# PRA EVALUATION:

## CHANGE IN PRIMARY COMPONENT COOLING TECH SPEC 3.7.3

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# PRA Evaluation: Change in Primary Component Cooling Tech Spec 3.7.3

## 1.0 Introduction

This evaluation documents the change in operational risk, at the system level (system availability) and at the plant level (core damage frequency), for a proposed change in the Allowed Outage Times (AOTs) for the Primary Component Cooling (PCC) System.

## 2.0 Background

The current Primary Component Cooling Tech Spec (TS 3.7.3) applies AOTs to all four PCC pumps. These pumps are each 100% capacity and provide redundancy for each train. Thus, to define operability, one train of PCC must contain one PCC pump and the associated flow paths to the PCC loads. On that basis, a new TS has been proposed, summarized in the table below:

| | Allowed Outage Time | |
|---|---|---|
| Components Inoperable | Current TS 3.7.3 | Proposed TS 3.7.3 |
| 1 PCC pump | 7 d | N/A |
| 2 PCC pumps, opposite loop | 72 hr | N/A |
| 2 PCC pumps, same loop | 24 hr | 72 hr |
| One loop | not explicit | 72 hr |

(See proposed Tech Spec 3.7.3, Attachment 1). The change for PCC pumps brings this Tech Spec in line with the Standard Tech Specs, which have a 72-hour AOT for single PCC train unavailability.

## 3.0 Discussion

This Tech Spec change impacts risk by increasing the likelihood that a PCC pump would be unavailable due to planned or unplanned maintenance. This change is evaluated by considering the impact on system unavailability (Section 3.1) and on the frequency of shutdown due to loss of one train of PCC (Section 3.2). These impacts are combined in the plant model to produce a delta core damage frequency (Section 3.3).

### 3.1 PCC System Model

The PCC system is included in the current Seabrook PRA, SSPSS-1990. This model includes the PCC pumps, the flow path through the PCC loads, and the associated pump area ventilation. The maintenance contribution to the PCC system model is described below (the "current" model); then the model with the change in Tech Spec is presented (the "new" model).

(1) Current Maintenance Model

This model includes contributions from *unplanned maintenance*, based on the number of pumps, the maintenance frequency, and the maintenance duration, as follows:

- PCC pump, for each loop (7-day LCO)

  = MNT1 = MNT2

  = 2 x ZMPOPF x ZMPLSD = 0.00907

where the frequency and duration variables are based on generic data from PLG-0500, as follows:

| | |
|---|---|
| ZMPOPF = 1.58E-4 (mean) | - Maint. Freq. - operating PCC pumps |
| ZMPLSD = 28.7 hr (mean) | - Maint. Duration - pumps, 7-day LCO |

Assumptions in the current model:

- Maintenance frequencies and durations are based on generic industry data and not on Seabrook specific data due to the limited operational data. This data was collected by PLG from a number of nuclear plants for similar equipment and is judged to be reasonably representative of expected Seabrook experience.
- No planned maintenance is done on the PCC system during power operation that makes a pump inoperable.
- No contribution is given to 2 PCC pumps in unplanned maintenance at the same time because of the low likelihood of dual pump failure or failure of the second pump while the first was being repaired.
- The maintenance contribution from pumps covers unplanned maintenance from other components. Thus, no explicit maintenance contribution is modeled for valves, instrumentation, etc., that would make a loop inoperable. The pump contribution is assumed to dominate maintenance unavailability.
- Maintenance contribution from failures of pump ventilation is not included because it is assumed that remedial action would be taken to keep the PCC system operational.
- Maintenance is unrecoverable. This assumption may be very conservative for some maintenance activities where the system can be made operable quickly.

