UNION ELECTRIC COMPANY

CALLAWAY PLANT

CYCLE 3

STARTUP REPORT

DECEMBER 22, 1987

FACILITY OPERATING LICENSE NPF-30

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UNION ELECTRIC COMPANY

CALLAWAY PLANT

STARTUP REPORT

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1.0 INTRODUCTION

This report presents a summary of plant startup and power escalation testing for Refuel 2 at Union Electric's Callaway Plant. It satisfies the requirement of Technical Specifications that a Startup Report be submitted following installation of fuel having a different design. It also satisfies a commitment contained in the Callaway SER (NUREG-0830, Supplement 2, section 4.2.3.1) that Union Electric inspect control rods during one of the first 5 refuelings and provide the results to the NRC.

Callaway Plant is a Westinghouse four-loop pressurized water reactor rated at 3411 MWt. It is located in Callaway County, Missouri, approximately 80 miles west of the St. Louis metropolitan area, and is owned and operated by Union Electric Company.

Callaway Plant operated in Cycle 2 with a transition core consisting of 109 Westinghouse 17 x 17 low-parasitic (LOPAR) fuel assemblies and 84 Westinghouse 17 x 17 Reconstitutable Optimized Fuel Assemblies. The unit was refueled with Westinghouse Vantage 5 fuel assemblies and the Cycle 3 core now consists of 13 LOPAR fuel assemblies, 84 optimized fuel assemblies, and 96 Vantage 5 fuel assemblies.

Cycle 3 fuel shuffle commenced on 9-25-87 and was completed on 10/16/87. Initial criticality for the cycle occurred on 11/6/87. The plant was synchronized to the grid on 11/15/87. The startup testing program was completed with the flux map at full power on 11/27/87.

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2.0 CORE REFUELING
(ETP-ZZ-00035)

OBJECTIVES

To specify the final core configuration and to control the unloading and loading sequences.

SUMMARY OF RESULTS

Core loading was completed and verified to be in accordance with core design by video core mapping.

DISCUSSION

Refueling was performed by completely offloading the Cycle 2 core to the Spent Fuel Pool, changing out fuel inserts, and then loading the Cycle 3 core. Concurrently, ultrasonic inspection of the core was performed, and 3 fuel assemblies which were to be reloaded were reconstituted. In addition, an eddy current inspection was performed on the control rods.

The off-load began at 10:38 on 9/25/87, and the reload was completed at 23:43 on 10/16/87, for a total elapsed time of 21.6 days.

The Cycle 3 core configuration is shown in Figures 2.1 through 2.3 and Tables 2.1 through 2.6.

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

180

90 (row 8, left) · 270 (row 8, right)

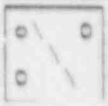
	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1					4A D14	5C E63	4B D45	5C E71	4B D83	5C E74	4A D24				
2			5C E84	3 C29	5C E85	4B D43	5A E15	4A D17	5A E18	4B D59	5C E62	3 C44	5C E93		
3		5C E66	5A E02	5C E79	4B D75	5B E31	4B D58	4B D51	4B D41	5B E38	4B D65	5C E80	5A E04	5C E76	
4		3 C49	5C E77	4B D82	5B E41	4A D22	5B E51	4A D27	5B E52	4A D09	5B E30	4B D80	5C E70	3 C53	
5	4A D35	5C E73	4B D53	5B E59	3 C46	5A E20	4A D23	5A E05	4A D29	5A E26	3 C16	5B E33	4B D46	5C E61	4A D04
6	5C E83	4B D70	5B E46	4A D21	5A E27	4A D10	5B E47	4A D39	5B E43	4A D06	5A E14	4A D20	5B E44	4B D78	5C E69
7	4B D79	5A E28	4B D71	5B E37	4A D05	5B E40	4B D44	5A E10	4B D54	5B E29	4A D12	5B E50	4B D81	5A E16	4B D77
8	5C E68	4A D11	4B D68	4A D32	5A E11	4A D40	5A E01	3 C36	5A E12	4A D34	5A E03	4A D26	4B D84	4A D18	5C E90
9	4B D55	5A E23	4B D52	5B E36	4A D03	5B E35	4B D47	5A E08	4B D67	5B E57	4A D28	5B E55	4B D61	5A E24	4B D64
10	5C E88	4B D49	5B E49	4A D30	5A E21	4A D15	5B E60	4A D37	5B E48	4A D25	5A E22	4A D16	5B E45	4B D57	5C E82
11	4A D02	5C E96	4B D42	5B E54	3 C63	5A E17	4A D38	5A E09	4A D33	5A E19	3 C56	5B E34	4B D73	5C E81	4A D08
12		3 C45	5C E78	4B D50	5B E58	4A D01	5B E32	4A D31	5B E39	4A D13	5B E53	4B D66	5C E87	3 C06	
13		5C E67	5A E06	5C E92	4B D69	5B E42	4B D74	4B D56	4B D62	5B E56	4B D76	5C E65	5A E07	5C E72	
14			5C E86	3 C26	5C E75	4B D60	5A E13	4A D36	5A E25	4B D72	5C E89	3 C27	5C E91		
15					4A D19	5C E95	4B D63	5C E64	4B D48	5C E94	4A D07				

0 DEG.

KEY:

