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SUBJECT: Forwards justification for single loop operation of Unit 1 w/Exxon Nuclear Co 8X8 fuel to support proposed Amends 66 & 1 to Licenses NPF-38 & NPF-22,respectively.

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Director of Nuclear Reactor Regulation
Attention: Dr. W. R. Butler, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
ADDITIONAL INFORMATION ON ENC SLO ANALYSIS
ER 100450 FILE 841-8
PLA-2554

Docket Nos. 50-387
50-388

Dear Dr. Butler:

On August 15, 1985, PP&L submitted ENC and GE analyses on Single Loop Operation at Susquehanna SES for your review in support of our proposed amendments 66 (Unit 1) and 1 (Unit 2). Attached is further information on the ENC analysis based on a request from your staff. Any questions on this material should be directed to Mr R. Sgarro at (215) 770-7855.

Very truly yours,

H Keiser

H. W. Keiser
Vice President-Nuclear Operations

Attachment

cc: M. J. Campagnone - USNRC
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A001
1/1

JUSTIFICATION FOR SINGLE-LOOP OPERATION

SUSQUEHANNA UNIT 1 WITH ENC 8X8 FUEL

LOSS-OF-COOLANT ACCIDENT ANALYSIS

To support operation of Susquehanna Unit 1 with Exxon Nuclear Company (ENC) 8x8 fuel with a single recirculating pump operating, ENC recommended the conservative use of GE MAPLHGR limits for the similar GE 8x8 fuel design with a multiplier of 0.81 applied for single-loop operation. The basis for this is two-fold: (1) The phenomena which require the reduction in MAPLHGR limits are a result of operation of the Susquehanna Unit 1 system with a single active recirculation loop, and are therefore, equally applicable to both GE and ENC fuel designs, and (2) The analysis methods used by GE have yielded conservative MAPLHGR limits relative to the MAPLHGR limits obtained using the ENC approved analysis models. Therefore, applying the more conservative GE MAPLHGR limit to ENC fuel provides a limit which assures conformance to NRC 10 CFR 50.46 criteria.

The major differences between operation with both recirculation pumps running and operating with only one active recirculation pump are reduced operating core flow, reduced core power, and reverse flow through the inactive loop jet pumps. Flow dependent MCPR limits assure reduced maximum assembly power during single-loop operation. The primary system coolant inventory and LOCA break conditions are essentially unchanged from the two-loop operation. Thus, the uncovery of the jet pump suction, recirculation suction line uncovery, and system depressurization rate would be expected to change little between one and two loop operation. The phenomena associated with these key parameters largely determine LOCA analysis results for both ENC and GE analyses. The analyses performed by GE confirm this system behavior in that the limiting pipe break LOCA is essentially unchanged from the two-loop analysis, as are the break size and core uncovery and reflood times. Although ENC LOCA analysis methods differ from those of GE, similar results would be expected from an ENC analysis because the phenomena are governed by the system parameters.

The major difference between the ENC and GE Methodologies that would impact analysis differences between single and two-loop operation is in the blowdown heat transfer. ENC's more mechanistic model calculates boiling transition times that are equivalent to or later than those reported from the GE model, and the ENC model explicitly calculates the blowdown heat transfer throughout the blowdown period while the GE model assumes an adiabatic heatup period. Thus, the conservative approach taken in the GE analysis of using an adiabatic heatup period and assuming an early boiling transition (0.1 sec) for single-loop operation would add more conservatism to an ENC single-loop analysis than to a GE analysis.

The principal LOCA concern associated with single-loop operation is the possibility of the LOCA break occurring in the operating loop, in which case there is no coastdown of an intact loop recirculation pump to sustain jet pump and core flow during the early portion of the system blowdown. An early boiling transition (CHF) may result from this early loss of flow capability.

To account for this possibility, GE derived a single-loop operation MAPLHGR multiplier of 0.81 to be used with calculated two-loop MAPLHGR limits during single-loop operation. The analyses which determined this multiplier assumed a near instantaneous boiling transition (0.1 second) even though a longer boiling transition time may have been calculated using approved models. This assumption is very conservative when applied to the GE fuel and would be similarly conservative when applied to the equivalent ENC 8x8 fuel.

