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MASTER

DUQUESNE LIGHT COMPANY
SHIPPINGPORT ATOMIC POWER STATION

TEST RESULTS

DLCS-2430104
T-641306

PERIODIC INTERCALIBRATION OF TEMPERATURE SENSING ELEMENTS

CORE I SEED 1

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Section 1 of 1 Section

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TEST RESULTS

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PERIODIC INTERCALIBRATION OF TEMPERATURE SENSING ELEMENTS

CORE 1 SEED 1

Purpose

To obtain intercalibration data for various temperature sensing elements in the Reactor Coolant System.

To obtain data for comparison between the calculated source activity levels and the observed channel levels.

Conclusions

The reading of 20 of the 62 core thermocouples were either less than 400°F, which was off scale on the recorder, or were $\pm 20^\circ\text{F}$ from the calibrating resistance thermometer temperatures (Mueller Bridge Recorder). In either case, the thermocouple was considered defective. The remainder of the readings were within ± 3 per cent of the temperatures of the calibrating thermometers which were used as a standard of comparison.

The reactor Main Coolant Loop resistance thermometers (Norwood indicators) all read within ± 0.2 per cent of the calibrating thermometers.

The data from the Source Range, Nuclear Instrumentation indicated a level ranging from less than 1.7 cps to 31 cps; Channel A indicating the highest. The recorded source activity levels were generally higher than the calculated source activity levels as they should be. There did not appear to be any correlation between coolant temperature and source log level source range indications.

Description of Test Equipment and Test Procedure

With all control rods inserted (CB-14 open) and the reactor coolant pressure at 1785 psig, the average coolant temperature was maintained at $485 \pm 2^\circ\text{F}$ for a period of four (4) hours prior to commencing the test. At the end of this period the average coolant temperature was maintained within $\pm 1/2^\circ\text{F}$ of 485°F for a period of two (2) hours. During this two hour period coolant loop pressurizer, core temperature and Source Range Nuclear Instrumentation data were recorded at twenty (20) minute intervals. Upon completion, the average coolant temperature was increased to 500°F . At each temperature level the same procedure as outlined for the 485°F run was followed.

A Leeds and Northrup Potentiometer and a Wheatstone Bridge were employed to read the pressurizer steam thermocouples, boiler secondary side resistance thermometers, and pressurizer steam resistance thermometer.

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Results

DLCS 2430104 was performed from October 8 to October 10, 1959. The data from this test are contained in Tables I-IX. The Station had been shut down since October 7, 1959.

The original T_c calibration thermometer corrections, as supplied by Westinghouse, were applied where applicable to the Mueller T_c data.

These T_c 's were then used as standards for all instruments recording reactor coolant temperatures. Calibration curves were plotted for the Norwood T_c and T_h indicators by using deviations from individual loop T_c 's where possible. In the case of the 515 F and 530 F runs only the 1C T_c was available and this was therefore used as a basis of comparison for all loop data. See Figures 1 to 6. Deviations of the seed and blanket water temperatures from the average of the calibrating thermometers are presented in Tables VI and VII. Any deviation of more than $\pm 20^\circ\text{F}$ or off scale readings (below 400°F) are considered indicative of a defective thermocouple. There were twenty (20) of these thermocouples. They included fourteen (14) blanket thermocouples (recorder points 11-17, 19, 23, 27, 33, 34, 36 and 37) and six (6) seed thermocouples (recorder points, 7, 8, 12, 13, 15 and 17).

The Bristol Recorder (MIP-RS) and the T_h and T_c Swartwout Recorders (Console-RS), with the exception of the 1A and 1B hot leg recorders, during the 485°F run, were within ± 0.6 per cent of the calibrating T_c 's.

The Average Coolant Temperature indicator (Console-RS) read within ± 0.2 per cent of the calibrating thermometers. The resistance bridge, used to measure T_h , read with ± 0.3 per cent of the calibrating thermometers, with the exception of the 1A and 1B boiler temperatures during the 515°F run.

The Reactor Chamber temperature, as indicated by the Multi-point Temperature Monitor generally appeared to be dependent on the container supply fan air temperature. See Table V.

The data from the nuclear Source Range instrumentation gave a source level of 1.7 cps to 31 cps, with Channel A indicating the highest (the Channel D NIS was out of service during the performance of this test). Although the NIS Channels A and B were reading within 20 per cent of each other, they both differed from the Channel C NIS by over 150 per cent. This difference is probably due to instrument error. See Table IX.

Readings were obtained only from the A Channel during the 485°F run, since the B and C Channel source range instruments were de-energized temporarily. The data from the 485°F , 500°F , 515°F and 530°F runs are tabulated with the corresponding calculated source activity level for each Channel. See Table VIII. The calculated source activity levels and the recorded source range activity levels were not of the same magnitude. Generally, the recorded levels were higher, by a factor of ten, than the calculated levels. This could be explained by the probability of the nuclear instrumentation receiving radiation not only from its associated sources, but also from gamma photon deuterium reactions in the reactor.

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There did not appear to be any correlation between the coolant temperature and the recorded source levels.

