CONNECTICUT YANKEE ATOMIC POWER COMPANY

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October 20, 1978

Docket No. 50-213

Director of Nuclear Reactor Regulation
Attn: Mr. D. L. Ziemann, Chief
Operating Reactors Branch #2
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

References: (1) W. G. Counsil letter to D. L. Ziemann dated September 22, 1978.
(2) W. G. Counsil letter to D. L. Ziemann dated September 29, 1978.

Gentlemen:

Haddam Neck Plant
Emergency Power Systems

In Reference (1), Connecticut Yankee Atomic Power Company (CYAPCO) submitted to the NRC Staff a summary and description of a main steam line break analysis (MSLB) for the Haddam Neck Plant, concluding that charging pump flow is not required for a MSLB for the remainder of the present cycle (Cycle 8). In Reference (2), CYAPCO proposed changes to the Technical Specifications that assured the validity of the MSLB analysis.

In subsequent phone conversations, the NRC Staff requested that CYAPCO provide additional information in support of the license amendment request of Reference (2). Accordingly, CYAPCO hereby submits the attached additional information.

We trust the attached information is sufficient to allow the NRC to affirmatively disposition the above referenced license amendment request.

Very truly yours,

CONNECTICUT YANKEE ATOMIC POWER COMPANY

W. G. Counsil

W. G. Counsil
Vice President

Attachment

W. F. Fee

W. F. Fee
Vice President

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DOCKET NO. 50-213

HADDAM NECK PLANT

EMERGENCY POWER SYSTEMS

ADDITIONAL INFORMATION

OCTOBER, 1978

MAIN STEAMLINE RUPTURE AT 100% POWER

An analysis was performed at 100% rated power (1825 MWT) to specifically investigate return to criticality for that condition. The previously docketed RELAP4 model was used with appropriate modifications to represent the full power condition.

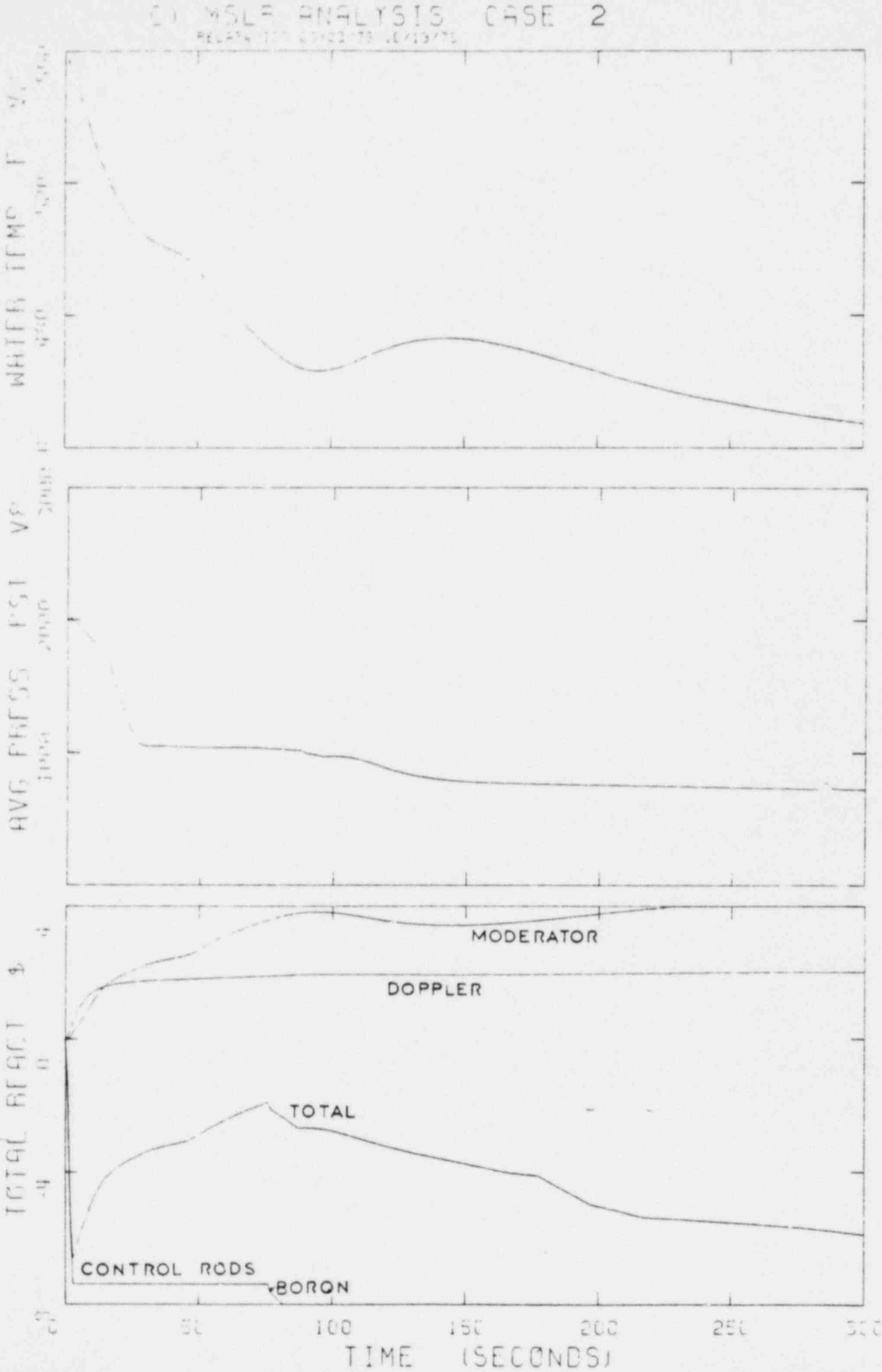
On the primary side this included changes to the core power level and primary system temperature distributions. The primary mass flow rates and pressure drops were also changed which necessitated re-initialization for steady state.

