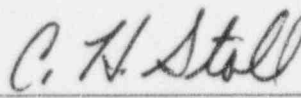


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**James A. FitzPatrick Nuclear Power Plant**  
**Anticipated Transients Without Scram (ATWS) Analysis**  
**for**  
**Recirculation Pump Trip (RPT) Setpoint Changes**

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C. H. Stoll

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**FITZPATRICK NUCLEAR POWER PLANT**  
**ANTICIPATED TRANSIENTS WITHOUT SCRAM (ATWS) ANALYSIS FOR**  
**RECIRCULATION PUMP TRIP (RPT) SETPOINT CHANGES**

## **1.0 INTRODUCTION**

The evaluation of the expected response of a nuclear power reactor to postulated ATWS events is not a design basis requirement. However, it is necessary to demonstrate that the plant is adequately protected during postulated ATWS events. A FitzPatrick specific study was previously performed to demonstrate the adequacy of FitzPatrick plant protection for ATWS events at power uprate conditions (Reference 1). This original analysis was performed for a range of high pressure RPT setpoints from 1105 psig to 1135 psig, and demonstrated that the current high pressure RPT setpoint of 1120 psig is acceptable even with 2 safety relief valves (SRVs) out of service (OOS).

The purpose of this current study is to evaluate the impact of two proposed ATWS Recirculation Pump Trip (RPT) setpoint changes, namely: (a) a 35 psi increase in the Tech Spec high pressure RPT setpoint from 1120 psig to 1155 psig, and (b) a 24 inch decrease in low level RPT setpoint from 479 inches above vessel zero (AVZ) to 455 inches AVZ. The impact of these changes, proposed to decrease the probability of unnecessary RPTs, are evaluated for 0, 1 and 2 SRVs OOS (although previous results from Reference 1 indicate that the 1155 psig setpoint would not be expected to meet the peak pressure requirements for 2 SRVs OOS.) All other assumptions (e.g., fuel characteristics) were assumed to remain unchanged from the previous Reference 1 ATWS analysis.

To meet the objective of this study, the most limiting ATWS events were reanalyzed to substantiate that the ATWS acceptance criteria are still met with the revised setpoints. For the high pressure revision, the Main Steamline Isolation Valve (MSIV) closure event with 1 SRV out of service is evaluated to verify that the peak reactor pressure vessel (RPV) pressure remains less than the 1500 psig acceptance criterion. The Inadvertent Opening of a Relief Valve (IORV) is the limiting event for peak suppression pool temperature (criterion is to remain less than 190°F), but this event is unaffected by either the high pressure or low level setpoint changes. The event most affected by the low level RPT setpoint change is the Loss of Feedwater (LOFW), which is evaluated to confirm that the fuel remains cooled (i.e., the core two phase coolant level remains above the top of the active fuel (TAF)).

As in the Reference 1 analysis, the analytical models used in this evaluation were the same as in Reference 2 (the current revision of the Reference 3 Engineering Computer Program (ECP) REDY was utilized for the RPV pressure transients). The analysis was performed in accordance with the requirements of NUREG-0460 (Reference 4) which permits the use of nominal values for selected plant parameters, with input assumptions being the same as in Reference 2.

## 2.0 ANALYSIS

The evaluations of the RPV response with the REDY ECP assumed the initial operating conditions and the other plant specific parameters listed in Tables 1 and 2. As with the previous (Reference 1) analysis, the evaluation assumed the uprated power and steam flow conditions, and [GE PROPRIETARY INFORMATION].

Evaluation of the high pressure RPT revision consisted of reanalyzing the limiting event for peak vessel pressure, namely the MSIV closure ATWS event, at the increased setpoint of 1155 psig, for 0, 1, and 2 SRVs OOS.

