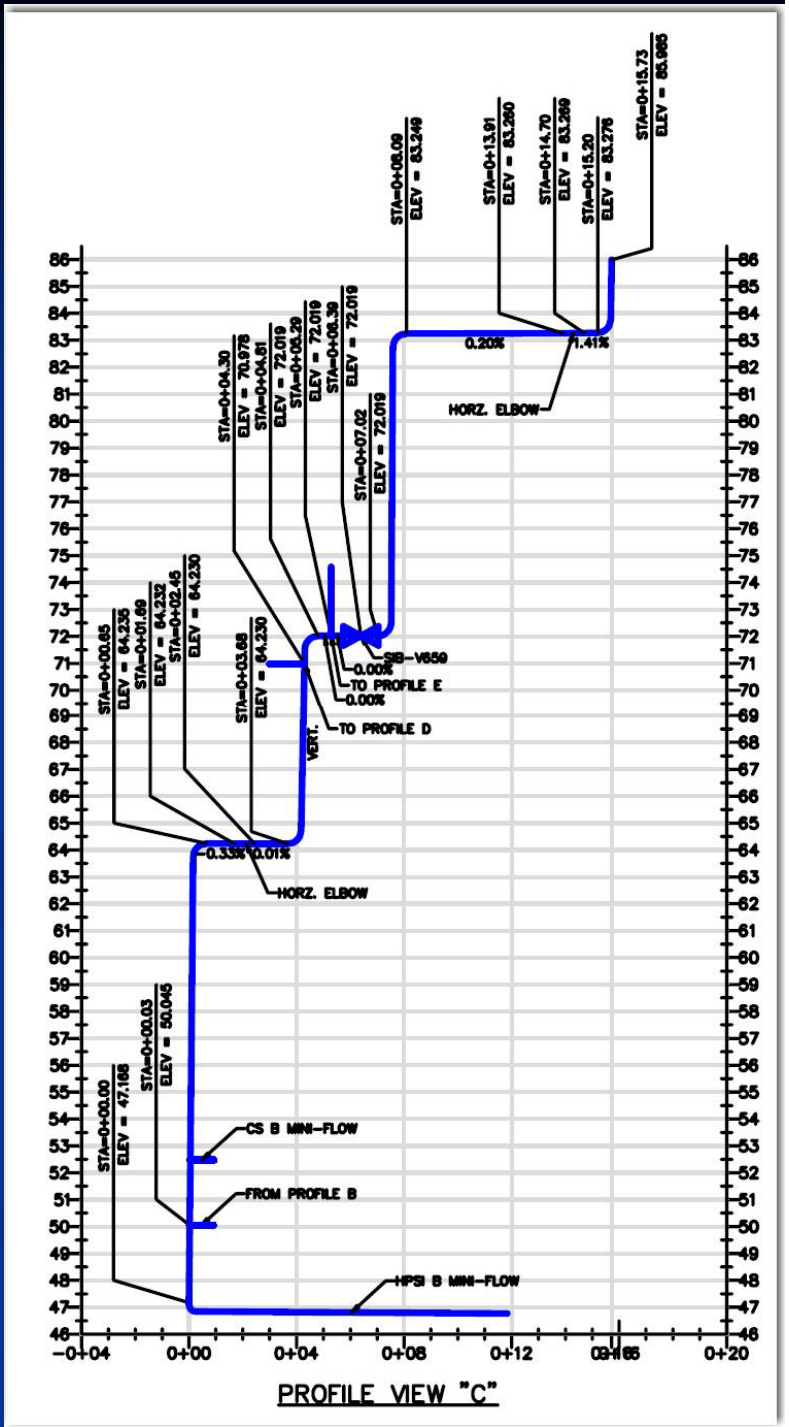
- Data Collected with Phase-Based 3D Laser Scanners.
- Lasers validated twice daily by modeling Optira designed calibration artifacts traceable to NIST
- Entire SI system placed on plant grid coordinates using Total Station Survey System
- Acceptable tolerance limits at +/-3mm and below

Data Extraction

- Leica Cyclone-MODEL v.6
- Double Entry Method
- In-house Data Entry Application
- Microsoft SQL Server 2005
- Segment Centerline Endpoints
  - WITH Insulation
  - WITHOUT Insulation

Typical One Line Drawing

One Line Drawings are AutoCAD views of a system by elevation and used to depict and then calculate high points along a centerline of pipe along that system.