R ID	R = REGION NUMBER ID = FUEL ASSEMBLY IDENTIFICATION

ASSEMBLY ORIENTATION:



o = REFERENCE HOLE
D = CORE PIN HOLE
\ = HOLDDOWN BAR

FUEL/REGION LOCATIONS

FIGURE 2.1

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

180

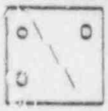
	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1					PD B	PD B	PD B	PD B	PD B	PD B	PD B				
2			PD B	R A	16A B	R A	PD B	R A	PD B	R A	16A B	R A	PD B		
3		PD B	8A B	24A B	R A	24A B	R A	SS4A B	R A	24A B	R A	24A B	8A B	PD B	
4		R A	24A B	R A	24A B	PD B	24A B	R A	24A B	PD B	24A B	R A	24A B	R A	
5	PD B	16A B	R A	24A B	PD B	PD B	PD B	24A B	PD B	PD B	PD B	24A B	R A	16A B	PD B
6	PD B	R A	24A B	PD B	PD B	R A	24A B	R A	24A B	R A	PD B	PD B	24A B	R A	PD B
7	PD B	PD B	R A	24A B	PD B	24A B	PD B	20A B	PD B	24A B	PD B	24A B	R A	PD B	PD B
90 8	PD B	R A	PD B	R A	24A B	R A	20A B	R A	20A B	R A	24A B	R A	PD B	R A	PD B 270
9	PD B	PD B	R A	24A B	PD B	24A B	PD B	20A B	PD B	24A B	PD B	24A B	R A	PD B	PD B
10	PD B	R A	24A B	PD B	PD B	R A	24A B	R A	24A B	R A	PD B	PD B	24A B	R A	PD B
11	PD B	16A B	R A	24A B	PD B	PD B	PD B	24A B	PD B	PD B	PD B	24A B	R A	16A B	PD B
12		R A	24A B	R A	24A B	PD B	24A B	R A	24A B	PD B	24A B	R A	24A B	R A	
13		PD B	8A B	24A B	R A	24A B	R A	SS4A B	R A	24A B	R A	24A B	8A B	PD B	
14			PD B	R A	16A B	R A	PD B	R A	PD B	R A	16A B	R A	PD B		
15					PD B	PD B	PD B	PD B	PD B	PD B	PD B				

0 DEG.

KEY:

TYPE OR	TYPE = COMPONENT TYPE PER FIGURE 4. OR = COMPONENT ORIENTATION

ASSEMBLY ORIENTATION:



o = REFERENCE HOLE
O = CORE PIN HOLE
\ = HOLDDOWN BAR

COMPONENT ORIENTATION:

A: NO SPECIAL ORIENTATION.
B: HOLDDOWN BAR IDENT OPPOSITE F/A REFERENCE HOLE.
C: HOLDDOWN BAR IDENT TOWARDS F/A REFERENCE HOLE.

NOTE:
SEE FIGURE 4. FOR COMPONENT CONFIGURATION, AND LOCATION OF HOLDDOWN BAR IDENTIFICATION.

CORE COMPONENT LOCATIONS

FIGURE 2.2

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

180

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							MD	TC		MD					
2			MD TC		TC	MD	TC	MD	TC		TC		TC		
3								MD		MD		MD		MD	
4		MD	MD TC		TC		TC	MD	TC		TC		TC		
5					MD				MD		MD		MD		
6	MD TC		MD TC		TC	MD	TC	MD	TC		TC		TC	MD	TC
7				MD			MD			MD			MD		
8	MD TC		MD TC		MD TC		MD TC		TC	MD	TC	MD	MD TC	MD	TC
9		MD							MD		MD				MD
10	TC		TC		MD TC		MD TC		TC		TC	MD	TC		TC
11	MD				MD			MD			MD				MD
12			TC		TC	MD	TC		MD TC		TC	MD	TC		
13			MD		MD			MD						MD	
14			MD TC		TC		MD TC		TC	MD	TC	MD	TC		
15					MD			MD TC							

90

270

0 DEG.

FDMD
TC

KEY:	TOTAL IN CORE
FD = FIXED DETECTOR	0
MD = MOVABLE DETECTOR	58
TC = THERMOCOUPLE	50

INSTRUMENTATION LOCATIONS

FIGURE 2.3

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

REGION: 3

ENRICHMENT: 3.09
CONDITION: RECYCLE

NUMBER REQUIRED: 13
IDENTIFICATION: AS LISTED

FUEL LOCATION	ASSEMBLY IDENTIFICATION	ANSI IDENTIFICATION	---CORE COMPONENT--- TYPE	IDENT	ORIENT
B-4	C53	LMOA41	R		A
B-12	C06	LMOA40	R		A
D-2	C44	LMOA48	R		A
D-14	C27	LMOA3J	R		A
E-5	C16	LMOA3D	PD		B
E-11	C[illegible]6	LMOA4F	PD		B
H-8	C36	LMOA4M	R		A
L-5	C46	LMOA47	PD		B
L-11	C63	LMOA4J	PD		B
M-2	C29	LMOA4C	R		A
M-14	C26	LMOA4S	R		A
P-4	C49	LMOA36	R		A
P-12	C45	LMOA30	R		A