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Power Stations Department
Shippingport Atomic Power Station

PERIODIC INTERCALIBRATION OF TEMPERATURE SENSING
ELEMENTS, SLCS-2430104
T-641306

TABLE I
COOLANT LOOP TEMPERATURES

Time	Temperature	2030	2050	2110	2130	2150	2210	2230	Avg.	0715	0735	0755	0815	0835	0855	0915	Avg.
1A Coolant Loop T ₁ (Norwood)		486.5	486.5	486.2	486.0	486.0	486.0	486.0	486.2	500.0	500.0	500.0	500.0	499.7	499.8	499.9	499.9
1B Coolant Loop T ₁ (Norwood)		485.2	486.5	485.5	485.5	485.5	485.5	485.5	485.7	499.8	500.0	499.9	499.8	499.6	499.8	499.5	499.7
1C Coolant Loop T ₁ (Norwood)		484.5	485.0	484.9	485.0	485.0	485.0	485.0	484.9	500.0	500.4	499.8	499.7	499.4	499.5	499.5	499.7
1A Coolant Loop T ₂ (Norwood)		485.8	485.9	485.9	485.9	485.9	485.9	485.9	485.9	500.0	500.3	500.0	500.0	500.0	500.0	500.0	500.0
1B Coolant Loop T ₂ (Norwood)		485.2	485.5	485.5	485.3	485.3	485.3	485.3	485.3	500.0	500.0	500.0	499.8	499.9	499.7	499.5	499.8
1C Coolant Loop T ₂ (Norwood)		486.0	486.0	486.0	485.8	485.8	485.8	485.8	485.9	499.8	499.9	499.8	499.8	499.8	499.8	499.6	499.8
1A Coolant Loop T ₃ (Swartout)		491	491	491	490	490	490	490	490.4	502.8	502.5	502.5	502.5	502.5	502.5	502.5	502.5
1B Coolant Loop T ₃ (Swartout)		489	489	489	489	489	489	489	489	501.2	501.6	501.5	501.5	501.3	501.3	501.5	501.5
1C Coolant Loop T ₃ (Swartout)		484	485	485	485	485	485	485	484.9	500.5	500.7	500.3	499.5	499.3	499.5	499.5	499.9
1A Coolant Loop T ₄ (Swartout)		003	003	003	003	003	003	003	003	003	003	003	003	003	003	003	003
1B Coolant Loop T ₄ (Swartout)		003	003	003	003	003	003	003	003	003	003	003	003	003	003	003	003
1C Coolant Loop T ₄ (Swartout)		486	486	486	486	486	486	486	486	500.0	500.0	500.0	499.5	499.5	499.5	499.5	499.7
1A Coolant Loop T ₅ (Mueller)		485.2	485.6	485.4	485.4	485.4	485.4	485.4	485.4	500.0	499.8	500.0	500.0	500.0	499.6	499.8	499.8
1B Coolant Loop T ₅ (Mueller)		485.2	485.6	485.6	485.4	485.4	485.4	485.4	485.4	499.8	499.6	499.8	499.4	499.6	499.2	499.4	499.5
1C Coolant Loop T ₅ (Mueller)		485.1	485.5	485.5	485.3	485.3	485.3	485.3	485.3	499.9	499.7	499.9	499.7	499.9	499.7	499.9	499.8
1A Boiler T ₆ (Resistance Bridge)		484.9	485.2	484.6	484.9	484.3	484.3	484.9	484.7	481.3	480.4	480.7	481.3	481.6	482.2	482.2	483.7
1B Boiler T ₆ (Resistance Bridge)		485.8	485.2	485.2	485.2	484.9	485.5	485.8	485.4	500.0	500.0	500.0	500.0	499.6	499.3	498.7	498.2
1C Boiler T ₆ (Resistance Bridge)		485.2	484.6	484.3	484.3	484.3	484.6	486.4	484.8	499.7	500.0	500.0	499.7	505.3	499.7	499.4	499.8
1A Reactor Outlet (Bristol)		486	486	486	486	486	486	486	486	499.0	499.0	499.0	499.0	499.0	499.0	499.0	499.0
1B Reactor Outlet (Bristol)		485	483	486	486	486	486	486	485.4	499.0	499.0	499.0	498.0	499.3	498.5	498.0	498.5
1C Reactor Outlet (Bristol)		488	488	488	488	488	488	488	488	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0
Average Coolant Temperature		485.2	485.2	485.0	484.9	484.9	484.8	484.9	485.0	498.0	498.0	498.0	496.0	497.8	497.8	497.8	497.6
Pressurizer Temperature (MC-8S)		576.2	576.2	576.2	576.2	576.2	576.2	576.2	576.2	576.0	576.0	576.1	576.1	576.1	576.1	576.1	576.1
Press. Ssn. Temp. (Thermocouple)-M.V.		16.06	16.07	16.10	16.11	16.12	16.11	16.11	16.10	16.02	15.98	16.01	15.85	15.92	15.92	15.92	15.94
Press. Ssn. Temp. (Thermocouple)-OP		563.3	563.7	564.7	565.0	565.3	565.0	565.0	564.6	562.9	561.7	562.5	557.7	560.0	560.0	560.0	560.5
Press. Water Temp. (Bristol)		573.0	574.0	575.0	575.0	575.0	575.0	575.0	574.6	NOT RECORDED							

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

PERIODIC INTERCALIBRATION OF TEMPERATURE SENSING
ELEMENTS, DLCS-2430104
T-641306

TABLE I
COOLANT LOOP TEMPERATURES (cont'd)

