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

January 29, 1996

LICENSEE: Houston Lighting and Power Company (HL&P), et al.

FACILITY: South Texas Project, Units 1 and 2 (STP)

SUBJECT: SUMMARY OF JANUARY 18, 1996, MEETING ON THE UNIT 1 CONTROL ROD INSERTION ANOMALY AND THE RESULTING ACTION PLANS

On January 18, 1996, representatives of HL&P and NRC staff met to discuss the above subject. Meeting attendees are listed in Attachment 1. Handouts provided by the licensee are in Attachment 2.

The licensee's presentation consisted of an overview of the anomaly, background information, trip recovery actions, investigation status, and action plans. The anomaly occurred during a December 18, 1995, reactor trip when three control rods stopped at six steps from bottom, and during subsequent testing when the same three rods plus one additional rod also stopped at six steps. The affected control rods were over high burnup assemblies. The licensee performed a safety evaluation which bounded the condition and developed plans to determine the cause and corrective action.

By way of background, the licensee informed the staff that the control rods are of silver-indium-cadmium composition with a stainless steel cladding. They have a 15-year calendar life and have been in service since October 1989. The lower guide tube geometry incorporates a double dashpot feature (Indian Point 2 and Ginna also have this feature) and the four fuel assemblies that experienced the anomaly are of the Westinghouse (W) XLR fuel design. In their investigation of the STP design versus the standard W design, the licensee determined that the STP fuel assemblies are about 30 inches longer and their hold down forces in the vessel are about 200 pounds greater, that the lower guide tube dashpot region length is about 10 inches longer and most plants have only a single dashpot, that the control rod radial clearances are about the same, that the STP fuel design has 2 addition grids, and that the fuel discharge burnup at STP is in the top half of W plants.

The licensee's investigation of industry experience of control rods failing to fully insert found the causes to include foreign material, control rod/drive line degradation, corrosion products, and guide tube bow. The licensee does not know the cause at STP, but has developed action plans to determine the cause and apply corrective action. These plans include inspecting the 4 high burnup Unit 2 assemblies in the spent fuel pool, performing hot full flow rod drop testing during the next shutdown in either unit (but no later than by 60 to 75 effective full power days (EFPDs) after the December 18, 1995, reactor trip on Unit 1; this was recently done on Unit 2 since Unit 2 was down for other reasons, and all Unit 2 control rods tested satisfactorily), performing Unit 1 hot, full flow rod drop testing at end-of-life during plant shutdown at the start of Refueling Outage 6 (1RE06), revising the Unit 1 Cycle 7 loading pattern to minimize or eliminate high burnup fuel assemblies, and inspecting and testing discharged Unit 1 fuel assemblies during and after 1RE06.

DF01

The staff thanked the licensee for the meeting and indicated that it was useful in keeping the staff up-to-date with the anomaly. The staff intends to closely evaluate the l ensee progress on the anomaly, including the planned testing and inspection results.

Original signed by
Thomas W. Alexion, Project Manager
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Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket Nos. 50-498 and 50-499

Attachments: 1. List of Meeting Attendees
2. HL&P Meeting Handouts

cc w/attachments: See next page

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The staff thanked the licensee for the meeting and indicated that it was useful in keeping the staff up-to-date with the anomaly. The staff intends to closely evaluate the licensee progress on the anomaly, including the planned testing and inspection results.

Thomas W. Alexion

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Project Directorate IV-1
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

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MEETING BETWEEN HL&P AND NRC ON CONTROL ROD ACTION PLANS

January 18, 1996

Name	Organization
T. Cloninger	HL&P
D. Leazar	HL&P
D. Hoppes	HL&P
R. Dunn	HL&P
S. Head	HL&P
J. Sparrow	Westinghouse
H. Menke	Westinghouse
S. Ray	Westinghouse
W. Beckner	NRC
T. Alexion	NRC
L. Kopp	NRC
D. Powers	NRC
S. Matthews	NRC
E. Kendrick	NRC
H. Richings	NRC
H. Ornstein	NRC
S. Koenick	NRC
K. Naidu	NRC
B. McCabe	NRC
E. Goodwin	NRC

ATTACHMENT 1

ATTACHMENT 2

SOUTH TEXAS PROJECT

PRESENTATION:

UNIT 1 CONTROL ROD INSERTION ANOMALY

TO

NRC

January 18, 1996

VISION: STP - - A WORLD-CLASS POWER PRODUCER

STP TEAM

STP Team

- Ted H. Cloninger - Vice President, Nuclear Engineering
- David A. Leazar - Manager, Nuclear Fuel & Analysis
- David F. Hoppes - Supervisor, Nuclear Fuels
- Roland F. Dunn - Supervisor, Reactor Engineering
- Scott M. Head - Supervisor, Nuclear Licensing
- Howard Menke - Manager, Product Performance Engineering, Westinghouse
- Sumit Ray - Manager, Fuel Licensing Integration, Westinghouse
- Jim Sparrow - Principal Engineer, Product Design, Westinghouse

Scope

- Technical issues relating to control rod insertion anomaly

MEETING AGENDA

Overview

Background Information

- STP fuel and control rod designs
- Rod position indication
- Rod testing
- Safety limits

Event Description

Trip Recovery Actions

- Rod testing
- Safety evaluation

Investigation Status

- Facts
- Fuel design comparisons
- Industry experience
- Potential causes

Action Plans

OVERVIEW

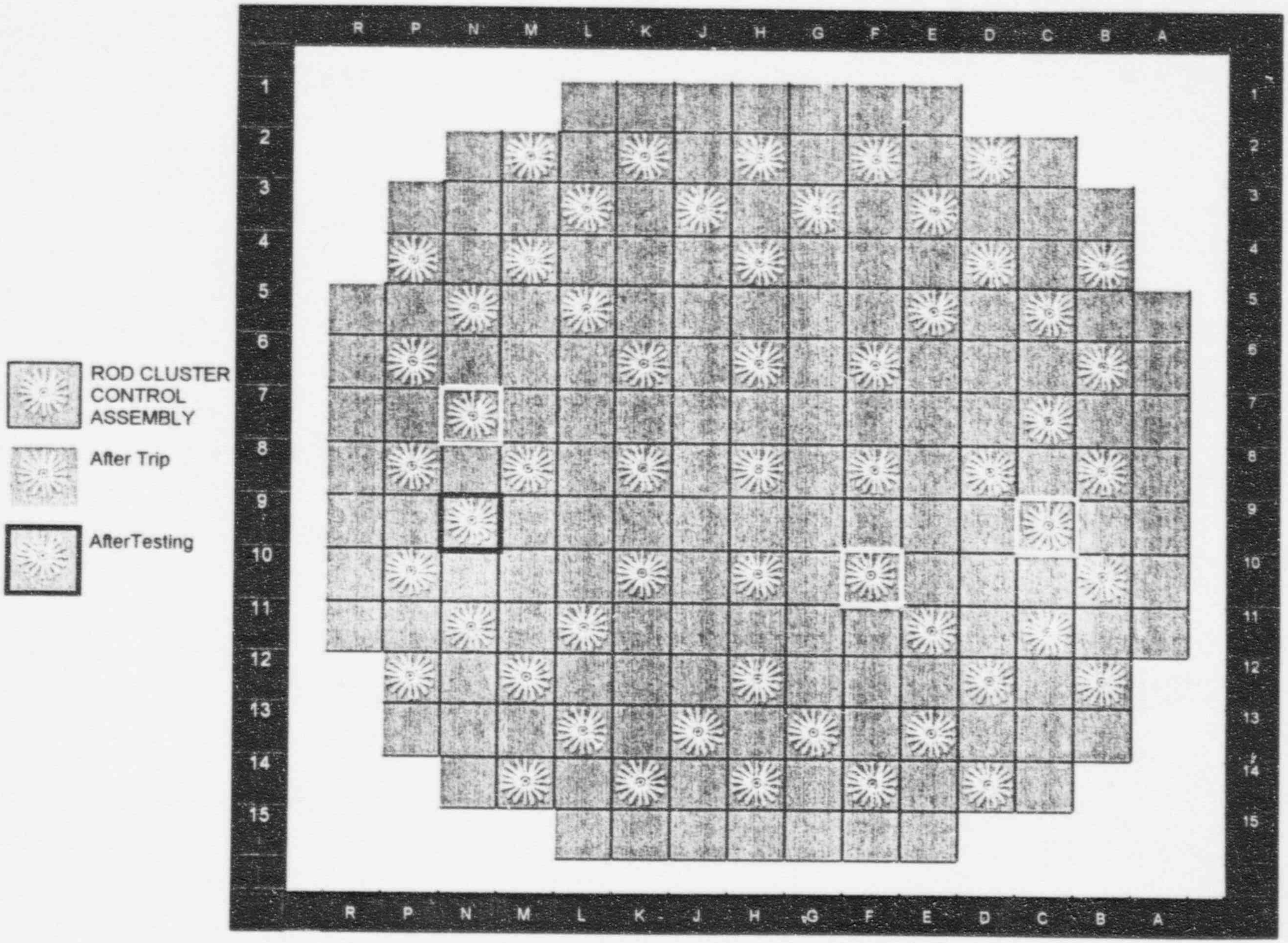
- December 18, 1995, Reactor Trip, three control rods stopped at six steps from the bottom
- Testing performed, one additional control rod stopped at six steps
- Affected control rods are over high burnup assemblies
- Performed safety evaluation which bounded current condition
- Monitoring plan to ensure conditions remain bounded by safety evaluation
- Plan established to determine cause and corrective action

BACKGROUND

Plant

- 4-Loop Westinghouse NSSS, PWR
- 3800 Mwt licensed reactor thermal power
- 193 fuel assemblies - Westinghouse designed and fabricated
- 14 foot active fuel length
- 57 silver-indium-cadmium control rods (RCCAs)
- Rapid refueling package - unrodded refuelings