ASSEMBLY LISTING FOR REGION 3

TABLE 2.1

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

REGION: 4A

ENRICHMENT: 3.39
CONDITION: RECYCLE

NUMBER REQUIRED: 40
IDENTIFICATION: D01 - D40

FUEL LOCATION	ASSEMBLY IDENTIFICATION	ANSI IDENTIFICATION	---CORE COMPONENT--- TYPE	IDENT	ORIENT
A-5	D04	LMOJ0Q	PD		B
A-11	D08	LMOJ0E	PD		B
B-8	D18	LMOJ0J	R		A
D-6	D20	LMOJ16	PD		B
D-8	D26	LMOJ0C	R		A
D-10	D16	LMOJ1C	PD		B
E-1	D24	LMOJ0M	PD		B
E-7	D12	LMOJ09	PD		B
E-9	D28	LMOJ0L	PD		B
E-15	D07	LMOJ0D	PD		B
F-4	D09	LMOJ1A	PD		B
F-6	D06	LMOJ0H	R		A
F-8	D34	LMOJ0S	R		A
F-10	D25	LMOJ0B	R		A
F-12	D13	LMOJ18	PD		B
G-5	D29	LMOJ12	PD		B
G-11	D33	LMOJ0T	PD		B
H-2	D17	LMOJ0Z	R		A
H-4	D27	LMOJ19	R		A
H-6	D39	LMOJ17	R		A
H-10	D37	LMOJ15	R		A
H-12	D31	LMOJ0X	R		A
H-14	D36	LMOJ0P	R		A
J-5	D23	LMOJ0G	PD		B
J-11	D38	LMOJ0R	PD		B
K-4	D22	LMOJ11	PD		B
K-6	D10	LMOJ0K	R		A
K-8	D40	LMOJ08	R		A
K-10	D15	LMOJ0Y	R		A
K-12	D01	LMOJ1B	PD		B
L-1	D14	LMOJ0W	PD		B
L-7	D05	LMOJ0N	PD		B
L-9	D03	LMOJ0A	PD		B
L-15	D19	LMOJ0V	PD		B
M-6	D21	LMOJ14	PD		B
M-8	D32	LMOJ0U	R		A
M-10	D30	LMOJ10	PD		B
P-8	D11	LMOJ07	R		A
R-5	D35	LMOJ13	PD		B
R-11	D02	LMOJ0F	PD		B

ASSEMBLY LISTING FOR REGION 4A

TABLE 2.2

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

REGION: 4B

ENRICHMENT: 3.80
CONDITION: RECYCLE

NUMBER REQUIRED: 44
IDENTIFICATION: D41 - D84

FUEL LOCATION	ASSEMBLY IDENTIFICATION	ANSI IDENTIFICATION	---CORE COMPONENT--- TYPE	IDENT	ORIENT
A-7	D77	LMOJ7M	PD		B
A-9	D64	LMOJ1H	PD		B
B-6	D78	LMOJ22	R		A
B-10	D57	LMOJ7Q	R		A
C-5	D46	LMOJ26	R		A
C-7	D81	LMOJ29	R		A
C-8	D84	LMOJ1R	PD		B
C-9	D61	LMOJ1D	R		A
C-11	D73	LMOJ1P	R		A
D-4	D80	LMOJ7V	R		A
D-12	D66	LMOJ2A	R		A
E-3	D65	LMOJ7N	R		A
E-13	D76	LMOJ1N	R		A
F-2	D59	LMOJ1Q	R		A
F-14	D72	LMOJ21	R		A
G-1	D83	LMOJ7R	PD		B
G-3	D41	LMOJ7W	R		A
G-7	D54	LMOJ1F	PD		B
G-9	D67	LMOJ7T	PD		B
G-13	D62	LMOJ23	R		A
G-15	D48	LMOJ1U	PD		B
H-3	D51	LMOJ1L	SS4A		B
H-13	D56	LMOJ1F	SS4A		B
J-1	D45	LMOJ1V	PD		B
J-3	D58	LMOJ7S	R		A
J-7	D44	LMOJ24	PD		B
J-9	D47	LMOJ27	PD		B
J-13	D74	LMOJ20	R		A
J-15	D63	LMOJ1M	PD		B
K-2	D43	LMOJ7U	R		A
K-14	D60	LMOJ1X	R		A
L-3	D75	LMOJ1W	R		A
L-13	D69	LMOJ1T	R		A
M-4	D82	LMOJ7Y	R		A
M-12	D50	LMOJ7X	R		A
N-5	D53	LMOJ28	R		A
N-7	D71	LMOJ25	R		A
N-8	D68	LMOJ1S	PD		B
N-9	D52	LMOJ1J	R		A
N-11	D42	LMOJ1Y	R		A
P-6	D70	LMOJ7P	R		A
P-10	D49	LMOJ1K	R		A
R-7	D79	LMOJ1G	PD		B
R-9	D55	LMOJ1Z	PD		B