Time	2140	2200	2220	2240	2300	2320	2340		0730	0810	0830	0850	0910	0930	0950	
Temperature				515°F				Avg.				530°F				Avg.
1A Coolant Loop T _h (Norwood)	514.6	514.6	514.7	514.6	514.6	514.6	514.6	514.6	535.0	534.0	533.5	532.8	532.2	532.0	531.2	532.9
1B Coolant Loop T _h (Norwood)	514.5	514.5	514.6	514.5	514.5	514.4	514.3	514.5	529.4	529.2	529.2	529.7	529.8	529.7	529.4	529.4
1C Coolant Loop T _h (Norwood)	514.3	514.3	514.3	514.4	514.3	514.3	514.4	514.3	527.9	520.0	528.0	528.7	528.7	528.6	528.6	527.2
1A Coolant Loop T _c (Norwood)	514.9	514.9	514.9	514.8	514.9	514.9	514.9	514.9	530.1	530.1	530.0	530.0	530.2	530.2	530.0	530.1
1B Coolant Loop T _c (Norwood)	515.0	515.0	515.0	515.0	514.9	515.0	515.0	515.0	530.7	530.3	530.2	530.6	530.6	530.7	530.2	530.4
1C Coolant Loop T _c (Norwood)	514.3	514.3	514.3	514.3	514.2	514.4	514.4	514.3	530.2	530.1	530.1	530.2	530.2	530.2	530.0	530.1
1A Coolant Loop T _c (Mueller)	514.9	514.9	514.9	514.9	514.9	514.9	514.9	514.9	532	531	531	530	529.5	529	529	530.1
1B Coolant Loop T _c (Mueller)	514.9	514.9	514.9	514.9	514.9	514.9	514.9	514.9	529	529	529	529	528.5	528.5	528.5	528.7
1C Coolant Loop T _c (Mueller)	514.9	514.9	514.9	514.9	514.9	514.9	514.9	514.9	528	528.5	528.5	529	529	529	529	528.7
1A Coolant Loop T _e (Swartout)	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS
1B Coolant Loop T _e (Swartout)	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS
1C Coolant Loop T _e (Swartout)	514.9	514.9	514.9	514.9	514.9	514.9	514.9	514.9	531	531	531	531	531	531	531	531
1A Boiler T _b (Resistance Bridge)	524.4	517.5	514.3	514.3	514.6	514.3	514.4	516.6	529.5	529.5	537.1	531.4	532.3	529.4	529.2	531.2
1B Boiler T _b (Resistance Bridge)	500.3	500.3	500.3	500.3	500.0	500.3	500.0	500.2	530.2	529.8	528.6	528.0	528.0	528.3	528.0	528.7
1C Boiler T _b (Resistance Bridge)	529.2	529.8	529.8	529.5	529.8	529.8	529.8	529.7	530.5	529.8	531.0	530.5	530.5	530.5	530.5	530.5
1A Reactor Outlet (Bristol)	515.5	515.5	515.5	515.5	515.5	515.5	515.5	515.5	531	531	531	531	531	531	531	531
1B Reactor Outlet (Bristol)	515.0	515.0	515.0	515.0	515.0	515.0	515.0	515.0	531	531	531	531	531	531	531	531
1C Reactor Outlet (Bristol)	516.0	516.0	516.0	516.0	516.0	516.0	516.0	516.0	532	532	532	532.5	532.5	532.5	532	532
Average Coolant Temperature	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS
Pressurizer Temperature(MCC-RS)	OFF SCALE								622.2	622.2	622.4	622.5	622.2	622.0	622.0	622.2
Press. Stm. Temp. (Thermocouple)-M.V.	15.86	15.85	15.85	15.85	15.85	15.85	15.83	15.85	17.59	17.55	17.55	17.53	17.54	17.53	17.54	17.54
Press. Stm. Temp. (Thermocouple)-°F	558.0	557.7	557.7	557.7	557.7	557.7	557.2	557.7	614.1	612.7	612.7	611.9	612.4	611.9	612.4	612.4
Press. Water Temp. (Bristol)	NOT RECORDED								NOT RECORDED							