AFFECTED CORE LOCATIONS
U1 C6

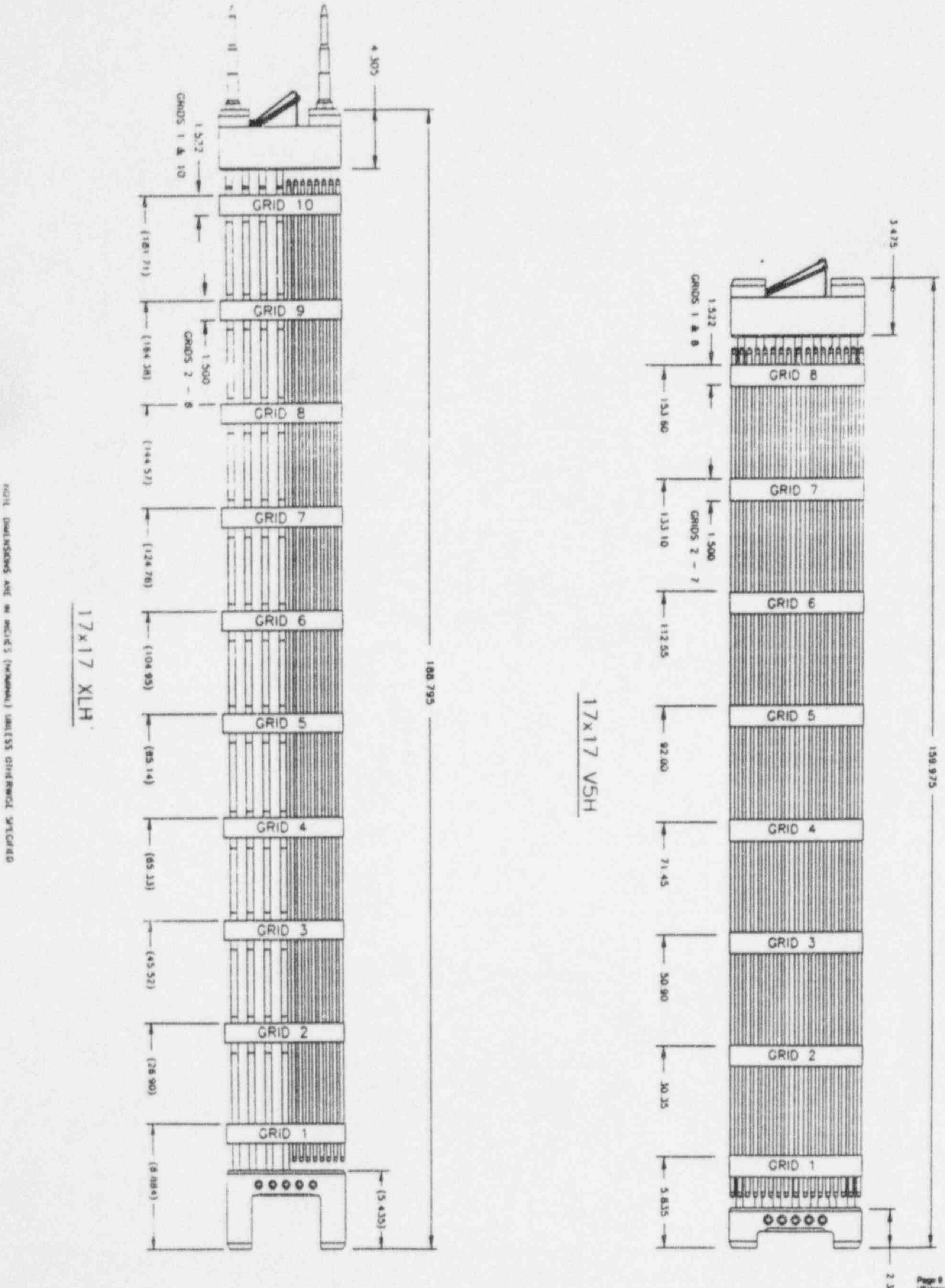


BACKGROUND

Fuel

- 3 typical design variations: XL, XLR, V5H
- XL - Inconel anti-snag grids
- XLR - Removable top nozzle, debris filter bottom nozzle, extended burnup capability
- V5H - Zirconium mid grids with XLR features, Integrated Fuel Burnable Absorbers
- Common features
  - 14 foot active fuel
  - Stainless steel top/bottom nozzles
  - 10 grids
  - Zirconium guide tubes
  - Double Dashpot for RCCA deceleration
- Typical initial enrichments: 3.8 to 4.2 w/o U-235

STP FUEL ASSEMBLY

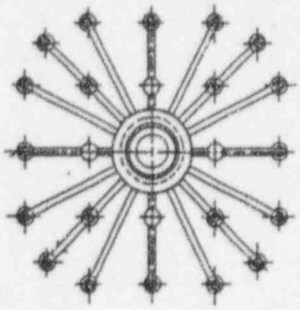


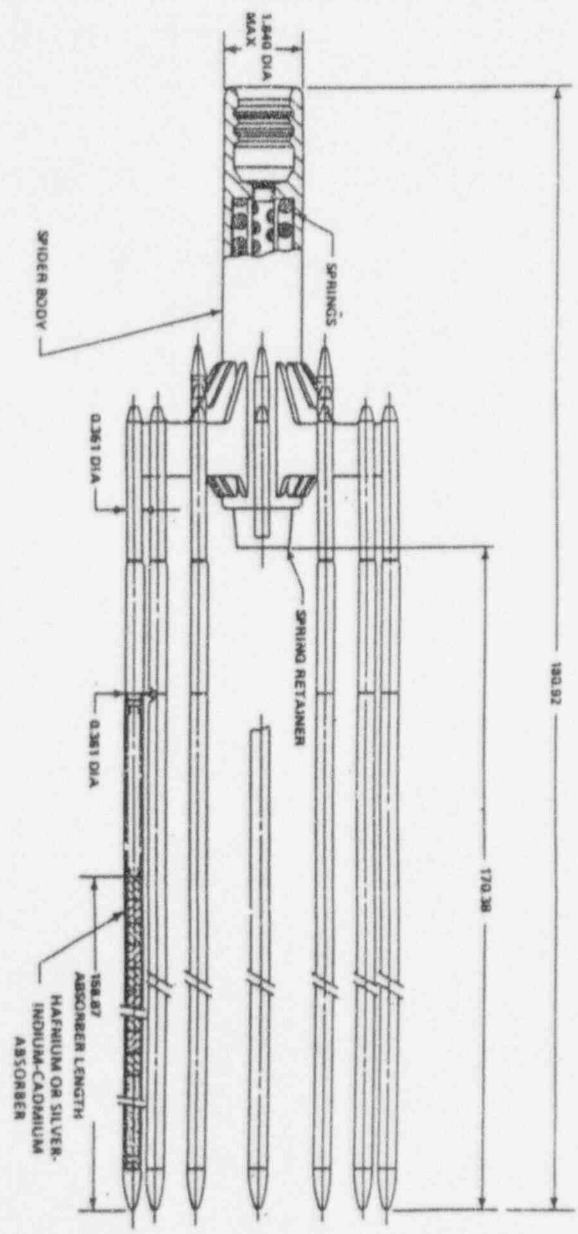
BACKGROUND

RCCAs

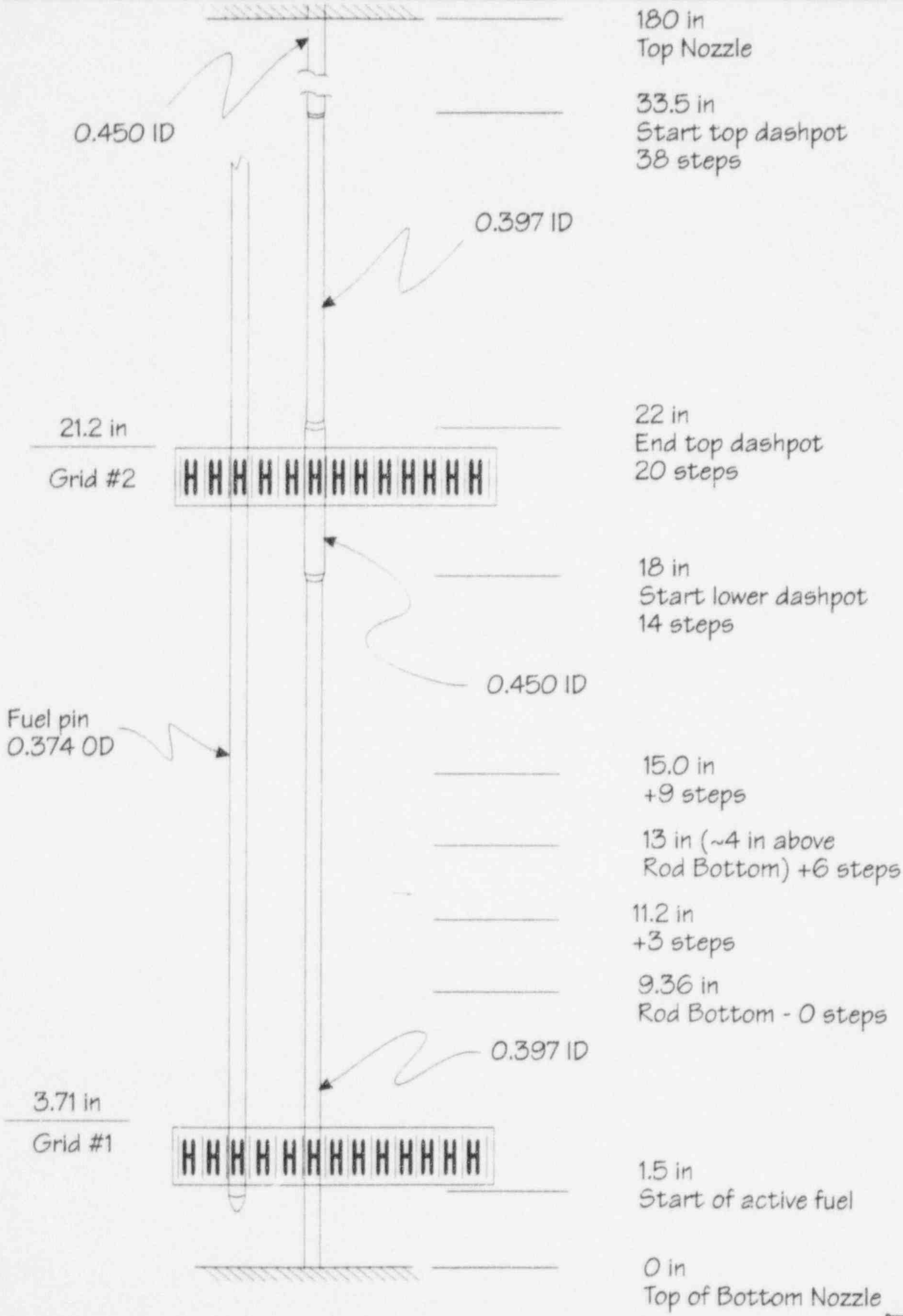
- Silver-Indium-Cadmium (80%Ag, 15%In, 5%Cd)
- Stainless steel cladding
- Spring hub to absorb trip energy
- 15 calendar year design life - in-service since 10/89
- Fully inserted is 0 steps or rod bottom
- Fully withdrawn is 259 steps
- Rod steps are 5/8 inch