Evaluation of the low level RPT revision consisted of examining the limiting event for peak suppression pool bulk temperature, namely the IORV, with both the increased pressure and decreased level changes incorporated to see if any changes in the integrated energy discharge from the SRVs could occur. The LOFW transient with the two setpoint changes incorporated was also investigated to substantiate that the fuel would remain covered with coolant throughout the transient.

### 3.0 RESULTS AND CONCLUSIONS

The results for the analyzed ATWS events with the subject setpoint revisions are summarized in Tables 3 and 4. The sequence of events for the two transients that change as a result of the setpoint revisions are presented in Tables 5 and 6. Figures 1 and 2 show the time histories of the important parameters for the MSIV closure events at the increased high pressure RPT setpoint for zero and one SRV OOS, respectively.

The results indicate that the limiting acceptance criteria were met. The calculated peak RPV pressure for an RPT setpoint of 1155 psig with 1 SRV OOS is significantly below the level C pressure (1500 psig) for the MSIV closure event although, as expected, the 2 SRV OOS case [GE PROPRIETARY INFORMATION].

The postulated ATWS transient most affected by a low level RPT setpoint change is the LOFW. This event was examined to determine the effect on minimum RPV downcomer water level and core coolant level. Calculations indicate that the lowering of the low level RPT [GE PROPRIETARY INFORMATION].

Based on these results, the proposed setpoint changes, namely: (a) a 35 psi increase in the Tech Spec high pressure RPT setpoint from 1120 psig to 1155 psig, and (b) a 24 inch decrease in low level RPT setpoint from 479 inches AVZ to 455 inches AVZ are acceptable and meet the acceptance criteria for performance during postulated ATWS events for one SRV OOS.

#### 4.0 REFERENCES

1. Anticipated Transients Without Scram (ATWS) Analyses for the James A. FitzPatrick Nuclear Power Plant, GE-NE-187-59-1191, November 1991.
2. Assessment of BWR Mitigation of ATWS, Vol. II., NEDE-24222, December 1979.
3. Analytical Methods of Plant Transient Evaluations for the GE BWR, NEDO-10802, February 1973.
4. Anticipated Transients Without Scram for Light Water Reactors, NUREG-0460, April 1978.
5. Standby Liquid Control System Solution Enrichment for ATWS Modification Number F1-85-055, May 1985.



TABLE 1. INITIAL OPERATING CONDITIONS

<u>PARAMETER</u>	<u>VALUE</u>
Dome Pressure (psia)	1055
Core Flow (Mlb/hr)/(% NBR)	77/100
Thermal Power (Mwt)	2535.8
Steam Flow (Mlb/hr)/(% NBR)	10.977/100
Feedwater Temperature (°F)	424
Void Reactivity Coefficient (Cents/%)	-11
Initial Water Level - NR (inches above vessel zero)	560.5*
Doppler Coefficient (Cents/°F)	-0.3
Sodium Pentaborate Solution Concentration (% by weight)	13
Enrichment of B-10 (Atom %)	26.7**
Suppression Pool Volume (Low Water Level ft <sup>3</sup> )	105923
Initial Suppression Pool Temperature (Tech. Spec Limit °F)	95***
Service Water Temperature (°F)	65/75
Core Average Void Fraction (%)	41.65

\* From Reference 2, and higher than the nominal value for the FitzPatrick plant. A higher elevation is conservative in ATWS evaluations.

\*\* A very conservative value from Reference 5.

\*\*\* Consistent with FitzPatrick EOP-4, Primary Containment Control, Section T/T.



