March 14, 2000

LICENSEE: Arizona Public Service Company

FACILITY: Palo Verde Nuclear Generating Station, Unit 2

SUBJECT: SUMMARY OF MEETING HELD ON DECEMBER 14, 1999, TO DISCUSS THE STEAM GENERATOR REPLACEMENT AND POWER UPRATE ISSUES

On December 14, 1999, the NRC and the Palo Verde licensee, Arizona Public Service Company, met in Rockville, Maryland, to discuss steam generator replacement and power uprate issues planned by the licensee for Palo Verde Unit 2. The licensee plans to replace both Unit 2 steam generators during the fall 2003 refueling outage with generators being fabricated in Milan, Italy, by Ansaldo. The new steam generators have an improved steam dryer design, have 26 percent more heat transfer area, and use Inconel 690 steel for the tubes. Construction and quality assurance activities were discussed during the meeting, as well as the plans to transport the generators through Mexico to the site. The licensee is planning to take advantage of the increased steam generator capacity by requesting NRC approval of a power uprate for Unit 2. The licensing submittals associated with the power uprate proposal would revise the appropriate sections of Chapters 6 and 15 of the Updated Final Safety Analysis Report, and would revise the Technical Specifications.

Enclosure 1 is the list of attendees for the meeting, and Enclosure 2 is a copy of the slides presented by the licensee.

It was agreed at the conclusion of the meeting that the staff and the licensee will meet within a year to discuss progress on these issues.

/RA/

Mel B. Fields, Project Manager, Section 2
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. STN 50-529

Enclosures: 1. List of Meeting Attendees
2. Licensee's Meeting Slides

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 14, 2000

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Docket No. STN 50-529

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MEETING ATTENDANCE

PALO VERDE NUCLEAR GENERATING STATION, UNIT 2

STEAM GENERATOR REPLACEMENT AND POWER UPRATE ISSUES

NRC/APS

DECEMBER 14, 1999

ARIZONA PUBLIC SERVICE COMPANY

Carl Churchman
Paul Clifford
Richard Bernier
Mohammad Karbassian
Kevin Neese
Ron Pontes
Larry Joy

ABB

Bill Gardner

NRC

Dick Wessman
Mel Fields
Chu-Yu Liang
Steve Dembek
Tony Attard
John Tsao

Enclosure 1

Palo Verde
Steam Generator Replacement
And Power Uprate Project

Presentation
To The
Nuclear Regulatory Commission

Enclosure 2

December 14, 1999

PALO VERDE

Palo Verde Steam Generator Replacement And Power Uprate Project

Project Status

Carl Churchman

SGR Project Director

PALO VERDE

Objectives

- Provide status of SG replacement and power uprate project
- Discuss preliminary results of safety analyses
- Discuss oversight activities
- Discuss baseline NDE program
- Discuss YGN central cavity flow issue

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Objectives

- Discuss cold leg nozzle relocation
- Provide update on licensing activities
- Provide an overview of upcoming activities
- Discuss integrated schedule

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RSG Fabrication Status

- Tubing
  - Sandvik of Sweden chosen to supply tubing
  - Melting and extrusion of billets in progress
  - Readiness assessment completed
  - Fabrication started November 1999 and will complete in May 2000

PALO VERDE

RSG Fabrication Status

- Tubesheet #1
  - I-600 cladding operation complete
  - Stay cylinder & stub barrel welded to tubesheet
- Tubesheet #2
  - I-600 cladding operation complete
  - Stay cylinder welded to tubesheet
- Tubesheet drilling to start mid-Dec 1999

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RSG Fabrication Status

- Transition cone
  - All six pieces bent into shape & welded
  - Nozzle penetration complete
- Stub barrel
  - Stub barrel rolled & welded
  - Five handholes (per SG) cut
  - FW nozzles welded into position
  - #1 Stub barrel welded to tubesheet

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RSG Fabrication Status

- Lower Shell
  - Six plates rolled and welded
  - Cutting handholes and nozzles
- Primary channel heads
  - Received from Japan Steel Works
  - Marking to cut manways and nozzles
- Support skirts and primary nozzles (6) received

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RSG Transportation

- Fagioli of Milan, Italy has been chosen as transportation contractor
- Completed detailed route survey from Puerto Penasco, Mexico
- Held meetings with various environmental and transportation officials in both countries

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Safety Analyses

- UFSAR Chapter 15 transient analysis
  - CENTS code and benchmark
  - Limiting transient events
    - Unit 2 versus Units 1/3
- ECCS performance analysis

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CENTS Code

- CENTS will replace CESEC-III as the primary tool for Chapter 15 non-LOCA transient analysis at PVNGS.
- CENTS has been generically approved for all CE plants. In accordance with GL 83-11 Supplement 1, no topical report will be submitted.
- CENTS to CESEC-III benchmark will be documented for all events.

PALO VERDE

CENTS Benchmark

TIME (sec)		EVENT	VALUE	
CESEC	**CENTS**		**CESEC**	**CENTS**
0.00	0.00	LOCV, Turbine Trip, MFW Trip	---	---
6.20	8.46	Pressurizer Pressure reaches trip setpoint (psia)	2425	2425
6.20	8.46	HPPT signal generated	---	---
6.70	8.97	Trip occurs	---	---
7.42	10.32	PSVs open (psia)	2550	2550
8.47	11.01	**Maximum RCS pressure (psia)**	**2739.3**	**2699.2**
8.51	12.80	MSSVs (Bank 1) open (psia)	1303.0	1303.0
11.38	15.23	MSSVs (Bank 2) open (psia)	1369.6	1344.2
14.32	---	MSSVs (Bank 3) open (psia)	1395.3	1370.0

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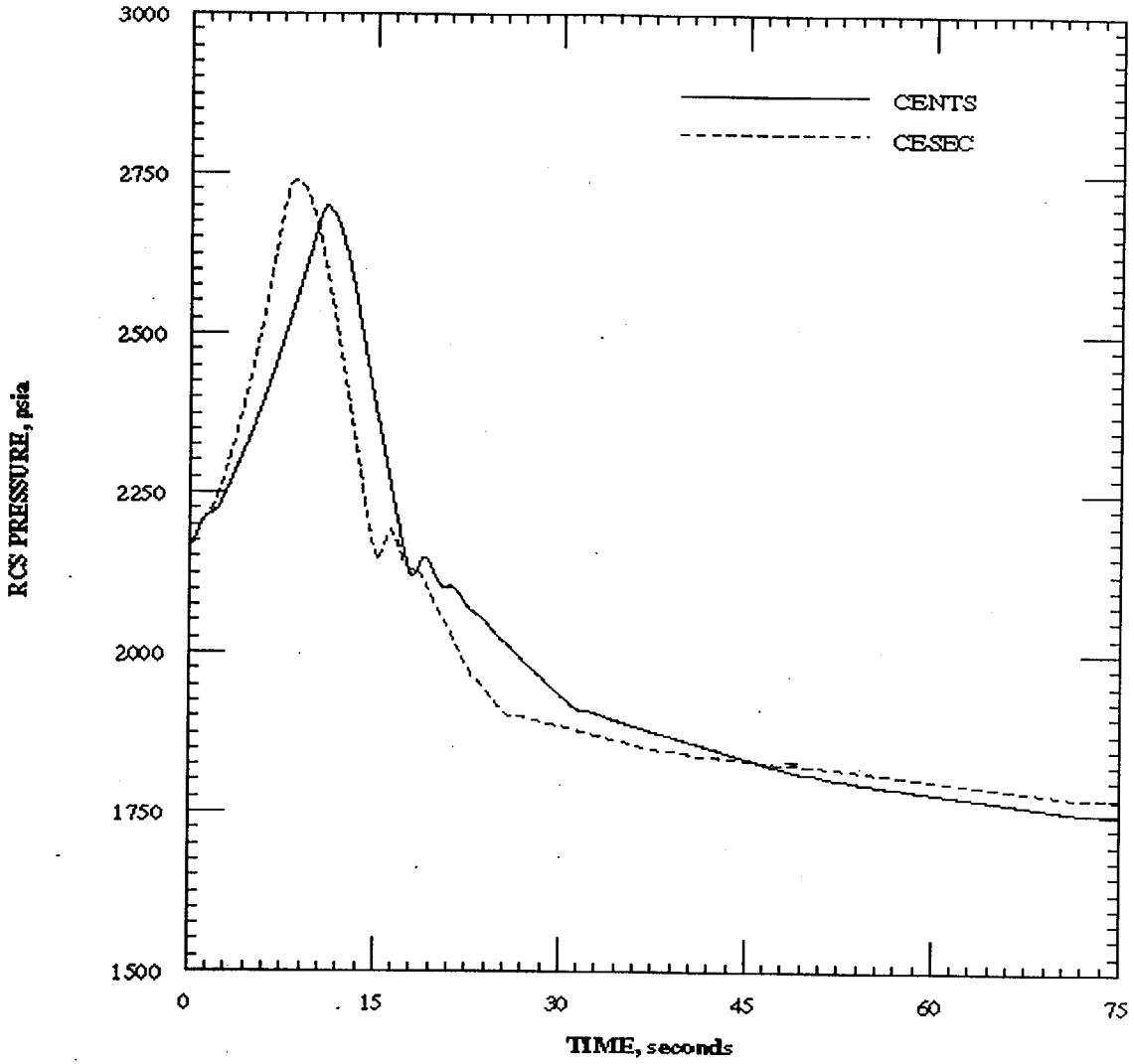
CENTS Benchmark



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Limiting Transient Events

Initial Conditions at Full Power

Values Include Appropriate Uncertainties

Power	= 4070 MWt
Inlet Temperature	= 548 to 568 °F
Pressurizer Pressure	= 2100 to 2325 psia
RCS Mass Flow Rate	= 95% to 116% of design
Pressurizer Level	= 24% to 59%
SG Level	= 4% to 92%NR
Axial Power Distribution	= -0.20 to +0.20 ASI
MTC	= -0.20 to -4.0 E-4 delta-rho/°F
Primary to Secondary Leakage	= 720 gpd / SG

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Limiting Transient Events

15.1 Limiting AOO with Single Failure

- Key assumptions
  - Modeled as LOF from SAFDL with stuck-open ADV.
  - ADV open from 0 to 1800 seconds.
  - DF of 1.0 affected SG, 100 unaffected SG.
- Methodology changes
  - None.
- Licensed results
  - Limited number of fuel cladding failures.
  - No DNB propagation / maintain coolable geometry.
  - Offsite dose within 10% of 10CFR100 Limits.
  - Primary & secondary pressure $\leq$ 110% design.

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Limiting Transient Events

15.1 Pre-Trip Main Steam Line Break

- Key assumptions
  - CPC VOPT credited for events with offsite power available.
  - CPC shaft speed trip credited for events with LOP.
  - Loss of offsite power at t=break.
  - DF of 1.0 affected SG, 100 unaffected SG.
- Methodology changes
  - None.
- Licensed results
  - No DNB propagation / maintain coolable geometry.
  - Offsite dose within 10CFR100 Limits (GIS $\leq$ 30 REM thyroid).
  - Primary & secondary pressure $\leq$ 110% design.