ROD CLUSTER CONTROL ASSEMBLY OUTLINE





LOWER GUIDE TUBE GEOMETRY

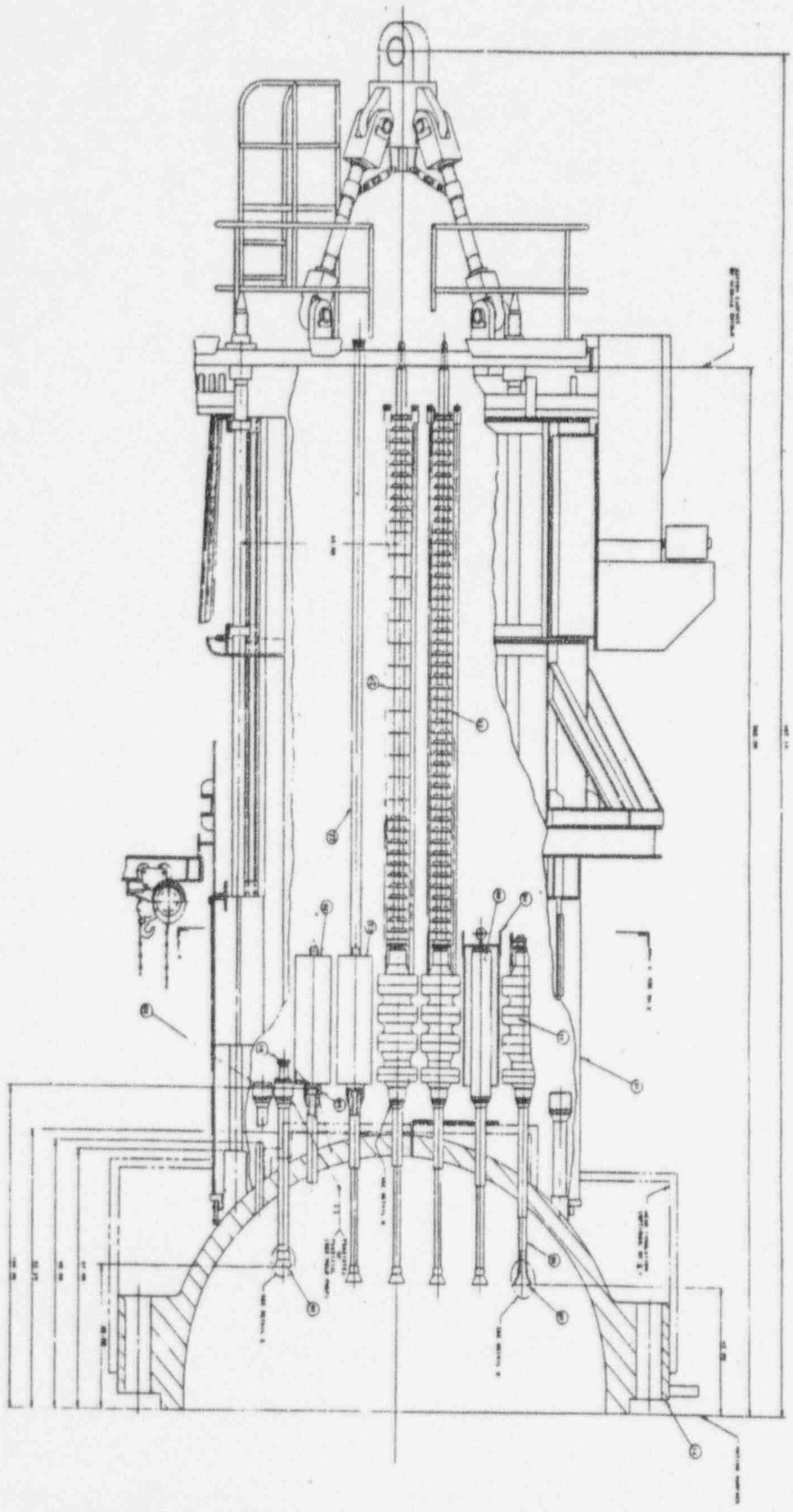


BACKGROUND

Rod position indication

- Digital Rod Position Indication (DRPI) at STP
- Drive rod connected to RCCA penetrates energized DRPI coil stack
- Impedance changes
- Provides true indication of actual rod position
- Indication in six (6) step increments with ± 3 step accuracy
- DRPI is used to measure rod drop times

