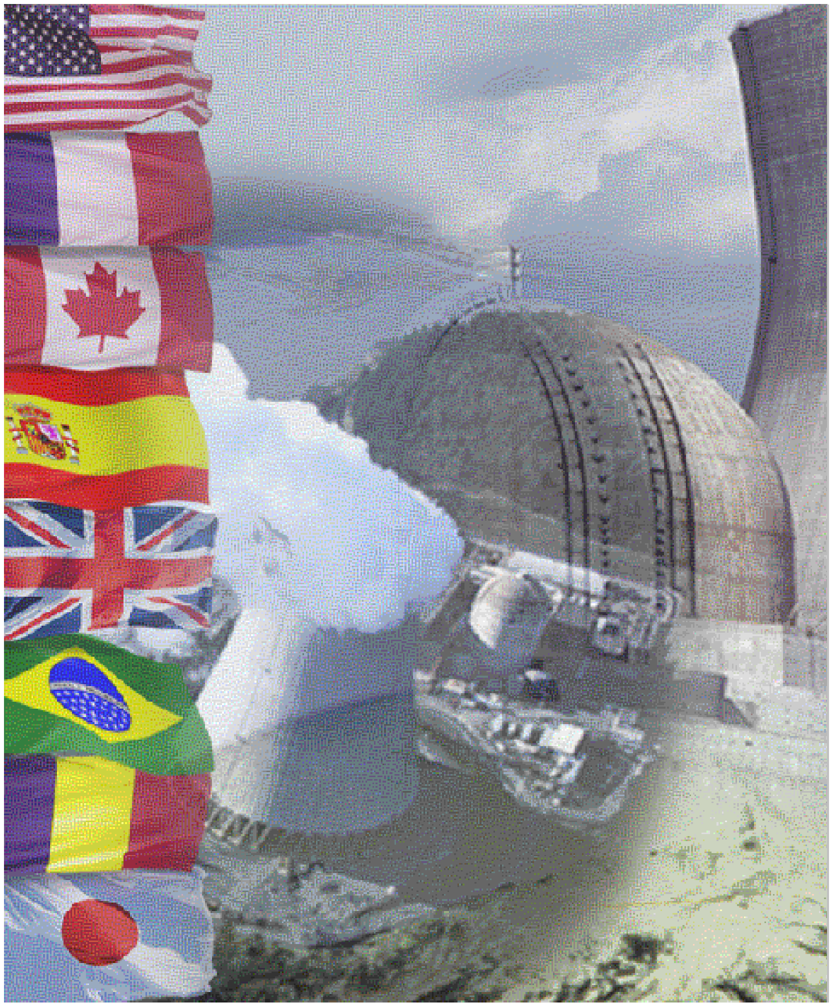


STRUCTURAL INTEGRITY PERFORMANCE CRITERION (SIPC) STATUS AND PLANS

NRC Technical Meeting
January 21, 2004, Washington, DC

EPRI

Presentation Summary

• Introduction and Opening Remarks	Forrest Hundley
• Historical Overview	Jim Riley
• Technical Presentation	Russ Cipolla
• Summary and Target Schedule	Forrest Hundley

Introduction

- We are pleased to have this opportunity to share with you the status of what is clearly an important topic to the utilities and the NRC
- We realize the urgency of bringing this issue to a satisfactory closure and have activities under way to achieve a timely set of results that can lead to the final submittal and acceptance of the GLCP
- It is our desire to continue to communicate with you on the progress of the work and receive your feedback today and in the months ahead
- What you will hear today is the status of work in progress whose outcome and the availability of technical resources dictate the target schedule for its completion

Historical Overview

Jim Riley

NEI

Structural Integrity Performance Criterion

Historical Overview

- Original revisions to SIPC to resolve industry and NRC comments on NEI 97-06 and related guidelines (Mid 2001)
- Changes to SIPC began in early 2002 to address comments
- White paper written on SIPC changes in October 2002 in support of GLCP
- Catawba TS submittal presented to NRC in March 2003 with additional comments and six RAIs from NRC
- Series of discussions with NRC to resolve RAIs on SIPC through May 2003 without complete resolution.