PALO VERDE

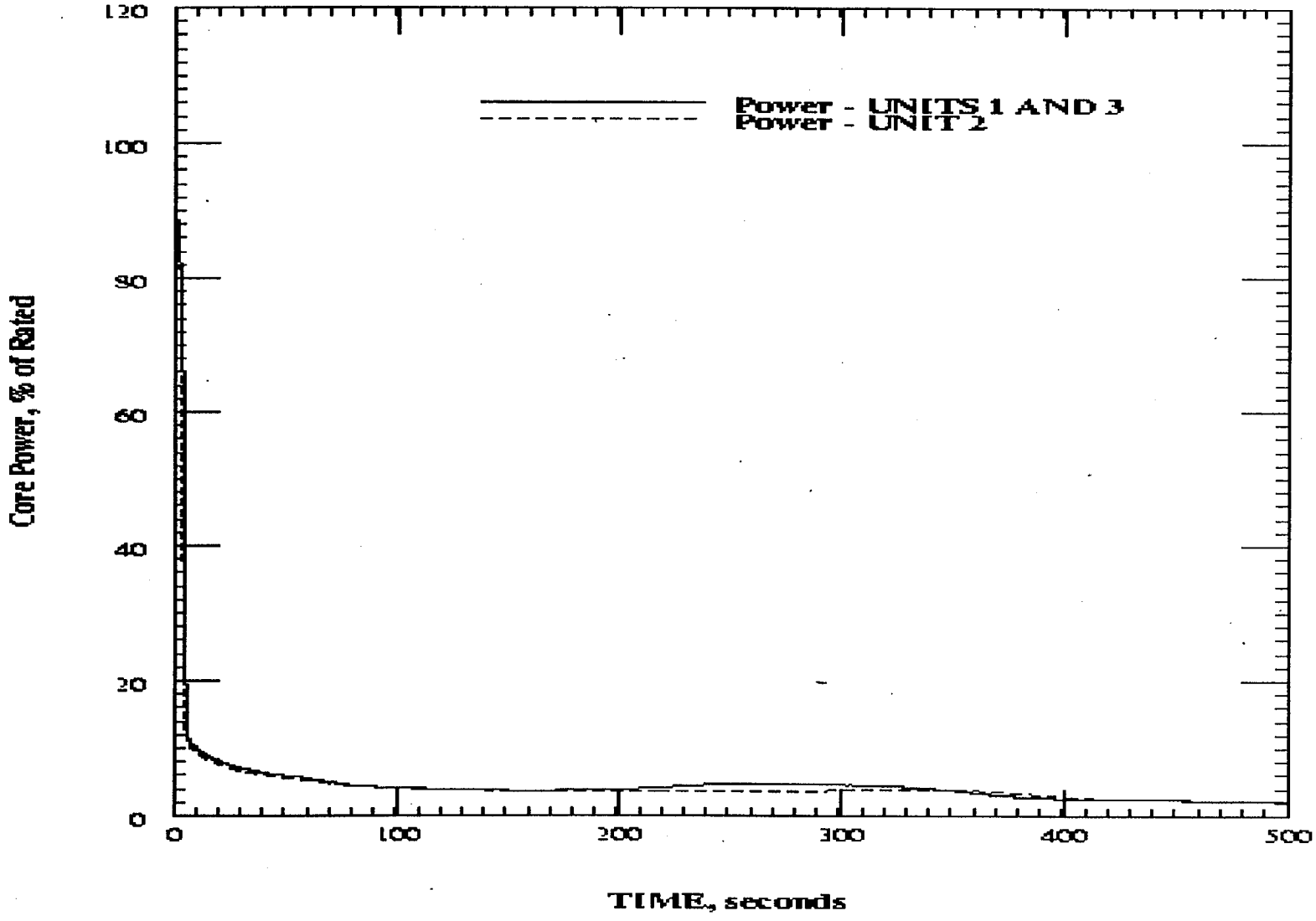
Limiting Transient Events

15.1 Post-trip main steam line break

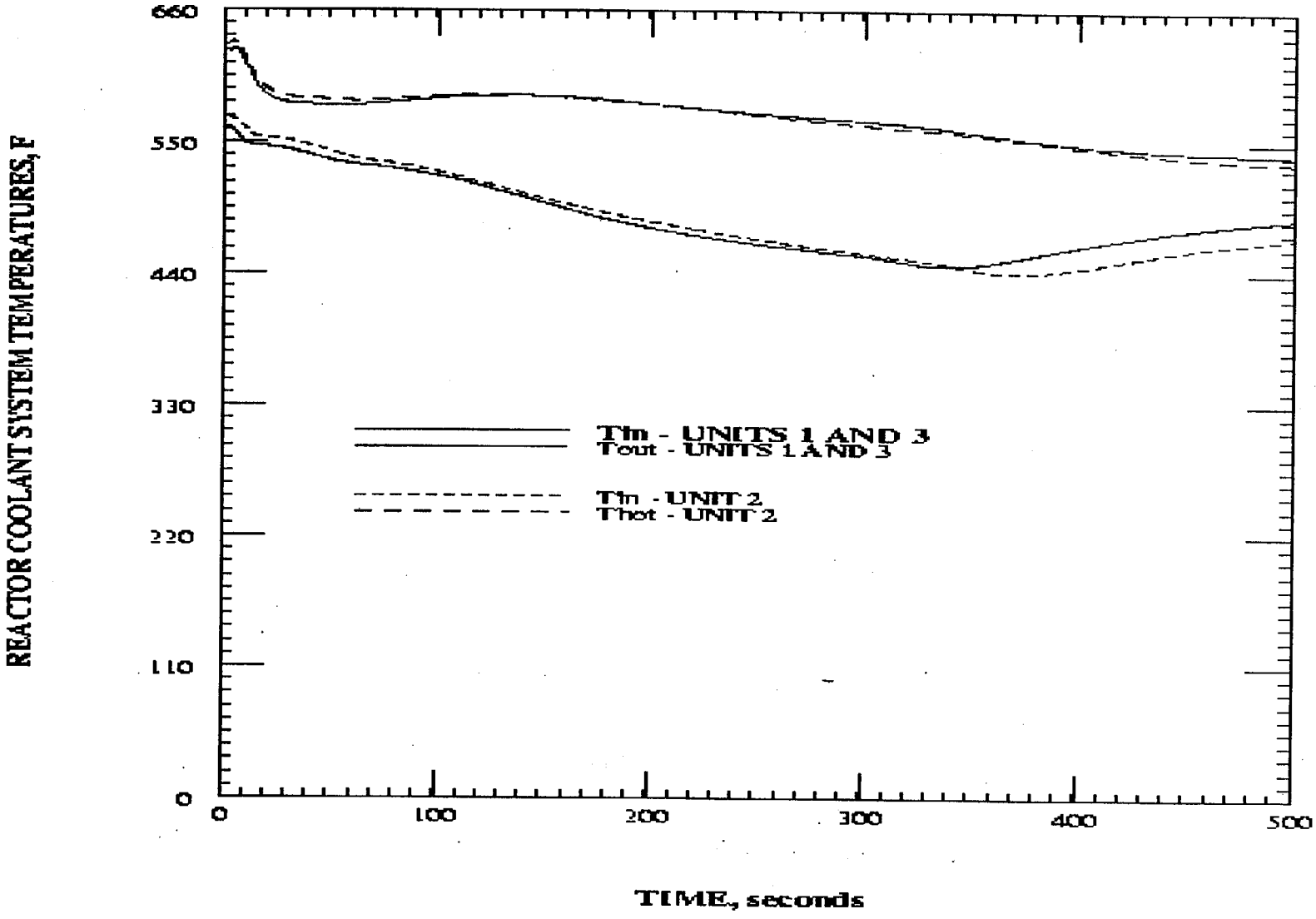
- Key assumptions
  - Lower Mode, HZP, and HFP cases analyzed.
  - Worst rod stuck out.
- Methodology changes
  - More detailed reactivity calculation including moderator density feedback in the hot channel. Methods previously reviewed and approved for other ABB utilities.
- Licensed results
  - No SAFDL violation.
  - Primary & secondary pressure $\leq$ 110% design.

PALO VERDE

Limiting Transient Events



Limiting Transient Events



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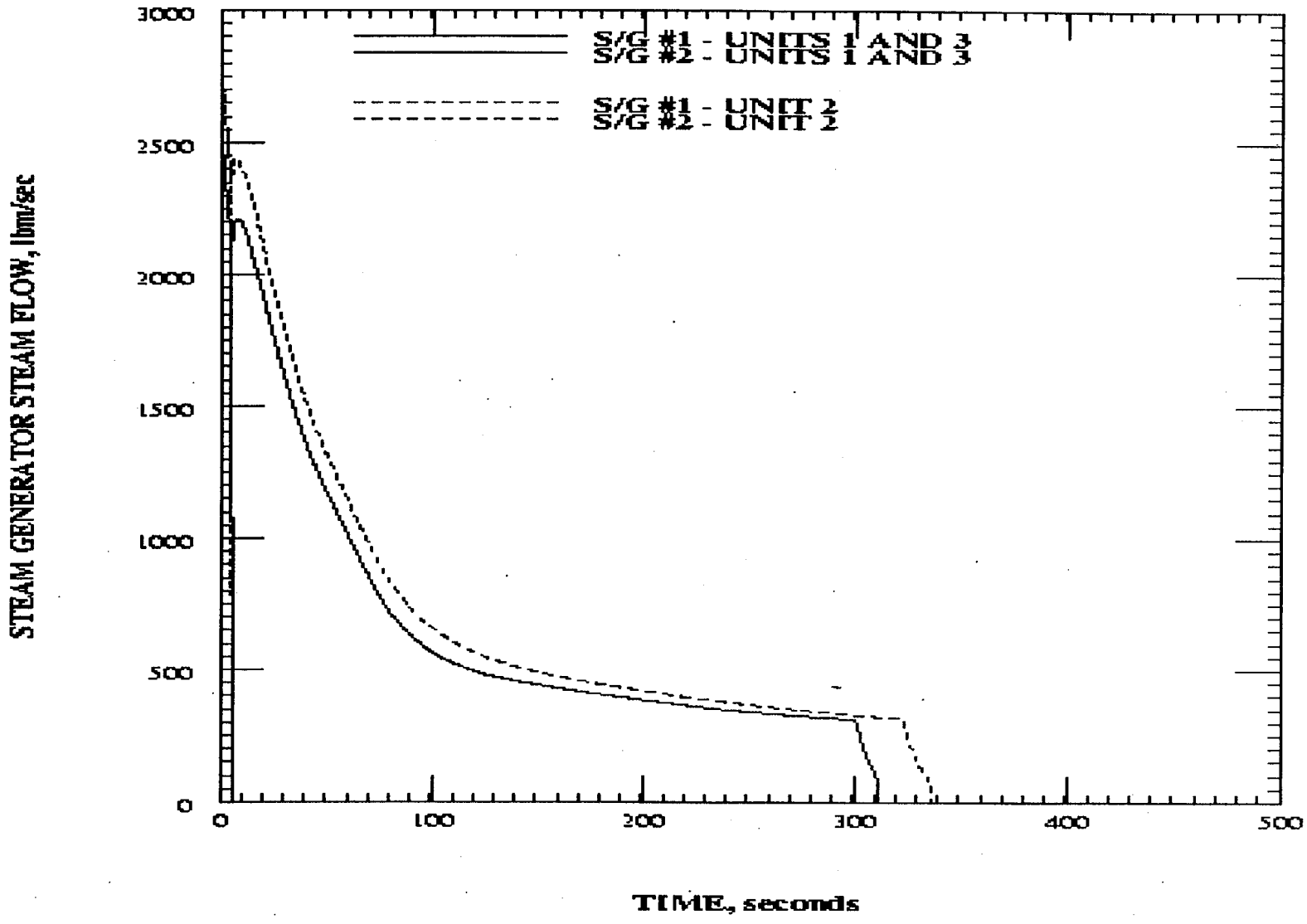
Limiting Transient Events



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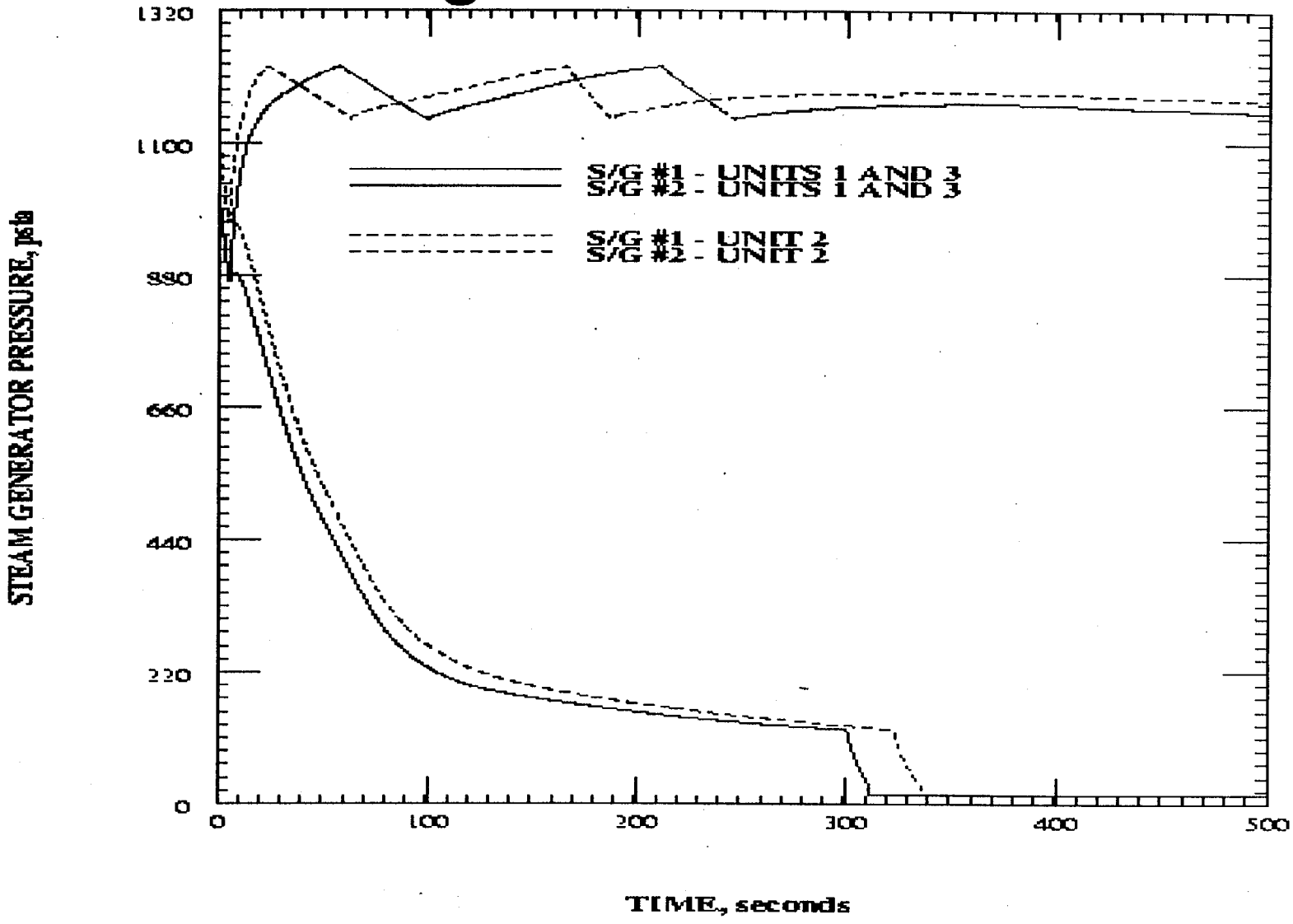

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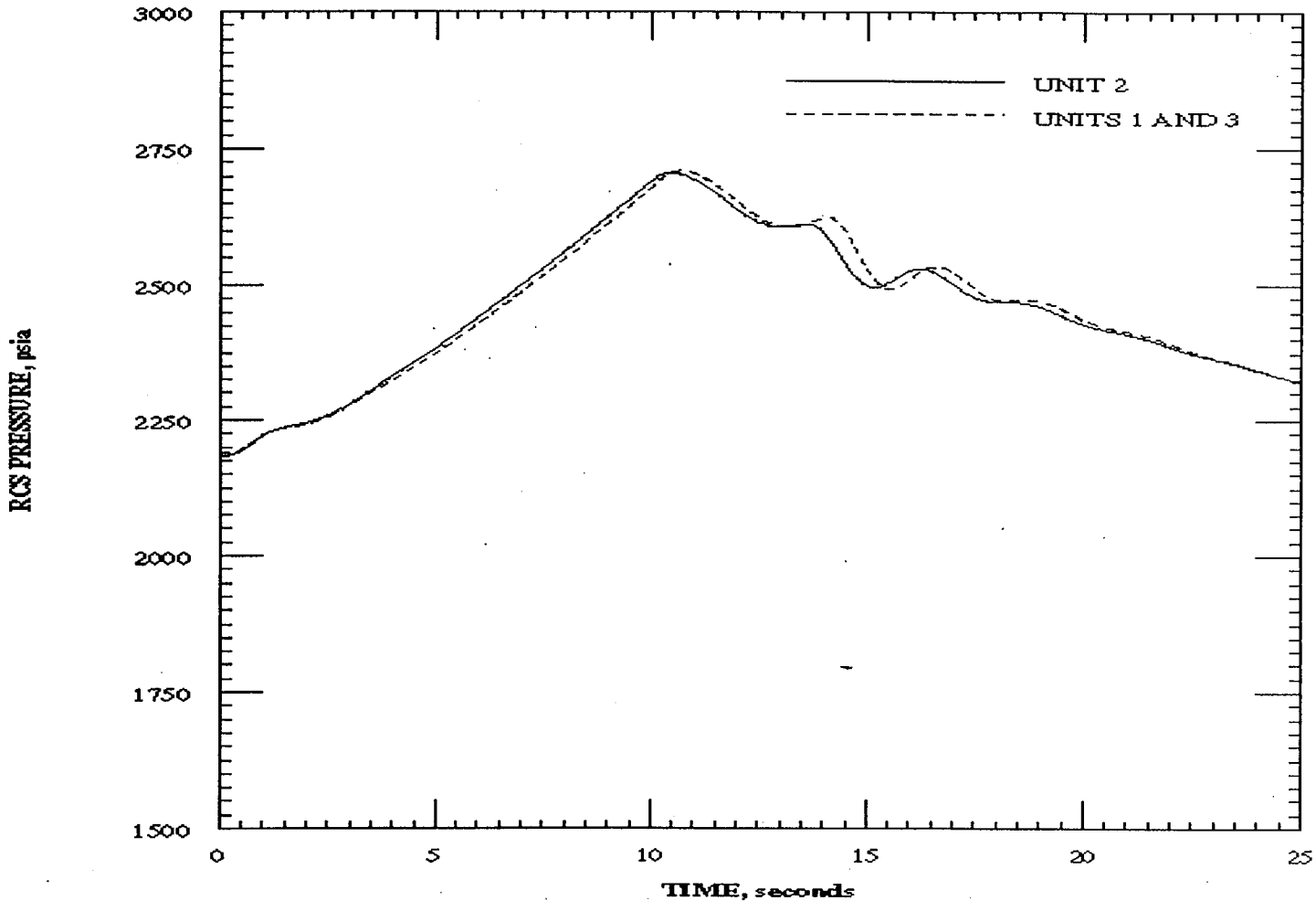
Limiting Transient Events

15.2 Loss of condenser vacuum

- Key assumptions
  - Peak primary and secondary pressure and PSV operability cases analyzed.
  - HPP trip credited. No credit for low SG level trip.
  - No credit for RPCS, SBCS, PLCS, and PPCS.
  - Immediate FWCS trip and TAV closure.
- Methodology changes
  - None.
- Licensed results
  - No SAFDL violation.
  - Primary & secondary pressure $\leq$ 110% design.

