CALVERT CLIFFS NUCLEAR POWER PLANT UNITS 1 & 2
STEAM GENERATOR REPLACEMENT

REPLACEMENT STEAM GENERATOR SAFETY EVALUATION REVIEW AND PROJECT STATUS

PRESENTATION TO THE NRC

NOVEMBER 1, 2000

Enclosure 2

Calvert Cliffs Nuclear Power Plant, Inc.

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Calvert Cliffs Nuclear Power Plant Attendees

Name	Title
A. R. Thornton	CCNPP Manager-Nuclear Project Management Department
T. L. Konerth	CCNPP Project Engineer
G. Tesfaye	CCNPP Senior Licensing Engineer
M. T. Finley	CCNPP Principal Engineer
W. C. Holston	CCNPP Supervisor Eng. Assessment
M. Massoud	CCNPP Consulting Engineer
K. J. Connell	SGT RSG Engineering Manager
M. D. Ceraldi	SGT Lead Licensing Engineer
M. B. Baker	FTI Senior Licensing Engineer
J. Millman	BWC Senior Project Engineer

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Meeting Objectives

- Present to the NRC staff an Overview of Replacement SG Safety Evaluation
- Update Licensing Status
- Update Engineering Status
- Update Fabrication Status

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Agenda

❊ Introduction	A. R. Thornton
❊ RSG Safety Evaluation	M. T. Finley
❊ Licensing Status	G. Tesfaye
❊ Engineering Status	T. L. Konerth
❊ Fabrication Status	T. L. Konerth
❊ Open Discussion	All Attendees
❊ Closing Remarks	A. R. Thornton
❊ Supplementary Presentation "Gothic Application"	M. Massoud

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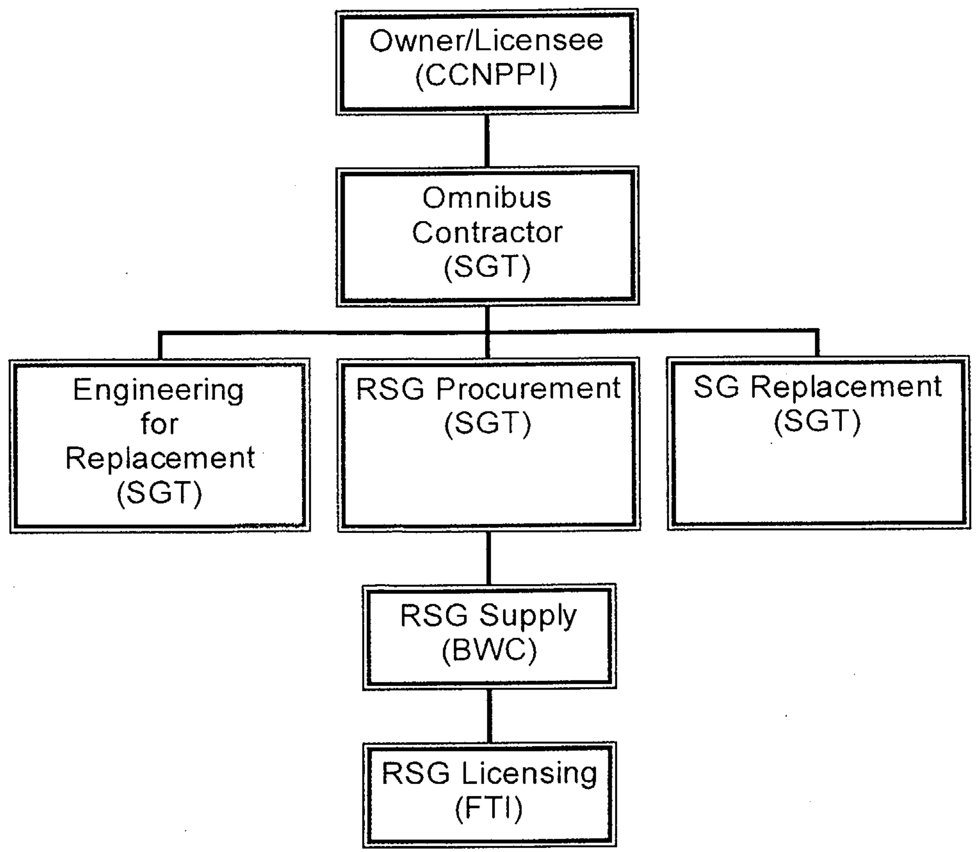
Functional Relationships



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SG Replacement Events

- Warehouse construction starts March 2001
- OSG storage facility construction starts March 2001
- Unit 1 RSGs arrive Oct-Nov 2001
- Unit 1 replacement outage starts March 2002
- Unit 2 RSGs arrive Oct-Nov 2002
- Unit 2 replacement outage starts February 2003

RSG Safety Evaluation

- Background
  - RSG designed similar to OSG
  - Most significant design/operating changes:
    - RSG tubing Alloy 690 with reduced wall thickness
    - UA 4% above zero plugged tube UA for OSG
    - Secondary steam pressure increases 50 psi (25 psi above current safety analysis assumption)
    - RCS flow increases (back to zero plugged tube value)
    - Integral flow restrictor (1.9 ft^2) installed
  - Primary and secondary inventory very similar by design

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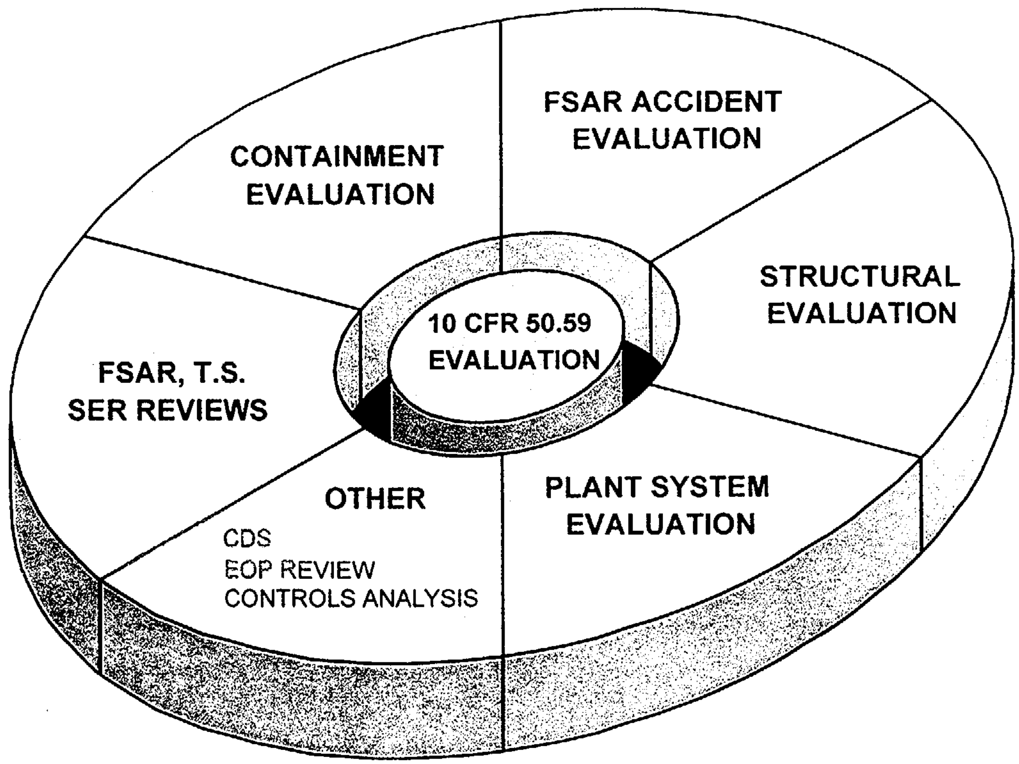
RSG Safety Evaluation 10CFR50.59 Scope



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RSG Safety Evaluation

- **Review Process** (Performed by FTI)
  - Review each accident and identify:
    - the acceptance criteria
    - the critical parameters that affect the approach to the acceptance criteria
  - Compare the OSG and RSG characteristics
  - Could use of the RSG adversely affect the approach to an acceptance criterion?
    - No. . .UFSAR remains bounding
    - Yes. . .Additional evaluation or analysis required
  - Are all acceptance criteria met?
    - Yes. . .Document evaluation or analysis in UFSAR
    - No. . .NRC prior approval required
  - All documents reviewed / approved by SGT & CCNPP

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Calvert Cliffs RSG Safety Analysis Matrix