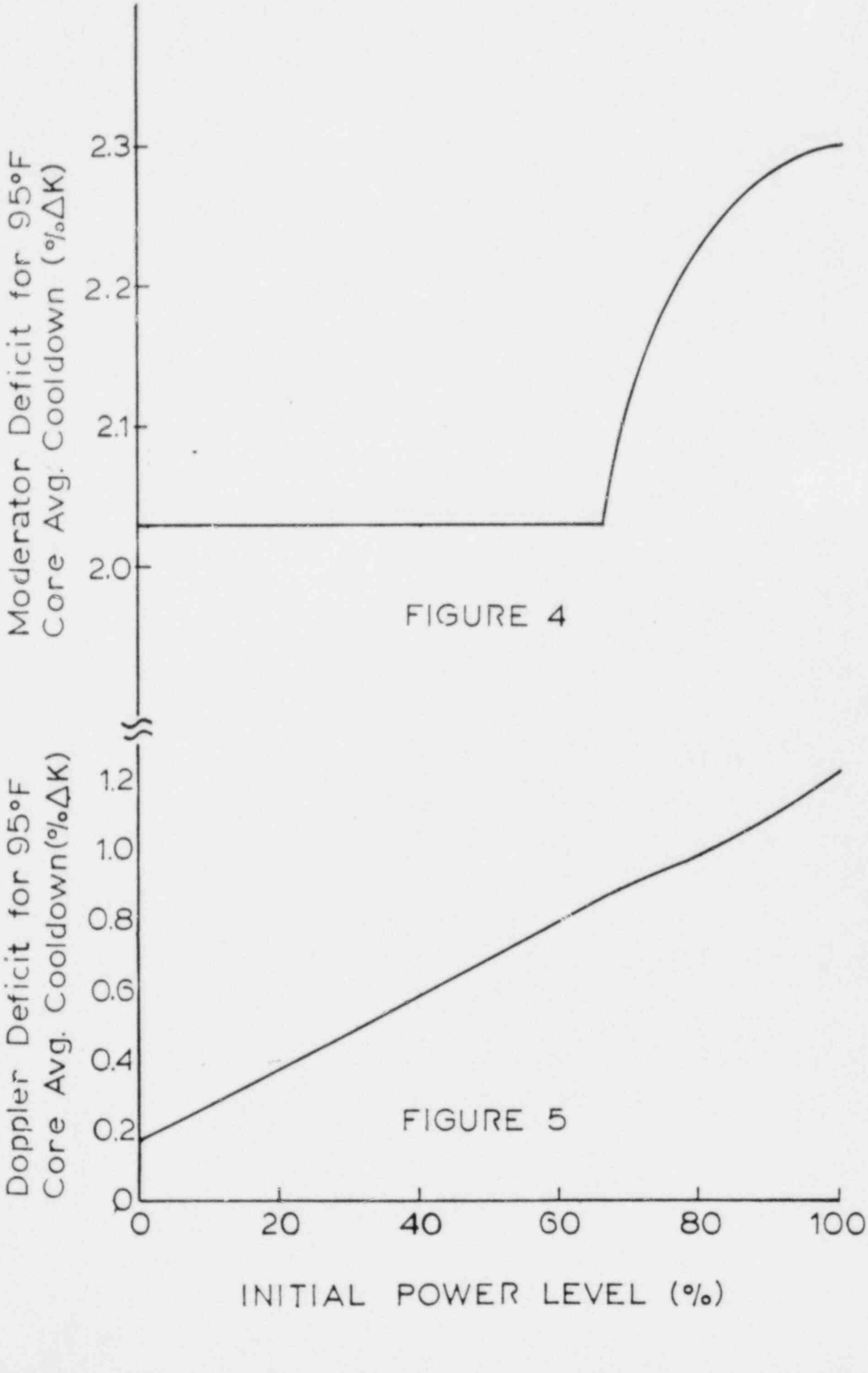
On the secondary side, the steam generator pressure, temperature and mass inventory were changed to represent full power conditions. Feedwater flow and steam dump were also modeled to account for the increased feedwater flow and steam dump subsequent to turbine trip. For the condition of coincident loss of offsite power, the feedwater pumps were modeled to coastdown to zero flow in 20 seconds.