PALO VERDE

Limiting Transient Events



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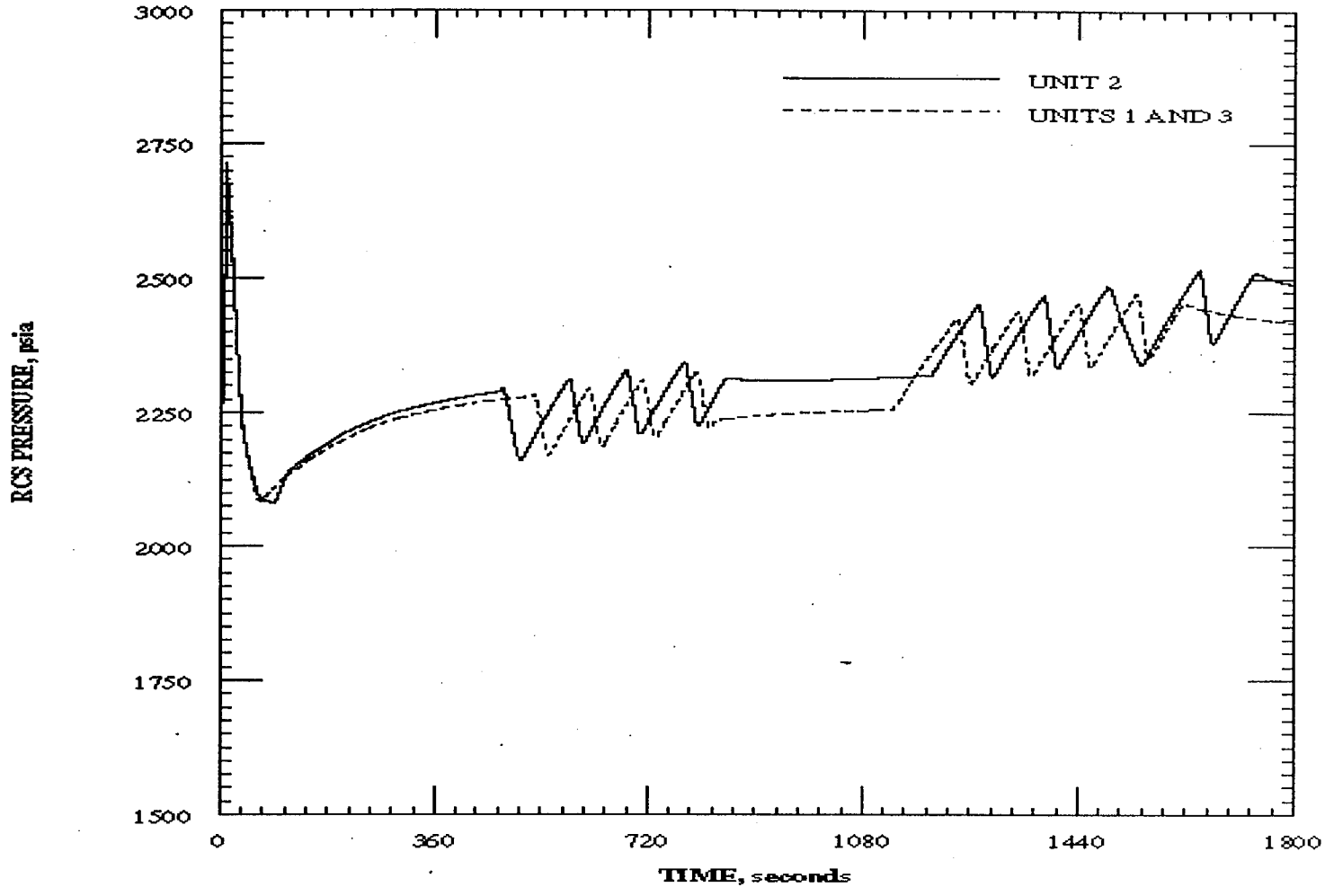

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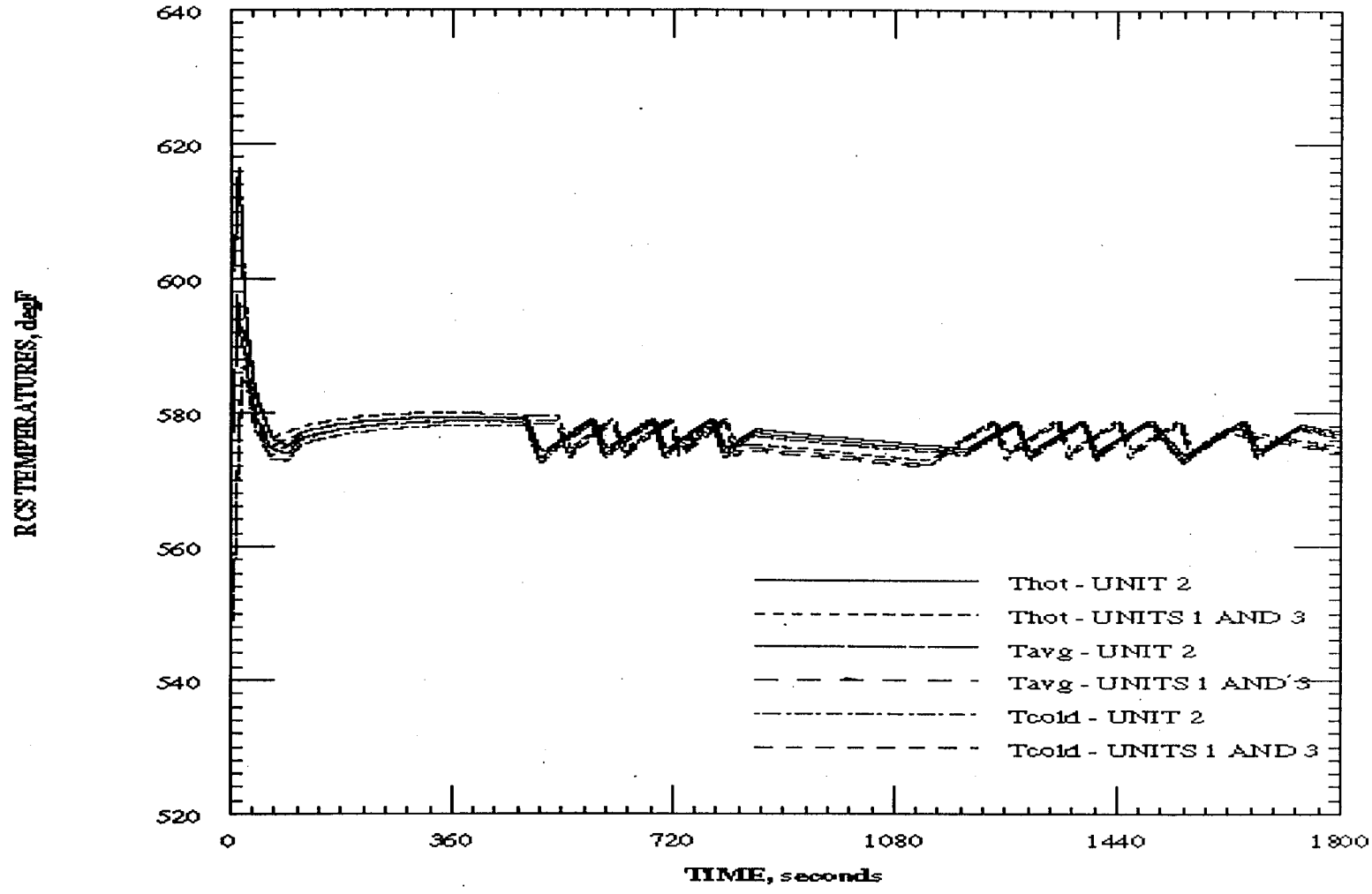

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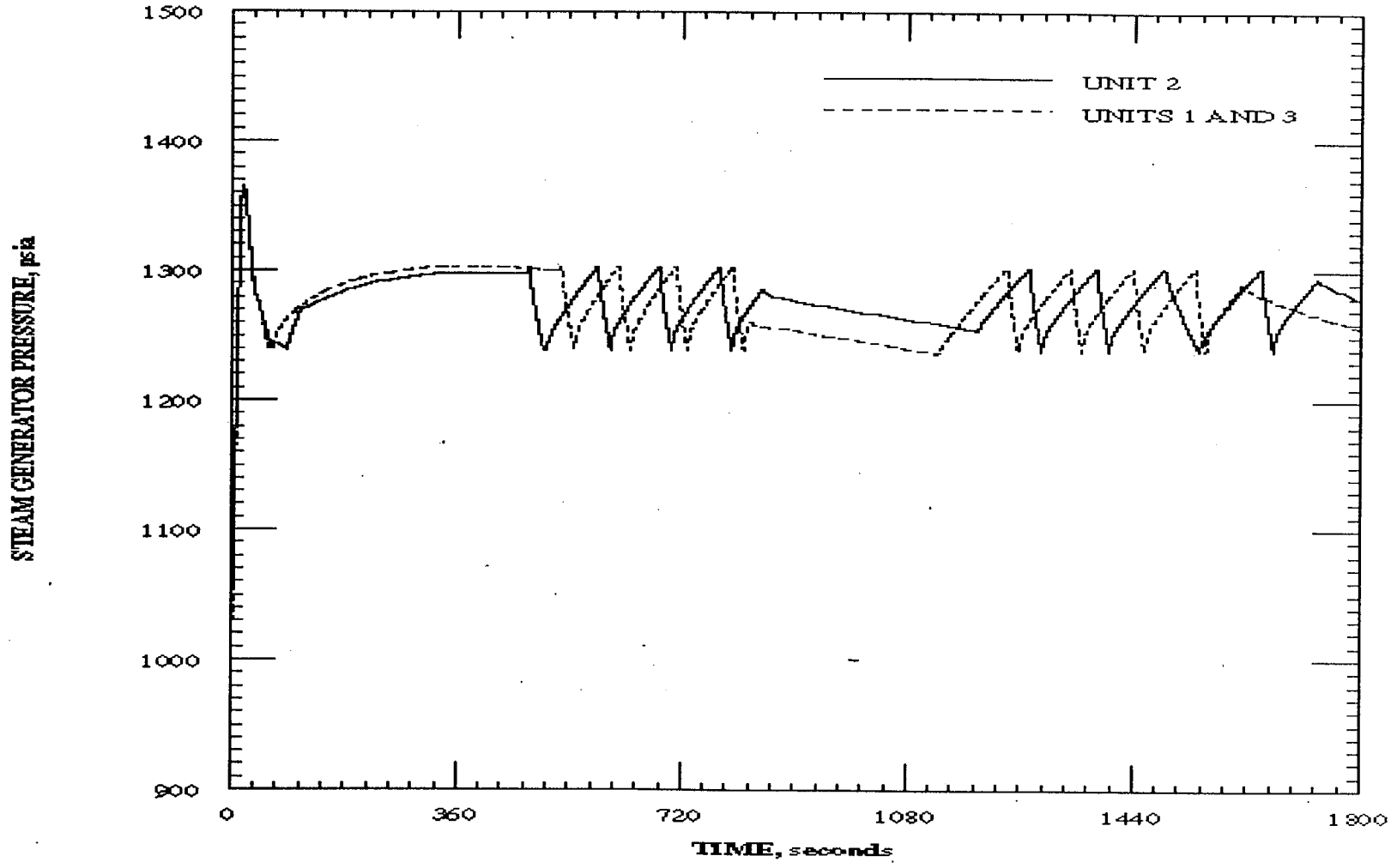

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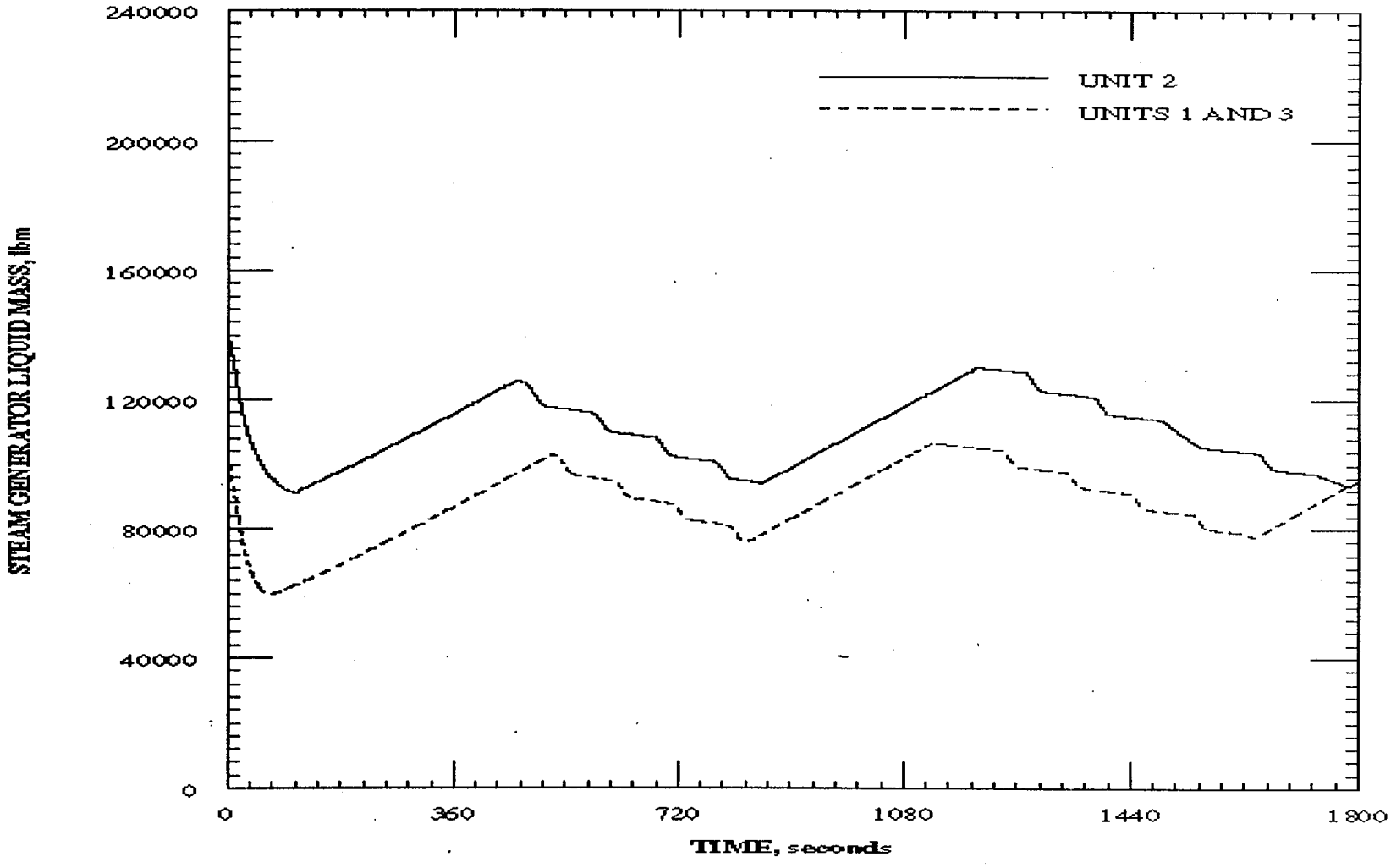

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Limiting Transient Events

15.2 Feedwater line break

- Key assumptions
  - Peak primary and secondary pressure, AFW capacity, and PSV operability cases analyzed.
  - All break sizes in combination with LOP and/or single failure evaluated.
  - Conservative CESSAR modeling assumptions maintained.
  - DF of 1.0 affected SG, 100 unaffected SG.
- Methodology changes
  - None.