Application of the GE calculated MAPLHGR limits to ENC fuel for single-loop operation will conservatively assure that the NRC criteria of 10 CFR 50.46 will be met for the following reasons:

(1) Since ENC has performed LOCA analyses for Susquehanna Unit 1 for two-loop operation and obtained MAPLHGR limits for ENC fuel which are higher than the equivalent GE limits, an ENC analysis for the similar single-loop operating conditions would be expected to also give MAPLHGR limits equal to or higher than those obtained by GE.

(2) The MAPLHGR reduction factor to protect against early boiling transition determined by GE is based on a conservative early boiling transition assumption which is also conservative when applied to the equivalent ENC 8x8 fuel because the physical characteristics of the fuel are essentially equivalent. The similarities in the ENC and GE fuel are shown in the attached Table. The only differences worth noting are the smaller pellet-to-clad gap and more open upper tie plate of the ENC fuel design. Both of these design features are beneficial in an ECCS analysis. The smaller pellet results in less initial stored energy. The more open upper tie plate allows more countercurrent liquid downflow to cool the fuel and refill the core faster.

(3) ENC two-loop operating MAPLHGR limits, in addition to being higher than the GE limits, have significant margin to peak cladding

temperature limits for most exposure conditions. This further assures that GE results will be conservative relative to ENC calculations.

ABNORMAL OPERATING TRANSIENTS

MCPR limits established for full flow two loop operation are conservative for single loop operation because of the physical phenomena related to part-power part-flow operation, not because of features in reactor models. A review of the most limiting delta CPR transients for single loop operation was conducted. Under single loop conditions, steady state operation can not exceed approximately 75% power and 60% core flow because of the capability of the recirculation loop pump. Thus, the technical specification change to allow single loop operation with the MCPR limits established for two loop operation up to 100% power are conservative for single loop operation.

Load Rejection Without Bypass

The limiting transient for the Susquehanna Units is the Load Rejection Without Bypass (LRWB) pressurization transient. In this transient, the primary phenomena is the pressurization caused by abruptly stopping the steam flow through rapid closure of the turbine control valve. When the rapid pressurization reaches the core it causes a power excursion due to void collapse.

At reduced power and flow there is a corresponding reduction in steam flow. With lower steam flow the maximum pressurization of the core is reduced in comparison to rated conditions when the control valve is closed. The resulting power excursion and associated delta CPR are reduced below those of the full power case.

Thus the MCPR limits based on LRWB analyses at full power are conservatively applicable to the lower powers associated with single loop conditions based on the physics of the transient. Furthermore, LRWB analyses by GE(1) and preliminary ENC analyses at reduced power and flow conditions with two loop operation confirm this trend, and GE analyses(2) under single loop conditions also confirm this trend.

Feedwater Controller Failure

The second most limiting transient for Susquehanna is the Feedwater Controller Failure (FWCF). This transient is also less severe at the reduced power and flow conditions associated with single loop operation.

This transient assumes the feedwater controller fails to maximum demand and allows the maximum amount of subcooled feedwater into the downcomer. When this cooler water reaches the core, the power rises. The core power rise is terminated through a turbine trip scram initiated by a high water level trip in the downcomer due to the additional amount of feedwater being injected.

At the reduced recirculation flows the subcooling in the downcomer due to high feedwater injection takes longer to transverse to the core such that a high level trip occurs before the core power rises as much as in the full power case. In the subsequent pressurization transient, the result of turbine trip is less severe for the reduced powers in transients from single loop conditions because of the reasons discussed in the LRWB transient.

Thus, because of the slower transport phenomena caused by the lower flow in the downcomer and because of the lower steam line flow in the pressurization portion of the transient, the FWCF has larger margin to the operating limit.

Summary

It is very conservative to use the reduced flow MCPR limit for single loop operations. The reduced flow MCPR limit is to protect against boiling transition during flow excursions to greater than full flow; excursions to such high flows are not possible during single loop conditions. Thus conservatively maintaining this two loop limit assures that there is even more thermal margin under single loop conditions than under two loop full power-full flow conditions.

