

ESBWR Main Steam Line Stress Analysis

May 2006



imagination at work

Scope

- Steam Lines 1 Through 4 Including DPV and SRV Outlet Flanges
- From RPV Nozzles to Containment Penetrations
- Modeling Includes SRV Discharge Lines to Suppression Pool

Classification

- Quality Group A and Requirements for Class 1 Components per Subsection NB, ASME Code Section III
- Seismic Category I

Design Requirements

- Design Pressure: 1250 PSI
- Design Temperature: 575° F
- Design Life: 60 Years
- Special Stress Limits
 - **Stress Range Not to Exceed $2.4 S_m$ for Eq. 10;
or Eq. 12 and 13 per NB-3653**
 - **Cumulative usage Factor < 0.10**

Input Loads

- Static Loads:

- Pressure

- Weight

- Thermal Expansion

- Dynamic Loads:

- Seismic

- LOCA; Chugging, Condensation, Annulus Pressurization

- SRV Actuations

- Turbine Stop Valve

Design & Analysis

- Design Specification Prepared by GE
- TSV Dynamic Inputs Prepared by GE
- SRV Dynamic Inputs Prepared by GE
- Main Steam Line Stress Analysis Performed by
Empressarios Agrupados

Extent of Analysis Results

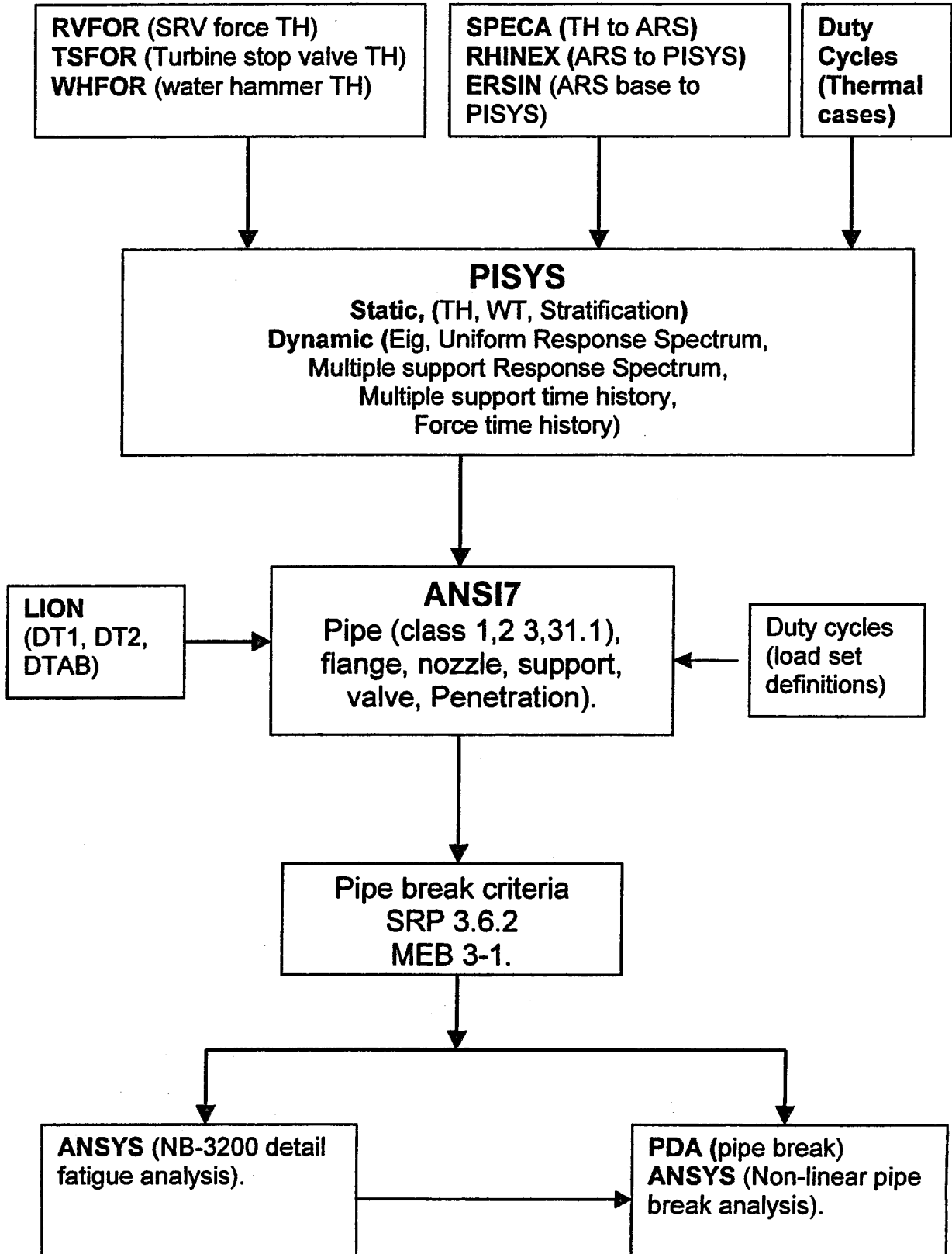
- Main Piping Stress Analysis & Cumulative Usage
- Component Stress Intensities & Usage
- Detailed Forces, Moments, Deflections
- Detailed Interface Loads
- Valve Accelerations
- Support Loads
- System Eigenvalues
- Duty Cycles