Minimum control rod worth was used in the analysis which corresponds to Bank B inserted 25% and including the maximum worth stuck rod. End of cycle moderator and doppler deficits were used as in the zero power case. The temperature dependence on inverse boron worth was conservatively neglected.

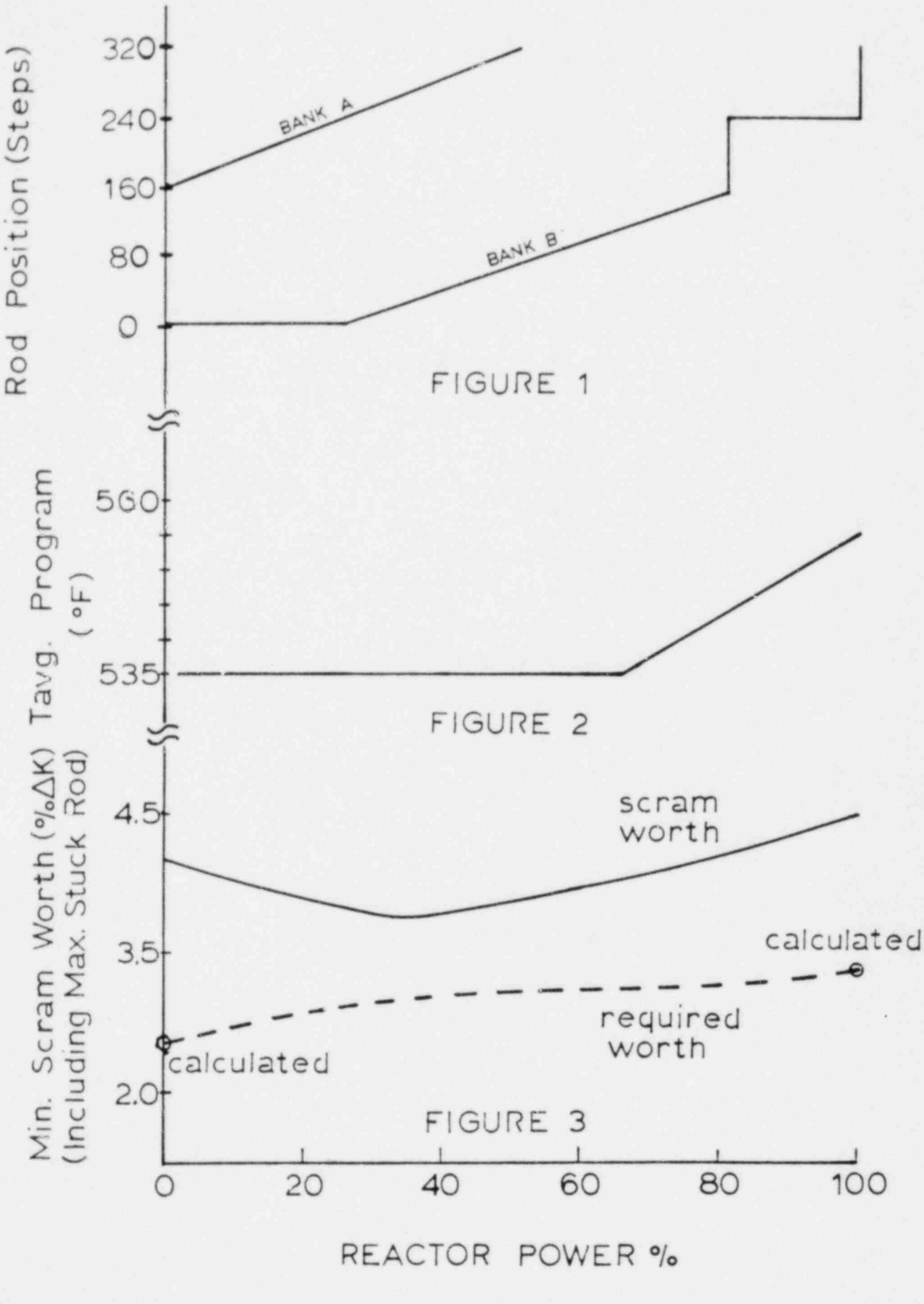
Results are shown on the attached Figure A. The reactivity transient turns around when the injected boron reaches the core. These results show adequate margin to return to criticality.