ASSEMBLY LISTING FOR REGION 4B

TABLE 2.3

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

REGION: 5A

ENRICHMENT: 3.60
CONDITION: NEW

NUMBER REQUIRED: 28
IDENTIFICATION: E01 THRU E28

FUEL	ASSEMBLY	ANSI	---CORE COMPONENT---		
LOCATION	IDENTIFICATION	IDENTIFICATION	TYPE	IDENT	ORIENT
B-7	E16	LMOLJV	PD		B
B-9	E24	LMOLK2	PD		B
C-3	E04	LMOLJF	8A		B
C-13	E07	LMOLJH	8A		B
E-6	E14	LMOLK4	PD		B
E-8	E03	LMOLJQ	24A		B
E-10	E22	LMOLK1	PD		B
F-5	E26	LMOLK8	PD		B
F-11	E19	LMOLJW	PD		B
G-2	E18	LMOLK3	PD		B
G-8	E12	LMOLJK	20A		B
G-14	E25	LMOLK5	PD		B
H-5	E05	LMOLJG	24A		B
H-7	E10	LMOLJN	20A		B
H-9	E08	LMOLJL	20A		B
H-11	E09	LMOLJS	24A		B
J-2	E15	LMOLJU	PD		B
J-8	E01	LMOLJR	20A		B
J-14	E13	LMOLK0	PD		B
K-5	E20	LMOLJT	PD		B
K-11	E17	LMOLJZ	PD		B
L-6	E27	LMOLJY	PD		B
L-8	E11	LMOLJM	24A		B
L-10	E21	LMOLK7	PD		B
N-3	E02	LMOLJJ	8A		B
N-13	E06	LMOLJP	8A		B
P-7	E28	LMOLJX	PD		B
P-9	E23	LMOLK6	PD		B

FUEL ASSEMBLIES IDENTIFIED E13 THRU E28 CONTAIN INTEGRAL FUEL BURNABLE ABSORBER RODS

ASSEMBLY LISTING FOR REGION 5A

TABLE 2.4

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

REGION: 5B

ENRICHMENT: 3.80
CONDITION: NEW

NUMBER REQUIRED: 32
IDENTIFICATION: E29 THRU E60

FUEL	ASSEMBLY	ANSI	---CORE COMPONENT---		
LOCATION	IDENTIFICATION	IDENTIFICATION	TYPE	IDENT	ORIENT
C-6	E44	LMOLKJ	24A		B
C-10	E45	LMOLKM	24A		B
D-5	E33	LMOLKC	24A		B
D-7	E50	LMOLKV	24A		B
D-9	E55	LMOLKY	24A		B
D-11	E34	LMOLKE	24A		B
E-4	E30	LMOLKD	24A		B
E-12	E53	LMOLL5	24A		B
F-3	E38	LMOLKP	24A		B
F-7	E29	LMOLKB	24A		B
F-9	E57	LMOLL3	24A		B
F-13	E56	LMOLL4	24A		B
G-4	E52	LMOLKX	24A		B
G-6	E43	LMOLKK	24A		B
G-10	E48	LMOLKZ	24A		B
G-12	E39	LMOLKN	24A		B
J-4	E51	LMOLLO	24A		B
J-6	E47	LMOLL6	24A		B
J-10	E60	LMOLKL	24A		B
J-12	E32	LMOLKF	24A		B
K-3	E31	LMOLKG	24A		B
K-7	E40	LMOLKT	24A		B
K-9	E35	LMOLKA	24A		B
K-13	E42	LMOLKH	24A		B
L-4	E41	LMOLKR	24A		B
L-12	E58	LMOLL1	24A		B
M-5	E59	LMOLKS	24A		B
M-7	E37	LMOLKQ	24A		B
M-9	E36	LMOLK9	24A		B
M-11	E54	LMOLKW	24A		B
N-6	E46	LMOLL2	24A		B
N-10	E49	LMOLKU	24A		B

ASSEMBLY LISTING FOR REGION 5B

TABLE 2.5

CALLAWAY UNIT 1
CORE LOADING PLAN
CYCLE 3

REGION: 5C

ENRICHMENT: 4.20
CONDITION: NEW

NUMBER REQUIRED: 36
IDENTIFICATION: E61 THRU E96

FUEL	ASSEMBLY	ANSI	---CORE	COMPONENT---	
LOCATION	IDENTIFICATION	IDENTIFICATION	TYPE	IDENT	ORIENT
A-6	E69	LMOLLX	PD		B
A-8	E90	LMOLLZ	PD		B
A-10	E82	LMOLLK	PD		B
B-3	E76	LMOLLV	PD		B
B-5	E61	LMOLL8	16A		B
B-11	E81	LMOLLE	16A		B
B-13	E72	LMOLLN	PD		B
C-2	E93	LMOLM2	PD		B
C-4	E70	LMOLLH	24A		B
C-12	E87	LMOLLM	24A		B
C-14	E91	LMOLM8	PD		B
D-3	E80	LMOLLG	24A		B
D-13	E65	LMOLLB	24A		B
E-2	E62	LMOLLL	16A		B
E-14	E89	LMOLM1	16A		B
F-1	E74	LMOLLY	PD		B
F-15	E94	LMOLM6	PD		B
H-1	E71	LMOLLW	PD		B
H-15	E64	LMOLLC	PD		B
K-1	E63	LMOLL9	PD		B
K-15	E95	LMOLM7	PD		B
L-2	E85	LMOLLD	16A		B
L-14	E75	LMOLLQ	16A		B
M-3	E79	LMOLLF	24A		B
M-13	E92	LMOLLR	24A		B
N-2	E84	LMOLM5	PD		B
N-4	E77	LMOLM0	24A		B
N-12	E78	LMOLM4	24A		B
N-14	E86	LMOLM3	PD		B
P-3	E66	LMOLLA	PD		B
P-5	E73	LMOLLP	16A		B
P-11	E96	LMOLL7	16A		B
P-13	E67	LMOLLT	PD		B
R-6	E83	LMOLLJ	PD		B
R-8	E68	LMOLLU	PD		B
R-10	E88	LMOLLS	PD		B

ASSEMBLY LISTING FOR REGION 5C

TABLE 2.6

2.1 ROD CLUSTER CONTROL ASSEMBLY (RCCA) EDDY CURRENT EXAMINATION (ETP-ZZ-00044)

OBJECTIVES

To perform eddy current examinations of the Callaway RCCA's.