Accident	UFSAR Chapter	Effect of RSG	Disposition
CEA Withdrawal	14.2	• UA ↑ beneficial • RCS flow ↑ beneficial • Core physics unaffected	Evaluation
Boron Dilution	14.3	• RCS inventory very similar • Boron worth unaffected	Evaluation
Excessive Load	14.4	• Steam flow increase is less than 3% • Steam flow remains less than analysis of record since 5% margin was available • RCS flow ↑ beneficial	Evaluation
Loss of Load	14.5	• UA ↑ beneficial for primary pressure, adverse for secondary pressure • Analysis for peak secondary pressure performed • RSG design pressure ↑ 15 psi • Result is less than 110% of design pressure	Analysis
Loss of Feedwater Flow	14.6	• Secondary inventory very similar • Decay and sensible heat very similar • Significant margin in analysis of record low level trip	Evaluation
Excess Feedwater Heat Removal	14.7	• Feedwater conditions unaffected • RCS flow ↑ beneficial	Evaluation
RCS Depressurization	14.8	• PORV and pressurizer unaffected • RCS flow ↑ beneficial	Evaluation
Loss of Coolant Flow	14.9	• RCP coastdown less rapid with fewer plugged tubes • RCS flow ↑ beneficial	Evaluation
Loss of AC Power	14.10	• Decay and sensible heat very similar • Secondary inventory very similar	Evaluation
CEA Drop	14.11	• Core physics unaffected • RCS flow ↑ beneficial	Evaluation
Asymmetric SG	14.12	• UA ↑ has small effect on core temperature tilt • RCS flow ↑ beneficial	Evaluation
CEA Ejection	14.13	• Core physics unaffected • RCS flow ↑ beneficial	Evaluation
SLB – IC	14.14	• Integral flow restrictor beneficial (break area ↓) • Secondary inventory very similar	Evaluation
SLB – OC	14.14	• UA ↑ and secondary pressure increase adverse • Significant margin in break size in analysis of record • RCS flow ↑ beneficial • Secondary inventory very similar – dose unaffected	Analysis
SGTR	14.15	• Tube ID ↑ is adverse • Shortest tube length ↑ is beneficial • Secondary pressure ↑ is beneficial • Ruptured tube flow is bounded • Adequate overfill volume	Evaluation
Seized Rotor	14.16	• RCS flow distribution and step change unaffected • RCS flow ↑ beneficial • UA ↑ beneficial	Evaluation
LOCA	14.17	• Primary inventory very similar • UA ↑ is beneficial • Decreased tube plugging is beneficial	Evaluation
Fuel Handling Inc.	14.18	• Unaffected	Evaluation
Turb. Overspeed	14.19	• Unaffected	Evaluation
Containment Resp. – LOCA	14.20	• Primary inventory very similar • RCS flow ↑ beneficial since Tave ↓	Evaluation
Containment Resp. – MSLB	14.20	• Smaller break with dry steam adverse • Peak pressure less than design • Temperature spike short with redundant spray	Analysis
Hydrogen Accum	14.21	• Unaffected	Evaluation
Waste Gas Inc.	14.22	• Primary inventory very similar	Evaluation
Waste Evap Inc.	14.23	• Unaffected	Evaluation
MHA	14.24	• Unaffected	Evaluation
Excess Charging	14.25	• Pressurizer and charging pumps unaffected • Primary inventory very similar	Evaluation
Feedline Break	14.26	• Secondary inventory very similar • UA ↑ is beneficial • Significant margin in break uncovery assumption in analysis of record	Evaluation

RSG Safety Evaluation

- CEA Withdrawal
  - Heatup event where increased UA is beneficial
  - Increased RCS flow is beneficial
  - Core physics unaffected
- Boron Dilution
  - Primary inventory is very similar
  - Boron worth is unaffected

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RSG Safety Evaluation

- Excess Load
  - Steam flow increase is less than 3%
  - Steam flow remains less than analysis of record since 5% margin is available
  - Increased RCS flow is beneficial
- Loss of Load
  - Increased UA beneficial for primary pressure, adverse for secondary pressure
  - Analysis required for maximum secondary pressure case
  - RSG design pressure is 15 psi greater
  - Result of analysis is peak secondary pressure is less than 110% of design pressure

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RSG Safety Evaluation

- Loss of Feed
  - Secondary inventory very similar
  - Decay and sensible heat very similar
  - Significant margin in analysis of record Low Level Trip set-point (-116" analysis trip vs. -50" actual trip set-point)

- Excess FW Heat Removal
  - FW temperatures are not affected
  - Increased RCS flow is beneficial

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RSG Safety Evaluation

- RCS Depressurization
  - PORV and pressurizer are not affected
  - Increased RCS flow is beneficial
- Loss of Flow
  - RCP coastdown less rapid with fewer plugged tubes
  - Increased UA is beneficial

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RSG Safety Evaluation

- Loss of AC Power
  - Decay and sensible heat are very similar
  - SG secondary inventory very similar
- CEA Drop
  - Core physics unaffected
  - Increased RCS flow is beneficial

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RSG Safety Evaluation

- Asymmetric SG
  - Increased UA has a small effect on RCS cold leg temperatures
  - Increased RCS flow is beneficial
- CEA Eject
  - Core physics unaffected
  - Increased RCS flow is beneficial since T_{hot} and fuel enthalpy are reduced

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RSG Safety Evaluation

- **MSLB-IC (Post-trip)**
  - Integral flow restrictor beneficial (smaller break size)
  - Secondary inventory is very similar
- **MSLB-OC (Pre-trip)**
  - Increased UA and higher secondary pressure are more adverse
  - Increased RCS flow is beneficial
  - Comparative analysis of peak power was performed
  - Peak power increases slightly for same break
  - Break size for RSG is decreased as compared to analysis of record
  - Peak power for RSG is less than analysis of record
  - Secondary inventory is similar so dose is unaffected

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RSG Safety Evaluation

- **SGTR**
  - Tube ID is slightly increased - adverse
  - Shortest tube length is increased - beneficial
  - Secondary pressure is increased - beneficial (reduced tube delta-P)
  - Detailed ruptured tube flow rate analysis shows RSG tube flow bounded by analysis of record
  - Adequate dome volume available for overfill

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RSG Safety Evaluation

Seized Rotor

- RCS flow distribution and step change not affected
- Increased RCS flow is beneficial
- Increased UA is beneficial

LOCA Core Response

- Primary inventory very similar
- Decreased tube plugging benefits steam vent during reflood (large break)
- Increased UA is beneficial (small break)

LOCA Containment Response

- Primary inventory very similar
- Increased RCS flow with decreased T_{ave} is beneficial

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RSG Safety Evaluation

- MSLB Containment Response
  - Integral flow restrictor reduces break size and causes dry steam blowdown
  - Current licensing basis is 20% moisture carryover
  - Reanalysis performed with zero moisture carryover
  - Methodologies have been approved for PWR use
  - Peak pressure less than design-Structural integrity maintained
  - Temperature spike short with redundant spray
  - Currently evaluating effect of temperature spike on EQ
  - No issues for NRC prior approval identified

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RSG Safety Evaluation

- **Waste Evaporator and Waste Gas Incident**
  - Primary inventory very similar
- **Excess Charging**
  - Pressurizer and charging flow are unaffected
  - Primary inventory very similar
- **Feed Line Break**
  - Secondary inventory very similar
  - Increased UA is beneficial
  - Significant margin in break uncovery assumption in analysis of record

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Licensing Status

❊ Draft Licensing Report (complete)	July 1999
❊ Interim Licensing Report	May 2000
❊ RSG 50.90 Submittal	Dec 2000
❊ RSG 50.59 Evaluation	Mar 2001
❊ Updated Licensing Report (Unit 1)	April 2002
❊ Updated Licensing Report (Unit 2)	April 2003

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Licensing Status

- **Activities Requiring Prior NRC Review and Approval**
  - **Technical Specification Revisions**
  - **ASME Code Relief Requests**
  - **No other items requiring NRC review are anticipated**
  - **All Submittals are planned for December 2000**

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Licensing Status

Technical Specification Revision

- SG Level References
  - Current SG levels are referenced with respect to the feed ring elevation
  - SG level set points are not expected to change relative to % span
  - Since feed ring elevation is lower, editorial change is needed
- SG Repair Options
- Increase RCS Minimum Required Flow

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Licensing Status

- ASME Code Relief Requests
  - Code Case N-20-4 (approved)
  - Code Case 2142-1 (approved)
  - Code Case 2143-1 (approved)
  - Code Case N-619 (will be submitted 12/00)

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Engineering Status

Replacement Steam Generator

- Two piece replacement with new moisture separation equipment
- Lower Assemblies designed to ASME III 1989 Edition No Addendum- NPT stamped
- Primary side hydrostatic test at BWC
- No secondary side hydrostatic Test at BWC
- Pre-service Inspection at BWC in accordance with ASME Section XI 1998 Edition No Addendum

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Engineering Status

Replacement Steam Generator

- Installation will be in accordance with ASME Section XI 1998 Edition No Addendum
- Post installation primary and secondary side Pressure test will be performed in accordance with Code Case N-416-1
- No post installation primary or secondary side hydrostatic test will be performed

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Engineering Status

Structural Analysis

- Re-created 3-D Dynamic Structural beam Model of RCS Loop in ANSYS
- Benchmarked to Original CE STRUDL Loop Analysis with excellent agreement
- Replaced the portion of the Model representing the Original Steam Generator with detailed Model of Replacement SG and recalculated seismic response.
- All loads and primary side attached piping anchor point motions bounded by original analysis loads/motions.