Table 3-6

TRANSIENT SUMMARY--LOAD REJECTION WITHOUT BYPASS

Plant	Analysis	Initial Power (% NBR)	Initial Flow (% NBR)	$\hat{\phi}$ (% initial)	$\hat{Q/A}$ (% initial)	$\hat{P}_{sl}$ (psig)	$\hat{P}_{v}$ (psig)	ΔCPR 7x7	ΔCPR 8x8	ΔCPR 8x8R	ΔCPR P8x8R
A	R	104	100	376	115	1178	1225	0.23	0.31	0.30	--
A	R	100	94	360	115	1173	1216	0.22	0.29	0.29	--
A	R	85	61	251	107	1157	1182	0.09	0.13	0.13	--
B	R	104	100	201	104	1203	1229	--	0.14	0.14	--
B	R	100	94	191	103	1189	1215	--	0.14	0.14	--
B	R	85	61	167	102	1162	1183	--	0.09	0.09	--
C	R	104	100	302	111	1172	1219	0.18	0.25	0.25	--
C	R	100	94	284	114	1168	1210	0.16	0.22	0.22	--
C	R	85	61	168	106	1154	1177	0.04	0.07	0.07	--
D	R	104	100	277	111	1189	1233	0.15	0.21	0.21	--
D	R	100	91	267	115	1180	1219	0.14	0.19	0.19	--
D	R	85	61	176	107	1153	1177	0.03	0.05	0.06	--
E	R	104	100	367	116	1209	--	0.22	0.30	--	--
E	R	100	92	348	114	1188	--	0.19	0.27	--	--
E	R	85	61	179	101	1149	--	0.04	0.07	--	--
F	NOT ANALYZED										
G	Ø	104	100	507[b]	114	1186	1208	--	--	0.17	0.17
G	Ø	100	94	489[b]	114	1180	1202	--	--	--	--
G	Ø	91	75	424[b]	113	1175	1194	--	--	--	--
G	Ø	85	61	332[b]	111	1165	1183	--	--	--	--
G	Ø	104	105	501[b]	113	1184	1207	--	--	0.17	0.18
G[a]	Ø	105	100	503[b]	115	1178	1200	--	--	0.18	0.18
G[a]	Ø	105	105	481[b]	114	1184	1206	--	--	0.18	0.18
H	Ø	100	100	679[b]	124	1206	1230	--	0.35	0.35	0.39
H	Ø	100	92	631[b]	122	1206	1228	--	0.31	0.31	0.34
H	Ø	92	75	396[b]	120	1183	1202	--	0.25	0.25	0.28
H	Ø	85	61	329[b]	122	1195	1208	--	0.23	0.24	0.26
H	Ø	100	87	576[b]	121	1205	1227	--	0.30	0.30	0.33
K	Ø	104	100	502[b]	117	1179	1213	0.14	0.19	0.19	0.19
K	Ø	100	94	469[b]	117	1174	1206	0.13	0.17	0.17	0.19
L	Ø	104	100	338[b]	108	1166	1189	--	--	--	--
L	Ø	100	94	320[b]	108	1160	1182	--	--	--	--
L	Ø	91	75	267[b]	108	1145	1168	--	--	--	--
L	Ø	85	61	216[b]	106	1145	1160	--	--	--	--
L	Ø	104	105	333[b]	108	1167	1191	0.07	--	0.11	0.11
L[a]	Ø	105	105	336[b]	108	1165	1188	0.08	--	0.11	0.11
L[a]	Ø	105	100	346[b]	109	1166	1187	0.08	--	0.11	0.11
M	Ø	104	100	653	120	1208	1246	--	0.22	0.22	0.24
M	Ø	100	94	596	120	1197	1231	--	0.20	0.20	0.23
SSES-1 Cycle 1	Ø	105	100	447	118	1189	1218	--	--	--	0.19
SSES-1 Cycle 1	Ø	100	87	453	117	1183	1204	--	--	--	0.18

[a]Feedwater temperature reduction

[b]% nominal rated

Table 1 Similarities in ENC and GE Fuels for SSES Unit 1 Affecting ECCS Analysis

Fuel Parameters	ENC 8x8 Design	GE 8x8R Design
Number of fuel pins	62	62
Fuel rod OD (in)	0.484	0.483
Pellet-to-clad cold gap (in)	0.0085	0.009
Pellet OD (in)	.4055	.410
Rod Pitch (in)	0.641	0.640
Bare bundle hydraulic diameter (ft)	.0452	.0446
Bare bundle rod flow area (in^2)	15.96	15.82
Upper tie plate flow area (in^2)	15.4	11.4
Prepressurization (atm)	3	3

References

1. "Extended Load Line Limit Analyses for Susquehanna Steam Electric Station Unit 1," NEDO-22128, General Electric Co., May 1982.

2. General Electic Co., "Susquehanna Single Loop Operation Analysis," GP-84-142, General Electric Co., June 1984.