FIGURE A


MSLB ANALYSIS CASE 2
MODERATOR
DOPPLER
TOTAL
CONTROL RODS
BORON
0
50
100
150
200
250
300
TIME (SECONDS)



Moderator Deficit for 95°F Core Avg. Cooldown (%ΔK)
2.3
2.2
2.1
2.0
FIGURE 4
Doppler Deficit for 95°F Core Avg. Cooldown (%ΔK)
1.2
1.0
0.8
0.6
0.4
0.2
0
FIGURE 5
0
20
40
60
80
100
INITIAL POWER LEVEL (%)



Rod Position (Steps)
320
240
160
80
0
BANK A
BANK B
FIGURE 1
Tavg. Program (°F)
560
535
FIGURE 2
Min. Scram Worth (%ΔK) (Including Max. Stuck Rod)
4.5
3.5
2.0
scram worth
calculated
required worth
calculated
FIGURE 3
0
20
40
60
80
100
REACTOR POWER %

INTERMEDIATE POWER

For initial power levels less than 100%, the primary plant cooldown due to a steamline break would be larger than at full power and approach that of the zero power case. This is due to the increased mass inventory in the steam generators and decreased stored energy in the primary system. Review of these mechanisms and the operating constraints of the plant at less than full power indicates the behavior is monotonic with power. This is justified since the dominating mechanism is steam generator inventory which is approximately a linear function of power. Feedwater response at lower power also becomes more favorable due to the control system characteristics. Offsetting the increased cooldown for accidents originating at less than full power is the reduced effect of the reactivity coefficients at the lower temperature. The core average coolant temperature varies with power level as shown in Figure 2. The moderator temperature coefficient is most negative at operating temperatures (555° - 535°) and becomes much less negative at the lower temperatures. The doppler coefficient behaves linearly with fuel average temperature which also decreases with decreasing power. The net effect is that accidents originating from less than full power begin their cooldown at a lower temperature and result in less reactivity addition for a given ΔT. To illustrate this effect, the moderator and doppler deficits have been calculated for various initial power levels assuming a core average cooldown of $95^{\circ}F$. Since this $95^{\circ} \Delta T$ is the core average cooldown at the minimum approach to criticality resulting from a steamline break from hot, zero power, it is larger than that expected for any other initial power level, and thus is conservative. Figures 4 and 5 show that the reactivity deficits become significantly less with decreasing power level. Sufficient reactivity is available in the control rods to keep the reactor subcritical as shown in Table 1 and figure 3. The inflection point is due to the worst combination of Bank B insertion and stuck rod worth. The maximum worth stuck rod is a bank A rod, even at 50% bank A insertion. Margins of 1.67% δk and 1.18% δk have been specifically calculated for the HZP and HFP cases, respectively. A conservative estimate of the cooldown reactivity due to a steamline break from 40% power shows an acceptable margin for the rod configuration providing the least available shutdown worth.

AVAILABLE SCRAM WORTH

Power (%) (MWT)	100 1825	81 1473	58 1060	33 600	26 470	0 0
Initial Rod Position (Steps Withdrawn)	B240 A320	B160 A320	B90 A320	B20 A250	B0 A230	B0 A160
Total Rod Worth (HZP, EOC, ARO) (%δK)	6.647	6.647	6.647	6.647	6.647	6.647
Max Stuck Rod (HZP, EOC) (%δK)	-1.97	-1.97	-1.97	-1.80*	-1.59*	-.80
Max Allowable Inserted Rod Worth (HZP, EOC)						
Bank B (%δK)	-.201	-.489	-0.706	-0.783	-0.783	-.783
Bank A (%δK)	-	-	-	-0.315	-0.435	-.891
Net Scram Worth (HZP, EOC) %δK	4.48	4.19	3.97	3.75	3.84	4.17
Required Worth To Remain Subcritical After SLBA With Coincident Loss Of Off-Site Power At EOC (%δK)	3.30			3.06**		2.50
Margin (%δK)	1.18			0.69**		1.67

**Conservatively approximated using HZP average temperature

*Interpolated cooldown of 95°F, and doppler and moderator deficits for 40% initial power level