DRPI COIL LAYOUT

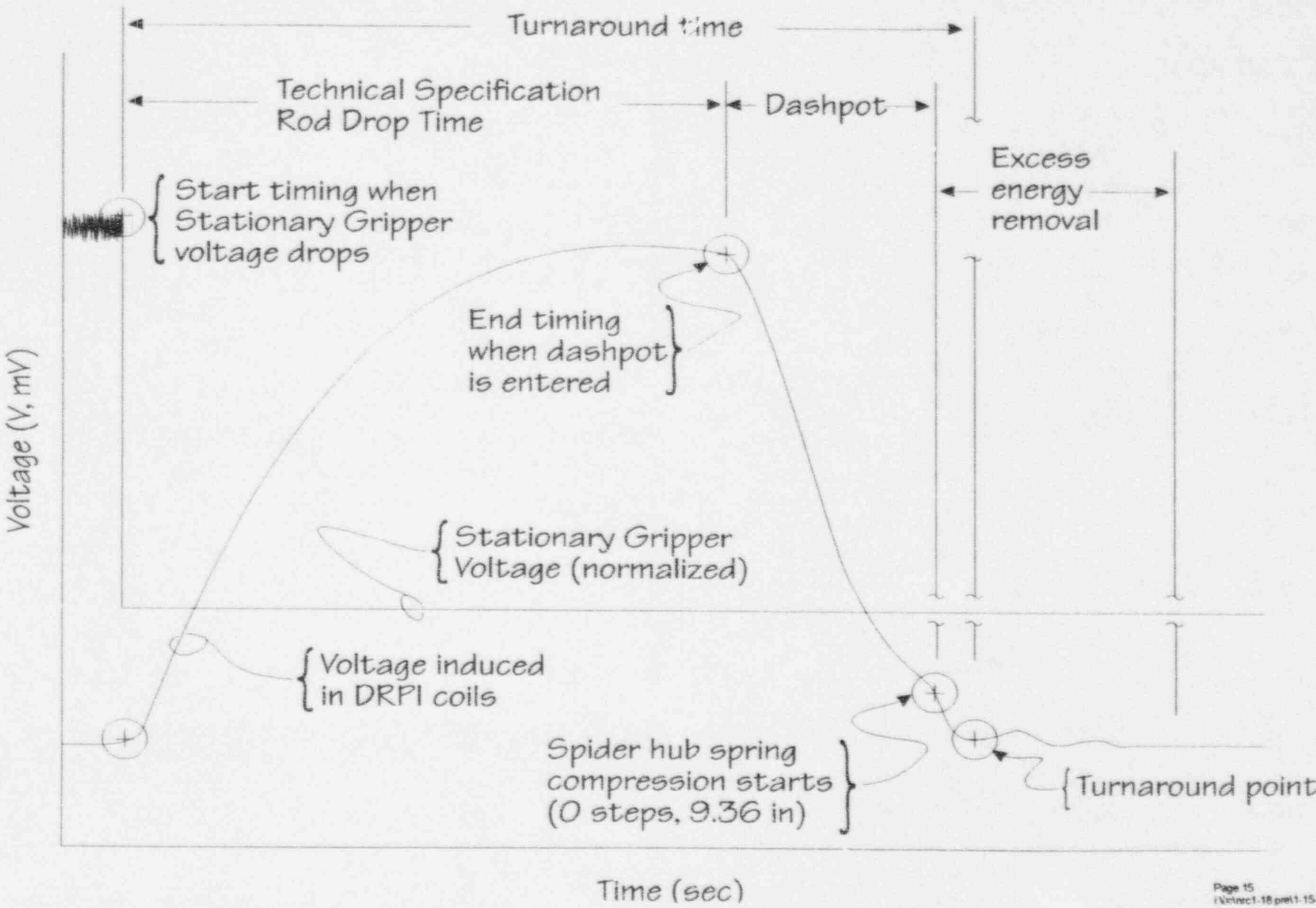


BACKGROUND

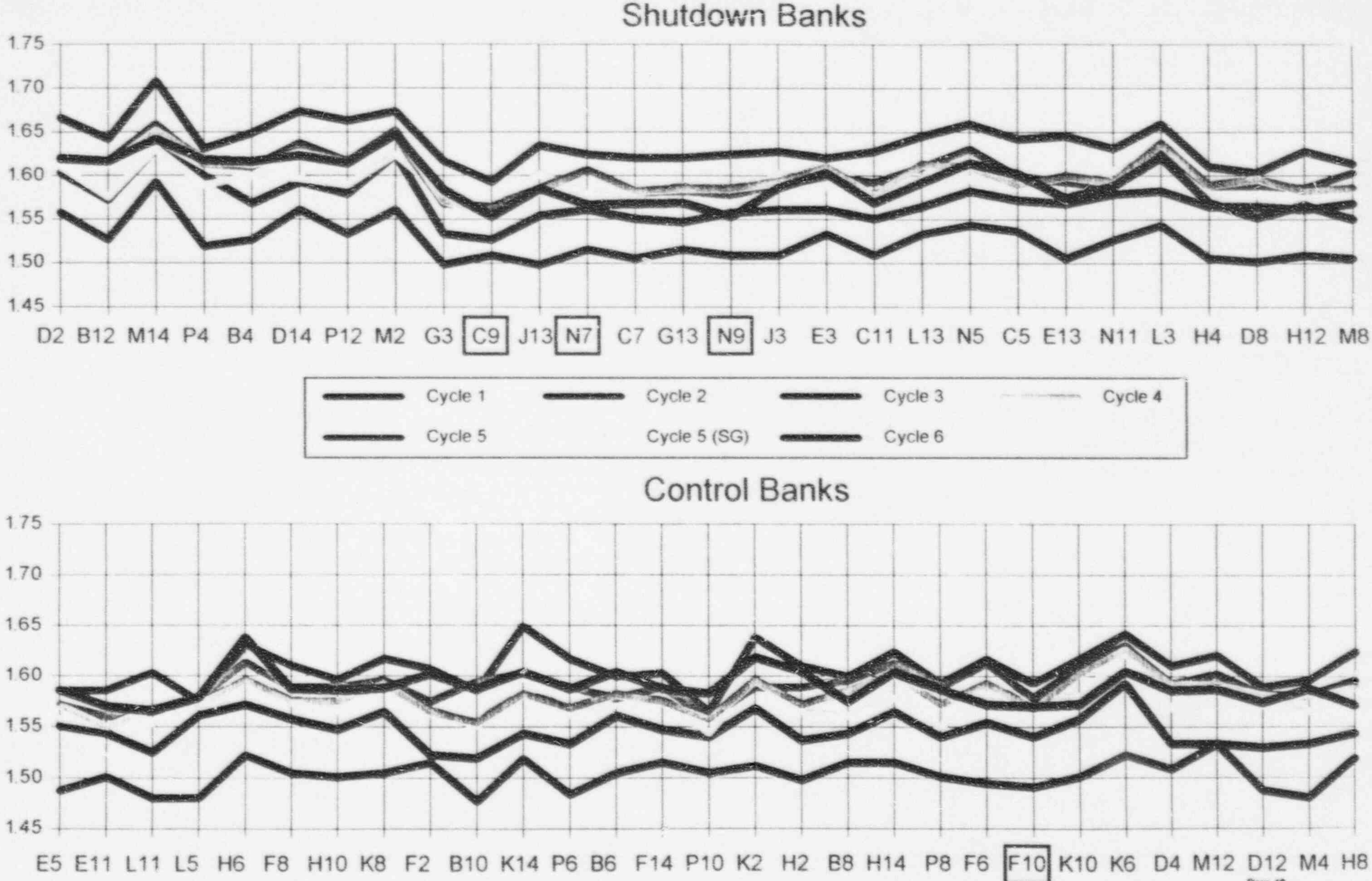
Rod Drop Time Testing

- Typically at BOL, hot standby, full flow conditions
- One at a time, bank at a time, or all rods simultaneously
- Dropped from 259 step position
- Trip breaker opened, rod drops by gravity
- Record electrical signal from de-energized DRPI coils
- Rod drop time - delta time between gripper power loss and dashpot entry
- No adverse trends noted
- Typical rod drop times approximately 1.55 to 1.65 seconds

TYPICAL ROD DROP TRACE



UNIT 1 ROD DROP TIME HISTORY



BACKGROUND

Safety iimits

- Tech Spec rod drop time: $\leq$ 2.8 seconds
- Shutdown Margin: $\geq$ 1.3% Δ k/k or 1300 pcm

EVENT DESCRIPTION

- Unit 1 Cycle 6 reactor trip on 12/18/95
- 3 of 57 control rods not at rod bottom - DRPI indicated 6 steps from rod bottom
- Core locations F-10, C-9, and N-7
- N-7 DRPI indication changed to rod bottom within about 1 hour
- No indications from Loose Parts Monitoring System
- DRPI indication was correct