Structural Integrity Performance Criterion

Historical Overview (Cont'd)

- Qualitative position on impact of new SIPC prepared in May 2003
- SIPC revised again to address Catawba RAIs with proposed SIPC submitted in June 2003
- Formal Impact Study initiated in July 2003 by SGMP IIG to evaluate quantitatively the effect of changes on past and future evaluations
- Catawba submits revised SIPC which removes the specific safety factors for accidents. Meeting with NRC on Catawba (Sep 4, 2003) identified a workable resolution through RAI process

Structural Integrity Performance Criterion

Historical Overview (Cont'd)

- In October 2003, NRC submits three new RAIs. Duke submits draft responses. Place RAIs on hold pending Impact Study results
- Discussion of Impact Study results and proposed Phase 2 plan – Technical meeting in Phoenix (Nov 12-13, 2003)
- Approval of Phase 2 of Impact Study at EPRI/TAG meeting Dec 2003
- Technical meeting with NRC on Jan 21, 2004

Technical Presentation

SIPC Impact Study

Russ Cipolla

Aptech Engineering Inc

Impact Study on Structural Integrity Performance Criterion

All inservice steam generator tubes shall retain structural integrity over the full range of normal operating conditions (including startup, operation in the power range, hot standby, and cooldown and all anticipated transients included in the design specification) and design basis accidents. This includes retaining a safety factor of 3.0 against burst under normal steady state full power operation primary-to-secondary pressure differential and a safety factor of 1.4 against burst applied to the design basis accident primary membrane loads. Apart from the above requirements, additional loading conditions associated with the design basis accidents, or combination of accidents in accordance with the design and licensing basis, shall also be evaluated to determine if the associated loads contribute significantly to burst. In the assessment of tube integrity, those loads that do significantly affect burst shall be determined and assessed in combination with the loads due to pressure with a safety factor of 1.2 on the combined primary loads and 1.0 on secondary (thermal) loads.

Impact Study on
Structural Integrity Performance Criterion

Major SIPC Elements Considered in Impact Study

- Limiting accident conditions were expanded from just faulted conditions to all design basis accidents,
- Accident tube loads assessed at 1.4 safety factor was changed from differential pressure only to include all primary membrane load sources,
- For treatment of non-pressure accident loads, a third requirement was evaluated whereby tube burst was assessed under a combined load basis with a factor of 1.2/1.4 on primary loads and 1.0 on thermal loads,
- Evaluated the use of elastic analysis in the determination of thermal system loads.

Impact Study on Structural Integrity Performance Criterion

Objectives

- Provide quantitative results for structural limits determined from the revised SIPC
- Establish the impact of revised SIPC in the form of new or added analyses, or reviews required to implement the revised SIPC
- Assess the impact of revised SIPC on past analyses

Impact Study on Structural Integrity Performance Criterion

Approach

- General design review to identify plants that could be most affected by the revised criterion.
- Review scope to cover existing and replacement steam generators for RSG and OTSG designs (W, FANP, and B&WC)
- Calculations and/or comparative reviews for a limiting plant design and possibly a typical plant design to identify:
  - *contributing non-pressure loads and sources*
  - *impact to structural calculations under combined loads (1.2/1.4 on primary and 1.0 on thermal)*
  - *design factors that would make a plant more susceptible to reanalysis (transients, high seismic, type of tube degradation, etc.)*

Impact Study Findings

General Findings

- No major impact to most plants. Structural limits will be controlled by differential pressure loading for most degradation modes and bundle locations
- Inclusion of all design basis accidents will have no impact (limiting accidents are Level D)
- Primary axial membrane loads are low and are not significant compared to limiting accident differential pressure (LADP)
- General agreement on tube loadings and Code classification of primary and secondary loads
- General consensus that there is no safety concern