(2) New Maintenance Model

A "new" PCC model was developed to account for the proposed changes in Tech Specs. The new model results in longer duration of unplanned maintenance and allows planned maintenance at power. These changes impact the modeling of maintenance as follows:

*Unplanned Maintenance:*

- standby PCC pump in each train (no LCO)

  = MNT1' = MNT2'

  = 2 x ZMPOPF x ZMPCCD = 0.0308

where the variables are based on generic data from PLG-0500, as follows:

ZMPCCD = 97.4 hr (mean) - Maint. Duration - PCC pumps, no LCO

Other variable - see current model

Assumptions:

- The standby PCC pump is repaired in unplanned maintenance with no special priority - consistent with other pumps with no LCO. This is believed to be conservative; a PCC pump failure would still receive high priority. The variable ZMPCCD was developed from the data variable ZMPNSD in PLG-0500, using generic data for PCC and SW pumps, judged to be more representative of the SW and PCC pumps at Seabrook.

*Planned Maintenance for the standby PCC pump in each train:*

= MNT1(PLANNED) = MNT2(PLANNED)

= 2 x (1/4 yr) x (1 yr/ 8760 hr) x (336 hr) = 0.0192

Assumptions:

- Each PCC pump is unavailable due to planned maintenance once every four years for 14 days.
- Planned maintenance is done on one pump at a time - no MNT1(PLANNED) X MNT2(PLANNED) terms.

The quantification for the "new" PCC model is in general as follows

PCC Unavail. = PCCpumps(hardware failure + *unplanned maint.* + *planned maint.*) + common components failure

where the terms in italic are the ones affected by the proposed TS change.

(3) Quantitative Results - Systems Analysis

The PCC system configuration is quantified for a several of different boundary conditions. Boundary conditions are the signals and support systems, external to the PCC system, that impact the system configuration. For example, with loss of offsite power (LOSP), the PCC pumps must restart, presenting a different failure mode - pump fails to start - that is not present when offsite power is available. The important boundary conditions for the PCC system are the number of support systems (e.g. AC power ) available, and LOSP.

The PCC system is quantified for four boundary conditions, as follows:

| System Unavailability (Current/New TS) | | | | Maintenance Contribution (Percent of TOTAL) | |
|---|---|---|---|---|---|
| System Configuration | | TOTAL | (Percent Change) | Unplanned Maint. | Planned Maint. |
| PCC1 | Both trains, transient [Normal system alignment] | 2.37E-6 | | 3.2 % | - |
| | | 2.54E-6 | (7.5 %) | 10.6 % | 6.8 % |
| PCC2 | Both trains, LOSP [PCC pumps must restart] | 4.51E-5 | | 2.0 % | - |
| | | 4.55E-5 | (0.8 %) | 6.7 % | 4.2 % |
| PA1 | Single train, transient | 6.13E-4 | | 2.0 % | - |
| | | 6.47E-4 | (5.5 %) | 6.7 % | 4.3 % |
| PA2 | Single train, LOSP | 1.64E-3 | | 2.6 % | - |
| | | 1.77E-3 | (8.0 %) | 8.4 % | 5.2 % |

The results at the system level indicate that the change in Tech Specs is not significant to system unavailability. Maintenance is a relatively small contribution to total system unavailability. Thus, increasing this small contribution results in small changes in system unavailability. This is due to the importance of non-maintenance related failure modes such as common cause pump failure, isolation valves failure to close on demand, etc. The impact of these changes in system unavailability are integrated into the plant model to estimate the change in risk.

### 3.2 Initiating Event Frequency

Loss of either train of PCC would affect the plant power generation through loss of cooling to the RCPs. The frequency of loss of one PCC train is given by the frequency of loss of a PCC pump over one year of operation and failure of the other pump while the first is being repaired. This also includes failure of the operating pump while the standby pump is out for maintenance - either planned or unplanned. (There are also other combinations of valves, heat exchangers, etc. that could fail and contribute to loss of the train; however, they are not affected by this TS change.)

The equation for loss of one PCC train can be written as follows:

$$L1PCC = F(PA)*T(yr) * F(PC)*T(repair) + F(PA)*T(yr) * M(PC)$$

where:

F(PA) = failure rate for operating PCC pump (A) to continue to run,

F(PC) = failure rate for standby PCC pump (C) to start and run while pump A is being repaired, T(yr) = duration the operating PCC pump must run = 8760 hr per yr * 0.70 , plant availability factor,

T(repair) = duration of unplanned maintenance on failed pump A,

M(PC) = pump C unavailability due to planned and unplanned maintenance.