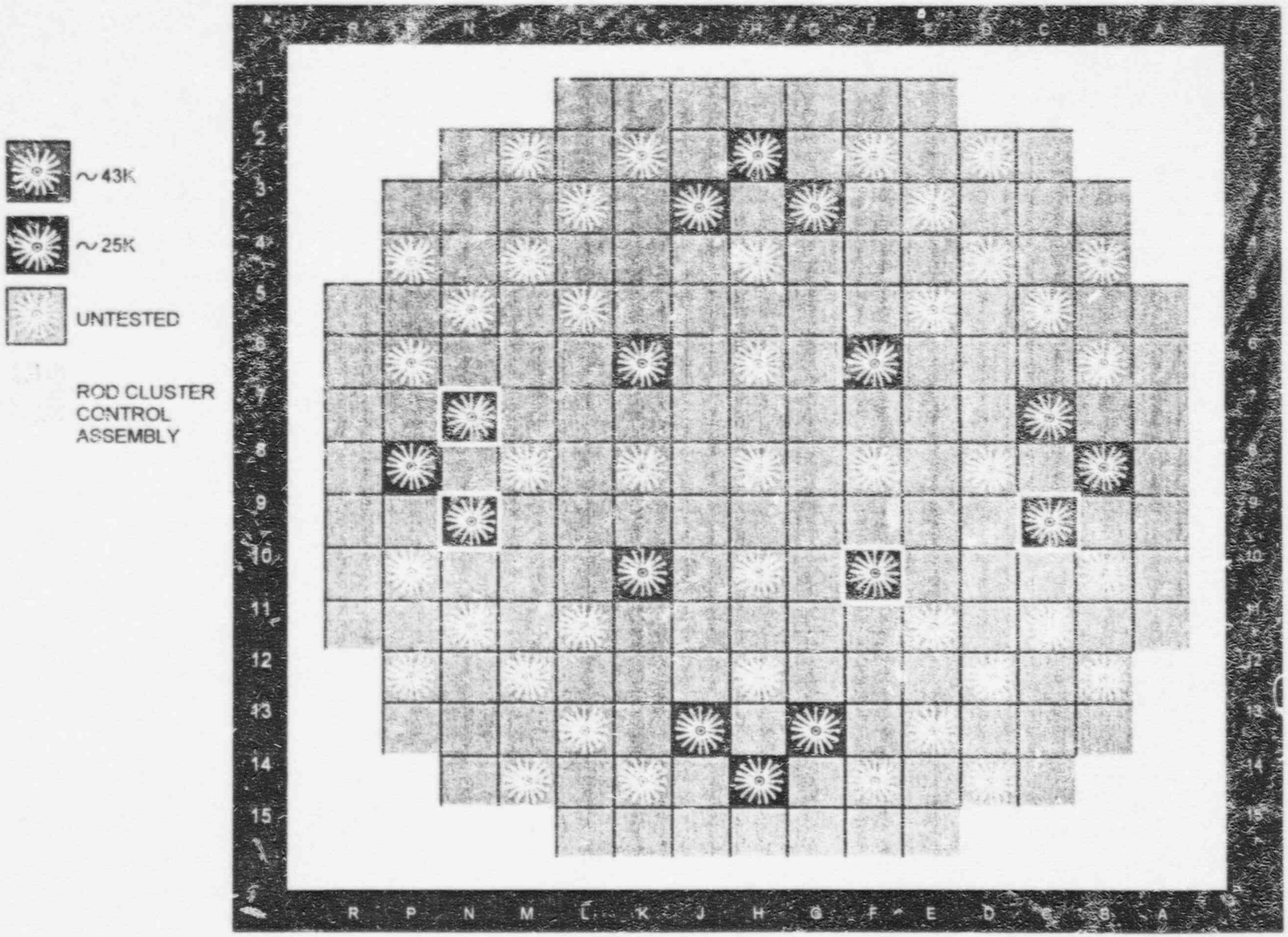
TRIP RECOVERY ACTIONS

Rod Testing

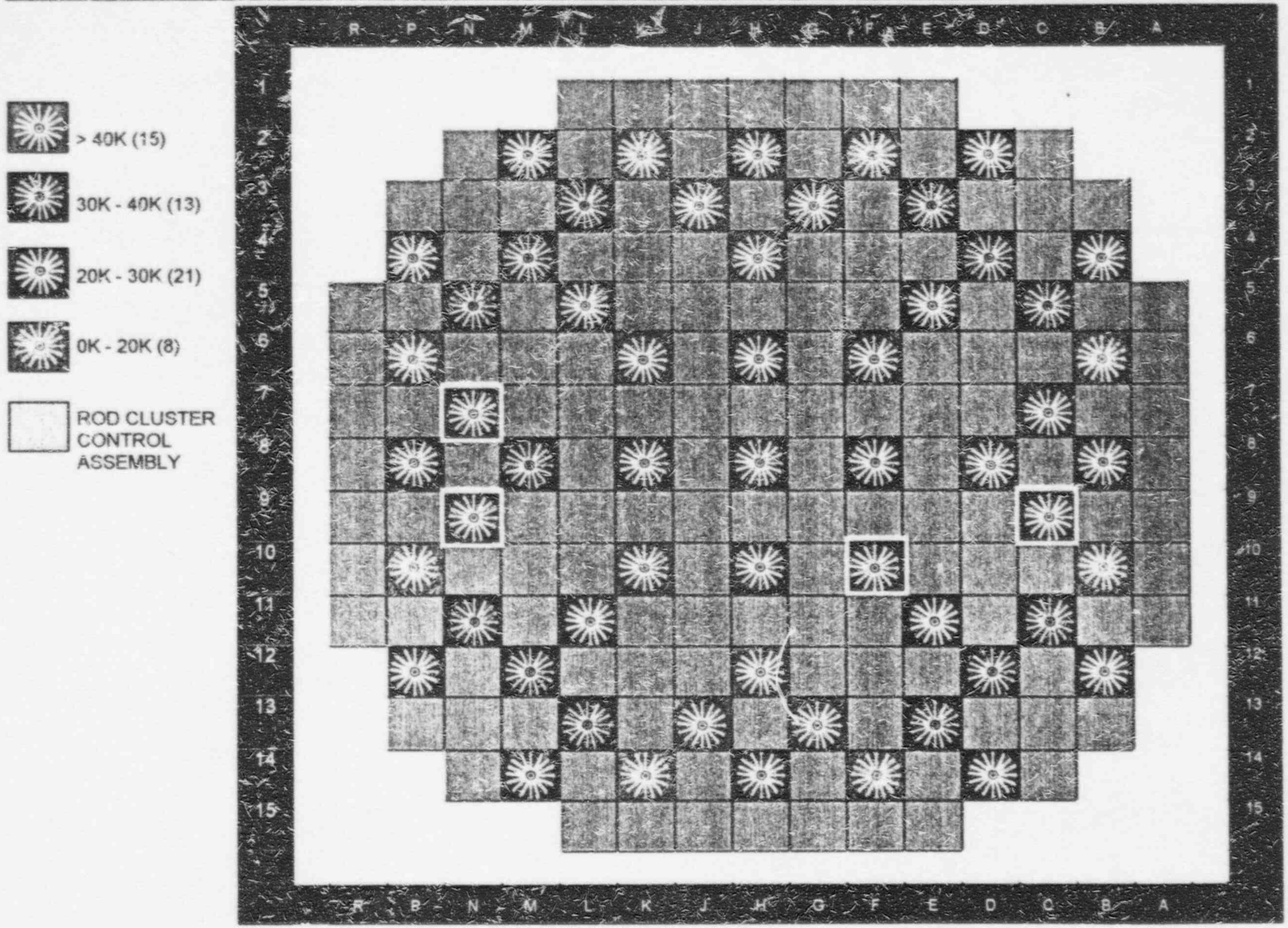
- Hot, full flow rod drop timing
- Tested Control Bank C and Shutdown Bank B (16 RCCAs)
- Control rod drive mechanism currents monitored on 3 affected rods
- Same 3 rods indicated 6 steps from rod bottom after drops
- New rod, N-9, also stopped at 6 steps
- Both N-7 and N-9 went to rod bottom within about 1 hour
- No significant change in dashpot entry time
- Repeatable rod sticking at 6 steps
- F-10 and C-9 were manually inserted to rod bottom