SUMMARY OF RESULTS

An RCCA is considered acceptable for continued use if at least 50% of the cladding cross sectional area for each rodlet remains at all axial locations. All RCCA's examined by eddy current testing met this acceptance criterion.

DISCUSSION

RCCA wear has been observed at a number of plants. This wear is believed to be due to fretting caused by flow induced vibrations between the RCCA rodlets and upper internals guide cards. Based on hafnium levels in the Reactor Coolant during Cycle 2, it was believed that the cladding of a number of rodlets at Callaway had worn through.

Westinghouse was therefore contracted to perform eddy current testing on the RCCA's to determine the extent of wear.

The Westinghouse eddy current fixture used encircling coils to take data on 6 rodlets while the RCCA was being inserted into the fixture. Each encircling coil provided data on the percent of eroded cladding cross-sectional area. Using this information, the operator selected 1 of the 6 rods, and used a pancake coil array to obtain sequential rod radii during withdrawal of the RCCA. The rod radii were used to plot wear scar profiles and estimate scar depths. The RCCA was rotated and the process repeated until encircling coil data had been obtained on all 24 rodlets of the RCCA.

3.0 CONTROL ROD DROP TIME MEASUREMENTS
(ESP-ZZ-00016)

OBJECTIVES

To measure the drop time of each Rod Control Cluster Assembly (RCCA) under hot, full flow conditions in accordance with Technical Specification 3/4.1.3.4.

SUMMARY OF RESULTS

Technical Specification 3/4.1.3.4 requires that the drop time for each RCCA from the fully withdrawn position be less than or equal to 2700 msec from the beginning of decay of stationary gripper coil voltage to dashpot entry with Tavg greater than or equal to 551°F and all reactor coolant pumps operating. Under these conditions, the longest drop time was 1466 msec for rod E03.

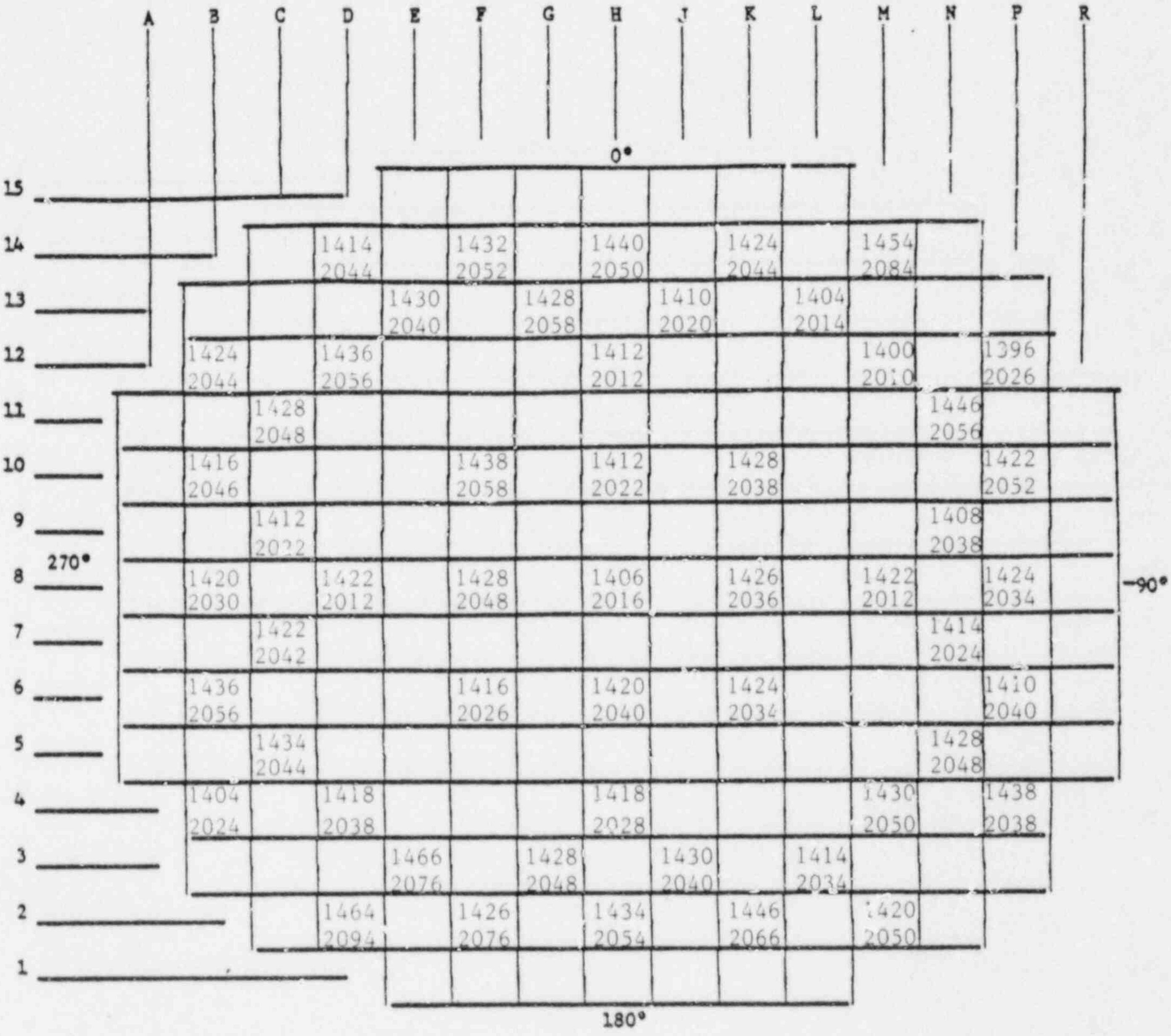
A summary of all rod drop times is presented as Figure 3.1. The mean drop time to dashpot entry was 1425 msec.