TABLE II

BLANKET EXIT AND INLET TEMPERATURES

Time	2030	2050	2110	2130	2150	2210	2230	Avg.	0715	0735	0755	0815	0835	0855	0915	Avg.
Temperature	485°F								500°F							
1	481.0	481.0	481.0	481.0	481.0	481.0	481.0	481.0	495.0	496.0	495.0	495.0	495.0	494.5	494.5	495.0
2	483.0	484.0	484.0	483.5	484.0	484.0	484.0	483.7	498.0	498.0	498.0	497.5	497.5	497.5	497.5	497.7
3	483.5	483.5	483.5	483.5	483.0	483.0	483.5	483.5	498.0	498.0	498.0	497.5	497.0	497.0	496.5	497.4
4	482.0	482.5	482.0	482.0	482.0	482.0	482.0	482.0	496.5	497.0	496.5	496.0	496.0	496.0	495.5	496.2
5	476.0	476.0	475.5	476.0	476.0	476.0	476.0	476.0	490.0	490.5	490.0	489.5	489.5	489.5	489.0	489.5
6	481.5	481.0	481.5	481.5	481.5	481.5	481.5	481.5	495.5	496.0	496.0	495.5	495.5	495.5	495.0	495.5
7	484.0	484.0	484.0	484.0	484.0	484.0	484.0	484.0	498.0	498.0	498.0	497.5	497.5	497.5	497.0	497.5
8	487.5	486.5	487.0	487.0	487.0	487.0	487.0	487.0	501.0	501.5	501.0	501.0	501.0	500.5	500.0	501.0
9	490.0	490.0	490.0	490.0	490.0	490.0	490.0	490.0	504.0	504.5	504.5	504.0	504.0	503.5	503.0	504.0
10	487.5	487.5	487.5	487.5	487.5	487.5	487.5	487.5	501.0	502.0	501.5	501.0	501.5	500.5	500.5	501.0
11-17	READINGS BELOW 400°F								READINGS BELOW 400°F							
18	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	494.0	494.0	494.0	493.5	493.5	493.5	493.5	493.5
19	417.0	417.0	417.0	417.5	417.5	417.5	417.5	417.2	430.0	430.0	430.0	429.5	429.5	429.5	429.5	429.5
20	483.5	483.5	483.5	483.5	483.0	483.5	483.0	483.5	498.0	498.0	498.0	497.5	497.0	497.0	497.0	497.5
21	481.5	481.5	481.5	481.5	481.0	481.5	481.5	481.5	496.0	496.0	496.0	495.5	495.5	495.0	495.0	495.5
22	482.0	482.0	482.0	482.0	482.0	482.0	482.0	482.0	496.5	496.5	496.5	496.0	496.0	496.0	496.0	496.2
23	434.0	434.0	433.5	434.0	433.5	434.0	440.0	434.7	441.5	442.0	441.0	440.5	442.0	441.5	441.5	441.5
24	482.5	482.5	482.5	482.5	482.5	482.5	482.5	482.5	497.0	497.0	497.0	497.5	496.5	496.5	496.5	497.0
25	480.5	480.5	480.5	480.5	480.5	480.5	480.5	480.5	495.0	495.0	495.0	494.5	494.5	494.5	494.5	494.6
26	481.0	481.0	481.0	481.0	481.0	481.0	481.0	481.0	495.5	495.5	495.5	495.5	495.0	495.0	495.0	495.3
27	426.0	425.5	425.5	426.0	426.0	425.5	426.0	426.0	438.5	438.5	438.5	438.0	438.5	438.5	438.0	438.5
28	484.0	484.0	484.0	484.0	484.0	483.5	484.0	484.0	498.0	498.0	498.0	498.0	498.0	498.0	497.5	498.0
29	483.5	483.0	483.0	483.0	483.0	483.0	483.0	483.0	498.0	497.5	497.5	497.0	497.0	497.0	496.5	497.2
30	482.0	482.5	482.5	482.5	482.5	482.5	482.0	482.5	497.0	497.0	497.0	496.5	496.5	496.5	496.5	496.7
31	483.5	483.5	483.5	483.5	483.5	483.5	483.5	483.5	498.0	498.0	498.0	497.5	497.5	497.5	497.0	497.5
32	486.0	486.0	486.0	486.0	486.0	485.5	486.0	486.0	500.5	500.0	500.5	500.0	500.0	500.0	499.5	500.0
33	458.0	458.0	458.5	458.0	458.0	457.0	458.0	458.0	471.0	471.0	471.0	471.0	469.5	469.5	470.0	470.0
34	457.5	458.0	458.0	457.5	457.5	457.5	457.0	457.5	471.0	471.0	471.0	471.0	469.5	469.5	470.0	470.0
35	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	489.0	489.5	489.0	489.0	488.5	488.5	488.5	488.8
36	433.0	433.5	433.5	433.0	433.5	433.5	433.5	433.5	445.0	445.5	445.0	445.0	444.5	444.5	444.5	444.8
37	455.5	455.5	456.5	455.5	456.0	455.5	456.0	455.7	460.0	469.0	469.0	468.0	468.0	468.0	467.5	468.2
38	485.0	485.0	485.0	485.0	485.0	485.0	485.0	485.0	499.0	499.5	499.0	499.0	498.5	498.5	498.5	498.8