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Engineering Status

Engineering Packages

- 6 Packages Common to both Units
- 28 Packages specific to Unit 1
- 28 Packages specific to Unit 2

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Engineering Status

- Engineering Packages Common to Both Units
  - Replacement Steam Generator
  - Steam Generator Offload
  - RSG Transport
  - Site Facilities
  - OSG Storage Facility

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Engineering Status

- Unit Specific Engineering Packages
  - Hatch Transfer System
  - Steam Generator Insulation
  - RCS Support
  - Steam Generator Supports
  - Contingency Elbows
  - Temporary Power
  - Various packages for interference removal and reinstallation

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Engineering Status

- **Status of Engineering Packages**
  - 14 Packages approved for installation
  - All Common and Unit 1 packages scheduled to be complete by June 2001
  - All Unit 2 packages scheduled to be complete by February 2002

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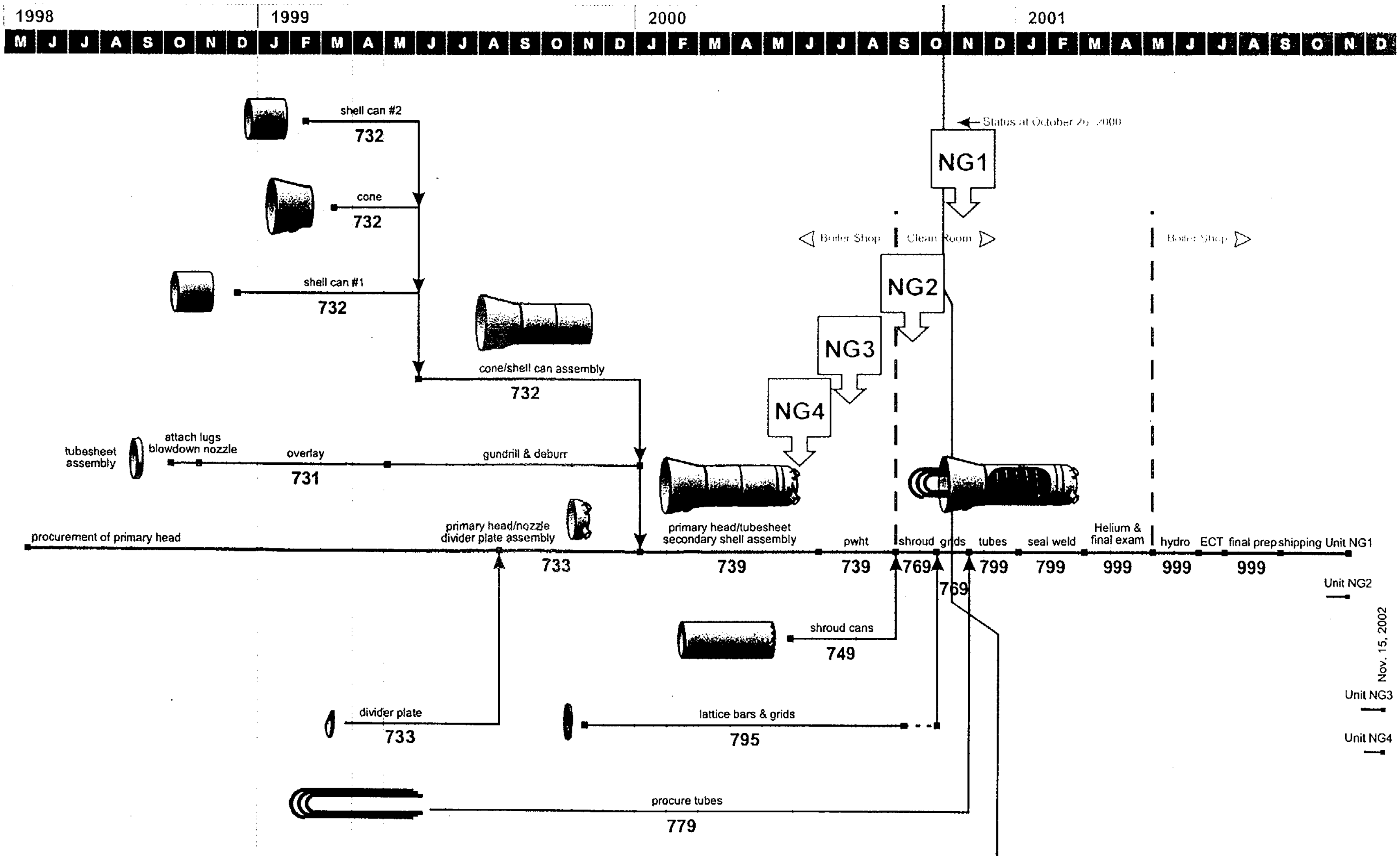
RSG Fabrication Schedule