**TABLE 2. EQUIPMENT PERFORMANCE CHARACTERISTICS**

<u>PARAMETER</u>	<u>VALUE</u>
Closure Time of MSIV (sec)	4
Relief Valve System Capacity (% NBR Steam Flow)/(No. of Valves)	83.08/11
Relief Valve Setpoint (psig)	1145
Relief Valve and Sensor Time Delay (sec)	0.4
Relief Valve Opening Time (sec)	0.15
Pressure Drop Below Setpoint for Relief Valve Closure (%)	9
SLCS Injection Flow Rate (gpm)	50
HPCI/RCIC Low Water Level Initiation Setpoint (inches above vessel zero) - Level 2	479
HPCI Commencement Time (sec)	20*
RCIC Commencement Time (sec)	20*
ATWS High Pressure RPT Setpoint (psig)	1155**
ATWS Low Water Level RPT Setpoint (inches above vessel zero) - Level 2	455**
Low Level MSIV Closure Setpoint (inches above vessel zero) - Level 1	370.5
Elevation of Top of Active Fuel (inches above vessel zero)	358.6
Minimum Steam Cooling Water Level (inches above vessel zero)	327.6
RHR Heat Exchanger Effectiveness (Btu/sec °F)	285.5

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\* Nominal value as per Reference 2. Earlier injection time is conservative in ATWS evaluation.

\*\* Setpoint values after proposed revision

**TABLE 3. MSIV CLOSURE EVENT RESULTS**

<u>Initiating Event</u>	Max Neutron Flux (% NBR)	Max.Avg. Fuel Heat Flux (% NBR)	Peak RPV Bottom Pressure (psig)
MSIV Closure 1155 psig Setpt. All SRVs Oper.	[GE PROPRIETARY INFORMATION]		
MSIV Closure 1155 psig Setpt. 1 SRV OOS	[GE PROPRIETARY INFORMATION]		
MSIV Closure 1155 psig Setpt. 2 SRVs OOS	[GE PROPRIETARY INFORMATION]		

**TABLE 4. IORV EVENT SUPPRESSION POOL HEATUP RESULTS**  
 (From Reference 1, as earlier results are unaffected by RPT Setpoint Changes)

<u>Initiating Event</u>	Service Water Temp. of 65°F		Service Water Temp. of 75°F	
	Max Pool Temp. (°F)	Time (sec.)	Max Pool Temp. (°F)	Time (sec.)
[GE PROPRIETARY INFORMATION]				

TABLE 5. MSIV CLOSURE EVENTS (@1155 psig RPT SETPOINT)

	<u>Sequence of Events</u>	<u>Time(Sec.)</u>		
		<u>0 SRVs</u> <u>OOS</u>	<u>1 SRVs</u> <u>OOS</u>	<u>2 SRVs</u> <u>OOS</u>
1.	Scram Fails	0	0	0
2.	Pressure Rise Begins	0	0	0
3.	Relief Valve Lift Commences	[GE PROPRIETARY INFO]		
4.	ATWS High Pressure Setpoint Reached - RPT	[GE PROPRIETARY INFO]		
5.	All Active Relief Valves Full Open	[GE PROPRIETARY INFO]		
6.	Peak Vessel Pressure Reached	[GE PROPRIETARY INFO]		
7.	FW Recirc. Valve Opens	[GE PROPRIETARY INFO]		
8.	Low Level Initiation of HPCI	[GE PROPRIETARY INFO]		
	(End of evaluation run)*	[GE PROPRIETARY INFO]		

**TABLE 6. LOSS OF FEEDWATER EVENTS**

	<u>Sequence of Events</u>	<u>Time(Sec.)</u>	
		479" AVZ Low Level RPT Setpt.	455" AVZ Low Level RPT Setpt.
1.	Feedwater Flow Stops [GE PROPRIETARY INFORMATION]		
2.	Pressure, Water Level and Power Start to Decline [GE PROPRIETARY INFO]		
3.	Reactor Water Level Drops to Level 2 and Initiates HPCI and RCIC [GE PROPRIETARY INFO]		
4.	Low Level RPT Trip [GE PROPRIETARY INFO]		
5.	HPCI and RCIC Flow Starts [GE PROPRIETARY INFO]		
6.	Water Level Reaches Minimum and Maintained manually. The Top of the Core Remains Covered throughout transient. [GE PROPRIETARY INFO]		

[GE PROPRIETARY FIGURES REMOVED]