DISCUSSION

The Westinghouse Automatic Rod Drop Test Set was used to measure rod drop times.

The test set consists of two Remote Units (one connected to each Digital Rod Position Indication (DRPI) cabinet inside containment) and a Central Unit (connected to the Rod Control Logic cabinet). A rod bank is withdrawn and the control circuit for one group of rods is interrupted from the Central Unit, causing the selected group of rods to drop. Analog signals created by the rods passing through the DRPI coils are fed into the Remote Units, where they are converted to digital signals and stored. Upon command the digital data is transmitted to the Central Unit for display (or printout) of a graphic representation of the rod drop signals and associated drop times. Following completion of data transmission the process is repeated for the remaining withdrawn group and, subsequently, for each bank.

FIGURE 3.1
ROD DROP TIME TABULATION
HOT, FULL FLOW; CYCLE 3



	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
15															
14				1414 2044		1432 2052		1440 2050		1424 2044		1454 2084			
13					1430 2040		1428 2058		1410 2020		1404 2014				
12		1424 2044		1436 2056				1412 2012				1400 2010		1396 2026	
11			1428 2048										1446 2056		
10		1416 2046				1438 2058		1412 2022		1428 2038				1422 2052	
9			1412 2022										1408 2038		
8		1420 2030		1422 2012		1428 2048		1406 2016		1426 2036		1422 2012		1424 2034	
7			1422 2042										1414 2024		
6		1436 2056				1416 2026		1420 2040		1424 2034				1410 2040	
5			1434 2044										1428 2048		
4		1404 2024		1418 2038				1418 2028				1430 2050		1438 2038	
3					1466 2076		1428 2048		1430 2040		1414 2034				
2				1464 2094		1426 2076		1434 2054		1446 2066		1420 2050			
1															

xxxx	TIME TO DASHPOT ENTRY (MSEC)
xxxx	TIME TO DASHPOT BOTTOM (MSEC)

4.0 INITIAL CRITICALITY
(ETP-ZZ-ST002)

OBJECTIVES

To achieve initial criticality following refueling in a cautious and controlled manner.

SUMMARY OF RESULTS

Initial criticality was achieved on 11/6/87 at 1126. Following stabilization, Control Bank D was at 172 steps with a boron concentration of 1520 ppm. The design critical boron concentration with Control Bank D at 160 steps was 1507 ppm.

DISCUSSION

From an initial condition of all rods in and a boron concentration of 2076 ppm, the Shutdown and Control Banks were withdrawn to a final position of Control Bank D at 160 steps with all other banks fully withdrawn. Inverse Count Rate Ratio (ICRR) plots were maintained during bank withdrawal.

Reactor Coolant System dilution was initiated at 60 gpm. During dilution, the ICRR was plotted. When the ICRR reached 0.1, the dilution rate was reduced to 30 gpm and the ICRR was normalized to a value of 1.0. When the ICRR decreased below 0.2, dilution was stopped; subsequent mixing brought the reactor critical.

5.1 DETERMINATION OF LOW POWER PHYSICS TESTING RANGE (ETP-ZZ-ST003)

OBJECTIVES

To determine the power level at which detectable reactivity feedback from fuel heating occurs and to establish the power range for low power physics testing.

SUMMARY OF RESULTS

Detectable reactivity feedback was observed at 1.2 E-6 amps as indicated by the Reactimeter. The low power physics testing range was set at 5.0 E-8 to 4.0 E-7 amps.

DISCUSSION

With the reactor critical at a power level of approximately 1 E-8 amps (as indicated by the Intermediate Range channels), approximately 30 pcm of positive reactivity was added by withdrawal of Control Bank D. Power was allowed to increase until reactivity feedback effects were observed as indicated on strip chart recorders by an increase in Tavg and a decrease in reactivity.

The upper physics testing range limit was set at one-third of the current at which fuel heating occurred. The lower physics testing range limit was set at .125 of the upper limit.

5.2 DYNAMIC CHECKOUT OF REACTIMETER (ETP-SE-ST002)

OBJECTIVES

To verify accuracy of reactivity measurements obtained from the Reactimeter.

SUMMARY OF RESULTS

The absolute deviation between indicated and theoretical reactivity was determined to be 2.7%. This met the acceptance criteria of 4.0%.

DISCUSSION

The Reactimeter is a digital computer-based system for the on-line computation of dynamic reactivity during low power physics testing.