Impact Study Findings

General Findings (Cont'd)

- Different analytical approaches used by vendors pointed to the need for an empirical model that considers bending loads
- Burst/collapse model for combined membrane plus bending has been proposed/used in study but requires validation
- Design Basis calculational methods and objectives are not applicable for use with SIPC to evaluate degraded tubing
  - Difficult to extract bending loads at specific locations
  - Code acceptance is based on meeting stress allowable and not on prediction of tube failure
  - Methods for combining loads are based on maximum envelope approach

Impact Study Findings

Summary of Impact on Plants

Based on Vendors' Judgment of Most Affected Plants:

- OTSG and ROTSG – No significant impact (minor document updates may be required)
- RSG and RRSG – Potential Impact to plants with high bending loads in u-bends
  - May result in lower structural limits for circumferential degradation
- Locked tube scenarios may also result in lower structural limits for circumferential degradation
- Assessments of axial degradation at any location will not be affected by revised criterion

Impact Study Findings

Impact on Existing Analyses

- Some level of review effort will be required to establish compliance with SIPC for u-bend circ-type degradation
- Potential reanalysis may be required to obtain detailed bending load information at region of concern
- Generic treatment for evaluating significance of bending loads may eliminate this issue for many plants
- No short term safety concerns due to absence of any structurally significant circumferential degradation in u-bends.

Impact Study Findings – Circ-Type Degradation

Vendor	Design	Location	Structural Integrity Performance Criterion Requirement				
			All Accidents	1.4 PML	1.2(PM+PB) + 1.0ATL	1.4(PM+PB) + 1.0ATL	1.0 ATL Effects
Westinghouse	CE-RSG	U-Bend	No Impact	No Impact Primary membrane loads small	No Impact Primary membrane loads small Inplane bending small Out-of-plane not considered	Impact	No Impact
	W-RSG (unlocked tube)	Straight Leg	No Impact	Minor Impact	No Impact	No Impact?	No Impact
		U-Bend TSP	No Impact	No Impact Seismic membrane loads small	No Impact	No Impact	No Impact
		U-Bend	No Impact	No Impact Seismic membrane loads small	Impact	Impact	No Impact
	W-RSG (locked tube)	Straight Leg	No Impact	Impact (Worst Case)	Impact (Worst Case)	Impact (Worst Case)	-
		U-Bend	No Impact	Impact	Impact	Impact	-
FANP	OTSG	Upper Tubesheet	No Impact	No Impact Primary membrane loads small	No Impact Seismic bending low Max crossflow moment not coincident with max ΔT Multiple plastic hinges required for collapse	No Impact	No Impact
B&WC	RRSG-CE	U-Bend	No Impact	Possible Impact?	Possible Impact?	Possible Impact?	No Impact
	ROTSG	Upper Tubesheet	No Impact	Possible Impact LBLOCA loads are high but are not Level C or D	No Impact Seismic bending low	No Impact	No Impact

Post Impact Study
Proposed Structural Integrity Performance Criterion

*All inservice steam generator tubes shall retain structural integrity over the full range of normal operating conditions (including startup, operation in the power range, hot standby, and cooldown and all anticipated transients included in the design specification) and design basis accidents. This includes retaining a safety factor of 3.0 against burst under normal steady state full power operation primary-to-secondary pressure differential and a safety factor of 1.4 against burst applied to the design basis accident **primary-to-secondary pressure differentials**. Apart from the above requirements, additional loading conditions associated with the design basis accidents, or combination of accidents in accordance with the design and licensing basis, shall also be evaluated to determine if the associated loads contribute significantly to burst. In the assessment of tube integrity, those loads that do significantly affect burst shall be determined and assessed in combination with the loads due to pressure with a safety factor of 1.2 on the combined primary loads and 1.0 on **axial thermal** loads.*