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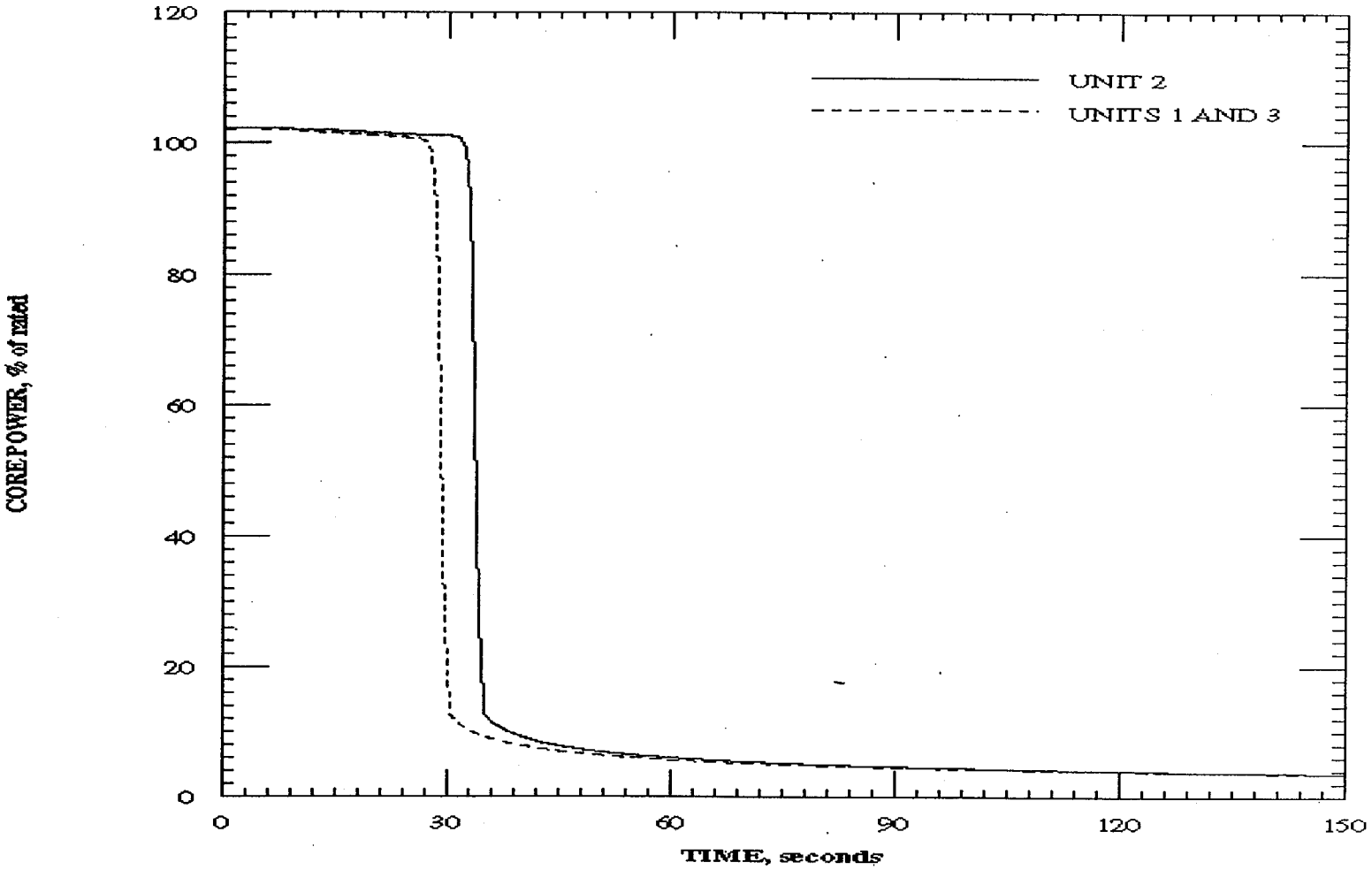
Limiting Transient Events

- **Licensed results**
  - **No DNB propagation / maintain coolable geometry.**
  - **Offsite dose within 10% of 10CFR100 limits.**
  - **Small FLB: primary & secondary pressure ≤ 110% design.**
  - **Large FLB and small FLB with LOP: primary & secondary pressure ≤ 120% design.**

Limiting Transient Events



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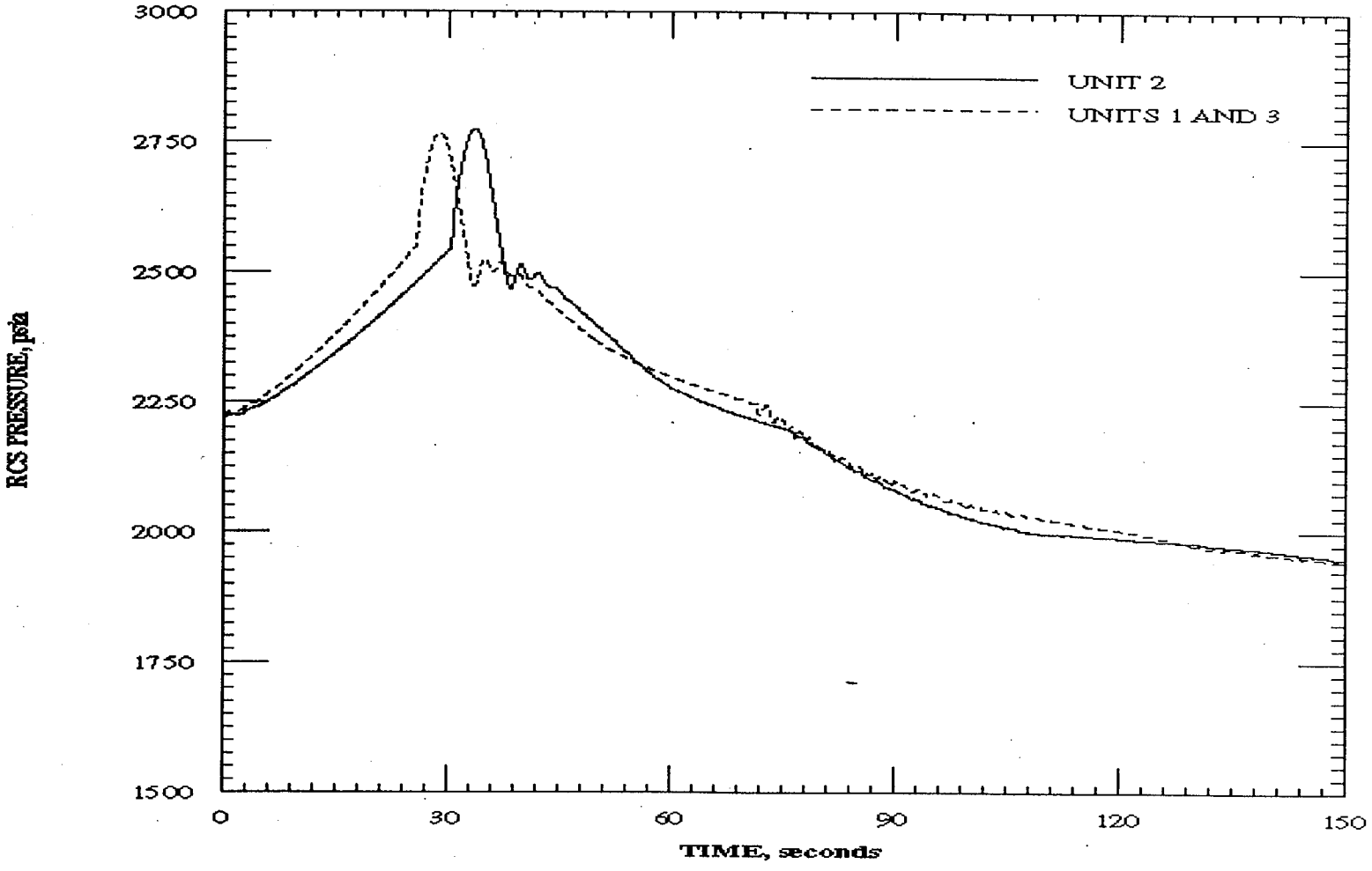

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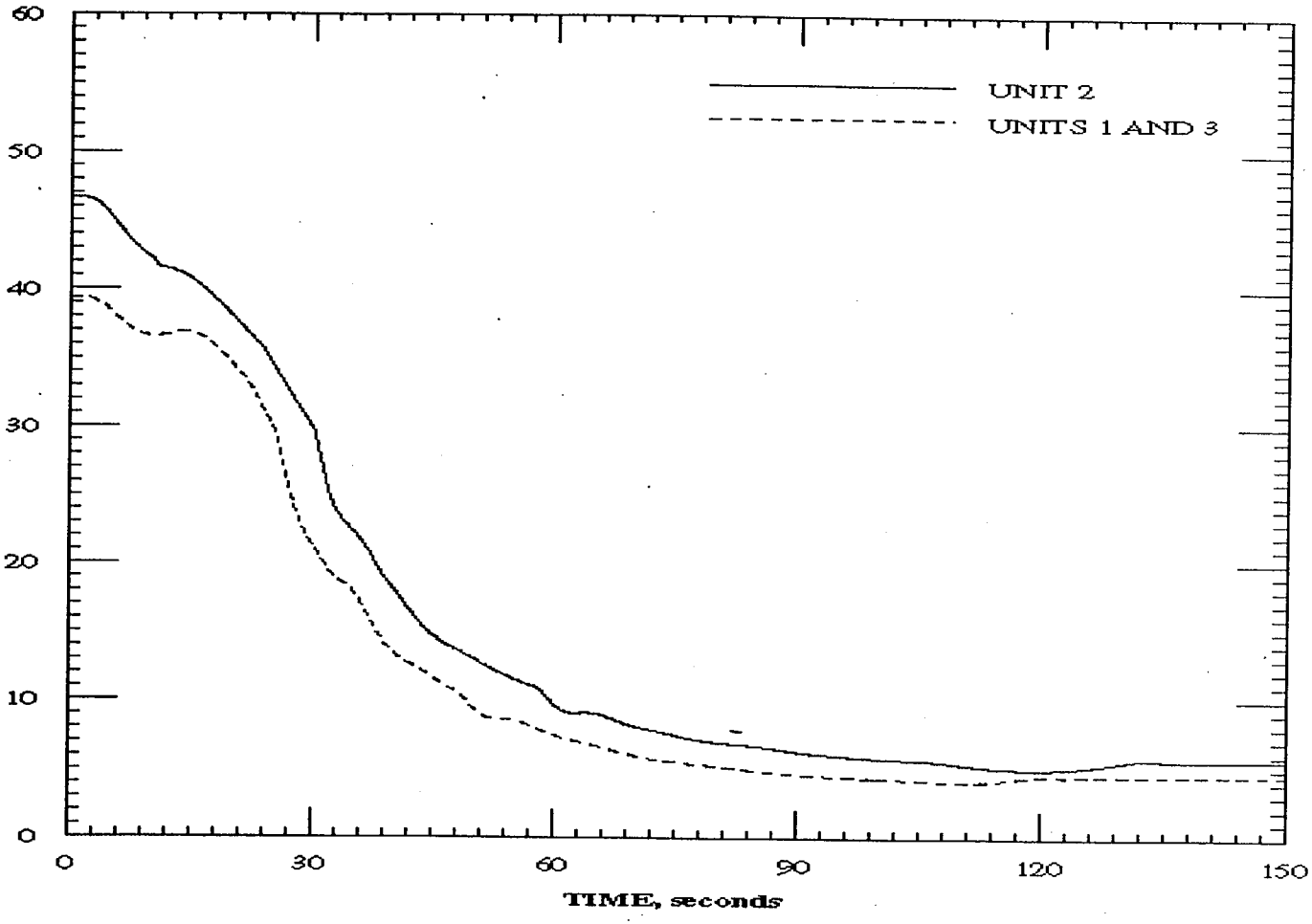

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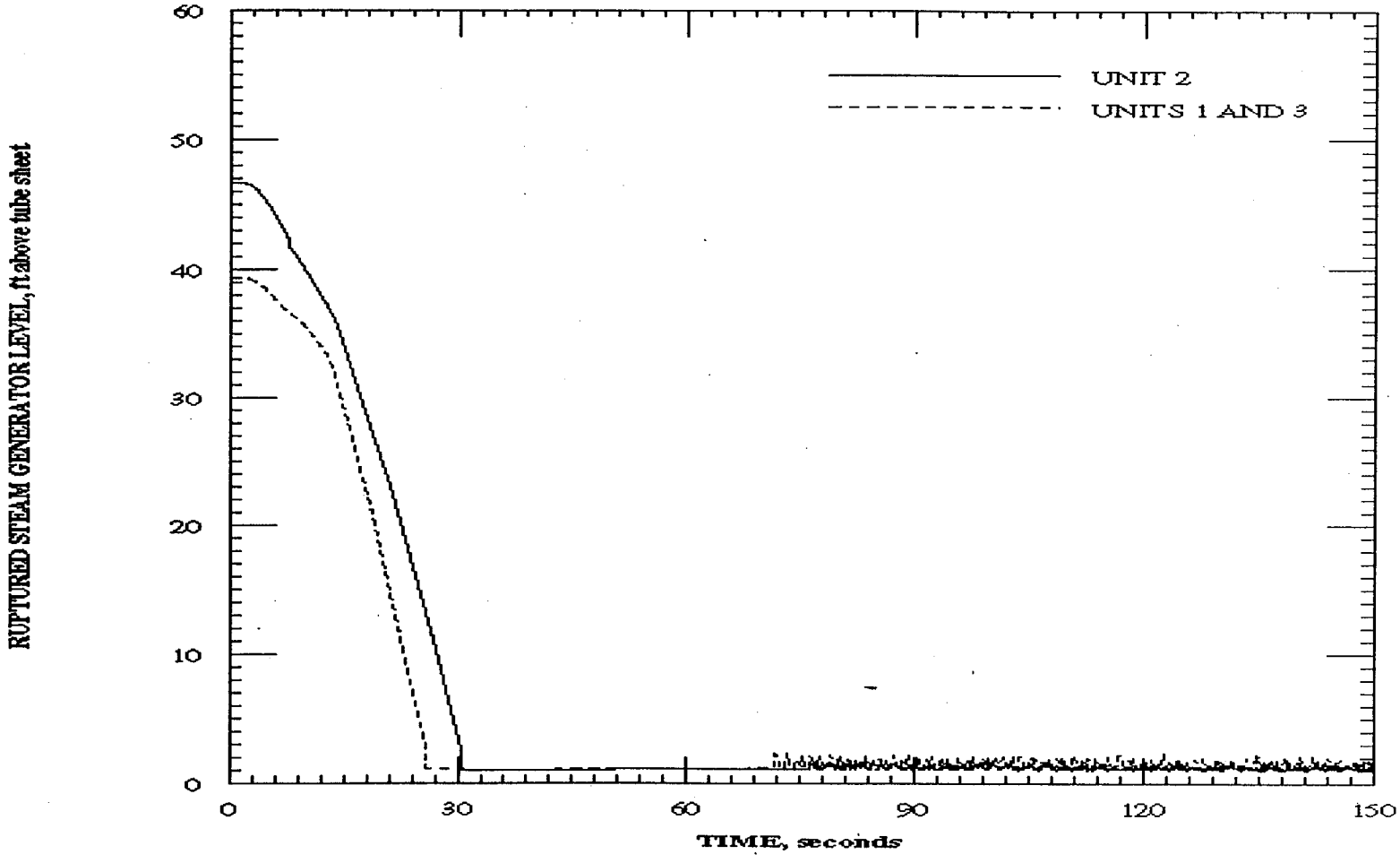

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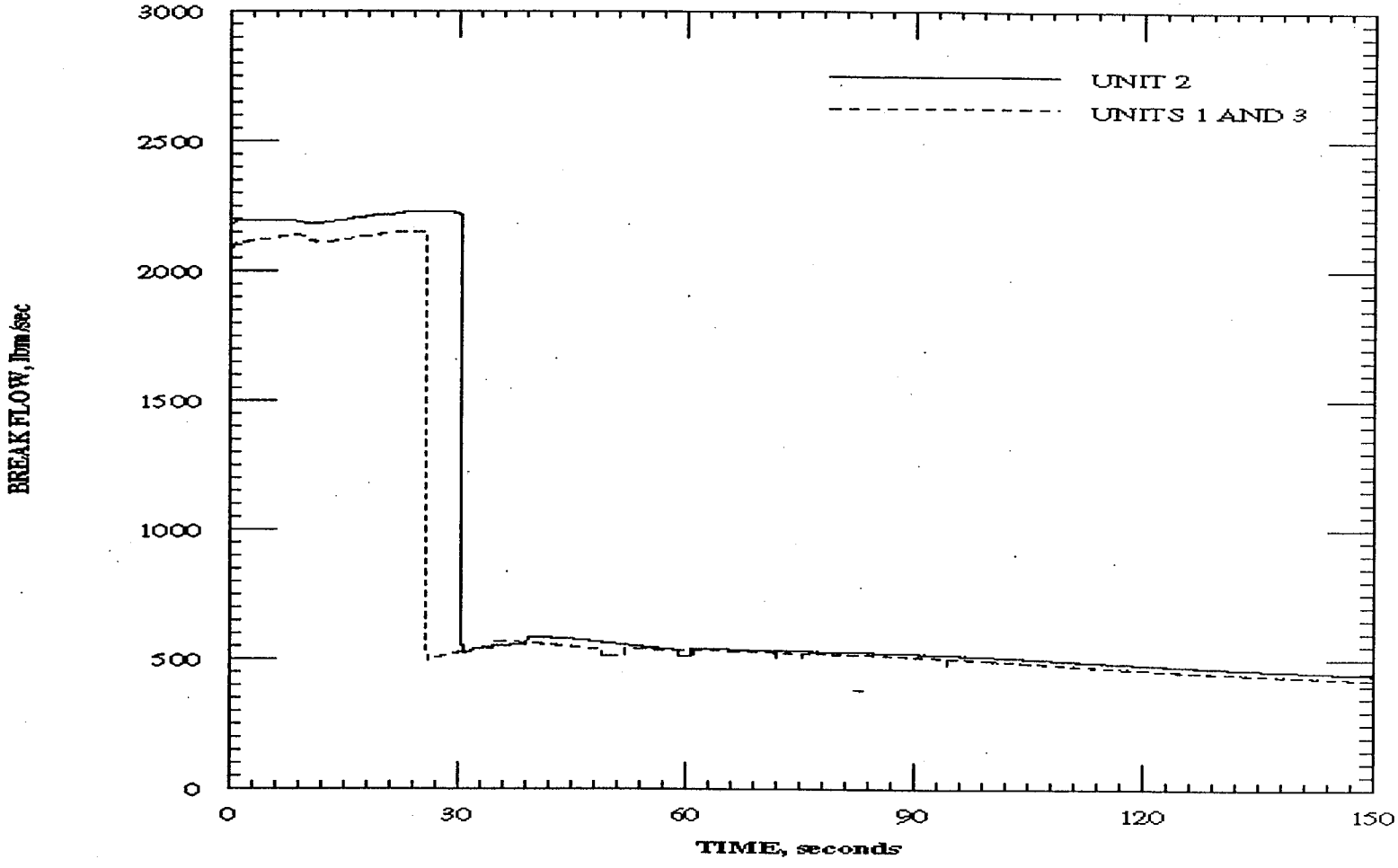

PALO VERDE

Limiting Transient Events

15.3 Single RCP sheared shaft with LOP

- Key assumptions
  - LOP credited 3 seconds after turbine trip (grid disturbance).
  - Shortly after reactor trip, an ADV is assumed to stick full open.
  - ADV open from ~0 to 3600 seconds.
  - DF of 1.0 affected SG, 100 unaffected SG.
- Methodology changes
  - None.
- Licensed results
  - No DNB propagation / maintain coolable geometry.
  - Offsite dose within 10CFR100 limits.
  - Primary & secondary pressure $\leq$ 110% design

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Limiting Transient Events

15.4 Uncontrolled bank CEA withdrawal

- Key assumptions
  - Subcritical, HZP, and HFP cases analyzed.
- Methodology changes
  - None.
- Licensed results
  - GDC 20 and 25 satisfied.
  - No DNBR SAFDL violation.
  - Fuel centerline temperatures below melting point.
  - Primary & secondary pressure $\leq$ 110% design.