Nov. 15, 2002

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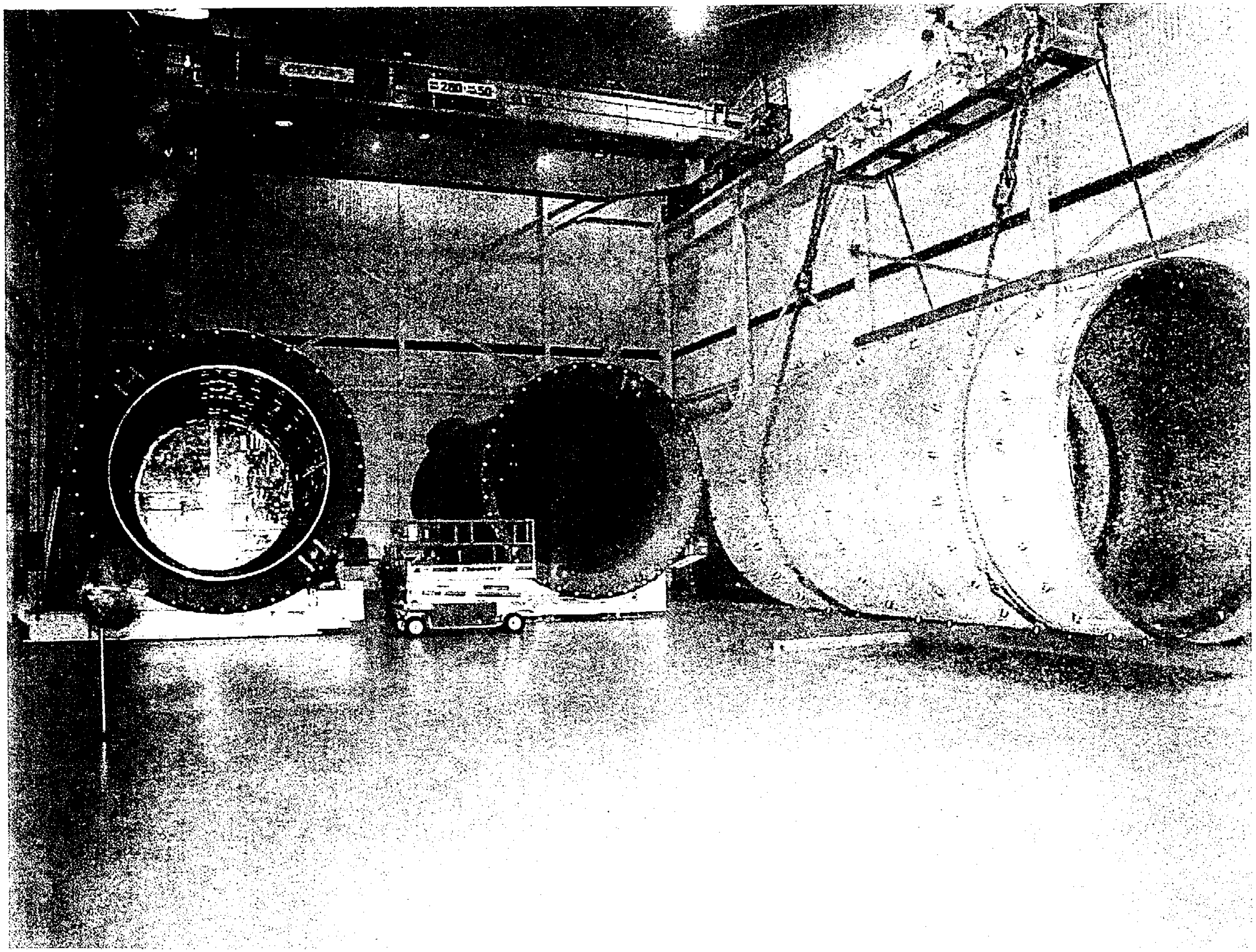
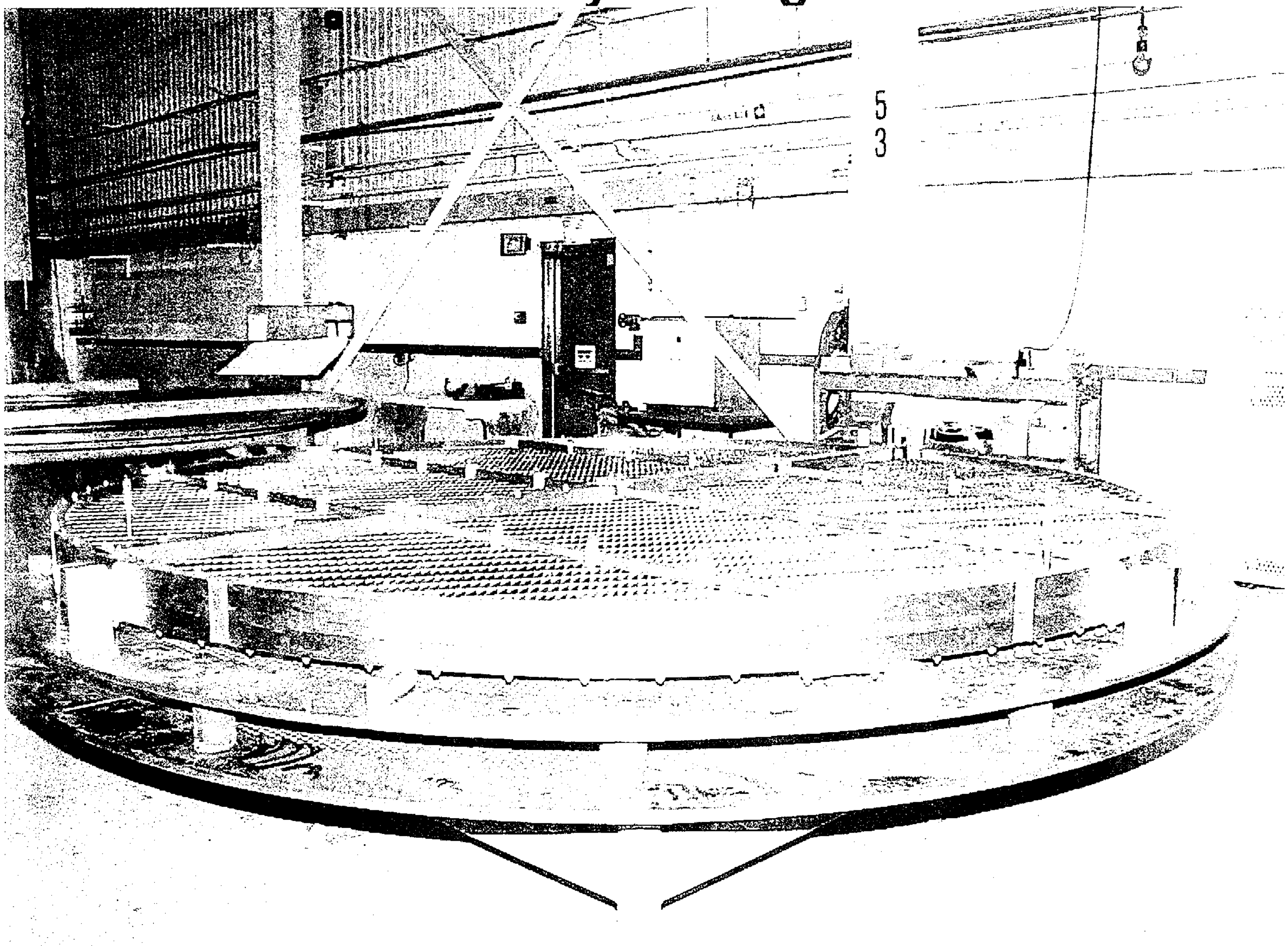
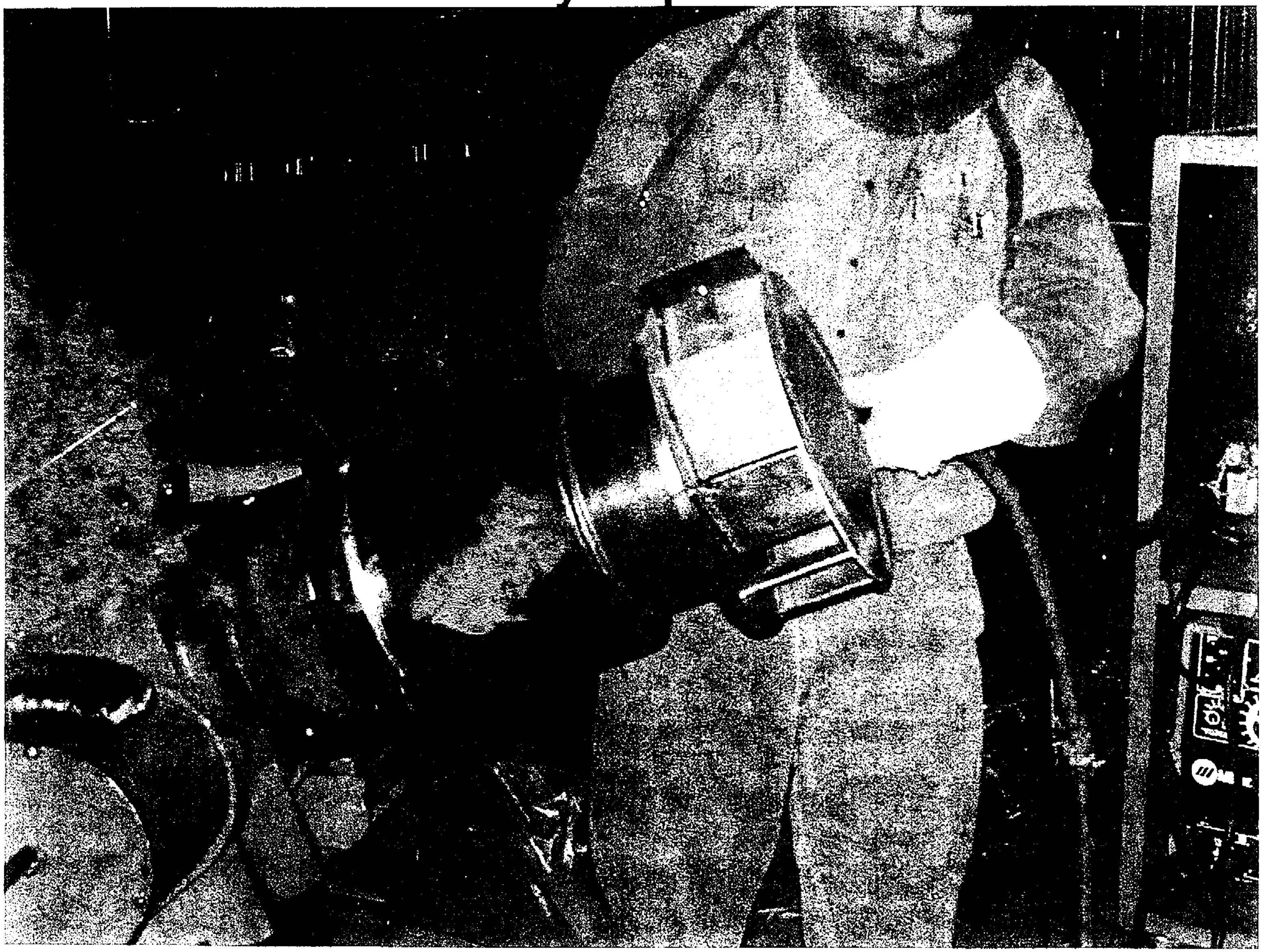
Insertion of Shroud into NG2 in Clean Room



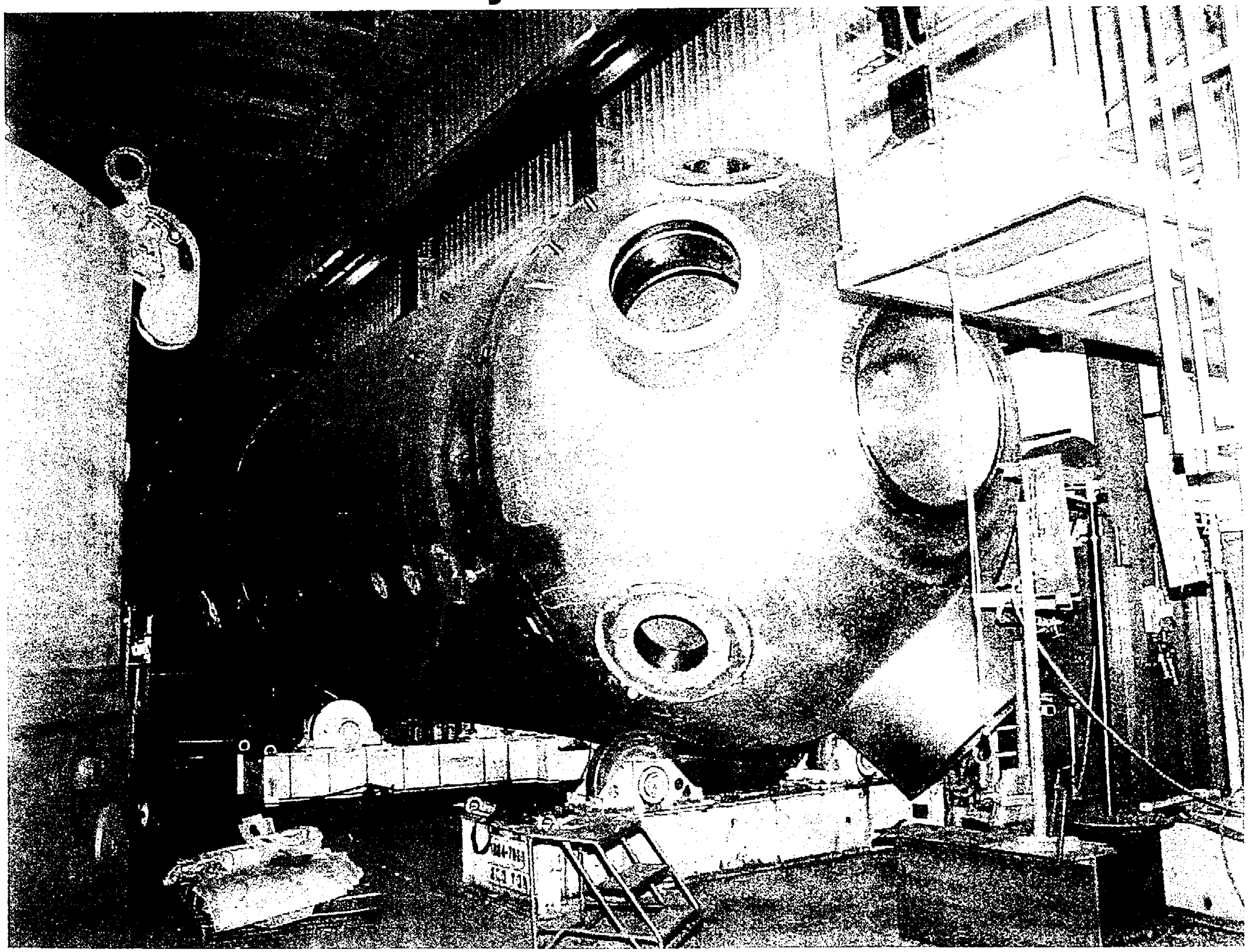
Lattice Grid Assembly on Alignment Test Table