SIPC Resolution - Phase 2

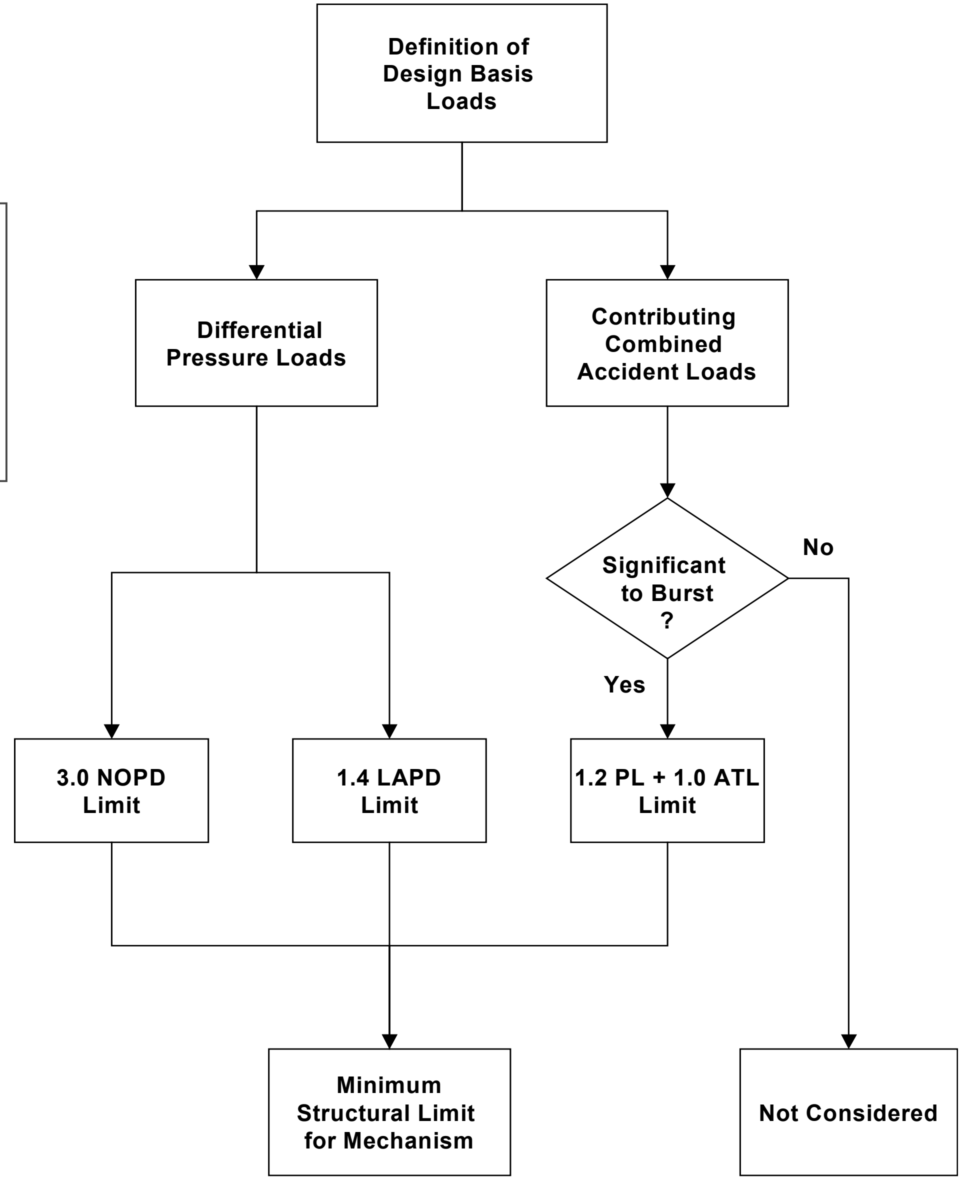
Objectives for Phase 2

Work towards providing a generic resolution:

- **Validate burst/collapse model for combined loads – (Benchmark burst/collapse model – laboratory tests)**
- **Understanding of existing design basis information (i.e., conservatisms in the design analysis calculations, availability of results required for burst calculations, etc.)**
- **Method of evaluating contributing loads and their significance to tube integrity (Apply analysis method to key examples – Catawba 1 & 2 and Diablo)**
- **Screening limits on bending loads for plants to establish conditions when non-pressure loads are contributing**
- **Guidance for In Situ Pressure Test (ISPT) when contributing loads are significant and lead to reduced structural limits**
- **Update White Paper - safety factors and bases**

SIPC Implementation

Structural limit to satisfy SIPC is minimum limit from three separate assessments for Normal Operating and Accident Conditions



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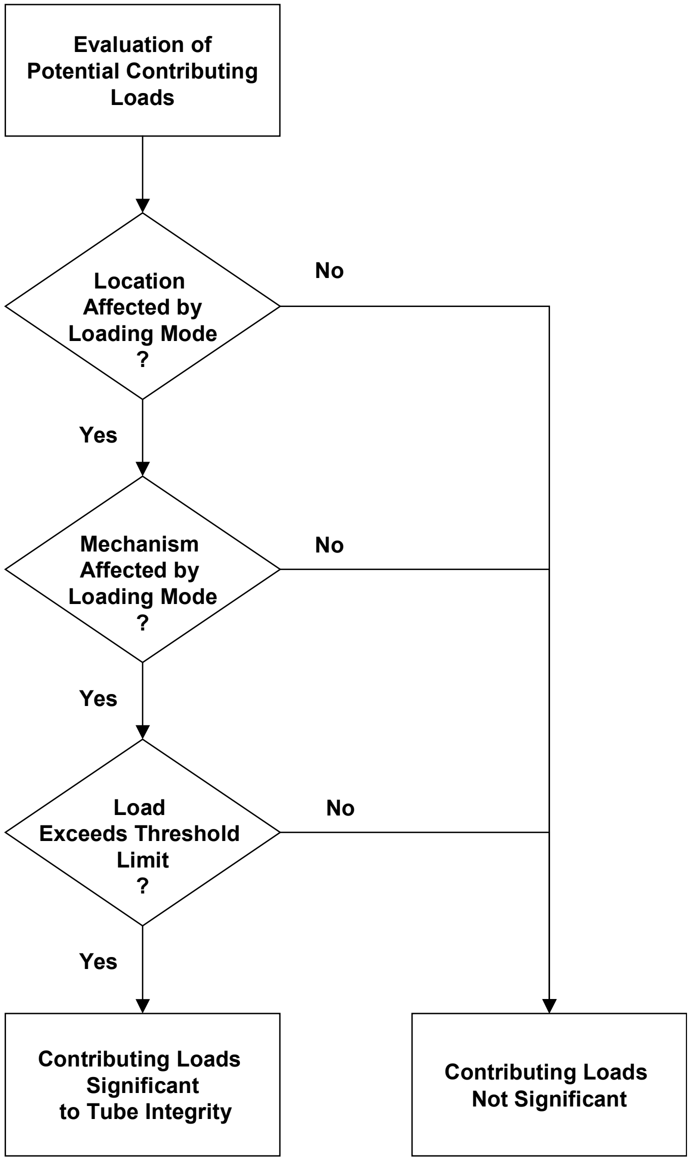
SIPC Implementation

Possible screening logic for evaluating contributing loads using threshold concept