TABLE II

BLANKET EXIT AND INLET TEMPERATURES

Time	2140	2200	2220	2240	2300	2320	2340		0750	0810	0830	0850	0910	0930	0950	
Temperature				515°F				Avg.				530°F				Avg.
1	508.5	509.5	509.5	509.0	509.5	509.5	509.0	509.2	524.0	424.5	524.0	524.5	524.5	524.5	524.5	524.3
2	512.0	512.0	512.5	512.0	512.0	512.0	512.0	512.0	528.0	527.5	527.5	527.5	527.5	528.0	527.5	524.6
3	511.5	512.0	512.0	511.5	512.0	512.0	511.5	511.7	527.0	527.0	527.0	527.0	527.0	527.0	527.0	527.0
4	510.0	510.0	510.5	510.0	510.0	510.0	510.0	510.0	525.5	525.5	525.5	526.0	525.5	526.0	526.5	525.8
5	503.5	503.5	504.0	503.5	503.5	503.5	504.0	503.6	518.0	518.5	518.5	518.5	518.5	519.0	518.5	518.5
6	509.5	509.5	509.5	509.5	509.5	509.5	509.5	509.5	525.0	525.0	525.0	525.0	525.0	525.0	525.0	525.0
7	511.5	511.5	512.0	512.0	511.5	511.5	511.5	511.6	527.0	527.0	527.0	527.5	527.0	527.5	527.0	527.1
8	515.0	515.0	515.5	515.5	515.5	515.5	515.5	515.5	530.5	530.5	530.5	531.5	530.5	531.0	530.5	530.6
9	518.5	518.5	518.5	518.5	518.5	518.5	518.5	518.5	534.0	534.0	534.0	534.5	534.0	534.5	534.0	534.1
10	515.5	515.0	515.5	515.5	515.5	515.5	515.5	515.5	530.5	530.5	530.5	531.0	531.0	531.0	531.0	530.8
11-17	READINGS BELOW 400°F							READINGS BELOW 400°F								
18	507.0	507.5	507.5	507.5	507.5	507.5	507.5	507.5	523.0	522.5	523.0	523.5	523.0	523.0	522.5	523.0
19	440.0	440.0	440.0	440.0	440.0	439.5	439.5	439.8	451.5	451.5	451.5	451.5	451.5	451.5	451.5	451.5
20	511.5	511.5	511.5	511.5	511.5	511.0	511.0	511.3	527.0	527.0	527.0	527.0	527.0	527.0	526.5	527.0
21	509.0	509.0	509.5	509.5	509.5	509.5	509.5	509.5	525.0	525.0	525.0	525.0	525.0	525.0	525.0	525.0
22	509.5	509.5	510.0	509.5	510.0	509.5	509.5	509.5	525.0	525.0	525.0	525.5	525.5	525.5	525.0	525.2
23	451.0	450.5	451.0	451.0	449.0	451.0	451.0	450.6	463.5	463.5	463.5	463.5	464.0	463.5	463.5	463.5
24	510.5	510.5	511.0	510.5	510.5	510.5	510.5	510.5	526.5	526.0	526.5	527.0	526.5	526.5	526.5	526.5
25	508.5	508.5	508.5	508.5	508.5	508.5	508.5	508.5	524.0	524.0	524.0	524.5	524.5	524.0	524.0	524.2
26	509.5	509.0	509.5	509.5	509.5	509.5	509.0	509.3	524.5	524.5	524.5	525.0	525.0	525.0	524.5	524.2
27	449.5	449.5	449.5	449.5	449.0	449.0	449.0	449.3	461.0	461.0	461.0	461.0	461.0	461.0	461.0	461.0
28	512.5	512.5	512.5	512.5	512.5	512.5	512.5	512.5	528.0	527.5	528.0	528.5	528.0	528.0	528.0	528.0
29	512.0	512.0	512.0	512.0	512.0	512.0	512.0	512.0	527.0	527.0	527.0	527.5	527.5	527.5	527.5	527.2
30	510.5	510.5	510.5	510.5	510.5	510.5	510.5	510.5	526.0	526.0	526.0	526.0	526.5	526.5	526.0	526.1
31	511.5	512.0	512.0	511.5	511.5	512.0	511.5	511.7	527.0	527.0	527.0	527.5	527.5	527.0	527.0	527.1
32	514.5	514.5	514.5	514.5	514.5	514.5	514.5	514.5	529.5	529.5	529.5	530.0	530.0	530.0	529.5	529.7
33	482.5	483.0	483.5	482.5	483.5	483.5	482.5	483.0	496.0	496.0	496.0	495.5	496.0	496.5	495.5	496.0
34	482.5	483.0	483.5	482.5	483.5	483.5	482.5	483.5	496.0	496.0	496.0	495.5	496.0	495.5	495.5	495.8
35	502.5	502.5	502.5	502.5	503.0	502.5	502.5	502.5	517.0	517.0	517.0	517.5	517.5	517.5	517.0	517.2
36	456.5	457.0	457.5	456.5	457.0	457.0	457.0	456.9	470.0	470.0	470.0	470.5	470.5	470.5	470.5	470.2
37	480.0	480.5	481.0	480.5	480.5	481.0	480.5	480.5	493.0	493.5	493.5	493.5	493.0	493.0	493.0	493.1
38	513.0	513.5	513.5	513.0	513.0	513.0	513.0	513.1	528.0	528.0	528.5	528.5	528.5	528.5	528.0	528.0

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TABLE III
BLANKET AND SEED FLOWS

Time Date Blanket	10-8 485°F	0815 10-8 500°F	2215 10-8 515°F	0830 10-9 530°F	Time Date Seed	485°F	0815 10-9 500°F	2315 10-9 515°F	530°F
1	77.0	76.5	75.7	75.3	1	86.5	85.8	85.4	85.0
2	92.1	91.1	90.2	90.8	2	89.4	89.2	88.7	88.2
3	76.0	72.7	71.7	71.6	3	88.0	87.3	86.5	86.5
4	86.5	85.4	82.0	83.1	4	88.6	88.0	87.5	87.3
5	75.5	75.0	74.3	74.0	5	83.6	83.2	82.5	82.3
6	87.9	87.0	86.4	86.1	6	86.5	86.7	86.0	85.8
7	73.6	73.0	72.7	72.0	7	85.8	85.3	84.7	84.4
8	80.2	79.1	79.1	78.5	8	87.3	86.7	86.4	85.5
9	81.2	80.2	80.0	79.1	9	89.0	88.7	88.2	87.6
10	78.2	77.9	77.0	77.0	10	87.6	86.6	86.5	86.3
11	80.5	80.0	78.7	78.6	11	83.8	83.3	83.0	82.1
12	80.3	79.9	78.7	78.3	12	84.0	83.4	83.3	82.5
13	78.8	78.0	77.3	77.0	13	89.3	88.4	88.0	87.6
14	78.0	77.4	77.0	76.8	14	85.6	85.1	84.8	83.8
15	75.9	75.9	105.7	105.7	15	90.0	89.4	88.9	88.5
16	78.1	78.0	77.4	76.8	16	84.9	84.4	84.3	83.4
17	80.0	79.5	78.9	78.0					
18	84.5	86.8	82.8	82.2					
19	77.2	77.8	75.8	75.5					
20	75.0	74.6	73.6	73.3					
21	85.9	85.1	84.3	84.3					
22	89.0	88.2	87.2	87.0					
23	87.0	86.2	85.3	85.0					
24	87.0	86.2	85.3	85.0					