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Limiting Transient Events

15.4 CEA ejection

- **Key assumptions**
  - Highest worth CEAs at various power levels analyzed.
  - Both fuel enthalpy and DNBR used to access fuel failure.
- **Methodology changes**
  - None.
- **Licensed results**
  - Radially averaged fuel enthalpy ≤ 280 cal/gm *[radially averaged less than 140 cal/gm and centerline less than 250 cal/gm].*
  - No DNB propagation / maintain coolable geometry.
  - Offsite dose within 10CFR100 limits.
  - Primary & secondary pressure ≤ 120% design.

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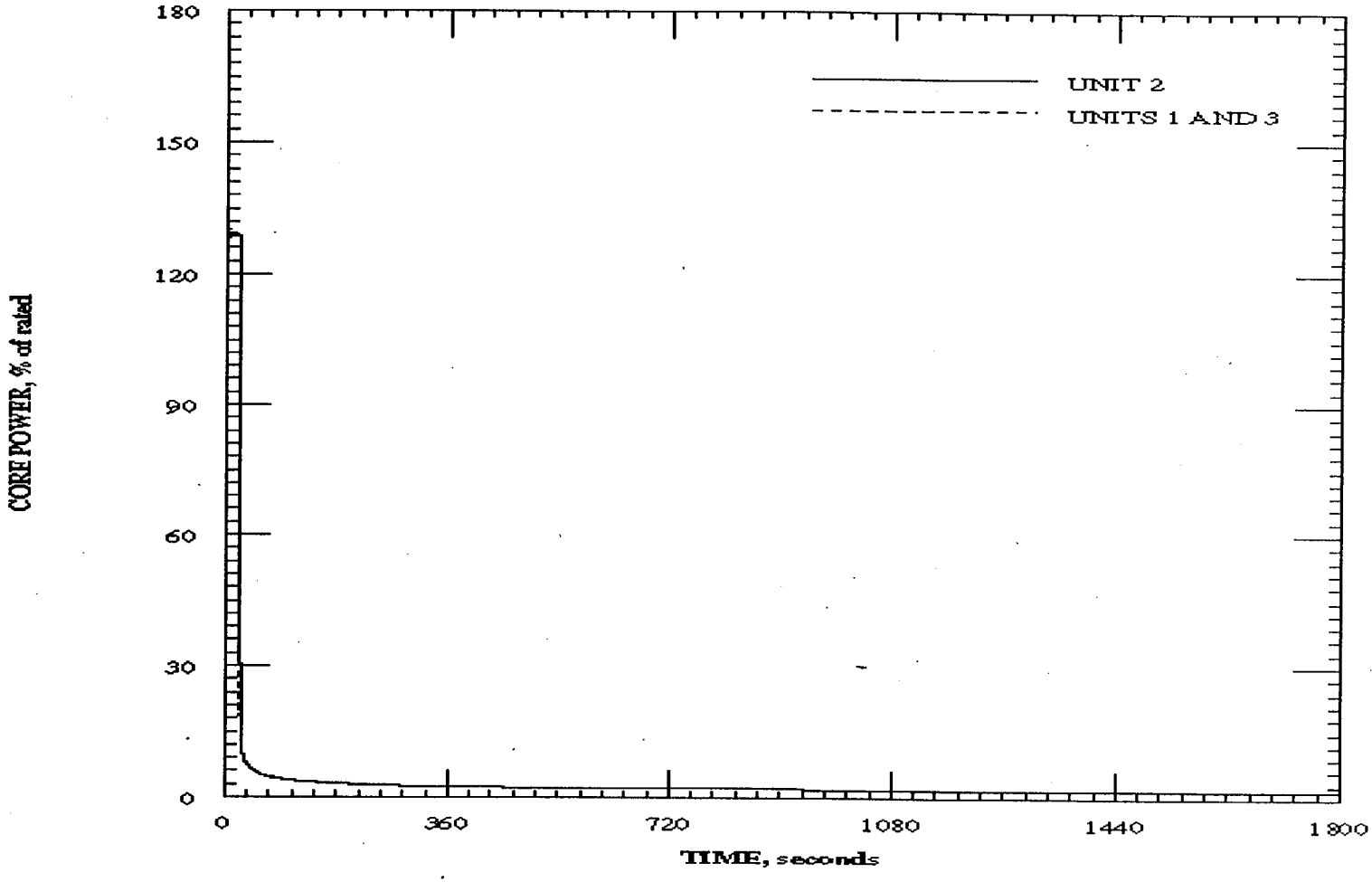
Limiting Transient Events



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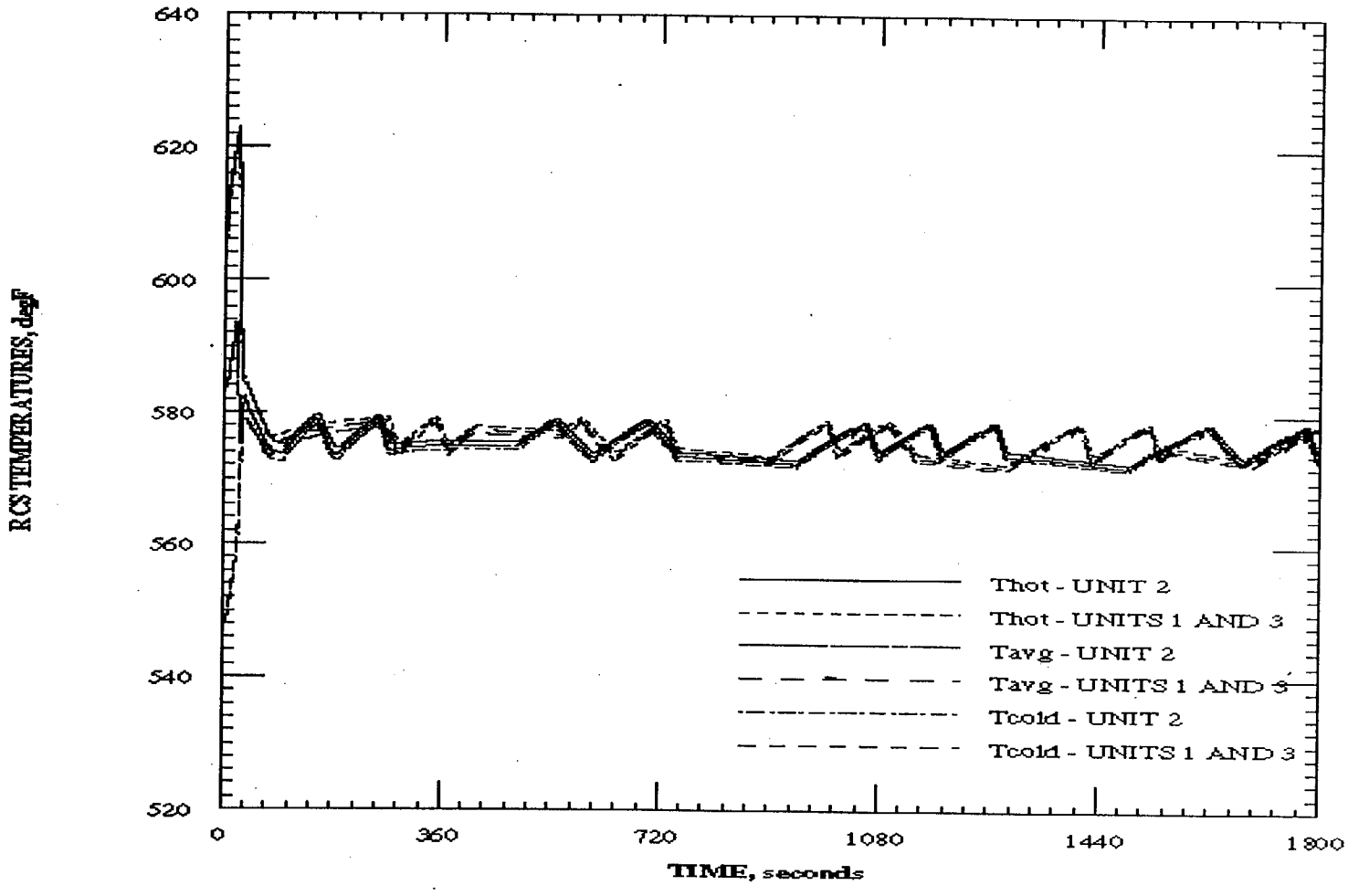

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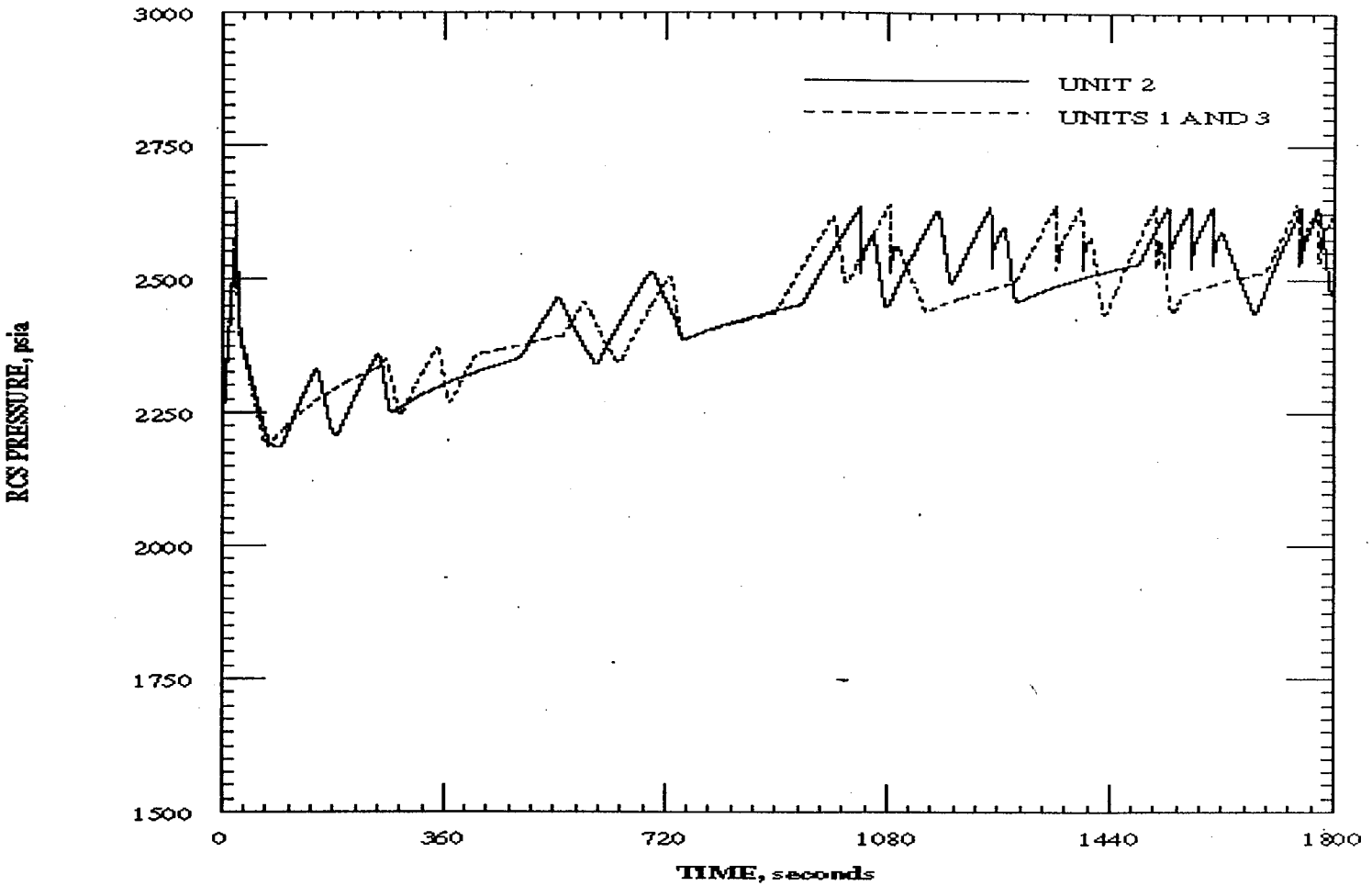
Limiting Transient Events