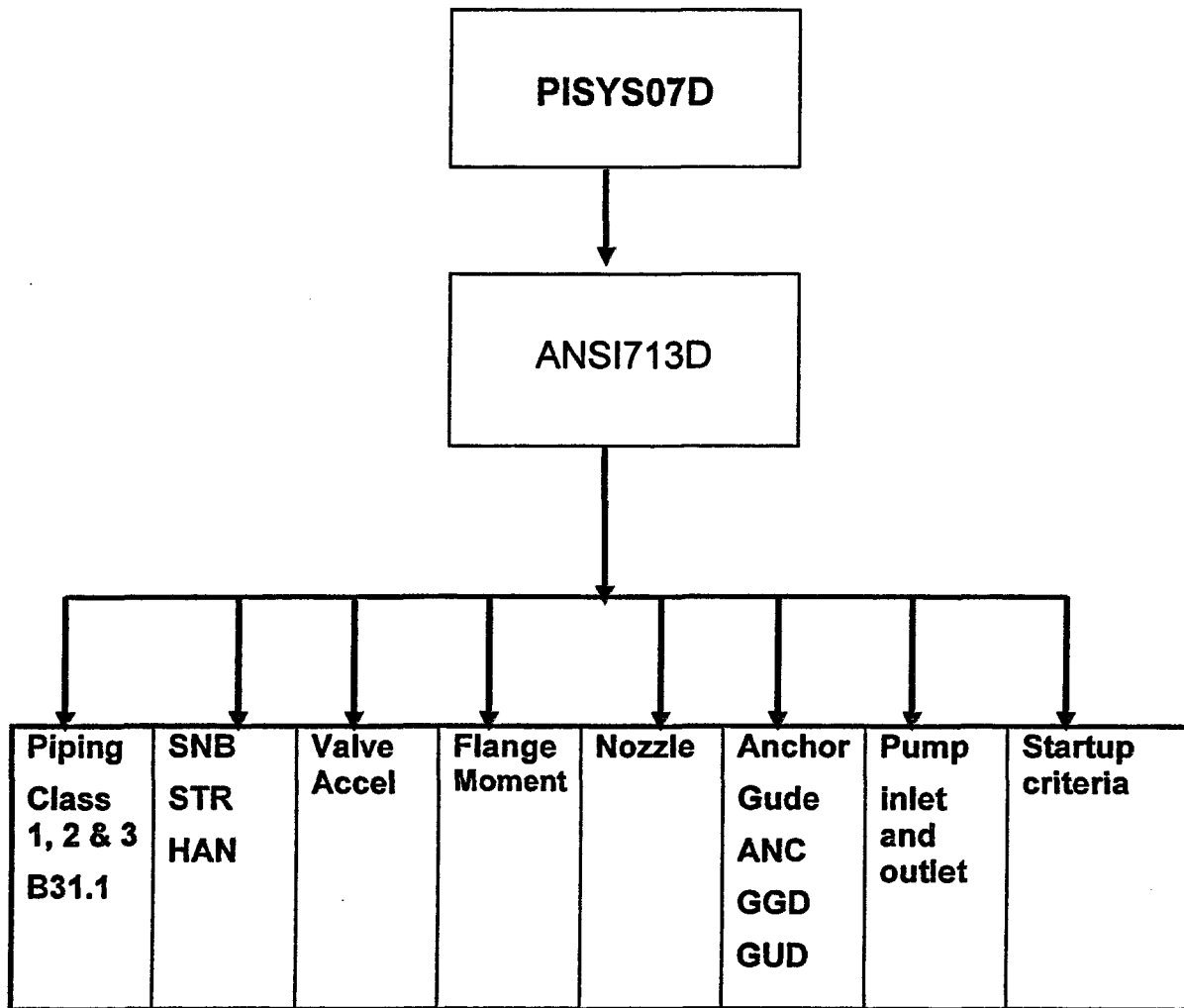
Modeling

- Two Models - Based on Layout Symmetry
 - One for Lines 1 and 4 (Longer Lines)
 - One for Lines 2 and 3 (shorter Lines)
- Each Model has the Main Steam Pipe From the RPV to the RCCV Penetration with the SRV Pipe connections
- Two Fixed Points have been Considered which Enables Analysis to be Decoupled from the Remainder of the Lines
 - Reactor Pressure Nozzle Connection
 - Containment Penetration

Computer Programs

- PISYS07 - Is a Computer Code for Analyzing Piping Systems Subjected to both Static and Dynamic Loads
- ANSI713 - Is a Computer Program for Calculating Stresses and Cumulative Usage Factors for Class 1, 2, and 3 Piping Components in Accordance with NB, NC & ND-3650





Brief Review of PISYS, and ANSI7 Program

ESBWR Main Steam Analysis Summary

Line	System	Eq 12 Max Stress Ratio (Thermal)	Eq 13 Max Stress Ratio (Dynamic)	Eq 14 Max Fatigue
Line 1	Main Steam	0.64	0.49	0.081
Line 2	Main Steam	0.76	0.49	0.078
Line 3	Main Steam	0.76	0.50	0.082
Line 4	Main Steam	0.64	0.46	0.071

Seismic Ground Acceleration = 0.3g

Lungmen Project - Containment Piping Experience

Lungmen Line #	System	Eq 12 Max Stress Ratio (Thermal)	Eq 13 Max Stress Ratio (Dynamic)	Eq 14 Max Fatigue
B21-2501A	Main Steam	0.70	0.46	0.079
B21-2502A	Main Steam	0.60	0.50	0.068
B21-2503A	Main Steam	0.54	0.50	0.076
B21-2504A	Main Steam	0.75	0.49	0.099
N22-2501	Feedwater	0.79	0.61	0.085
N22-2502	Feedwater	0.79	0.63	0.085
E11-2501	RHR	0.54	0.53	0.074
E11-2502	RHR	0.78	0.75	0.077
E22-2501	High Pressure Core Flooder	0.60	0.45	0.079

Lungmen Seismic Ground Acceleration = .4 g