TABLE IV

SEED EXIT AND INLET TEMPERATURES

Time	2030	2050	2110	2130	2150	2210	2230		0715	0735	0755	0815	0835	0855	0915	
Temperature	485°F							Avg.	500°F							Avg.
1	474.0	474.5	475.0	475.0	474.5	475.0	475.0	474.7	488.0	489.0	488.0	488.0	488.0	488.0	488.0	488.1
2	479.5	479.5	480.0	480.0	479.5	479.5	479.5	479.6	493.0	493.5	493.0	493.0	493.0	493.0	493.0	493.0
3	481.0	481.0	481.0	481.5	481.0	481.5	481.5	481.1	495.0	495.5	495.0	495.0	495.0	495.0	495.0	495.0
4	470.0	470.0	470.0	469.5	470.0	470.0	470.0	470.1	483.0	483.0	483.0	483.0	483.0	483.0	482.5	482.7
5	476.0	476.0	476.0	476.0	476.0	476.5	476.5	476.2	489.5	490.0	489.5	489.5	489.0	489.0	489.5	489.4
6	481.0	481.0	481.0	481.0	481.0	481.5	481.5	481.0	495.0	496.0	495.0	495.0	495.0	495.0	495.0	495.1
7	465.0	465.0	465.0	464.5	464.5	465.0	465.0	465.1	477.5	478.0	478.5	477.5	477.5	477.5	477.5	477.7
8	455.5	455.5	455.5	456.5	456.0	456.0	456.0	455.8	468.0	468.0	468.0	468.0	467.0	467.5	468.0	467.8
9	476.0	476.0	476.5	476.5	476.5	476.0	476.0	476.2	489.5	490.0	490.0	489.5	489.5	489.5	489.5	489.8
10	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	488.5	489.0	488.5	488.0	488.0	488.0	488.0	488.2
11	471.5	471.5	471.5	471.5	472.0	472.0	472.0	471.7	485.0	485.5	485.0	485.0	484.5	485.0	485.0	485.0
*13	471.5	471.5	471.5	471.5	471.0	471.5	471.5	471.5	485.0	485.5	485.0	485.0	485.0	485.0	485.0	485.0
14	475.5	476.0	476.0	475.5	476.0	476.0	476.0	475.8	489.0	489.5	489.0	489.0	489.0	489.0	489.0	489.0
15	470.0	470.0	470.0	470.0	470.5	470.0	470.0	470.0	483.5	484.0	483.5	483.5	483.5	483.5	483.5	483.5
16	484.5	484.5	484.5	484.5	484.5	484.5	484.5	484.5	498.0	498.5	498.0	498.0	498.0	498.0	498.0	498.0
*18	479.5	479.5	479.5	479.0	479.0	480.0	480.0	479.5	493.0	494.0	493.5	493.5	493.5	493.5	493.5	493.5
19	480.0	480.5	480.5	480.0	480.5	480.5	480.5	480.2	494.5	495.0	494.5	494.5	494.0	494.0	494.5	494.5
20	480.0	480.0	480.5	480.0	480.5	480.5	480.5	480.2	494.0	494.5	494.0	494.0	494.0	494.0	494.0	494.0
21	482.0	483.0	483.0	482.5	482.5	483.0	483.0	482.4	496.0	497.0	496.0	496.5	496.5	496.5	496.5	496.5
22	484.0	484.5	484.5	484.5	484.5	484.5	484.5	484.5	498.0	498.5	498.0	498.5	498.5	498.5	498.5	498.5
23	482.5	482.5	483.0	483.0	483.0	483.0	483.0	482.6	496.5	497.0	496.5	497.0	496.5	496.5	497.0	496.7
24	482.5	482.5	483.0	483.0	483.0	483.0	483.5	483.0	496.0	497.0	496.5	497.0	496.5	496.5	497.0	496.7
Cold Junction																
Temp.	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	86.5	86.5	86.5	86.5	86.5	86.5	86.5	86.5
* Points 12 and 17 were drifting and were unable to be read.																

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TABLE IV

SEED EXIT AND INLET TEMPERATURES (cont'd)

Time	2140	2200	2220	2240	2300	2320	2340		0750	0810	0830	0850	0910	0930	0950	
Temperature	515°F							Avg.	530°F							Avg.
1	502.0	502.0	501.5	502.0	502.0	501.5	502.0	501.8	516.0	515.5	516.0	516.0	516.0	516.5	515.5	516.0
2	507.5	507.5	507.5	507.5	507.5	507.5	507.5	507.5	522.5	522.0	522.0	522.0	522.0	522.5	522.0	522.1
3	509.5	509.5	509.5	509.5	509.5	509.5	509.5	509.5	523.5	524.0	523.5	524.0	524.0	524.0	523.5	523.7
4	499.5	500.0	499.5	499.5	500.0	500.0	500.0	499.8	517.0	516.5	516.5	516.5	516.5	516.5	516.0	516.5
5	503.5	503.5	503.5	503.5	503.5	503.5	503.5	503.5	518.0	518.0	518.0	518.0	518.0	518.0	517.5	518.0
6	510.0	510.0	509.5	509.5	510.0	510.0	510.0	509.8	524.5	524.5	524.5	524.5	525.0	525.0	524.0	524.5
7	491.5	491.5	491.5	491.5	491.5	491.5	492.0	491.5	506.0	505.0	505.0	505.0	505.5	505.5	505.0	505.3
8	480.0	480.0	481.0	481.5	480.5	481.0	481.0	480.7	493.0	493.5	493.5	493.0	493.0	493.0	493.0	493.1
9	503.5	503.5	503.5	503.5	503.5	503.5	503.5	503.5	518.5	518.5	518.0	518.5	519.0	519.0	518.0	518.5
10	502.0	502.5	502.0	502.0	502.5	502.0	502.0	502.1	517.0	516.5	517.0	516.5	517.0	517.0	516.5	516.7
11	499.0	499.5	499.0	499.0	499.5	499.0	499.0	499.0	513.5	513.5	513.0	513.5	514.0	514.0	513.0	513.5
*13	498.5	499.0	499.0	499.0	499.0	499.0	499.0	499.0	513.5	513.5	513.5	513.5	513.5	513.5	513.5	513.5
14	503.5	504.0	503.5	503.5	503.5	503.5	503.5	503.5	518.0	517.5	518.0	518.0	518.0	518.0	517.5	517.8
15	497.5	498.0	498.0	497.5	498.0	498.5	498.0	498.0	512.0	512.0	512.0	512.0	512.5	512.5	512.0	512.1
16	513.0	513.5	513.0	513.0	513.0	513.0	513.5	513.1	527.5	527.5	528.0	528.0	528.0	528.0	527.5	527.8
*18	508.0	508.5	508.0	508.0	508.5	508.0	508.5	508.1	523.0	522.5	523.0	523.0	523.0	523.0	522.5	522.6
19	509.0	509.0	509.0	508.5	509.0	508.5	509.0	508.8	523.5	523.5	524.0	524.0	524.0	524.0	523.5	523.7
20	508.5	508.5	508.5	508.5	508.5	508.5	508.5	508.5	523.5	523.5	523.5	523.5	524.0	524.0	523.0	523.5
21	511.0	511.0	511.0	511.0	511.0	511.0	511.0	511.0	526.0	525.5	526.0	526.0	526.5	526.5	526.0	526.0
22	513.0	513.0	513.0	513.0	513.0	513.0	513.0	513.0	528.5	528.0	528.5	528.5	528.5	528.5	528.0	528.3
23	511.0	511.0	511.0	511.0	511.5	511.0	511.5	511.1	526.5	526.0	526.0	526.5	526.5	526.5	526.0	526.3
24	511.0	511.0	511.0	511.0	511.5	511.0	511.5	511.1	526.5	526.0	526.5	526.5	526.5	526.5	526.0	526.4
Cold Junction																
Temp.	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
* Points 12 and 17 were drifting and were unable to be read.																