No unusual indications during subsequent reactor startup

16 TESTED LOCATIONS
U1 C6 - 12/19/95

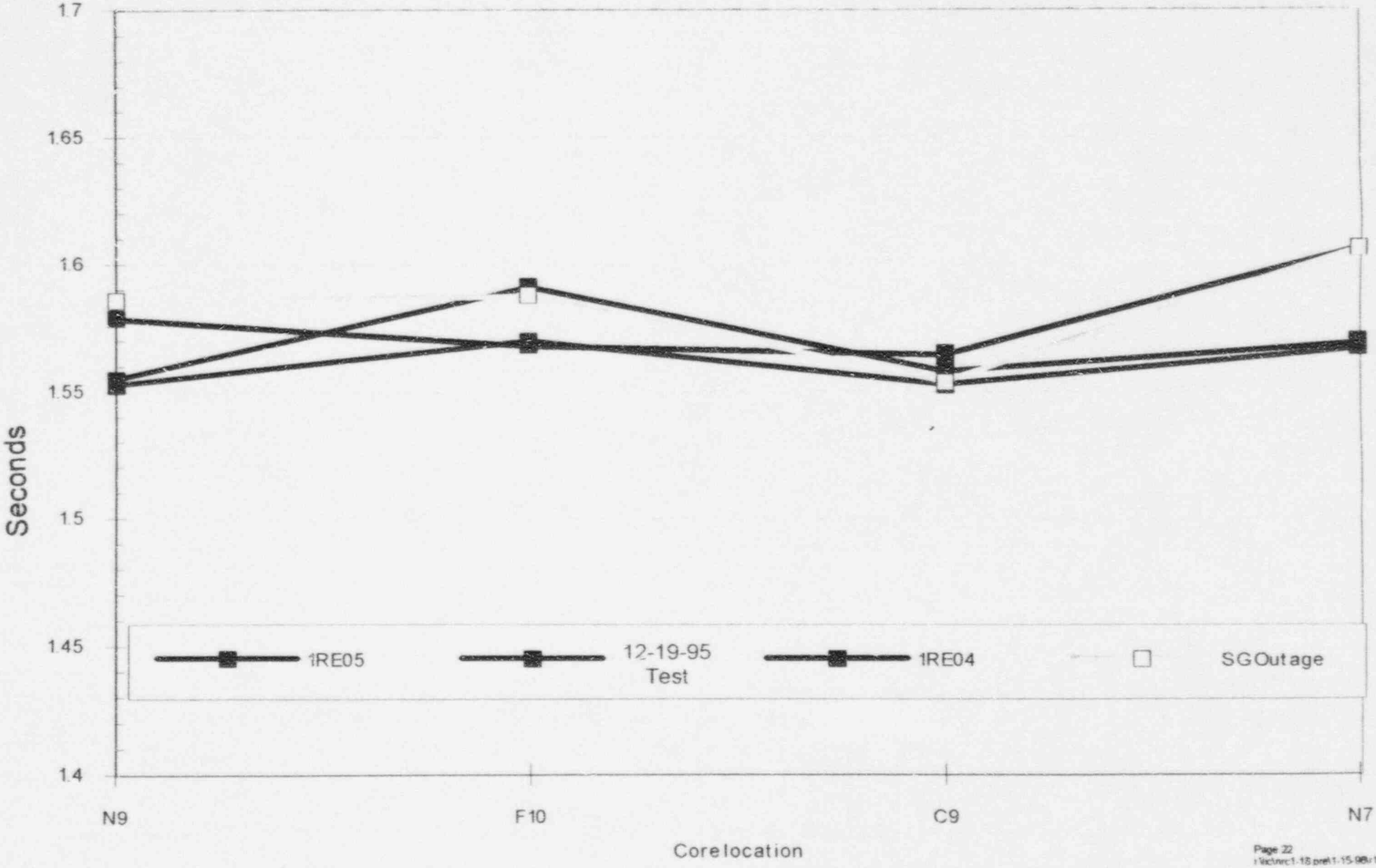


U1 C6 RODDED BURNUP DISTRIBUTION
12/18/95

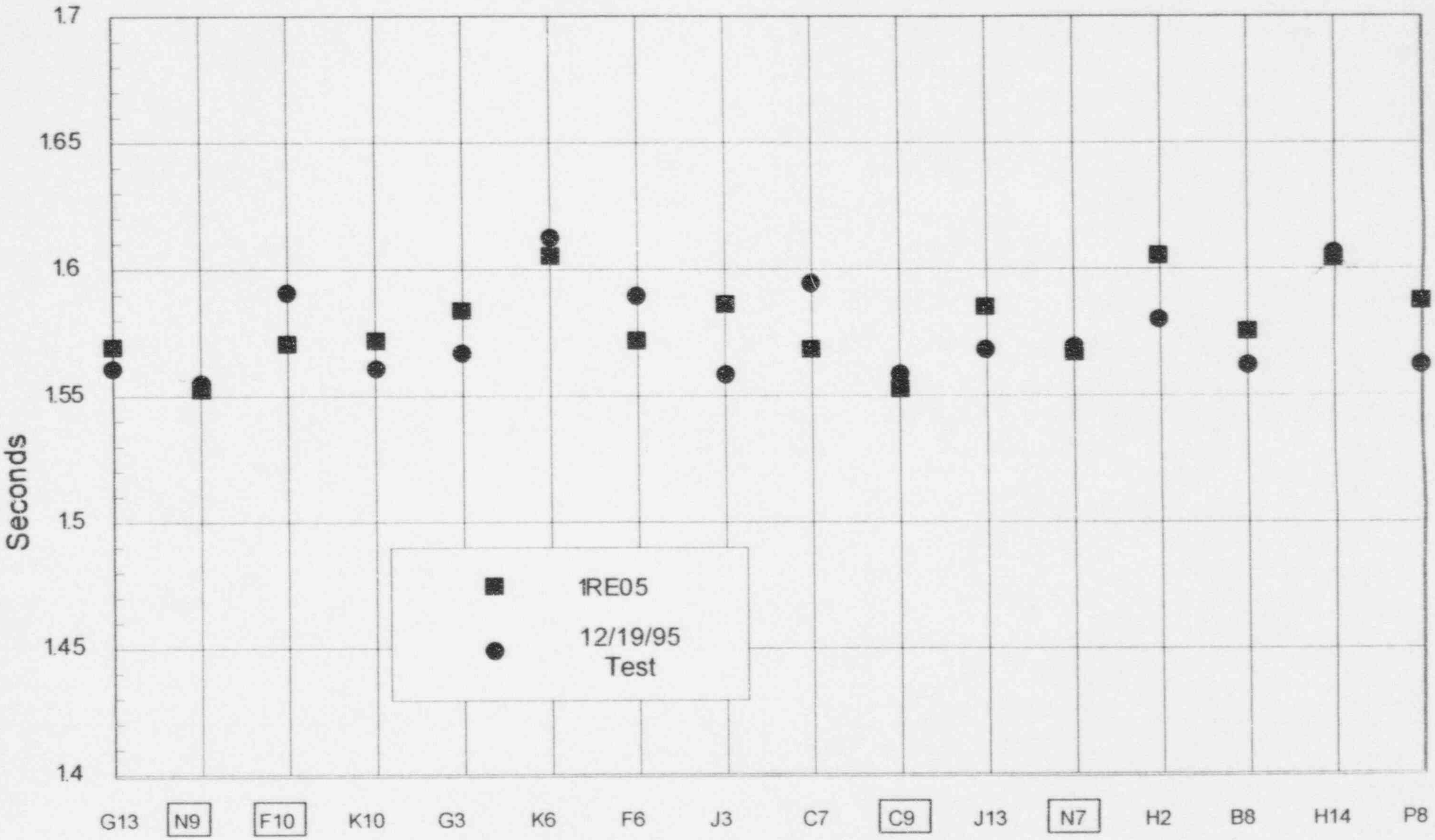


Burnup ranges from about 9.8K to about 44K mwd/mtu

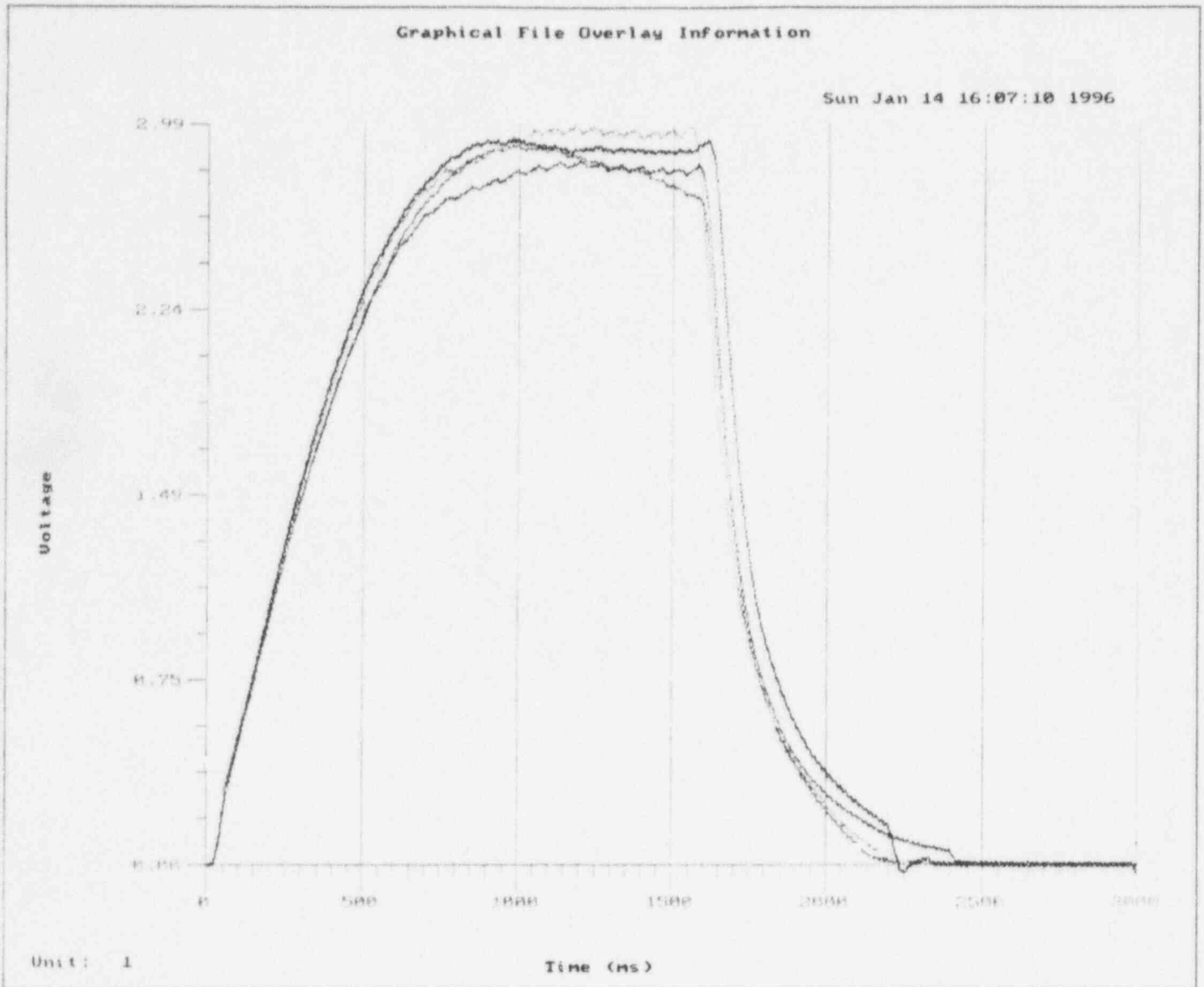
COMPARISON OF DASHPOT ENTRY TIMES
AFFECTED RODS



COMPARISON OF DASHPOT ENTRY TIMES
TESTED RODS

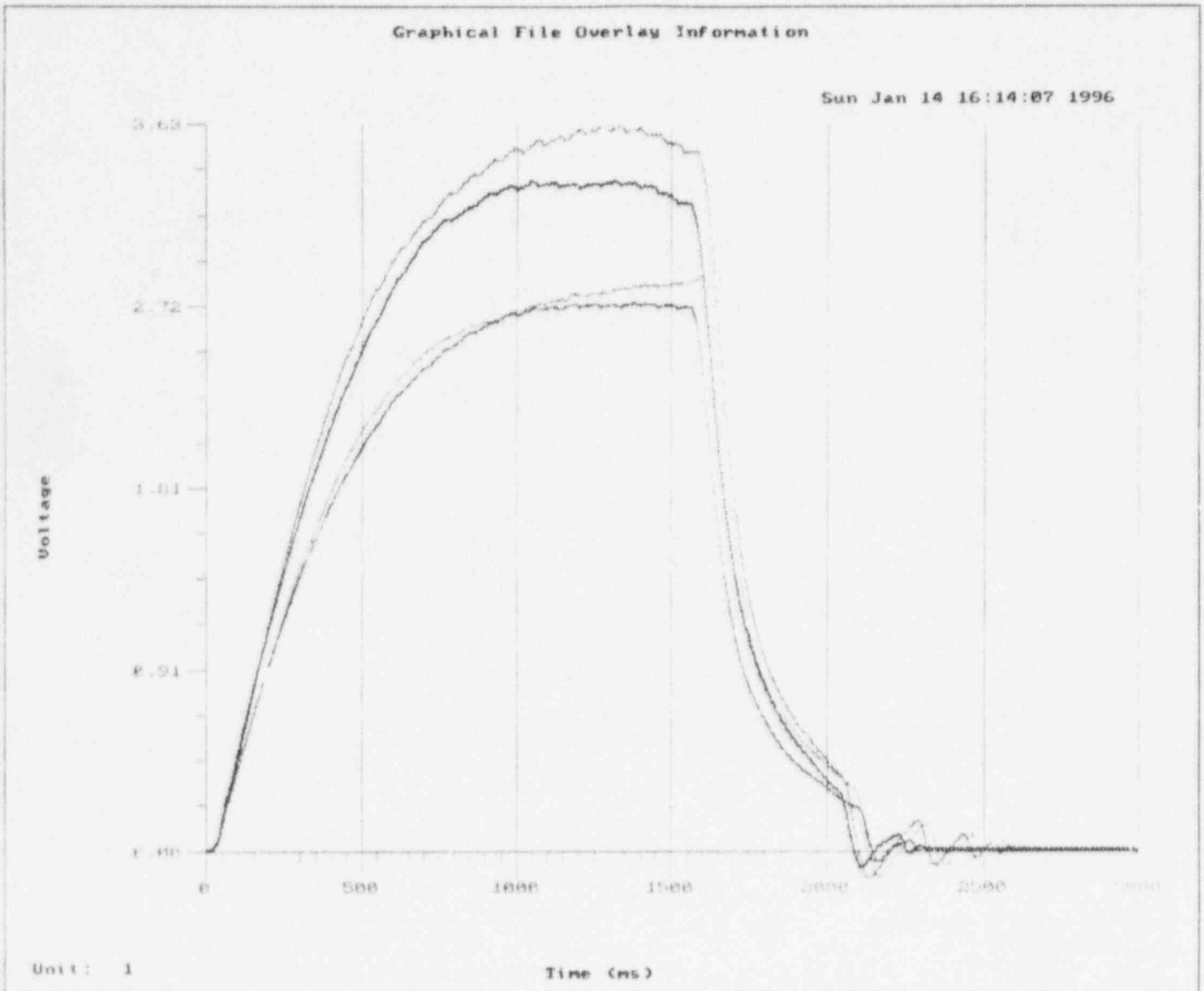


ROD DROP TRACES



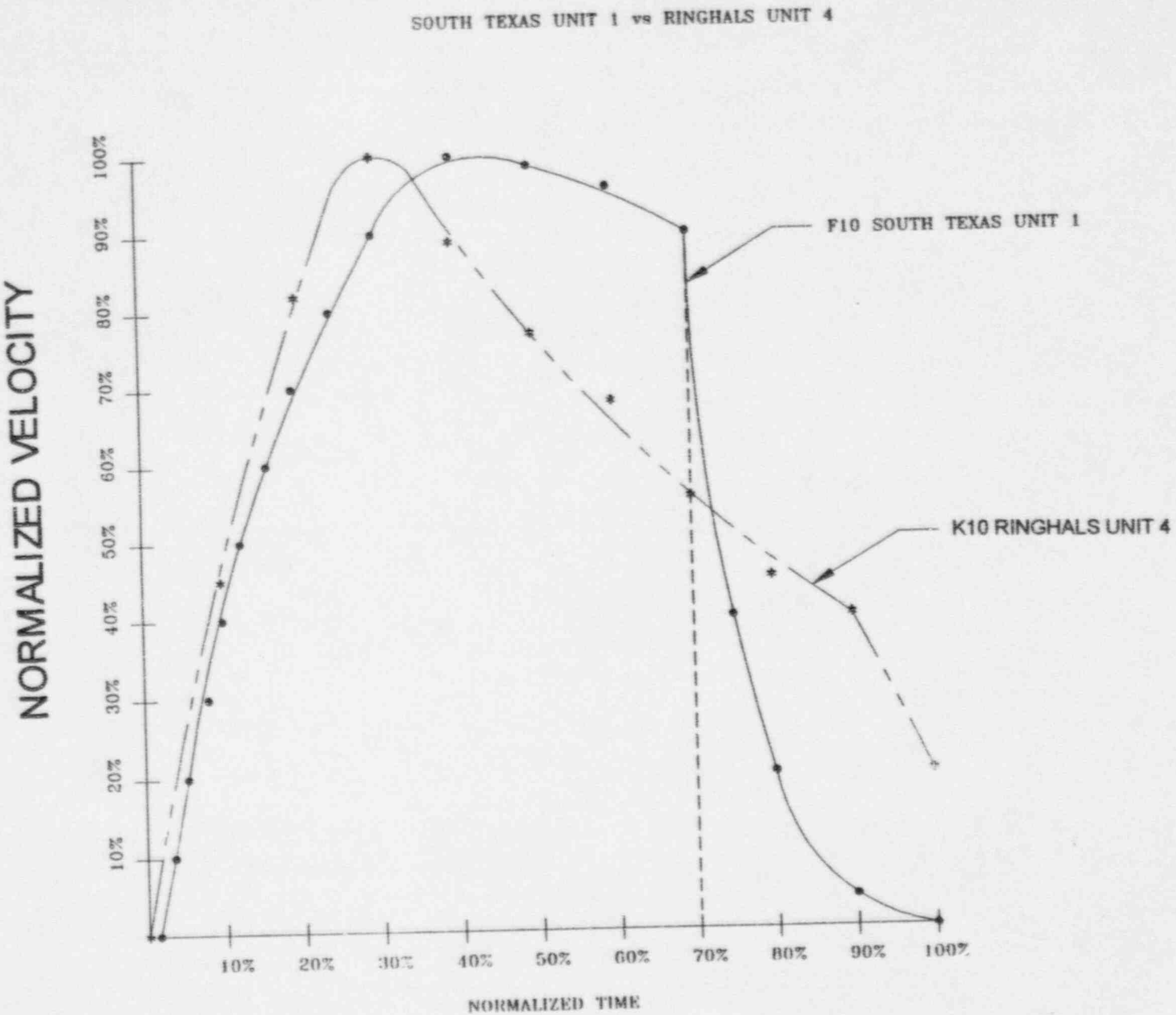
Rod:	F10	K10	F6	K6
Drop:	1	1	1	1
File:	F1012951.RDA	[illegible]1012951.RDA	F612951.RDA	K612951.RDA
Dashpot:	1591	1561	1590	1613
TAround:	2738	2571	2705	2234
Temp:	568.0 Deg F	568.0 Deg F	568.0 Deg F	568.0 Deg F
Press:	2235.0 PSIG	2235.0 PSIG	2235.0 PSIG	2235.0 PSIG
Fl Rate:	100.0 %	100.0 %	100.0 %	100.0 %
Cycle:	6	6	6	6

ROD DROP TRACES



Rod:	H2		H14		B8		P8	
Drop:	1		1		1		1	
File:	H212951.RDA		H1412951.RDA		B812951.RDA		P812951.RDA	
Dashpot:	1580		1607		1562		1562	
TAround:	2102		2136		2146		2086	
Temp:	568.0	Deg F	568.0	Deg F	568.0	Deg F	568.0	Deg F
Press:	2235.0	PSIG	2235.0	PSIG	2235.0	PSIG	2235.0	PSIG
Fl Rate:	100.0	%	100.0	%	100.0	%	100.0	%
Cycle:	6		6		6		6	

CONTROL ROD DROP CHARACTERISTICS



TRIP RECOVERY ACTIONS

Safety Evaluation

- Affected rod's safety function maintained - shutdown margin (SDM) met through EOL
- Accident analyses not adversely impacted
- Conservative assumptions:
  - All rodded twice-burned core locations affected (32 of 57)
  - 32 rods stop at 12 steps from bottom after presumed trip