For dynamic checkout of the Reactimeter, the controlling bank was withdrawn approximately 25 pcm while monitoring reactivity using the Reactimeter. The resulting reactor period was determined from the increasing flux level. The measured reactor period was used to calculate a theoretical reactivity which was compared with the reactivity measured by the Reactimeter. This process was repeated for positive reactivity additions of approximately 50 and 75 pcm. The average absolute deviation between indicated and theoretical reactivity was then calculated for comparison with the acceptance criteria.

5.3 BORON ENDPOINT MEASUREMENTS
(ETP-ZZ-SI004)

OBJECTIVES

To measure the critical boron concentration at various Control Bank configurations.

SUMMARY OF RESULTS

All boron endpoint measurements met the design criteria, as summarized below.

Bank Configuration	Measured Boron Concentration (ppm)	Acceptance Criteria (ppm)
All Rods Out	1550	1523 ± 50
Control Bank D In	1486	1459 ± 219
Control Banks C and D In	1379	1340 ± 201

DISCUSSION

Conditions were established with the controlling rod bank within 50 pcm of its endpoint configuration with the reactor critical in the low power physics testing range. The controlling bank was inserted/withdrawn as applicable to its endpoint configuration while monitoring reactivity. The changes in reactivity due to bank movement and Tavg deviation from Tref were converted to equivalent boron concentration units and used to correct the initial boron concentration, yielding the endpoint boron concentration.

5.4 MODERATOR TEMPERATURE COEFFICIENT MEASUREMENTS
(ESP-ZZ-00009)

OBJECTIVES

To measure the Isothermal Temperature Coefficients (ITC) and determine the Moderator Temperature Coefficients (MTC) under various Control Bank configurations.

SUMMARY OF RESULTS

As required by Technical Specification 3/4.1.1.3, the MTC for the all rods out (ARO) configuration must be less positive than 0 pcm/°F. The subject MTC was determined to be 0.37 pcm/°F.

All ITC measurements met the design criteria, as summarized below.

Bank Configuration	Measured Boron ITC (pcm/°F)	Acceptance Criteria (pcm/°F)
All Rods Out	-1.97	-2.79 ± 3
Control Bank D In	-2.92	-3.68 ± 3
Control Banks C and D In	-6.06	-6.92 ± 3

DISCUSSION

The ITC measurement was performed by first decreasing, then increasing Tavg using steam dumps and measuring the resulting reactivity changes. The ITC is the change in reactivity divided by the associated change in temperature.

The MTC was determined by subtracting the design Doppler Temperature Coefficient from the ITC.

Due to measurement of a positive MTC for the ARO configuration, rod withdrawal limits were established (presented as Figure 5.4.1) and a Special Report (ULNRC-1679) was submitted to the Commission.

5.5 BANK REACTIVITY WORTH MEASUREMENTS (ETP-ZZ-ST005)

OBJECTIVES

To measure integral reactivity worth of each Control Bank.

SUMMARY OF RESULTS

All design criteria were met, as summarized below.

Control Bank	Integral Worth (pcm)	Acceptance Criteria (pcm)
D	551	533 ± 53
C	896	986 ± 99
B	1327	1391 ± 139
A	394	384 ± 38

DISCUSSION

Integral bank worths were measured using the boron exchange method. Reactor Coolant System dilution was initiated at a constant rate. The subject bank was periodically inserted in response to the change in reactivity caused by dilution. The reactivity resulting from each incremental bank movement was measured using the Reactimeter and summed to yield integral bank worth.

6.0 FLUX MAPPING
(ETP-SR-ST001)

OBJECTIVES

To verify adequate flux symmetry and power distribution during initial startup following refueling.

SUMMARY OF TEST RESULTS

Low power flux map results are presented as Table 6.1. The Safety Review Criteria that incore tilt is ≤1.04 was met. The Design Review Criteria that incore tilt is ≤1.02 and the error between measured and predicted normalized enthalpy rise for each instrumented assembly is ≤ 10% was also met.

Intermediate power flux map results are presented as Table 6.2. The Design Review Criteria that the error between measured and predicted normalized enthalpy rise for each instrumented assembly is ≤ 10% was met.

Full power flux map results are presented as Table 6.3. The Design Review Criteria that the error between measured and predicted normalized enthalpy rise for each instrumented assembly is ≤ 10% was met.

DISCUSSION

A full core flux map was taken prior to criticality to check the operability of the Flux Mapping System.

At approximately 30 percent power a full core flux was taken. Safety review criteria for incore tilt ≤1.04 was met, as well as the design review criteria for incore tilt ≤1.02 and ≤10% error between measured and predicted normalized enthalpy rise for each instrumented assembly.

At approximately 48% power the nuclear enthalpy rise hot channel factor and the heat flux hot channel factor were verified to be within the limits prescribed by Technical Specifications.

At approximately 100% power the following surveillances were performed:

1. The absolute incore versus indicated axial flux difference was verified to be less than 3%.
2. The nuclear enthalpy rise hot channel factor and the heat flux hot channel factor were verified to be within the limits prescribed by Technical Specifications.