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TABLE IV

SAMPLE CALCULATION

Channel A (Calculated Source Value)

Polonium-Beryllium Source No. PN-288

Original activity, factory calibrated on 9-6-57

$$N_0 = 2.66 \times 10^8 \text{ neutrons/sec*}$$

Polonium-Beryllium Half-life, $1/2 t = 138.3$ days.

$$\lambda = \frac{0.693}{1/2 t} = \frac{0.693}{138.3} = 5.02 \times 10^{-3} \text{ days}^{-1}$$

$$N = N_0 e^{-\lambda t}$$

Where N_0 = original activity

N = activity at any time

λ = decay constant for isotope

From 9-6-57 to 10-8-59, $t = 763$ days

$$N = 2.66 \times 10^8 e^{-(5.02 \times 10^{-3})(7.63 \times 10^2)}$$

$$N = 5.9 \times 10^6 \text{ neutrons/sec}$$

SAMPLE CALCULATION

(Conversion of counts/sec to neutrons/sec)

From station logs on 11-29-57, average count rate = 113.4 cps; $N = 1.745 \times 10^8$ neutrons/sec, on 11-29-57, from DL-S-243, Section I, Third Performance, "Sample Calculations." Therefore:

$$\left(\frac{1.745 \times 10^8 \text{ neut/sec}}{113.4 \text{ cps}} \right) = 1.54 \times 10^6, \text{ proportionality constant}$$

Therefore:

$$\frac{CR}{5.9 \times 10^6} = \frac{113.4}{1.745 \times 10^8}$$

$$\text{Count Rate} = 3.83 \text{ cps}$$

* From WAPD-PWR-To-116

TABLE V
MISCELLANEOUS DATA

Date 10-8 through 10-10-59		485°F 2045	500°F 0830	515°F 2220	530°F 0945
Run Time					
Pressurizer Pressure-(WR)-AIP	PSIG	1225	1175	1165	1760
Pressurizer Pressure-(NR)-AIP	PSIG	OOS	OOS	OOS	OOS
Thermocouples in Reactor Chamber					
Temperature Indicator Points					
6	F	111.0	111.0	111.0	111.0
7	F	117.0	116.5	115.0	113.0
8	F	111.0	110.0	109.0	107.0
9	F	114.0	113.5	112.0	110.0
10	F	128.0	129.0	126.0	123.0
11	F	94.0	95.0	95.0	93.0
12	F	96.0	97.5	93.0	87.0
13	F	117.0	119.5	120.5	113.0
14	F	122.0	123.5	121.0	116.0
15	F	123.0	124.5	122.5	120.0
16	F	175.0	176.0	176.5	173.0
Supply and Exhaust Fans					
*1A Supply Fan Temperature	F	73	76	62	55
*1B Supply Fan Temperature	F	70	73	58	50
1A Exhaust Fan Temperature	F	114	115.5	114	110
1B Exhaust Fan Temperature	F	114	115.5	113	110
1A Main Coolant Loop Flow	LBS/hr x 10 ⁶	7.73	7.68	7.61	7.59
1B Main Coolant Loop Flow	LBS/hr x 10 ⁶	7.40	7.32	7.28	7.22
1C Main Coolant Loop Flow	LBS/hr x 10 ⁶	7.60	7.54	7.48	7.42
Reactor Pressure	psig	1250	1220	1170	1780

* Both 1A and 1B supply and exhaust fans in service.