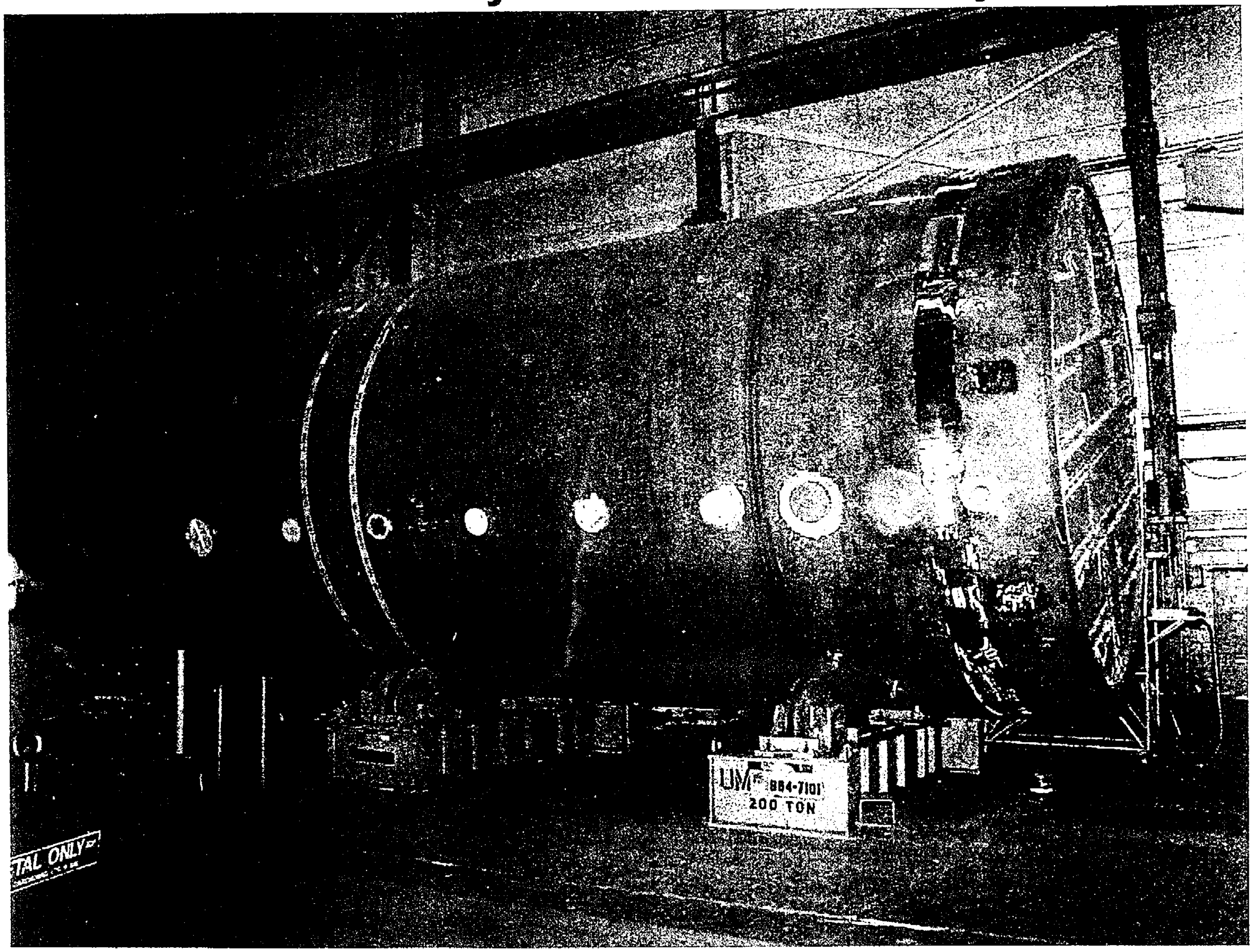
Primary Separator



Lower Assembly #3 without Base Support



Lower Assembly #4 without Primary Head



CCNPP-NRC Meeting Schedule

- Project overview meeting (July 29,1998)✓
- SG Fabrication QA/QC review and project status meeting (April 28, 1999) ✓
- Replacement SG safety evaluation review meeting (November 15, 1999) ✓
- Replacement SG safety evaluation review meeting (November 1, 2000) ✓
- Pre-installation meeting Unit 1 (Spring 2002)
- Post installation meeting Unit 1(Fall 2002)
- Pre-installation meeting Unit 2 (Spring 2003)
- Post Installation meeting Unit 2 (Fall 2003)
- Other meetings as needed

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CALVERT CLIFFS NUCLEAR POWER PLANT UNITS 1 & 2
STEAM GENERATOR REPLACEMENT

SUMMARY OF CCNPPI EXPERIENCE IN APPLICATION OF THE GOTHIC COMPUTER CODE

PRESENTATION TO THE NRC
NOVEMBER 1, 2000

Enclosure 3

Calvert Cliffs Nuclear Power Plant, Inc.

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BACKGROUND

- CCNPPI Has Been Using GOTHIC Since 1994
- A Total Of 17 Design Calculations (Formally Quality Assured & Documented) Using The GOTHIC Code Are Prepared
- Extensive Benchmark Is Made With The COPATTA Code On Containment Response
  - Cold-leg LOCA, Maximum Safety Injection
  - Cold-leg LOCA, Minimum Safety Injection
  - Hot-leg LOCA, Minimum Safety Injection
  - Main Steam Line Break

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BACKGROUND (Cont'd)

- CCNPPI Has Also Gained Experience In Non-containment Related Applications
- CCNPPI Has Made **5** Presentations To GOTHIC Advisory Group Meetings

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Containment Related Applications

- Developing Containment Response Model For Benchmark With COPATTA
- Developing Break Flow Model To Calculate Long Term Mass & Energy Transfer Rates
- Performing Sensitivity Study Regarding Time Step Size Effects On Containment Peak Pressure And Temperature

Containment Related Applications (Cont'd)

- **Developing Models For Containment Electrical Penetrations**
- **Analyzing Containment Response To Various Heat Sink Coating (Paint/primer) Systems**

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Non-Containment Related Applications

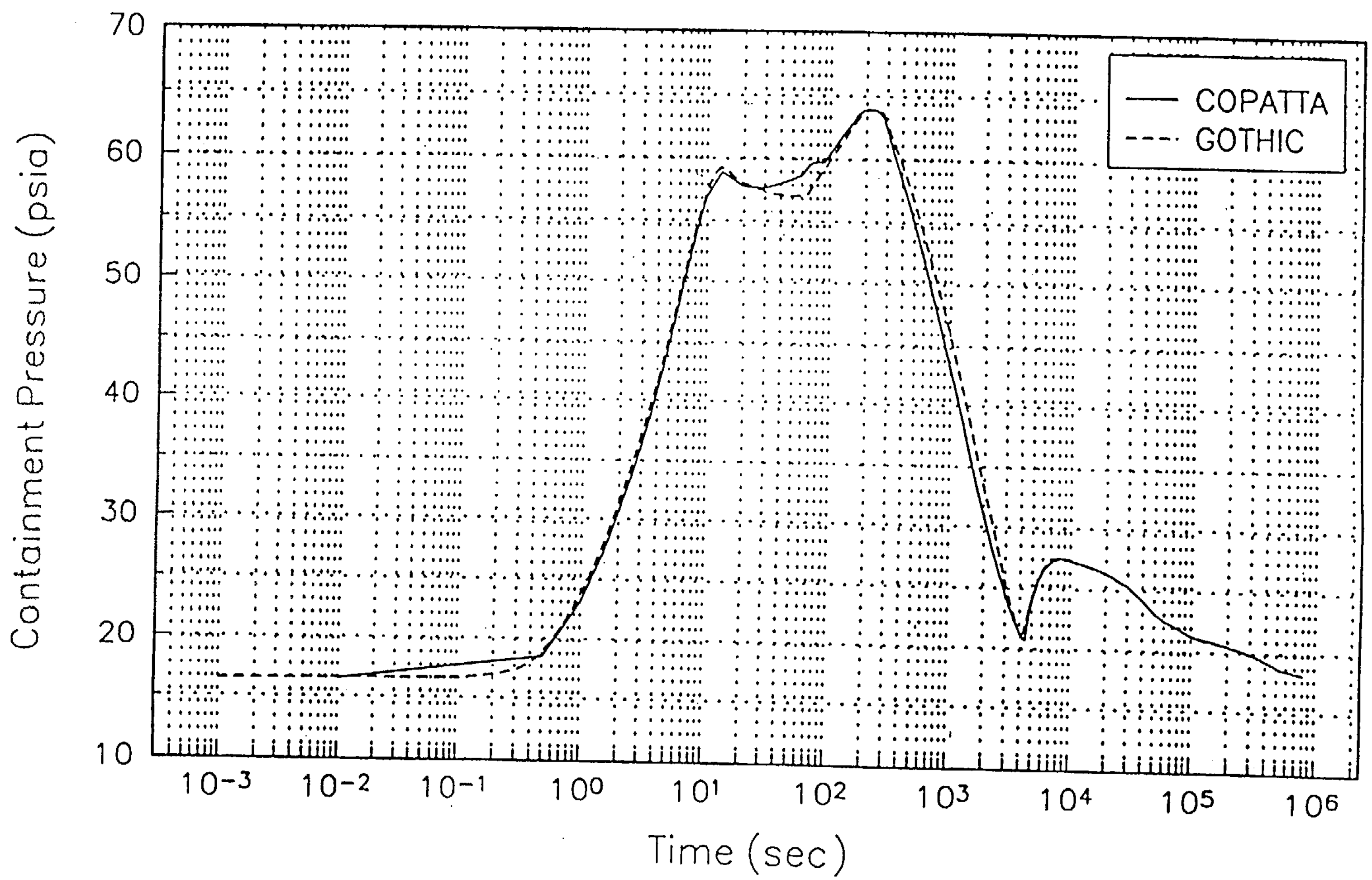
- Natural Circulation In The Vessel And The Refueling Pool After Loss Of Shutdown Cooling With Upper Guide Structure (UGS) Installed Or Removed
- Analysis Of Issues On "Independent Spent Fuel Storage Installation (ISFSI)"
  - Calculation Of Maximum Flow Rate To Flood "Dry Storage Cask (DSC)" In Support Of Unload Procedure
  - Design Optimization Of Pump & Bypass Loop Orifice To Flood DSC
  - Determination Of The Critical Helium Mass And Temperature In Blowdown, Dry Up, And Fill Phases