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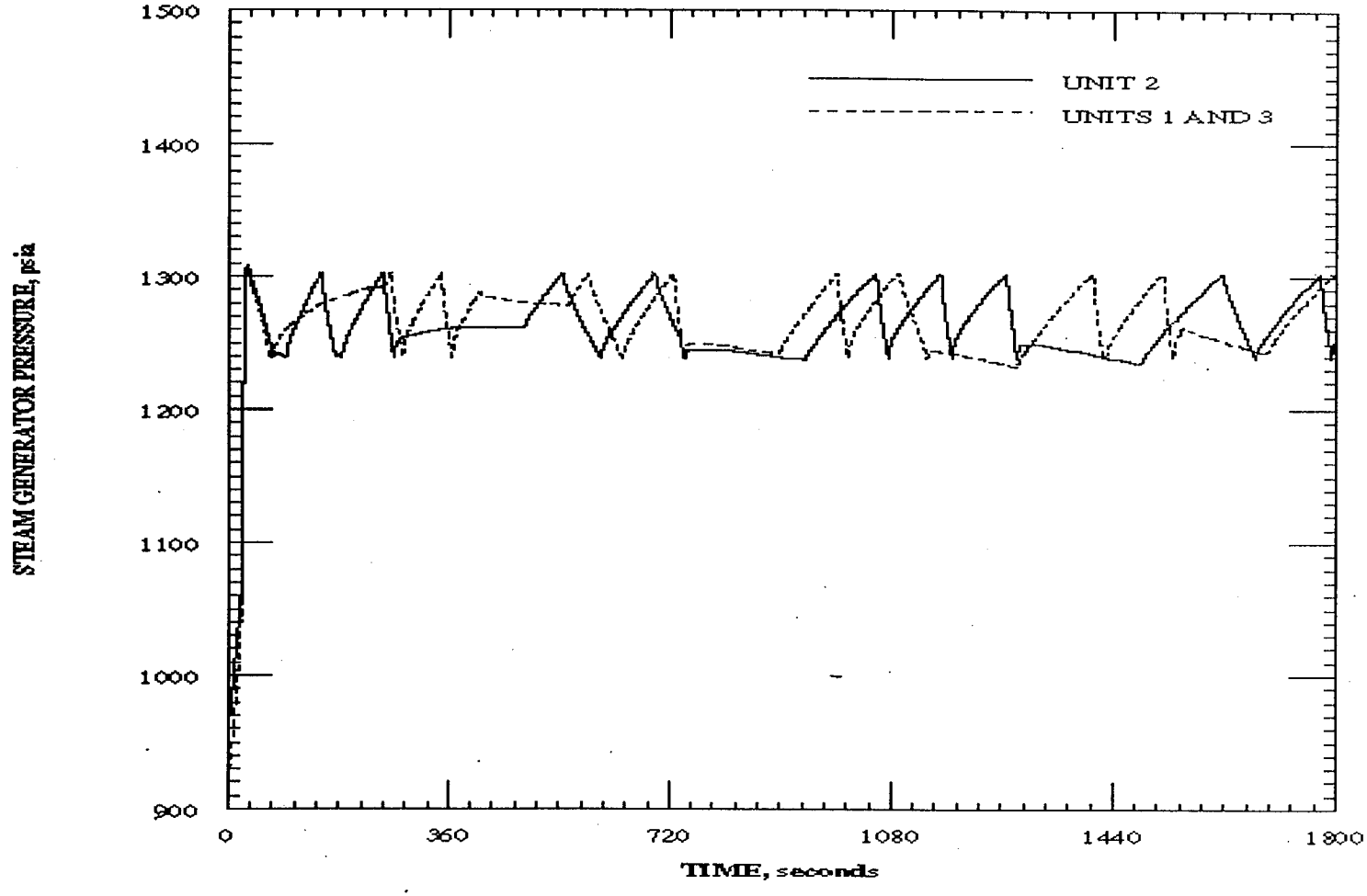

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Limiting Transient Events

15.6 SGTR with LOP

- Key assumptions
  - Double-ended U-tube rupture analyzed.
  - Operators actions based upon EOPs credited.
  - Flashing calculated based upon local conditions.
  - DF of 1.0 for flashed leak, 100 for unflashed leak (which mixes with SG inventory).
- Methodology changes
  - Operators isolate affected SG to minimize releases.
- Licensed results
  - No SAFDL violation.
  - Offsite dose within 10% of 10CFR100 limits - GIS activity.
  - Offsite dose within 10CFR100 limits - PIS activity.
  - Primary & secondary pressure $\leq$ 110% design.

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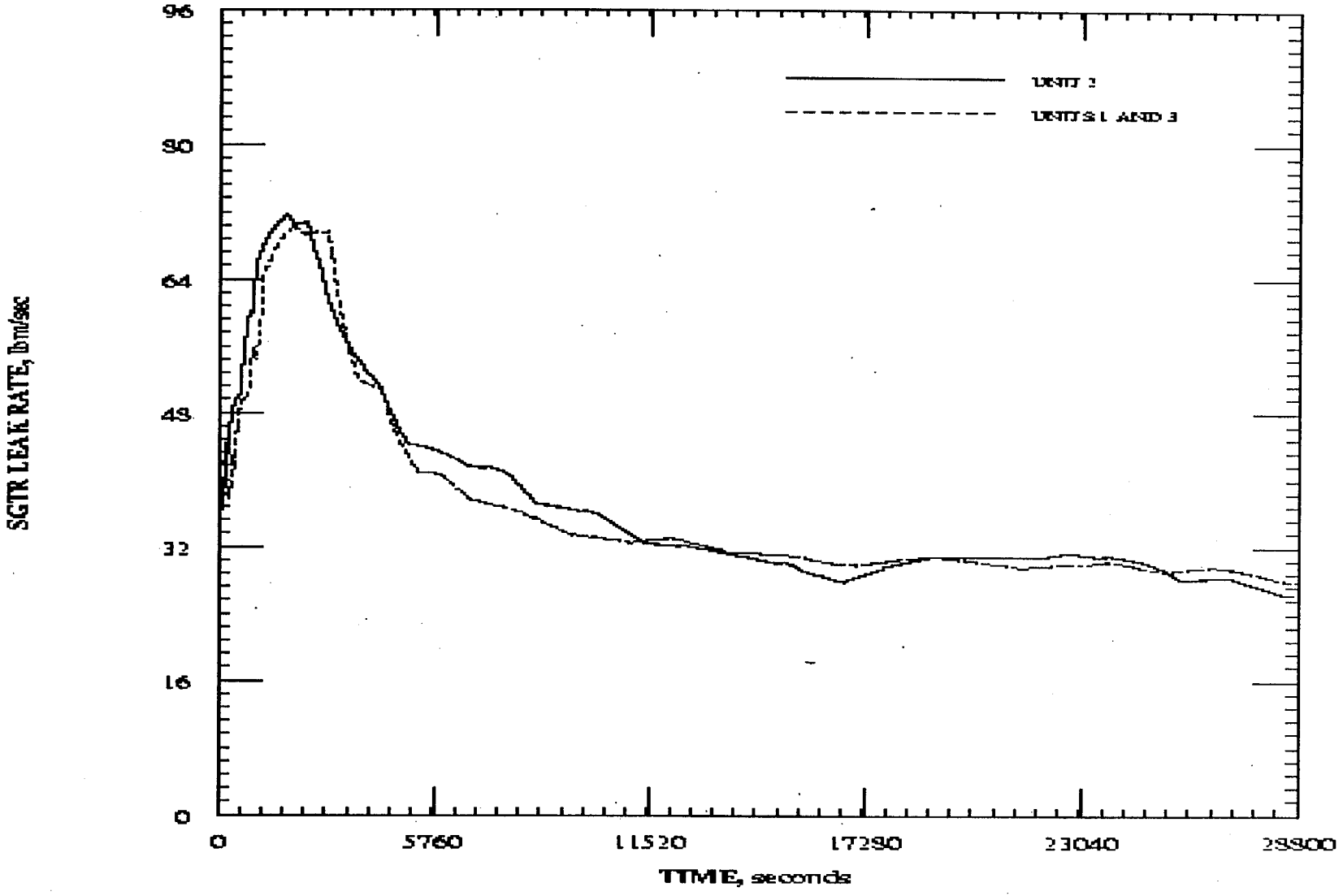
Limiting Transient Events

15.6 SGTR with LOP and stuck-open ADV

- Key assumptions
  - Double-ended U-tube rupture analyzed.
  - ADV open 2 minutes post-trip for duration.
  - Operators actions based upon EOPs credited.
  - DF of 1.0 for flashed leak, 100 for unflashed leak (which mixes with SG inventory).
- Methodology changes
  - Flashing calculated based upon local conditions.
- Licensed results
  - No SAFDL violation.
  - Offsite dose within 10CFR100 limits - GIS activity.
  - Offsite dose within 10CFR100 limits - PIS activity.
  - Primary & secondary pressure $\leq$ 110% design.