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TABLE VI

BLANKET EXIT AND INLET DEVIATIONS - °F

Point	Location	485°F	500°F	515°F	530°F
1	13 J BX	- 4.0	- 5.0	- 5.8	- 5.7
2	10 M BX	- 1.3	- 2.3	- 3.0	- 2.4
3	3 I BX	- 1.5	- 2.6	- 3.3	- 3.0
4	3 J BX	- 3.0	- 3.8	- 5.0	- 4.2
5	3 K BX	- 9.0	-10.5	-11.4	-11.5
6	2 J BX	- 3.5	- 4.5	- 5.5	- 5.0
7	7 I BX	- 1.0	- 2.5	- 3.5	- 2.9
8	7 H BX	+ 2.0	+ 1.0	+ 0.5	+ 0.6
9	6 I BX	+ 5.0	+ 4.0	+ 3.5	+ 4.1
10	5 I BX	+ 2.5	+ 1.0	+ 0.5	+ 0.8
18	11 C BX	- 5.0	- 6.5	- 7.5	- 7.0
19	9 C BX	-67.8	-70.5	-75.2	-78.5
20	10 C BX	- 1.5	- 2.5	- 3.7	- 3.0
21	5 M BX	- 3.5	- 4.5	- 5.5	- 5.0
22	6 M BX	- 3.0	- 3.8	- 5.5	- 4.8
23	11 E BX	-50.3	-58.5	-64.4	-66.5
24	13 G BX	- 2.5	- 3.0	- 4.5	- 3.5
25	13 F BX	- 4.5	- 5.4	- 6.5	- 5.8
26	14 F BX	- 4.0	- 4.7	- 5.7	- 5.8
27	13 E BX	-59.0	-61.5	-65.7	-69.0
28	6 C BI	- 1.0	- 2.0	- 2.5	- 2.0
29	8 H BI	- 2.0	- 2.8	- 3.0	- 2.8
30	6 K BI	- 2.5	- 3.3	- 4.5	- 3.9
31	10 M BI	- 1.5	- 2.5	- 3.3	- 2.9
32	10 E BI	+ 1.0	0	- 0.5	- 0.3
33	12 F SX	-27.0	-30.0	-32.0	-34.0
34	8 L SX	-27.5	-30.0	-31.5	-34.2
35	12 J SX	-10.0	-11.2	-12.5	-12.8
36	5 K SX	-51.5	-55.2	-58.1	-59.8
37	4 J SX	-29.3	-31.8	-34.5	-36.9
38	6 D SX	0	- 1.2	- 1.9	- 1.8

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TABLE VII

*SEED EXIT AND INLET DEVIATION - °F

Point	Location	485°F	500°F	515°F	530°F
1	6 L SX	10.3	11.9	13.2	14.0
2	5 K SX	5.4	7.0	7.5	7.9
3	4 J SX	3.9	5.0	5.5	6.3
4	4 H SX	14.9	17.3	15.2	13.5
5	8 D SX	8.8	10.6	11.5	12.0
6	10 D SX	4.0	4.9	5.2	5.5
7	11 E SX	19.9	23.3	23.5	24.7
8	12 F SX	29.2	32.2	34.3	36.9
9	12 H SX	8.8	10.2	11.5	11.5
10	12 J SX	10.0	11.8	12.9	13.3
11	11 K SX	13.3	15.0	16.0	16.5
13	8 L SX	13.5	15.0	16.0	16.5
14	4 F SX	9.2	11.0	11.5	12.2
15	5 E SX	15.0	16.5	17.0	17.9
16	6 D SX	0.5	2.0	1.9	2.2
18	12 J-1 SX	5.5	6.5	6.9	7.4
19	12 I SX	4.8	5.5	6.2	6.3
20	12 J-2 SX	4.8	6.0	6.5	6.5
21	11 L SX	2.6	3.5	4.0	4.0
22	10 L-1 SX	0.5	1.5	2.0	1.7
23	10 L-2 SX	2.4	3.3	3.9	3.7
24	9 L SX	2.0	3.3	3.9	3.6

* All deviations in this table are negative.

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TABLE VIII

COMPARISON OF CALCULATED SOURCE RANGE ACTIVITY WITH RECORDED DATA
 (10/8/59 - 10/10/59)

**Calc. Source Activity Neutrons/sec cps	Channel A				Channel B				Channel C			
	5.9×10^6 3.83				6.5×10^6 4.0				6.1×10^6 3.97			
Average Recorded Activity - cps	1.7	20	25	21.4	*	7.7	7.4	7.3	*	21.6	20	20
Tavg - F	485	500	515	530	485	500	515	530	485	500	515	530

* Instrument de-energized

** See Sample Calculations

Channel A - Source No. PN-288

Channel B - Source No. PN-291

Channel C - Source No. PN-289

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TABLE IX

TABULATION OF SOURCE RANGE READINGS*
(October 8-10, 1959)

Tavg - 485°F
("A" Channel read an average of 1.7 cps; "B" and "C"
Channels were de-energized)

Tavg - 500°F							
Source Range Readings							
Time	2030	2050	2110	2130	2150	2210	2230
Channel A (cps)	20	22	18	19	20	20	22
Channel B (cps)	8	7	7	7.5	8.5	8.0	8.0
Channel C (cps)	21	20	21	20	20	21	21

Tavg 515°F							
Source Range Readings							
Time	2140	2200	2220	2240	2300	2320	2340
Channel A (cps)	22	22	24	25	31	24	28
Channel B (cps)	8	7	7	7	8	8	7
Channel C (cps)	19	19	21	21	20	20	20

Tavg - 530°F							
Source Range Readings							
Time	0730	0810	0830	0850	0910	0930	0950
Channel A (cps)	22	21	21	21	22	22	21
Channel B (cps)	7	7	8	7	7.5	8	8
Channel C (cps)	20	20	20	20	20	19	

* Channel "D" was out of service.

TEST RESULTS DLCS 2430104

T-641306

PERIODIC INTERCALIBRATION OF TEMPERATURE SENSING ELEMENTS

Results Prepared By John F. Patten

Results Reviewed By John Shanks Jr.

Approved (Duquesne Light Company) [Signature] 16-24-60

SECOND ISSUE APPROVAL

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