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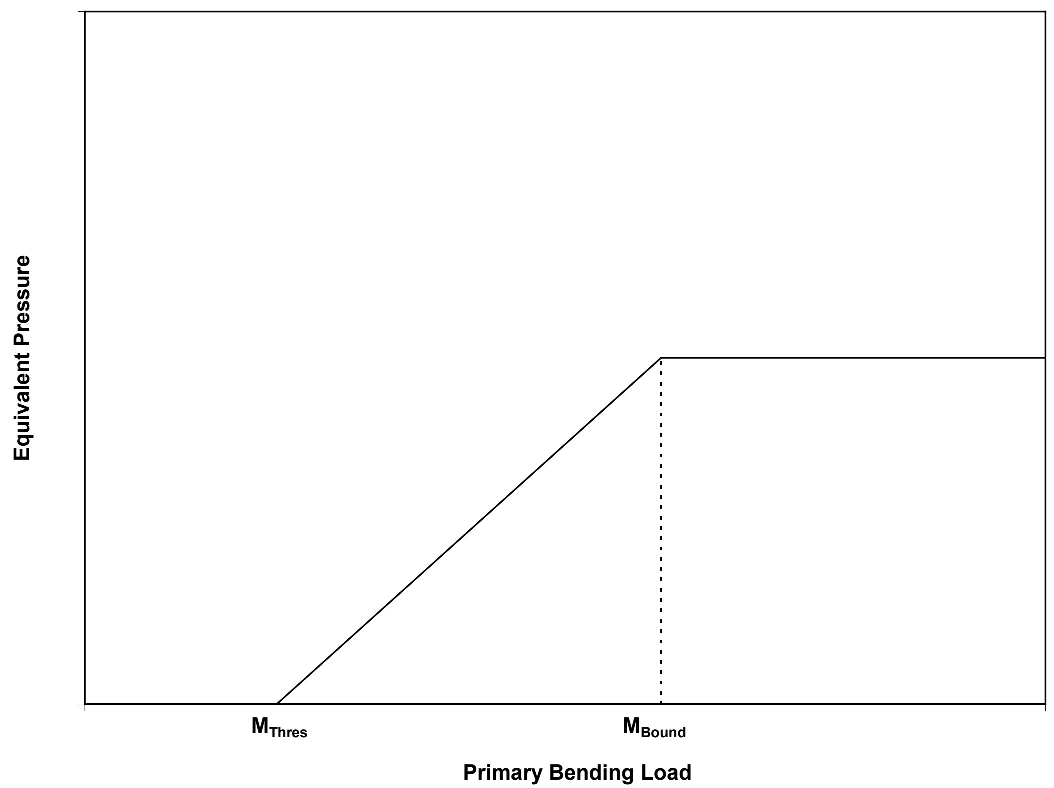
SIPC Implementation

Example of Threshold Concept for Screening Loads and Establishing ISPT Adjustments



Remaining SIPC Issues

SIPC for Accident Loads

- Use of 1.4 safety factor on differential pressure only, and not on all primary membrane loads
  - Phase 1 determined other primary membrane loads to be negligible
- Method/procedure for determining contributing loads and their significance to tube burst – Phase 2
- Safety factors used on significant contributing loads to be explicitly defined (combined membrane and bending) – White Paper Topic
- Licensing basis (ASME Code) was followed to define the safety factors – White Paper Topic

Summary and Target Schedule

Forrest Hundley

Chair, SGMP IIG

Summary and Schedule

- Industry has been actively resolving the SIPC questions.
- Physical testing to quantify the effects of bending loads on burst pressure is a significant effort whose outcome will dictate the extent of work that must be done to demonstrate compliance with SIPC.
- Application of the SIPC to specific plants and the case studies conducted under this effort will provide the means to establish methodologies for other utilities to follow.
- The schedule is predicated on the availability of technical resources and the outcome of the physical tests leading to the development of an empirical relationship among bending load, crack size, and burst pressure.

SIPC Resolution Actions and Target Schedule

➢ Validate burst model	April 2004*
➢ Method for assessing contributing loads (use of design stress reports, thresholds, etc)	June 2004*
➢ Finalize impact study ➢ Finalize SIPC and technical basis (White Paper)	July 2004*
➢ Prepare guidance for SIPC implementation	Sept 2004*
➢ Resubmit necessary portions of GLCP	October 2004*

* Schedule assumes validation of the existing analytical model.

Closing Statements

- Impact Study indicates no short term safety concern identified with SIPC issues.
- This is the last issue to be resolved for the GLCP. Industry is actively working toward final resolution.
- Periodic status updates with NRC are planned consistent with scheduled milestones. Target first update will be in April 2004