  - Rod drop times < 2.8 seconds (actuals are about 1.6 seconds)

Recent shutdown margin calculations, SDM met through EOL for:

- 57 control rods at 12 steps
- 28 control rods at 20 steps (in 28 highest rodded burned fuel)
- 20 control rods at 38 steps (in 20 highest rodded burned fuel)

INVESTIGATION

STP Facts

- 4 affected core locations - twice burned (43000 mwd/mtu) XLR
- Fuel assemblies F26 (F-10), F25 (N-9), F64 (N-7), F59 (C-9)
- Highest U1 burnups to date
- U2 C4 comparable at EOL - 4 rodded assemblies at 43000 mwd/mtu
- 1st fuel region in Unit 1 with XLR features
- U1 C6 BOL rod drops sat
- U1 trip on 8/29/95 - all rods on bottom - 3900 mwd/mtu delta between 8/29 and 12/18

INVESTIGATION

STP Facts

- U1 current and previous core - defect free
- Manufacturing reviews - no indications
- No indications from site receipt drag testing of affected rods
- No correlation from previous U1 C1 cladding wear measurements in affected locations
- Rods in-service since C2 (10/89)

INVESTIGATION

STP Facts

- Satisfactory monthly rod exercise just before trip
- Rods not significantly slowing down until dashpot
- Recoil trends may be an indicator
- Cycle-to-cycle rod drop times 1.55 to 1.65 seconds
- No adverse flux map trends
- No chemistry excursions in U1 C6

U1 RECOIL TRENDS
(16 TESTED RCCAs)

LEGEND
X - No Recoil
O - Recoil

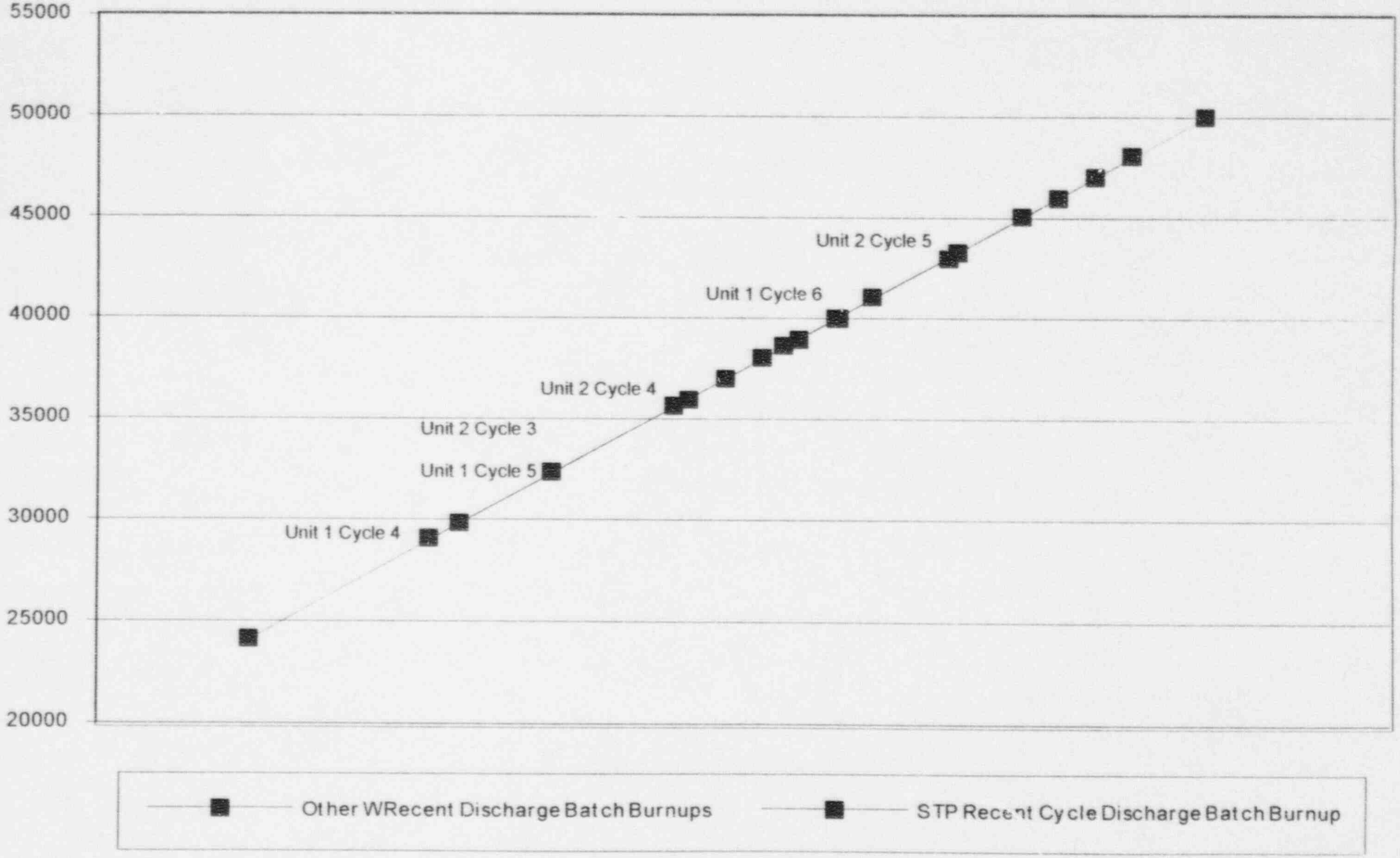
RCCA	BOL C5	BOL C6	12/19/95
F10	0	X	X
C9	0	X	X
N7	0	X	X
N9	0	X	X
K10	0	X	X
K6	0	0	0
F6	0	0	X
J3	0	0	0
C7	0	0	X
G3	0	0	0
J13	0	0	0
G13	0	0	0
H2	0	0	0
B8	0	0	0
H14	0	0	0
P8	0	0	0