Non-Containment Related Applications (Cont'd)

- Analysis Of Once-through Core Cooling (OTCC)
- RCS Response To SIT Nitrogen Ingress In A SB-LOCA
- Determination Of NPSH For HPSI Pumps In A Loss Of CCW To The Reactor Coolant Pump Seals

COMPARISON OF GOTHIC CODE WITH BECHTEL'S COPATTA

Pump Discharge LOCA, Min. Safety Injection



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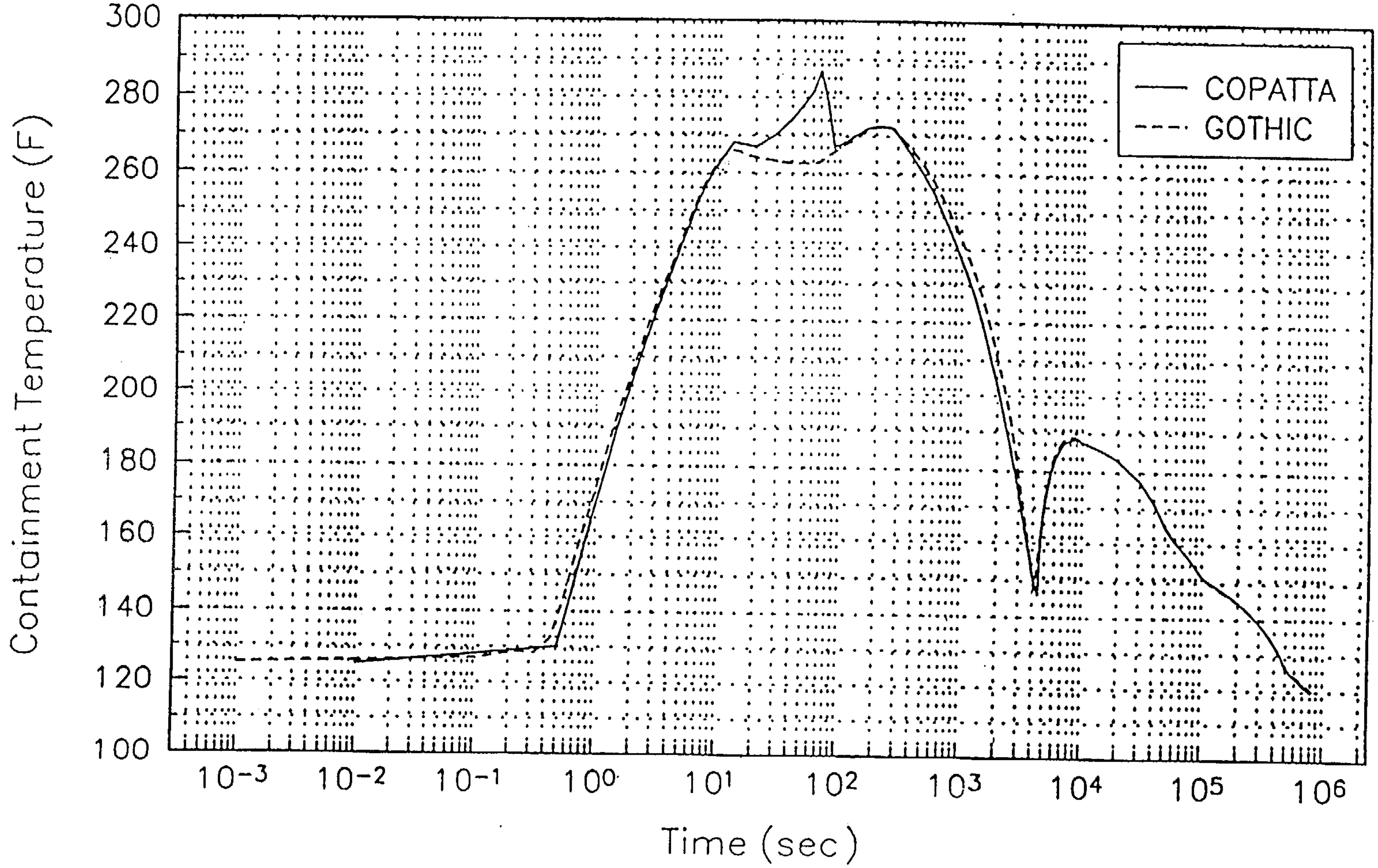
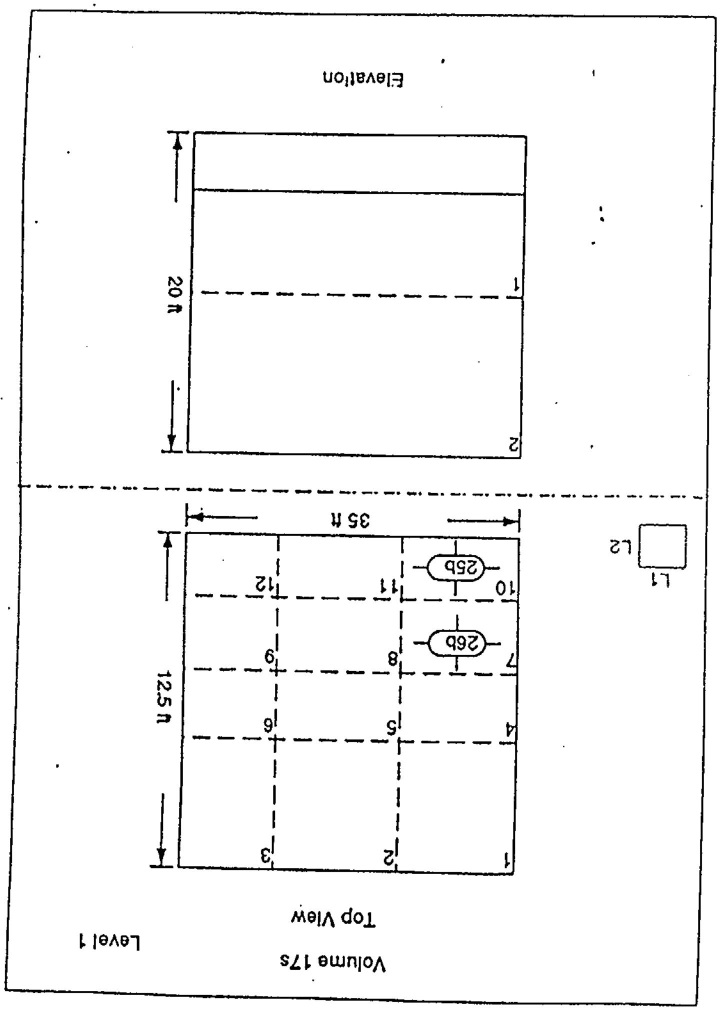
COMPARISON OF GOTHIC CODE WITH BECHTEL'S COPATTA