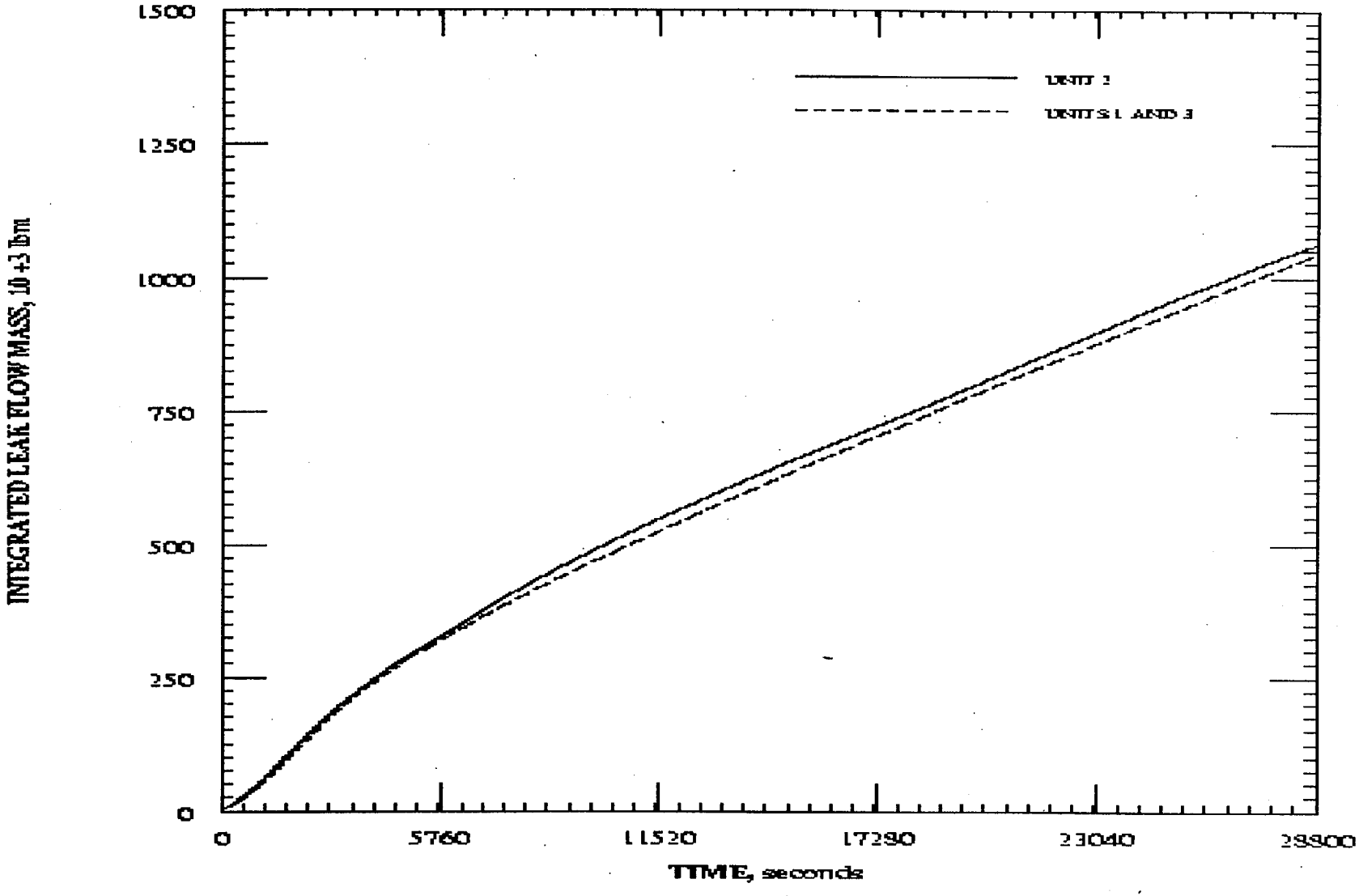
PALO VERDE

Limiting Transient Events

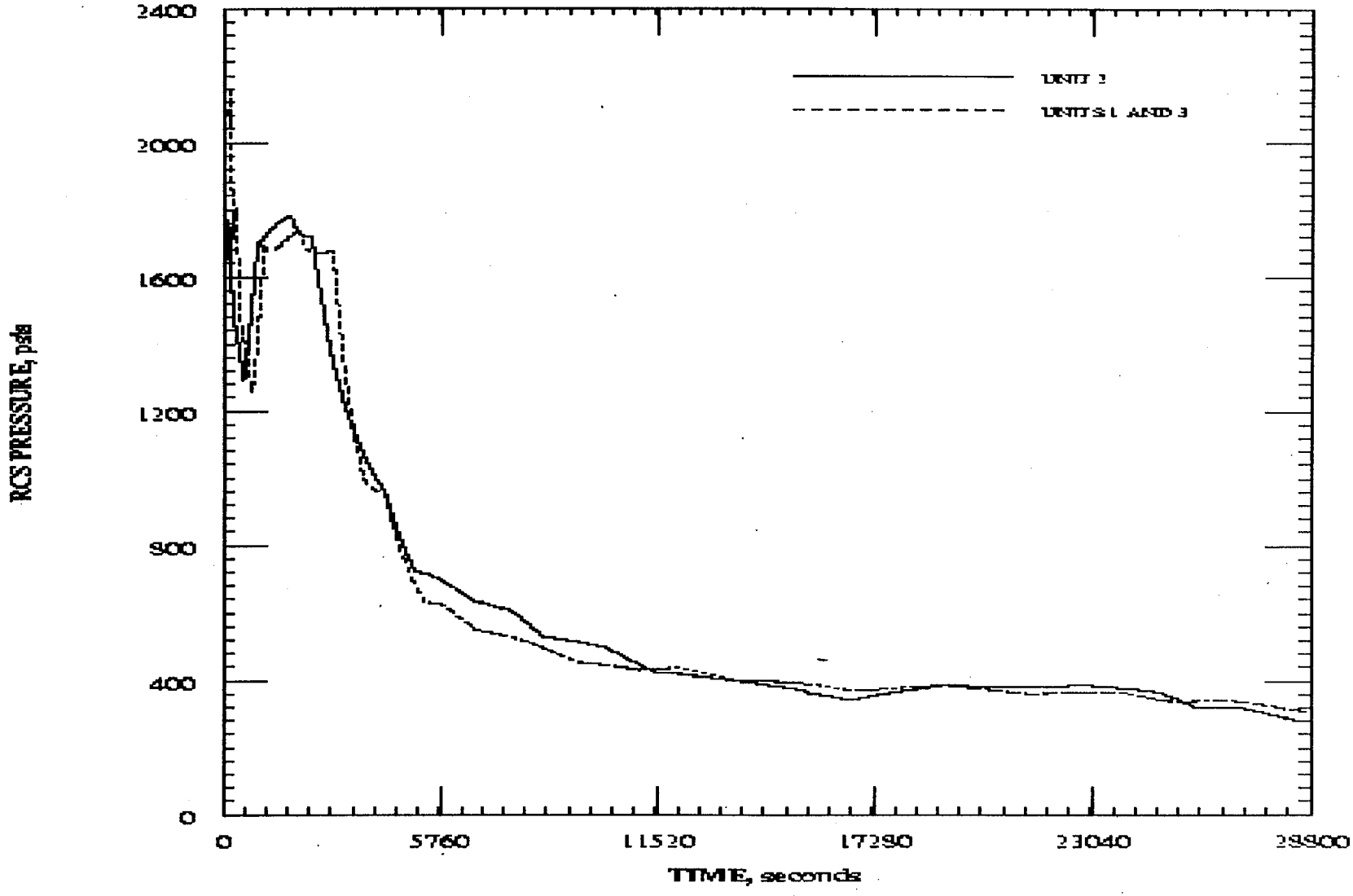


PALO VERDE

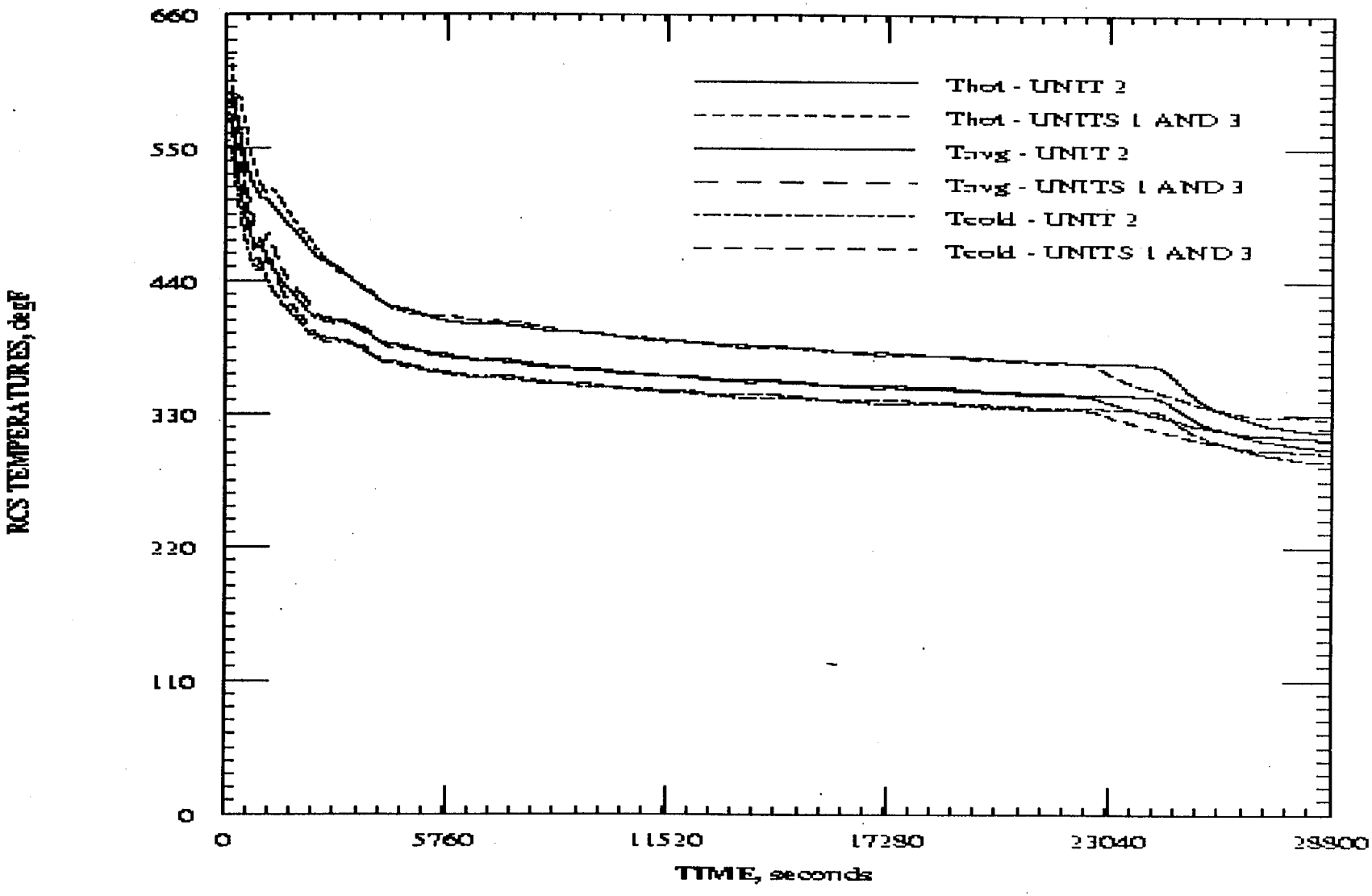
Limiting Transient Events



Limiting Transient Events

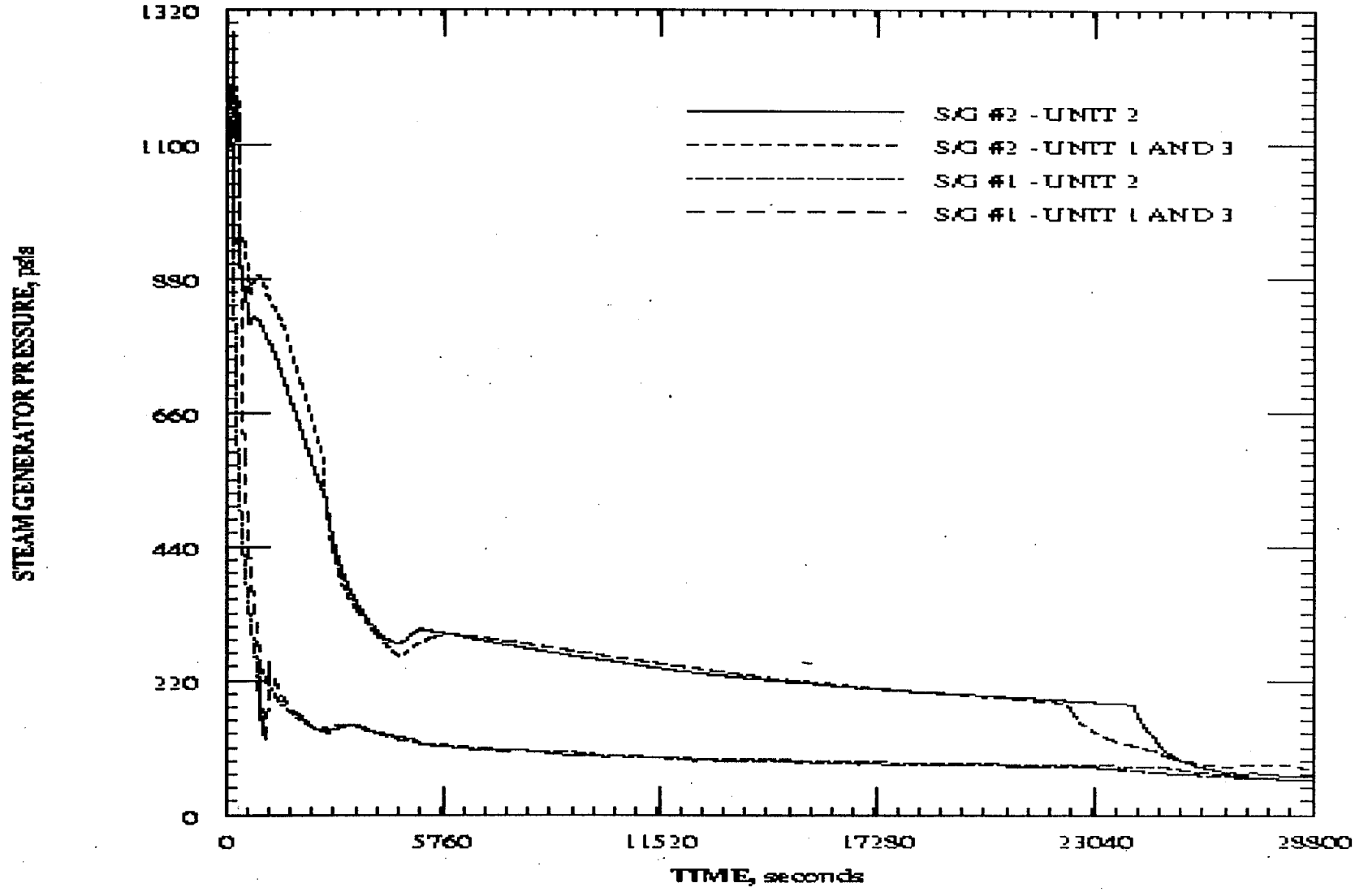


Limiting Transient Events



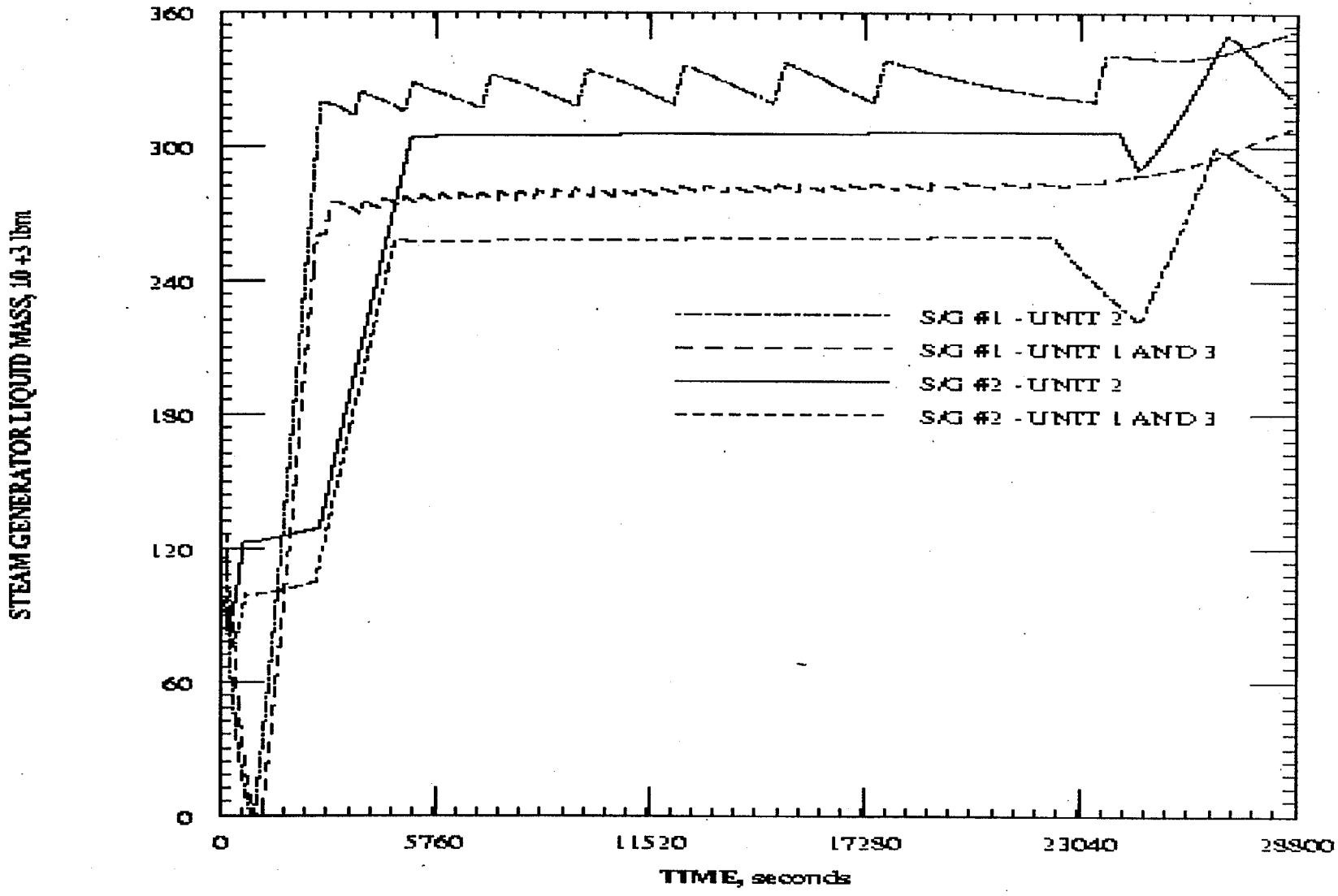
PALO VERDE

Limiting Transient Events

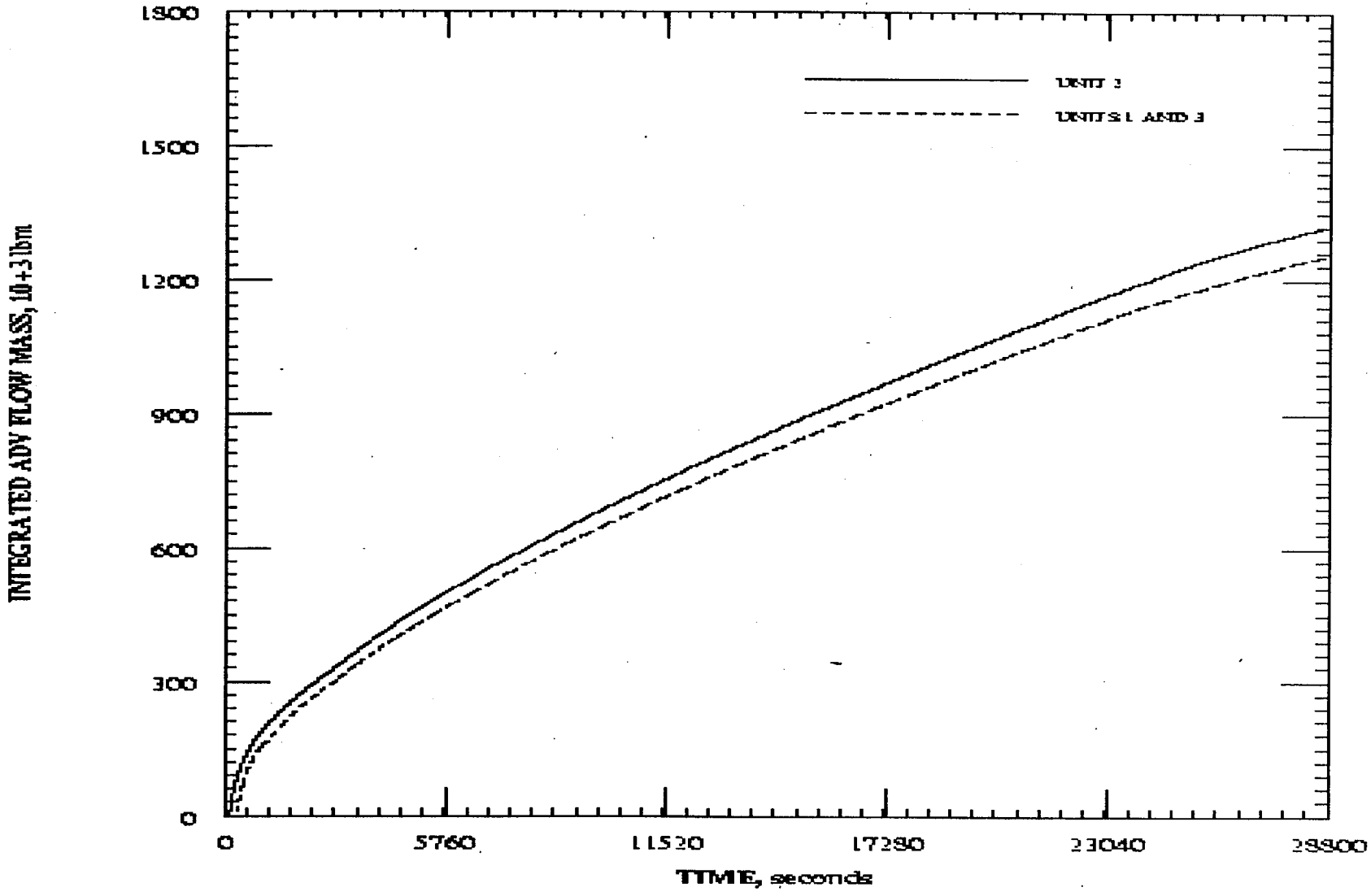


PALO VERDE

Limiting Transient Events



Limiting Transient Events



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ECCS Performance Analysis

- PVNGS Analyses of Record (AOR) is based on core power level of 4070 MWt (3990 x 1.02)
- No explicit analyses are scheduled for this project
- ABB will demonstrate that the RSGs result in increased margin of safety compared to the AOR
- The LBLOCA, SBLOCA and long-term cooling analyses in the AOR remain applicable

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Oversight Activities

- **Audited ABB Chattanooga in May 1999**
  - **Seven findings**
    - **Software control**
    - **Design control**
    - **Internal Audit program**
    - **Corrective Action Program**

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Oversight Activities

- Audited Ansaldo Milan in June 1999
  - Wisconsin Public Service Corp. participated
    - Six findings
      - Weak and ineffective corrective action
      - Non-compliance ANSI Standard
      - Procurement control
      - Compliance with cleaning spec (WPSC)
      - Documentation of witness points

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Oversight Activities

- Audited Ansaldo Genoa in June 1999
  - Wisconsin Public Service Corp. participated
    - Two findings
      - Procurement control
      - Corrective action program

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Oversight Activities

- **Audited ABB Windsor in August 1999**
  - **Eight findings**
    - **Software control/design control**
    - **Weakness QA audits/auditor training**
    - **Corrective Actions**

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Sandvik Oversight Plan

- Sandvik Personnel to Provide Required QA Oversight
- Ansaldo Personnel to Provide 2nd Party Verification
- SAQ (acting for APS) to Provide 3rd Party Oversight
- APS / Ansaldo Completed Readiness Assessment of Sandvik in October 1999
- APS Senior Management Review November 1999
- APS NDE Level III Review in December 1999
- APS / Ansaldo Quality Team Review March & May 2000

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Baseline NDE Program

- 100% full length bobbin ECT
- 100% MRPC ECT at top of hot leg tubesheet using + point probe
- 100% MRPC ECT of row 1 & 2 at U-bend using + point probe

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YGN Central Cavity Flow Induced Wear