TABLE 6.1

LOW POWER FLUX MAP RESULTS

Map ID: 87-026

Date Performed: 11-17-87

Power Level: 31%

Cycle Burnup: 24.7 MWD/MTU

Boron Concentration: 1250 ppm

Rod Position: CBD at 200 steps

Limiting Measured F_Q: 2.0623 Axial Location 32 Core Location N12
T.S. Limit: 4.0623

Limiting Measured $F_{\Delta H}$: 1.4243
T.S. Limit: 1.8002

Total Core Axial Offset: 12.717%

Maximum $F_{\Delta H}$ Error:: 8.1% Core Location N12

Incore Tilts:

QUADRANT	UPPER CORE TILT	LOWER CORE TILT
1	1.012	1.014
2	0.992	0.993
3	1.003	0.999
4	0.994	0.994

TABLE 6.2

INTERMEDIATE POWER FLUX MAP RESULTS

Map ID: 87-027

Date Performed: 11-18-87

Power Level: 48%

Cycle Burnup: 51.6 MWD/MTU

Boron Concentration: 1181 ppm

Rod Position: CBD at 199 steps

Limiting Measured F_Q: 2.0182 Axial Location 49 Core Location D03
T.S. Limit: 3.0160

Limiting Measured $F_{\Delta H}$: 1.4132 Core Location P09
T.S. Limit: 1.7195

Total Core Axial Offset: 2.274%

Maximum $F_{\Delta H}$ Error: 5.19% Core Location G12

Incore Tilts:

QUADRANT	UPPER CORE TILT	LOWER CORE TILT
1	1.009	1.011
2	0.992	0.993
3	1.001	0.999
4	0.998	0.997

TABLE 6.3

FULL POWER FLUX MAP RESULTS

Map ID: 87-033

Date Performed: 11-27-87

Power Level: 100%

Cycle Burnup: 249 MWD/MTU

Boron Concentration: 1033 ppm

Rod Position: CBD at 224 steps

Limiting Measured F_Q: 1.8284 Axial Location 19 Core Location N08
T.S. Limit: 2.0163

Limiting Measured $F_{\Delta H}$ 1.3742 Core Location N08
T.S. Limit: 1.4874

Total Core Axial Offset: -4.123%

Maximum $F_{\Delta H}$ Error: 8.01% Core Location H06

Incore Tilts:

QUADRANT	UPPER CORE TILT	LOWER CORE TILT
1	1.001	1.000
2	1.000	1.000
3	0.999	0.999
4	1.000	1.000

7.0 ALIGNMENT OF NUCLEAR INSTRUMENTATION SYSTEM (ETP-SE-ST001)

OBJECTIVES

To generate alignment data for the Intermediate and Power Range detectors prior to criticality.

To verify adequate overlap between the Source and Intermediate Range channels and between the Intermediate and Power Range channels.

To verify that initial calibration of the Intermediate and Power Range channels using calculated alignment data did not result in non-conservative trip setpoints.

To normalize Power Range detectors during power ascension.

SUMMARY OF RESULTS

The acceptance criteria that the overlap between the Source and Intermediate Range channels is ≥ 1½ decades was met.

DISCUSSION

A preliminary alignment of the Intermediate and Power Range channels was performed prior to criticality in anticipation of reduced currents and a mismatch between the Intermediate and Power Range channels (based on Cycle 2 alignment).

The preliminary alignment was based on calculations which multiplied Cycle 2 currents by the ratio of the sum of selected assembly powers (predicted) of Cycle 3 to the same (actual) from Cycle 2. Intermediate and Power Range trip setpoints were monitored during power ascension to ensure that the initial alignment did not result in non-conservative setpoints. The percent power indications of the Power Range channels were adjusted during power ascension based on secondary calorimetrics.

An incore/excore calibration was performed at approximately 77% RTP. An incore/excore comparison was performed at approximately 100% RTP, which verified agreement.

8.0 REACTOR COOLANT FLOW MEASUREMENT (ESP-BB-03015)

OBJECTIVES

To determine the Reactor Coolant System (RCS) flow rate by precision heat balance measurements.

SUMMARY OF RESULTS

The RCS flow rate was determined to be 410,750 gpm. This met the acceptance criteria that the RCS flow rate be ≥ 382,630 gpm.

DISCUSSION

The RCS flow rate measurement was performed at approximately 100% RTP. The instrumentation used for determination of steam pressure, feedwater temperature, and feedwater venturi delta-P was calibrated within seven days of performing the calorimetric.

9.0 CORE REACTIVITY BALANCE
(ESP-ZZ-00013)

OBJECTIVES

To compare the overall core reactivity balance with predicted values at full power.

SUMMARY OF RESULTS

The equivalent reactivity difference between measured and predicted boron concentration was 284 pcm (21 ppm) which met the acceptance criteria of 1000 pcm, as required by Technical Specification 4.1.1.1.2.

DISCUSSION

Under equilibrium conditions at approximately 100% RTP, the Reactor Coolant System boron concentration was corrected to yield the Hot Full Power, All Rods Out, Equilibrium Xenon/Samarium boron concentration for comparison with the predicted boron concentration.

UNION ELECTRIC
Callaway Plant

January 22, 1988

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

ULNRC-1711

DOCKET NUMBER 50-483
CALLAWAY PLANT UNIT 1
FACILITY OPERATING LICENSE NPF-30
STARTUP REPORT

The enclosed Startup Report is submitted pursuant to Sections 6.9.1.1, 6.9.1.2, and 6.9.1.3 of the Callaway Unit 1 Technical Specifications.

Very truly yours,

Donald F. Schnell

Donald F. Schnell

DFS/JDB/crc

Enclosure

cc: Distribution attached

IE26
1/1

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