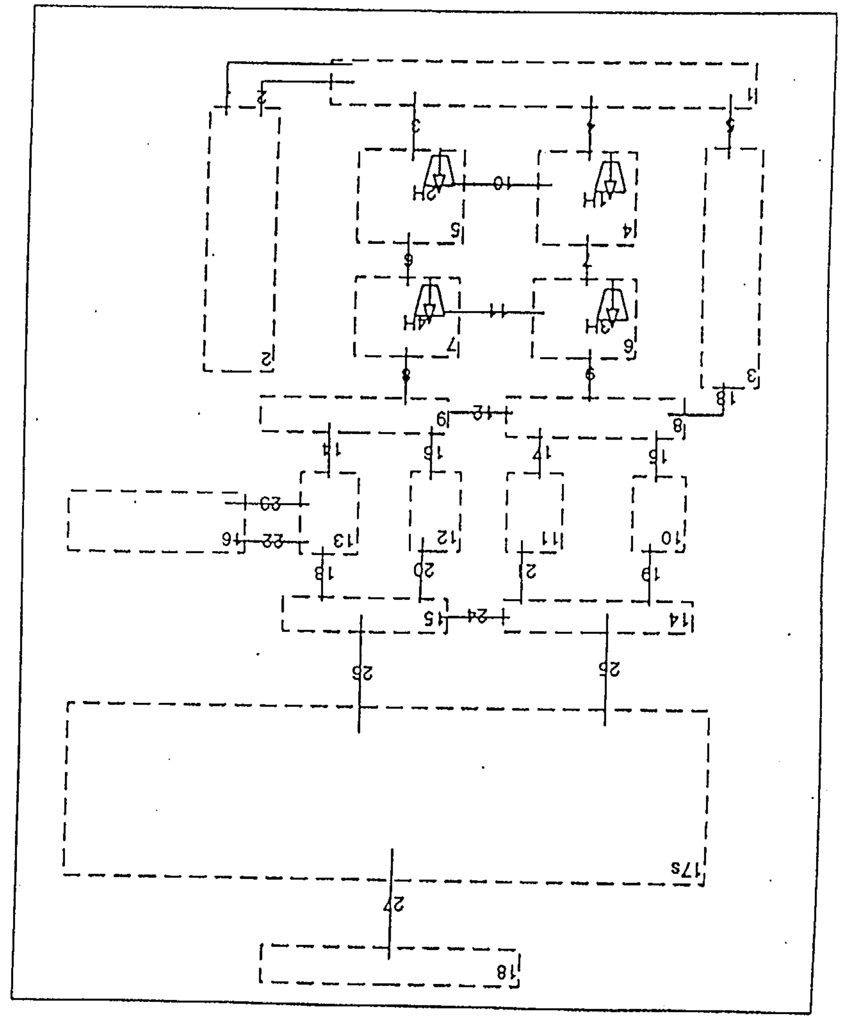
Pump Discharge LOCA, Min. Safety Injection



6/2

GOTHIC Nodalization of Quadrant Vessel & RFP UGS (Installed)





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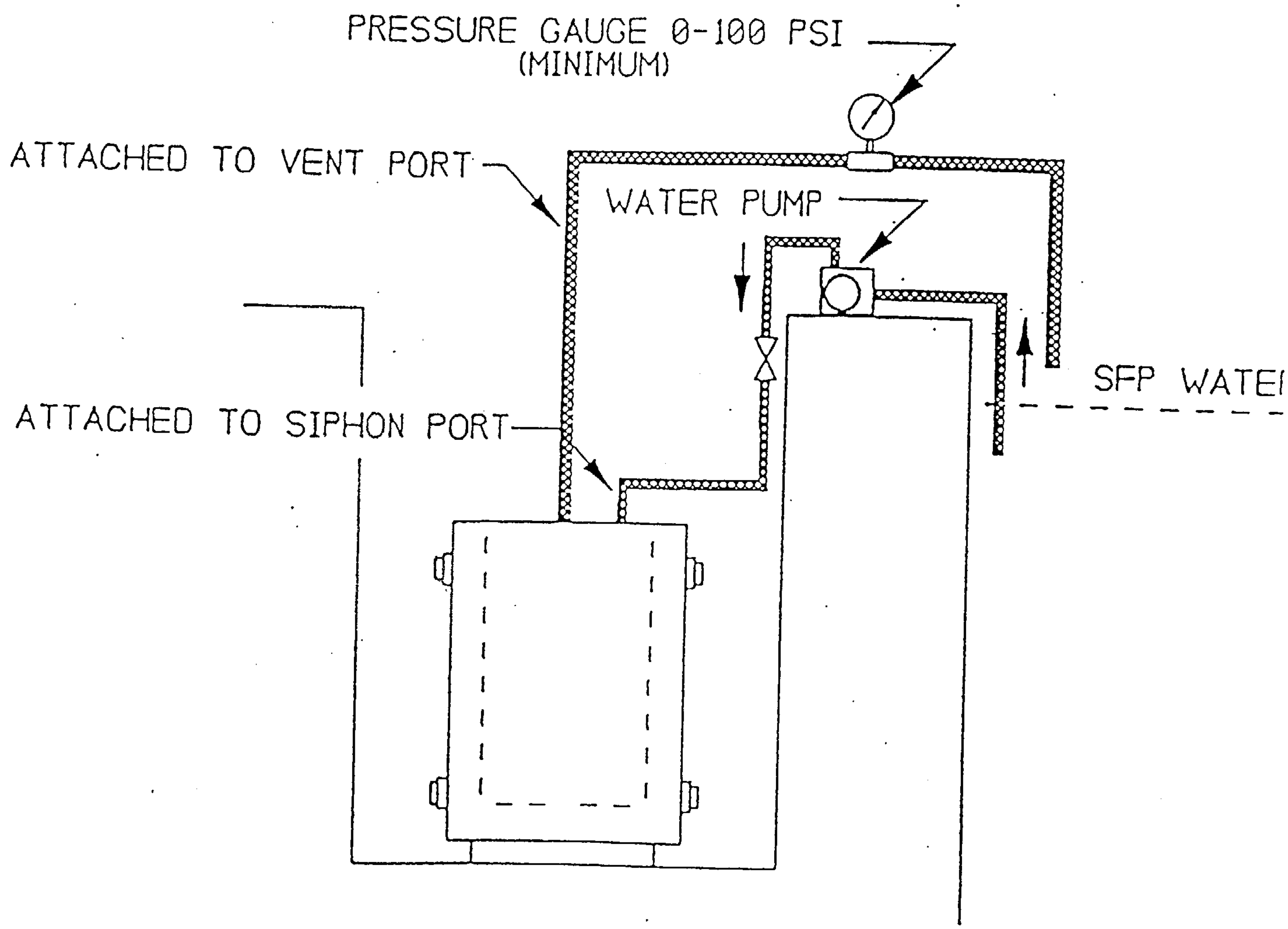
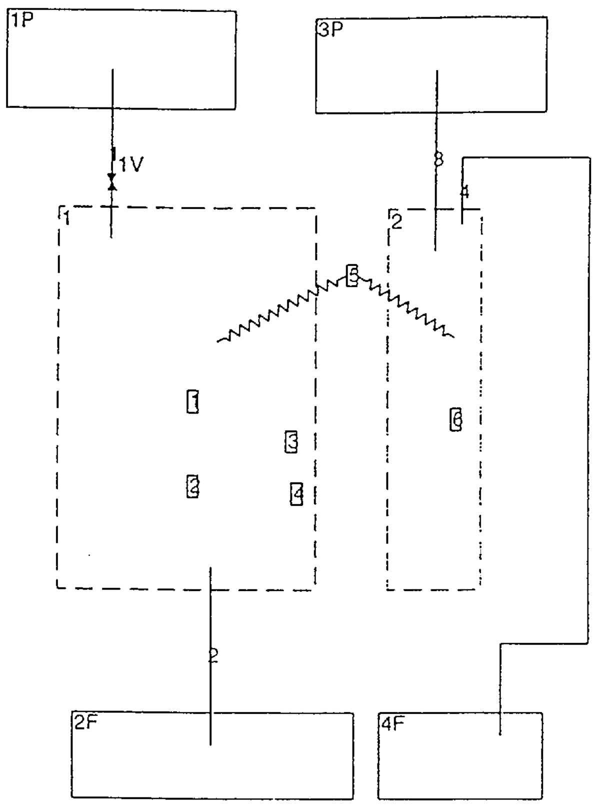
Stage 6: DSC In Reflood Mode