- Present status of YGN Units
  - YGN - 3
    - Cycle 3
    - 3 tubes plugged
    - 52 indications
  - YGN - 4
    - Cycle 3
    - 40 tubes plugged
    - 148 indications

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YGN Central Cavity Flow Induced Wear

- YGN units similar to PVNGS-RSG
- Failure mechanism
  - Flow induced motion of tube
  - Similar to batwing stay cylinder wear
  - Population of affected tubes in RSG ~120
- PVNGS personnel visited YGN for technical interface meeting

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YGN Central Cavity Flow Induced Wear

- The Design team reviewed six options
  - Option 0 - Modify spacing of partial eggcrates
  - Option 1 - Add a local vertical grid above the central cavity
  - Option 2 - Add a non-integral center vertical grid
  - Option 3 - Add an additional partial eggcrate
  - Option 4 - Add eggcrate flow distribution plates
  - Option 5 - Add integral center vertical grid and reduce the number of grids from six to five

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YGN Central Cavity Flow Induced Wear

- **Decision**
  - **Option 5 selected**
  - **Reduces the number of susceptible tubes by ~90% without increasing design uncertainties associated with new/unproven components**

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PVNGS RSG Cold Leg Issue

- Original RSG design could not support mid-loop operation

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PVNGS RSG Cold Leg Issue

- **Background**
  - **Maintain spatial location of nozzle end**
  - **Maintain same angle from vessel centerline to nozzle centerline**
  - **Wider steam generator lowered nozzle lip 5.1 inches**

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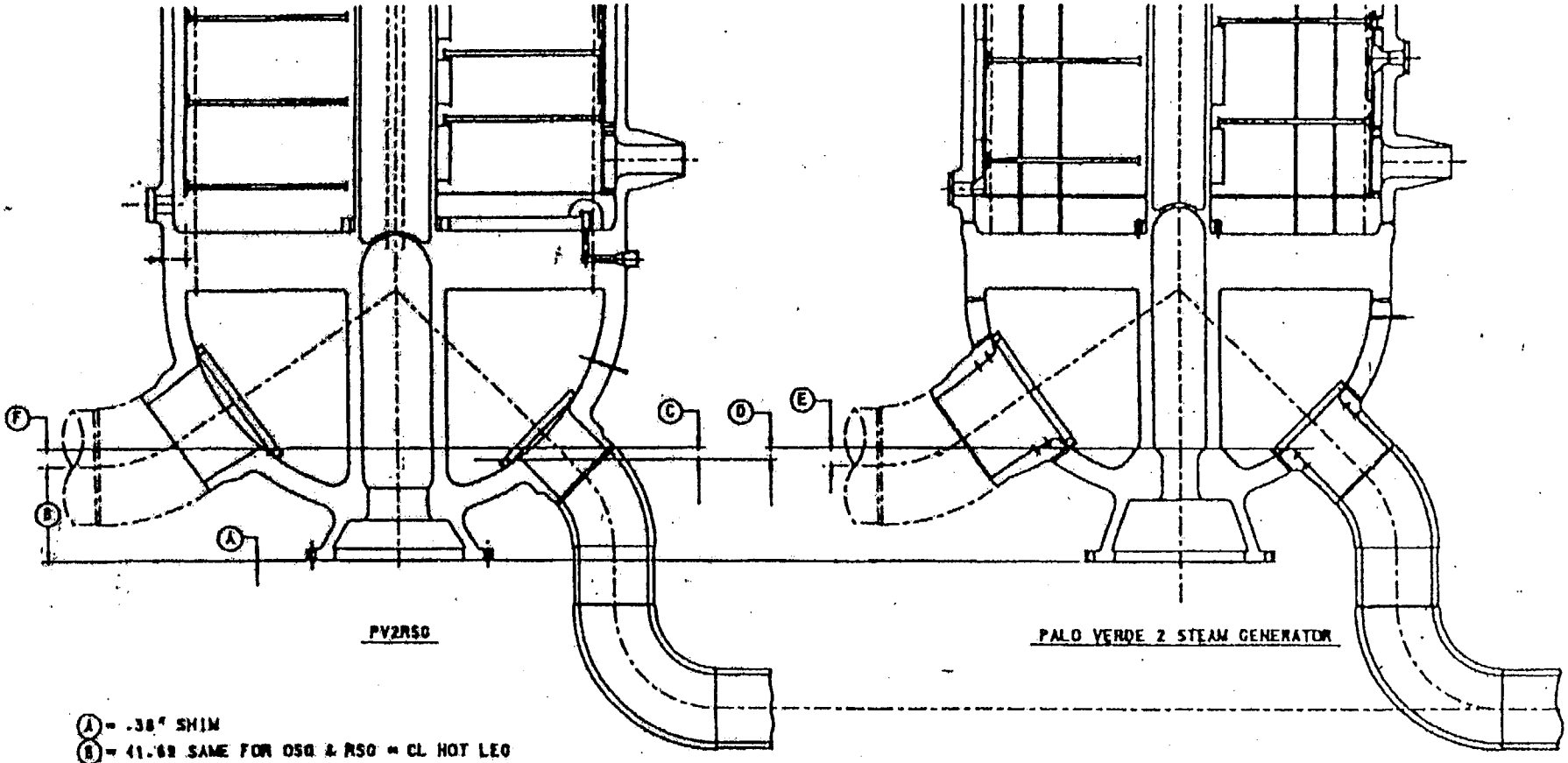
PVNGS RSG Cold Leg Issue



(A) = .38" SHIM
(B) = 41.68 SAME FOR OSG & RSG = CL HOT LEG
(C) = 5.2" = DIFFERENCE BETWEEN RSG HOT LEG "LIP" AND COLD LEG LIP"
(D) = 6.1" = OSG COLD LEG "LIP" - RSG COLD LEG "LIP" = CHANGE IN MID LOOP LEVEL
(E) = 7.78 = OSG COLD LEG "LIP" - CL HOT LEG
(F) = 7.88" = RSG HOT LEG "LIP" - CL HOT LEG

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PVNGS RSG Cold Leg Issue

- Current operations box (40OP-9ZZ16)
  - 101' 7" to 101" 11"
- APS team evaluated alternatives
  - Maintain operations box
  - Increased angle of nozzle to raise elevation
  - Moved end of nozzle
  - Requires new elbow and spool piece

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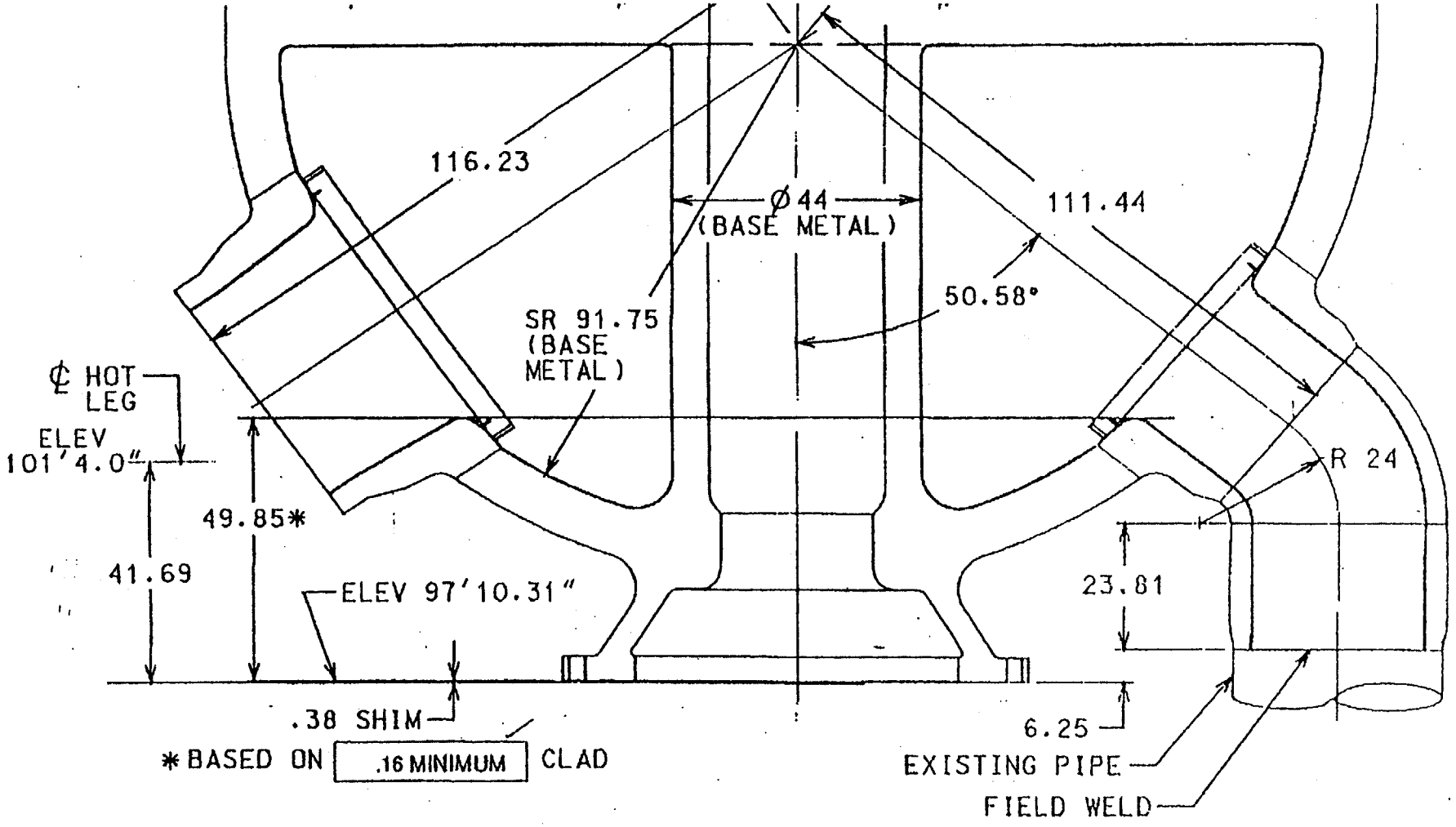
PVNGS RSG Cold Leg Issue



PVNGS RSG Cold Leg Issue

- **Corrective actions**
  - **ABB design review**
  - **APS "change analysis" team review**
  - **Increased Bechtel's scope of work**

Licensing Submittals

- **August 2000**
  - Chapter 15 analyses
  - Most of Chapter 6 analyses
- **February 2001**
  - Seismic analysis of RCS branch lines
  - EQ evaluations
  - Remainder of Chapter 6 analyses

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Potential Technical Specification Changes

- Definition of Rated Thermal Power
- Low SG pressure reactor trip setpoint
- Low SG pressure MSIS setpoint
- Peak containment pressure
- Operating range for cold leg temperature at 100% power

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Major Activities

- **U2R8 (spring 1999)**
  - Laser templating of piping in containment
  - UT RCS piping to verify thickness
  - Measure roundness of equipment hatch
  - Optical measurement of SG snubbers
  - General walkdown of containment

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Major Activities

- U2R9 (fall 2000)
  - Laser templating of piping in containment
  - Design verification walkdowns in containment
  - Polar crane inspections
- U2C10 (winter 2000 - spring 2002)
  - Personnel access and north side sally port

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Major Activities

- **U2R10 (spring 2002)**
  - Replace 2 feedwater heaters
  - Remove interfering commodities from bioshield wall
  - Polar crane preparations (based on U2R9 inspection)
  - SG2 auxiliary crane supports

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Major Activities

- **U2C11 (summer 2002 - fall 2003)**
  - **Craft access facility**
  - **Outside lift system**
  - **Haul route**
  - **RSG preparations**
  - **RSG lifting and rigging concept**

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Major Activities

- **U2R11 (fall 2003)**
  - **Replace 4 feedwater heaters**
  - **Bioshield wall modifications and interference removal**
  - **Replace steam generators**

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Project Milestones

- Dec. 1997 — Signed fabrication contract
- Oct. 1998 — Commenced fabrication
- Dec. 1998 — Signed transportation contract
- Jan. 1999 — Signed installation contract
- August 2000 — Submit licensing package
- May 2002 — RSG delivery to Palo Verde
- Sept. 2003 — SGR outage U2R11

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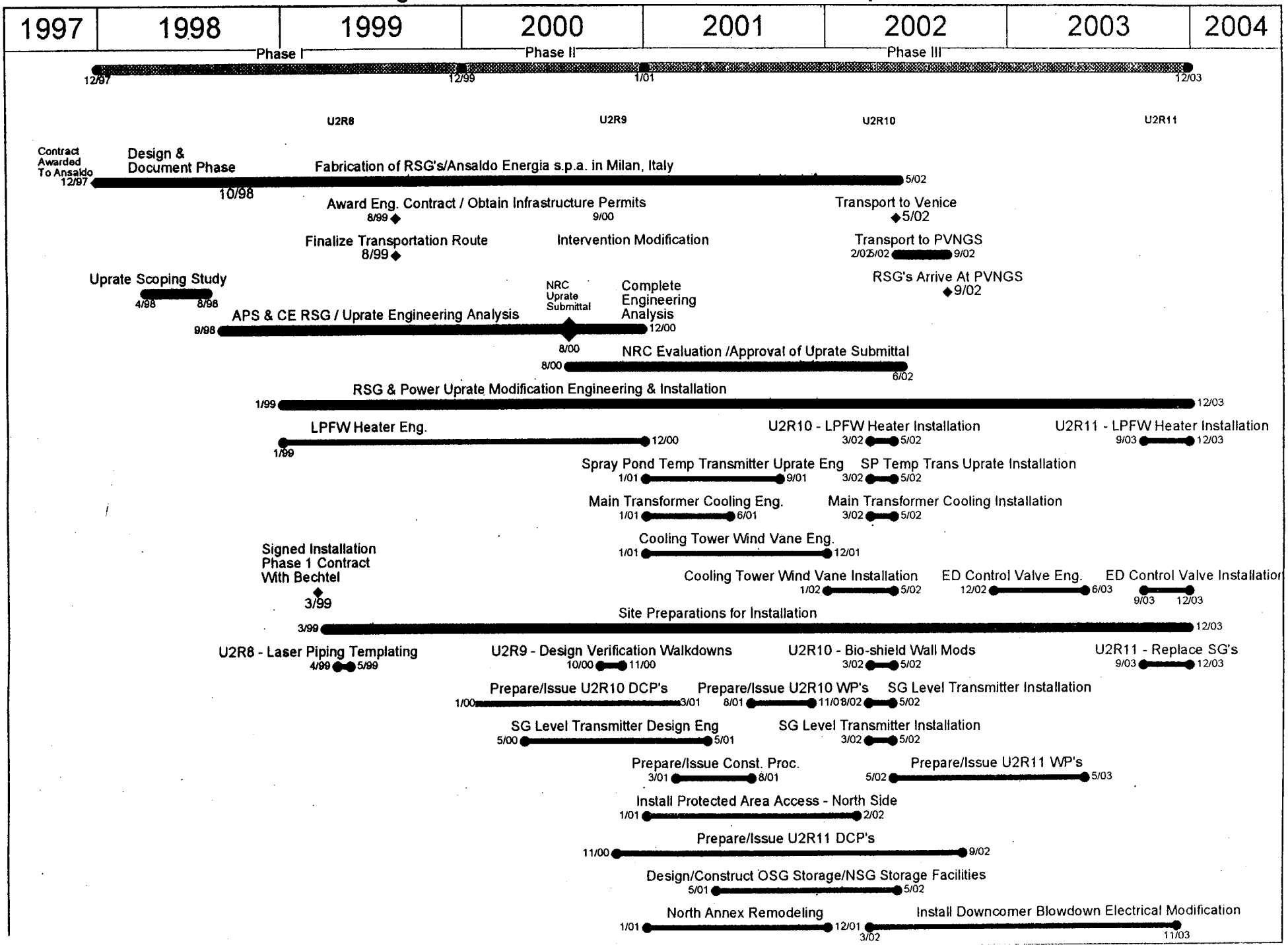
PVNGS Unit 2 Steam Generator Replacement Project
Integrated Level One Schedule for RSG & Power Uprate



Future Activity

- Conduct periodic meetings with Region IV and NRR
- Keep NRC residents informed of progress and site activity
- Work with NRC to perform inspection module 50001

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