Data Processing

- In-house Data Transform Application
- Normalized Data for each Type [0, 1]
- Microsoft Excel Analysis Pack Add-in
- Regression
  - Case 1 as “real” value
  - Case 2 as sample value
  - Intra Partitions based on residual clustering

Model Validation

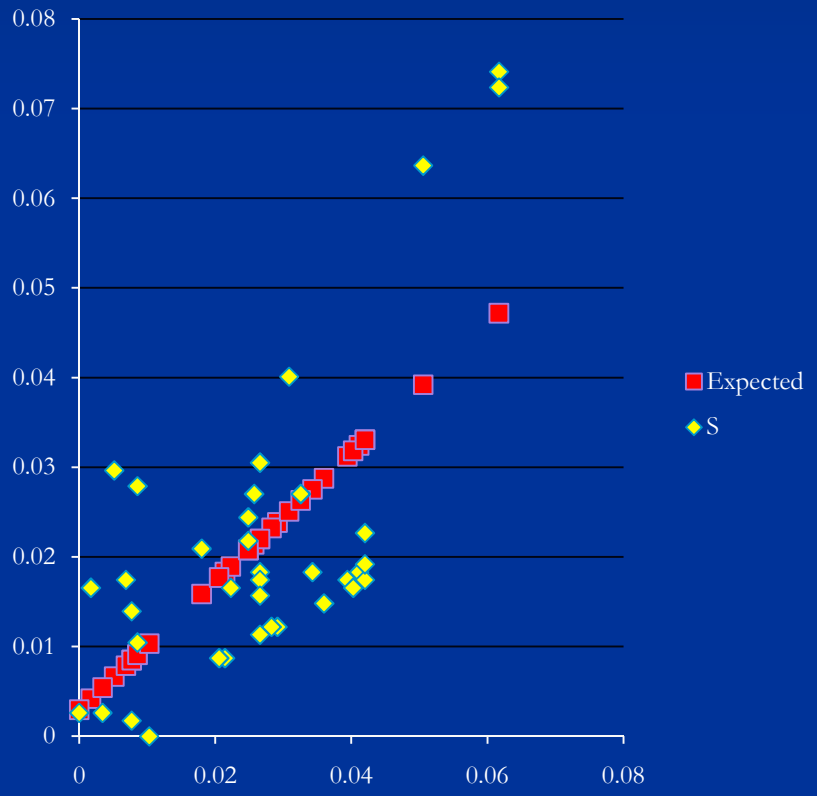
- R values extremely good…
- But, R alone is not enough
- Graphical model confirmation
  - Regression Model plots "stacked"
  - Visually, the sample data fits the modeled values

Resulting Actions from Generic Letter 2008-01

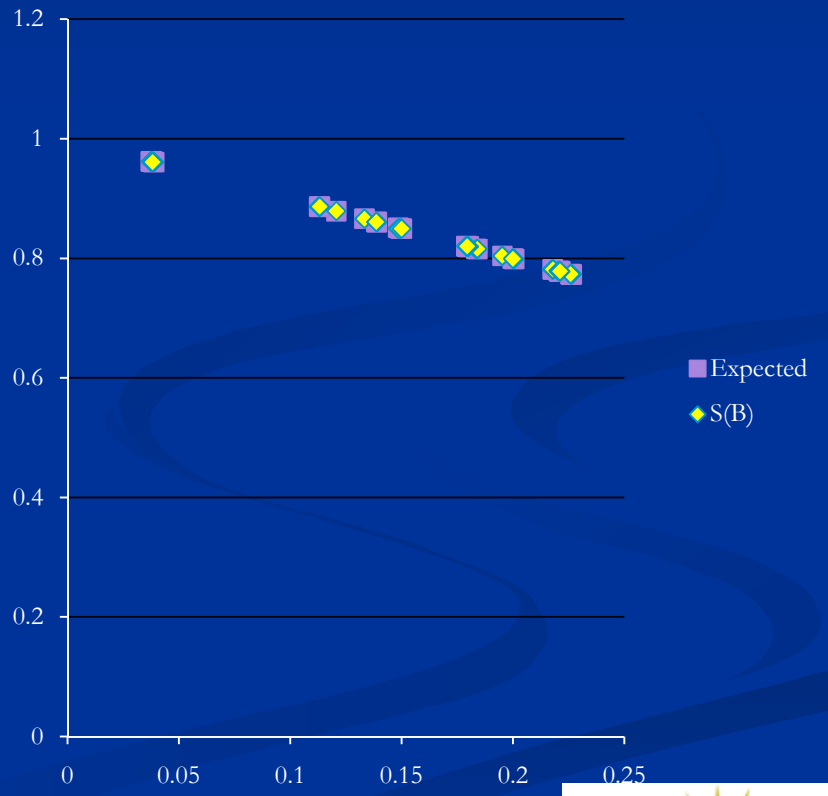
- Least squared linear regression test demonstrated CalSil and FFG were excellent predictors of the un-insulated pipe's high point having accuracy between 99.89 and 99.99 percent, while the RMI insulation proved less than 45.00 percent accurate based on the Adjusted R from the respective regression models

Regression Fits

RMI Model



CalSil Model



QUESTIONS