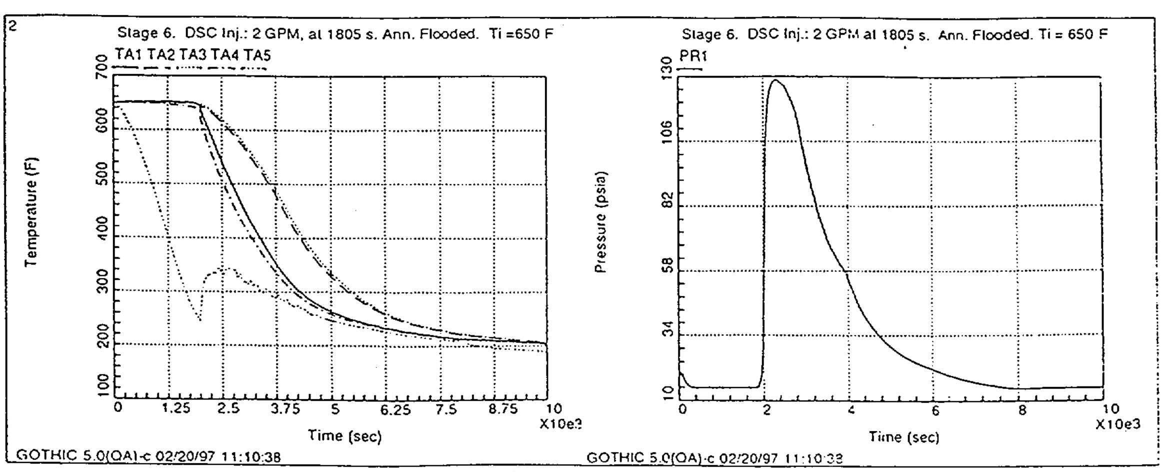
DSC Temperature & Pressure in Stage 6



DIRECT HTC OPTION

SPLIT: 0 - 1

1. Assemblies
2. Spacer
3. Support
4. Sleeves
5. DSC Wall
6. TC Wall



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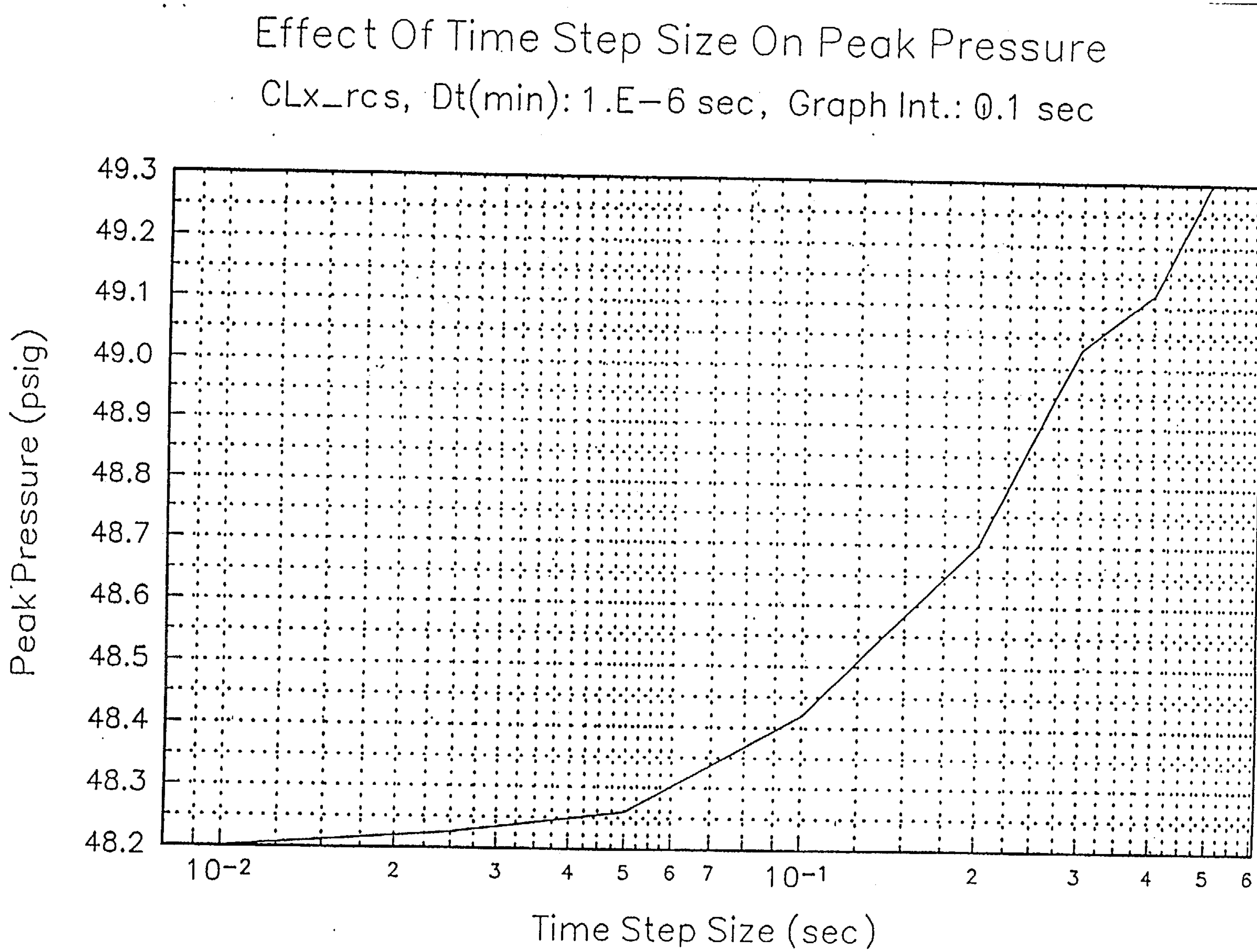
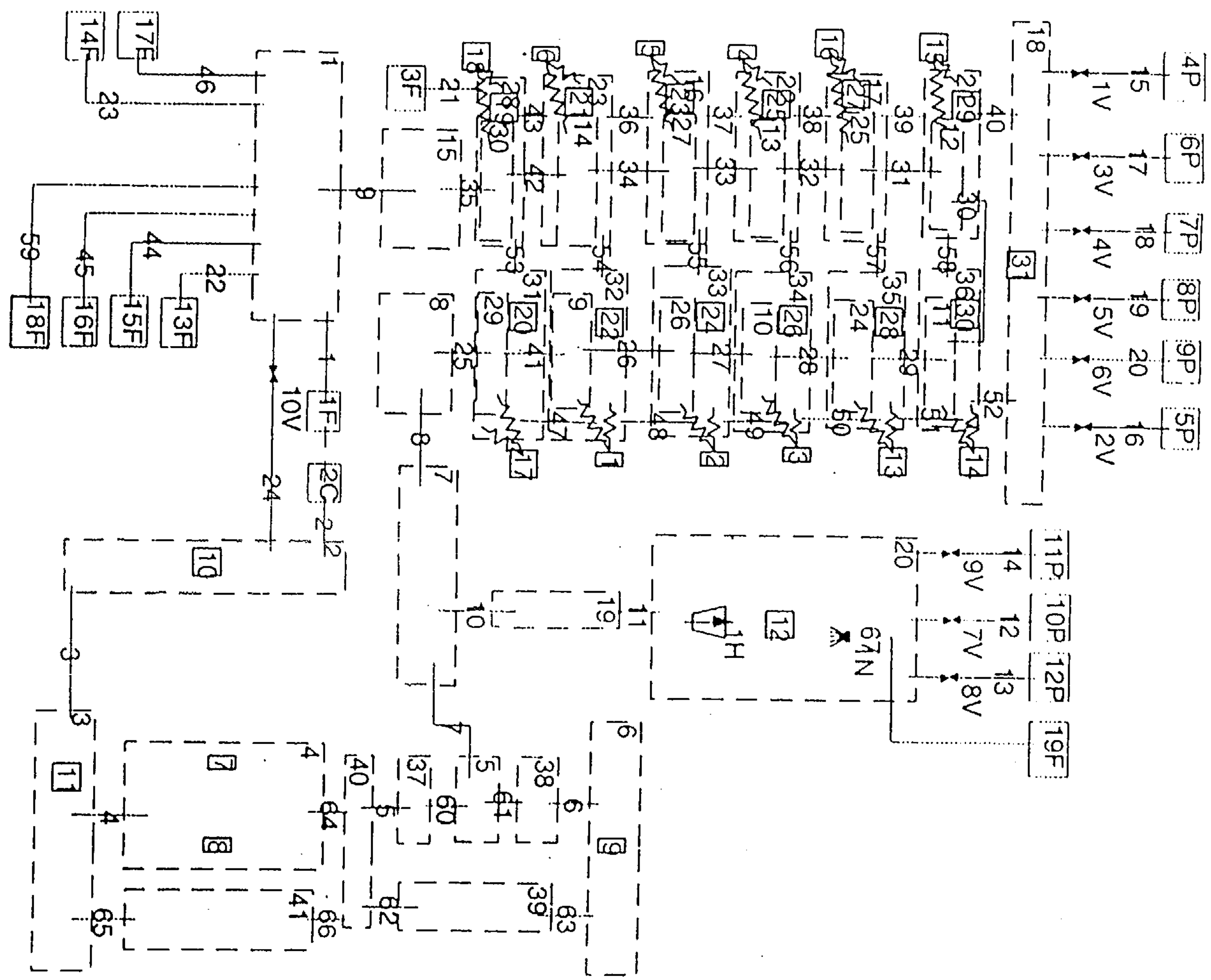

Effect Of Time Step Size On Peak Pressure
CLx_rcs, Dt(min): 1.E-6 sec, Graph Int.: 0.1 sec
Peak Pressure (psig)
49.3
49.2
49.1
49.0
48.9
48.8
48.7
48.6
48.5
48.4
48.3
48.2
10-2
2
3
4
5
6
7
10-1
2
3
4
5
6
Time Step Size (sec)

Nodalization of RCS and Steam Generator



Calvert Cliffs OTTCC Matrix

				PORVs						
				1[A]			2			
				Charging Pumps						
				1	2	3	1	2	3	
HPSIs	1	ADVs[C]	0	x	x	x	x	x	CC	A
			1	x	x	x	x	x	CC	B
			2	CU [2: 40]	CU [3: 25]	CU [5: 5]	CU [2: 45]	CU [3: 30]	CC	C
	2		0	x	x	x	CU [3: 30]	CC	CC	D
			1	x	x	x	CU [3: 45]	CC	CC	E
			2	CU [3: 10]	CU [3: 50]	CU [5: 15]	CC	CC	CC[B]	F
	3		0	x	x	CU [5: 10]	CC	CC	CC	G
			1	x	x	CU [5: 10]	CC	CC	CC	H
			2	CU [3: 15]	CU [4]	CU [5: 40]	CC	CC	CC[B]	I
				a	b	c	d	e	f	

Nodalization of Integrated RCS and Containment