INVESTIGATION

STP Design vs. Standard

- Fuel assembly length
- Hold down forces in vessel
- Dash pot region length
- Double dashpot
- Radial clearances
- Grids
- Discharge burnup

CURRENT WESTINGHOUSE 17x17 FUEL BURNUP EXPERIENCE



GENERAL FUEL FEATURES COMPARISON

Feature	**XL (5 ea)**	**XLR (136 ea)**	**V5H (52 ea)**	**Standard 12' (N/A)**
Grid material				
Bottom, Top	Inconel	Inconel	Inconel	Inconel
Mid	Inconel	Inconel	Zirc	Inconel
Guide tube Sleeve	SS	SS	Zirc	SS
Mid Grid Pitch (in)	19.81	19.81	19.81	20.55
Grid height				
Bottom, top (in)	1.322	1.522	1.522	1.522
Mid (in)	1.322	1.322	1.500	1.322
Guide tube sleeve length (in)	2.590	2.590	0.750	2.590
Control rod travel (in)	162.2 (From 259 steps)	162.2	162.2	143.125
Reactor Vessel engagement:				
Top:	Pins on fuel	Pins on fuel	Pins on fuel	Pins on Upper Core Plate
Bottom:	Pins on Core Plate	Pins on Core Plate	Pins on Core Plate	Pins on Core Plate

GENERAL FUEL FEATURES COMPARISON (CONT.)

Feature	XL (5 ea)	XLR (136 ea)	V5H (52 ea)	Standard 12' (N/A)
Guide tube overall length (in)	178.695	179.055	179.055	154.117
Guide tube wall thickness (in)	0.017	0.017	0.017	0.017
Guide Tube OD (in)	0.484	0.484	0.476	0.484
Control rod radial clearance				
Dashpot (in)	0.006	0.006	0.006	0.006
Above Dashpot (in)	0.035	0.035	0.031	0.035
Dashpot length (total) (in)	33.845	33.845	33.845	23.995
Dashpot wall thickness (in)	0.017	0.017	0.017	0.017
Guide tube material	Zirc	Zirc	Zirc	Zirc

GENERAL FUEL FEATURES COMPARISON (CONT.)

Feature	XLR	STD 12'	Fragema (12')
Average Spring force (lbf)	1372	1072	1372
Hydraulic lift force (lbf)	1652	1387	611
Weight (lbf)	1692	1445	1445
Net holdown force (buoyancy included) (lbf)	1242	1000	2076
Average guide tube normal stress (psi)	3490	2732	5023
% Difference (Fragema = 1.0) (%)	-30.5	-45.6	0.0

GENERAL FUEL FEATURES COMPARISON (CONT.)

Feature	XL	Standard
Spider assembly		
Material	304 SS	304 SS
Spring	Inconel	Inconel
Travel	1.05	0.88
Poison		
Material	Ag-In-Cd	Ag-In-Cd
Length	158.87	142.0
Diameter	0.341	0.341
Spring	Inconel	Inconel
Clad		
ID	0.344	0.344
OD	0.381	0.381
Inserted length	170.370	150.585
Number of rodlets	24	24
Shuffling	Rapid refueling	Non-Rapid refueling
Axial repositioning	Normally quarterly	Various

INDUSTRY EXPERIENCE

Events of Control Rod Failure to Fully Insert

Foreign Material

- Surry 1 (6/84)- spring clamp from Fuel Assembly Top Nozzle lodged in rodlets
- Palo Verde 1 (1/88)-ball bearing lodged in rod guide tube
- STP 1 (9/87)- ball bearing lodged in rod guide card
- ANO2 (3/90)- unidentified material in rod guide card
- Braidwood 2 (4/94)- dowel pin lodged in rod guide card
- ASCO (1995) - foreign material in guide tube
- French 900 Mwe plants (1/90, 1/92) - foreign material in rod guide tube, rod guide card
- French 1300 Mwe Plant (5/94) - foreign material in rod guide card

INDUSTRY EXPERIENCE
DEGRADED CONTROL ROD INSERTION

Control Rod - Drive Line Degradation

- Maanshan 1 (9/88) - hafnium rod swelling
- SONGS 1 (12/81 - rod assembly weld failure
- Foreign plant (11/84) - loose CRDM breach guide screw lodged and prevented motion (NRC IE Information Notice 85-14)
- French 900 Mwe plants (6/83, 12/88, 7/89, 9/89) - guide card deformation
- French 900 Mwe plant (1989) - broken rodlet
- Westinghouse plants (1986-1981) - RCCA spider vane separation (3 events)

Corrosion Products

- ANO2 (2/91) - corrosion products in rod guide tube
- BW plants in 1993 (Oconee 2, Oconee 1, TMI 1) - crud deposits in upper drive line. This resulted in slower rod drop times, but no failure to fully insert.

INDUSTRY EXPERIENCE
DEGRADED CONTROL ROD INSERTION

Guide Tube Bow

- Ringhals 4 (8/94)- 12' 17x17 Fragema fuel with burnup of 37,000 to 41,000 mwd/mtu
  - Rod stuck at 18 steps out; 4 rods stuck during subsequent testing
  - Rod drop testing showed rod speed affected well before dashpot
  - S-shaped bow observed in fuel under problem control rods

- Doel 3 (Fall 1994)- 12' 17x17 Siemens fuel with burnup of 37,000 mwd/mtu
  - Rod could not be fully inserted; moved freely in top half of travel
  - Fuel assembly was discharged; no exam of fuel or control rod

- French 1300 Mwe Plant (10/92) - 14' fuel, rod stuck at 7 steps; fuel assembly was bowed (25mm)

Cause Not Determined

- WWE-1000 (Russian plants, after 1992) - rod stuck near the bottom of the core
- Kozlodny NPP Unit 6 (Oct. 1994) - rod stuck near the bottom of the core

POTENTIAL CAUSES AND CHARACTERISTICS

Debris - Foreign Material

- Sudden decrease in speed
- Rods hard to move
- Reproducible
- Burnup/time independent

POTENTIAL CAUSES AND CHARACTERISTICS

Control Rod or Drive Line Degradation

- Core location dependent - no radial shuffling at STP
- Likely to be repeatable
- Ag-110m trends - show no changes

POTENTIAL CAUSES AND CHARACTERISTICS

Corrosion Products

- Guide tubes, rod cladding, guide cards
- Gradual effect
- Worsens with time
- Not core location dependent
- Tight clearances required

POTENTIAL CAUSES AND CHARACTERISTICS

Guide Tube Bow

- Banana bow
  - Prevelant
  - Not known to degrade RCCA insertion
  - Not burnup dependent

- S-shape bow
  - Rare
  - Can cause RCCA interference
  - May be burnup dependent

ACTION PLANS

- Approve safety evaluation for Unit 2 Cycle 5 by 2/8/96
- Inspect (drag testing, visuals) the 4 high burnup Unit 2 fuel assemblies discharged to SFP during 2RE04 - proposed start date is 1/22/96
- Complete review of fuel and control rod manufacturing records
- Perform hot, full flow rod drop testing during next shutdown in either unit
- Perform Unit 1 hot, full flow rod drop testing approximately 60 to 75 EFPD after the 12/18/95 reactor trip (subject to change if forced outage occurs)
- Perform Unit 1 hot, full flow rod drop testing at EOL during plant shutdown at the start of 1RE06
- Evaluate performing cold, full flow rod drop testing during 1RE06 plant shutdown on affected rod banks, and perform if necessary. Decide by 3/18/96.

ACTION PLANS, CONTINUED

- Revise Unit 1 Cycle 7 loading pattern to minimize or eliminate high burnup fuel assemblies (> 40000 MWD/MTU at EOL) in rodded locations
- Evaluate performing RCCA testing
- Visually inspect affected Unit 1 fuel assemblies (scheduled for discharge) during 1RE06
- Complete further testing of affected Unit 1 fuel assemblies as soon as practical following 1RE06.
- Testing under consideration includes: drag testing of guide tubes, boroscopic examination of guide tubes, feeler gauge measurements in guide tubes, and assembly axial growth measurements.