The last two term are the ones that change due to the new TS AOT, as follows:

| | Current TS Model | New TS Model |
|---|---|---|
| T(repair) | ZMPLSD | ZMPCCD |
| M(PC) | | |
| Planned Maint. | none | 2*(1/4)*(1/8760)*336 |
| Unplanned Maint. | ZMPOPF*ZMPLSD | ZMPOPF*ZMPCCD |

where the variables are defined earlier.

The results are given below:

| L1PCC | Current TS Model | New TS Model |
|---|---|---|
| TOTAL | 2.94E-3 per yr | 4.74E-3 per yr |
| Planned Maint. Contrib. | 0.0 % | 1.5 % |
| Unplanned Maint. Cont. | 0.8 % | 2.6 % |

Thus, the initiator frequency increases by about a factor of 1.6. This is a significant increase despite the fact that maintenance is a small contributor to the total. The increase is due primarily to the increase in the repair time, which does not show up directly as a maintenance contribution.

### 3.3 Quantitative Results - Core Damage Frequency

As a result of the change in TS, the CDF (mean) changes by about 4.1E-6 per year, or 4.4 % increase in the total (9.4E-5/yr). This change is due to the following impacts:

- system unavailability (1.7 %)
- initiating event frequency (2.7 %)

This is a change in the mean value from 9.4E-5 to 9.8E-5, compared to the range of the CDF distribution, which is approximately one order of magnitude (from 5th to 95th percentile). Thus, this is an insignificant change within the uncertainty bounds on the CDF distribution.

## 4.0 Conclusion

As a result of the quantitative evaluation above, the effect of the changes proposed for TS 3.7.3 is generally small for the PCC system unavailability and is significant for the PCC initiating event frequency. However, with these changes in the plant model, the overall result is insignificant to the core damage frequency. This evaluation is based on a best estimate of planned and unplanned PCC pump maintenance.

The evaluation does not include the positive contributions due to removing the major PCC pump maintenance activities from outages. These contributions include reducing the unavailability of PCC pumps during outages and permitting more flexibility in outage planning. The outage effects are very sensitive to the configuration of the primary system, time after shutdown, other systems unavailable, etc. and thus are difficult to estimate. The evaluation includes a slight increased risk from fire in this area as a result of additional maintenance at power. Both the SSPSA and the IPEEE Report showed this area to be important because on the location of all four PCC pumps. It is important that, during any maintenance at power, the combustible control program be strictly adhered to in order to limit this risk.

As a result, the proposed Tech Spec change does not increase the core damage risk within the bounds of the uncertainty.

PROPOSED TECH SPEC

PLANT SYSTEMS

## 3/4.7.3 PRIMARY COMPONENT COOLING WATER SYSTEM

### LIMITING CONDITION FOR OPERATION

3.7.3 At least two independent primary component cooling water loops shall be OPERABLE, including ~~two~~ one OPERABLE pumps in each loop.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTION:

a. With one primary component cooling water (PCCW) ~~pump~~ loop inoperable, restore the required primary component cooling water ~~pumps~~ loop to OPERABLE status within ~~7 days~~ 72 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

~~b. With two primary component cooling water pumps inoperable, restore at least one of the inoperable primary component cooling water pumps to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.~~

~~c. With two primary component cooling water pumps within one loop inoperable, restore at least one of the inoperable pumps to OPERABLE status within 24 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.~~

### SURVEILLANCE REQUIREMENTS

4.7.3 At least two primary component cooling water loops shall be demonstrated OPERABLE:

a. At least once per 31 days by verifying that each valve (manual, power-operated, or automatic) servicing safety-related equipment that is not locked, sealed, or otherwise secured in position is in its correct position; and

b. At least once per 18 months during shutdown, by verifying that:

1) Each automatic valve servicing safety-related equipment actuates to its correct position on its associated Engineered Safety Feature actuation signal, and

2) Each of the four primary Component Cooling Water System pump starts automatically upon loss of or failure to start of its redundant pump within the loop.