

PSA Applications: Allowed Outage Time (AOT) Extensions for Turkey Point NPP

International Workshop

on

**Use of PSA in Operation of NPPs and in
Regulatory Decision-Making**

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Turkey Point AOT Extensions

Management wished to explore the possibility of increasing equipment AOTs such that more maintenance could be performed on-line

If and Only If

Associated increase in risk was minimal.

Turkey Point AOT Extensions

- Operations decided to pursue AOT extensions for the RHR/LPSI pumps and the EDGs.
- Operations requested the support of the PSA group to prepare risk-informed submittals for the AOT extensions.
- These submittals would go to NRC for their review.

NRC Submittal

- The submittals consisted of several parts:
 - Introduction and Background - why we wanted the extensions.
 - Proposed Tech Spec Changes
 - Justification
 - Design Basis and Safety Analysis Impact
 - Deterministic Assessment
 - Probabilistic Assessment

RHR AOT Extension

- First AOT extension applied for by Turkey Point.
- Extension from 3 days to 7 days.
- Strong deterministic arguments for performing RHR maintenance on-line versus during an outage. Very likely risk-beneficial.
- Good first choice for a risk-informed submittal for an extended AOT.

Relevant Plant Features

- 2 RHR trains for each unit (no crosstie).
- Highly redundant secondary cooling capability
 - 2 MFW pumps per unit
 - 3 shared turbine-driven AFW pumps
 - 2 standby steam generator feedwater pumps
- RHR needed on-line primarily for mitigating large-break LOCAs, and for long-term recirculation cooling for small-break LOCAs.
- 4 HHSI pumps with crosstie between units including the RWSTs.

NRC Guidance Documents

- Regulatory Guide 1.177, NRC Guidance Document for Tech Spec Changes
- Regulatory Guide 1.174, NRC Guidance Document for General PSA Applications

Regulatory Guide 1.177

Three-Tiered Approach

- **Tier 1** - Risk assessment of the proposed AOT
- **Tier 2** - Avoidance of risk-significant configurations
- **Tier 3** - Risk Monitoring

Reg Guide 1.177 (Tier 1)

“.... TS AOT change has only a small quantitative impact on plant risk. An ICCDP or less than $5.0E-7$ is considered small for a single TS AOT change. An ICLERP of $5.0E-08$ or less is also considered small

ICCDP/ICLERP

Incremental Conditional Core Damage Probability

ICCDP = [(CDF with the subject equipment out of service) - (baseline CDF with nominal expected equipment unavailabilities)] * (duration of single AOT under consideration)

Incremental Conditional Large Early Release Probability

ICLERP = [(LERF with the subject equipment out of service) - (baseline LERF with nominal expected equipment unavailabilities)] * (duration of single AOT under consideration)

Corrective/Preventive Cases

Corrective Maintenance (CM)

Maintenance is to fix a component that has failed. For this case, there is a possibility that the redundant component(s) could fail due to the same cause.

Preventive Maintenance (PM)

Component has not failed, but has been taken out of service for preventive maintenance. Risk of failure due to a common cause is much less.

Turkey Point RHR AOT Extension ICCDPs/ICLERPs

<u>Case</u>	<u>ICCDP</u>
Corrective Maintenance (CM)	1.0E-07
Preventive Maintenance (PM)	3.2E-08

<u>Case</u>	<u>ICLERP</u>
Corrective Maintenance (CM)	7.8E-11
Preventive Maintenance (PM)	2.5E-11

Reg Guide 1.174

“When the calculated increase in CDF is very small, which is taken as being less than 10^{-6} per reactor year, the change will be considered regardless of whether there is a calculation of the total CDF....”

“When the calculated increase in LERF is very small, which is taken as being less than 10^{-7} per reactor year, the change will be considered regardless of whether there is a calculation of the total LERF....”

Two Cases

- **Best Estimate** - uses a realistic estimate of how many hours of maintenance time will be transferred from outage to on-line.
- **Upper-Bound Estimate** - uses a bounding value for how many hours of maintenance time will be transferred from outage to on-line.

Increase in CDF and LERF for Best-Estimate Case, Post-AOT Extension

<u>Risk Measure</u>	<u>Absolute Increase</u>	<u>% Increase</u>
CDF	5E-09 per year	0.1%
LERF	2E-11 per year	0.1%

CDFs and LERFs for Upper-Bound Case Post-AOT Extension

<u>Risk Measure</u>	<u>Absolute Increase</u>	<u>% Increase</u>
CDF	7.8E-08 per year	0.9%
LERF	5.0E-11 per year	0.2%

Reg Guide 1.177 (Tier 2)

- “The licensee has demonstrated that there are appropriate restrictions on dominant risk-significant configurations associated with the change....”
- No Tier 2 restrictions were deemed necessary for the RHR AOT extension.

Reg Guide 1.177 (Tier 3)

“The licensee has implemented a risk-informed plant configuration control program. The licensee has implemented procedures to utilize, maintain, and control such a program....”

- Addressed by the configuration risk management program (CRMP) implemented in response to Section (a)(4) of the Maintenance Rule.

RHR AOT Extension Chronology

- 10/00 Turkey Point submits request for RHR AOT extension from 3 days to 7 days.
- 4/01 One-time extension is granted.

EDG AOT Extension

- Second AOT extension applied for by Turkey Point .
- Extension from 3 days to 14 days.
- Deterministic arguments for performing EDG maintenance on-line versus during an outage not as strong as for RHR.

Relevant Plant Features

- 4 EDGs for 2 units
- Any one EDG can successfully power two 4160V Safety buses.
- EDGs can be connected between units using the SBO crosstie.
- 3 shared turbine-driven AFW pumps
- Diesel-driven standby SG feedwater pump

Turkey Point EDG AOT Extension ICCDPs/ICLERPs

<u>Case</u>	<u>ICCDP</u>
Corrective Maintenance (CM)	4.4E-07
Preventive Maintenance (PM)	3.2E-07

<u>Case</u>	<u>ICLERP</u>
Corrective Maintenance (CM)	3.4E-10
Preventive Maintenance (PM)	2.5E-10

Increase in CDF and LERF for Best-Estimate Case, Post-AOT Extension

<u>Risk Measure</u>	<u>Absolute Increase</u>	<u>% Increase</u>
CDF	1.4E-07 per year	1.6%
LERF	1.2E-10 per year	0.3%

Increase in CDF and LERF for Upper Bound Case, Post-AOT Extension

<u>Risk Measure</u>	<u>Absolute Increase</u>	<u>% Increase</u>
CDF	3.4E-07 per year	3.8%
LERF	2.5E-10 per year	0.7%

Tier 2 - Analysis of Other Configurations

- Two EDGs out of service, one from each unit, at the same time
- One EDG and the Station Blackout Crosstie out of service at the same time
- One EDG and the Startup Transformer out of service at the same time

ICCDPs/ICLERPs for Two EDGs OOS, One on Each Unit

<u>Case</u>	<u>ICCDP</u>
Corrective Maintenance (CM)	8.6E-07
Preventive Maintenance (PM)	6.0E-07

<u>Case</u>	<u>ICLERP</u>
Corrective Maintenance (CM)	6.6E-10
Preventive Maintenance (PM)	4.5E-10

ICCDPs/ICLERPs for One EDG and SBO Crosstie OOS

<u>Case</u>	<u>ICCDP</u>
Corrective Maintenance (CM)	6.9E-06
Preventive Maintenance (PM)	4.5E-06

<u>Case</u>	<u>ICLERP</u>
Corrective Maintenance (CM)	5.2E-09
Preventive Maintenance (PM)	3.4E-09

ICCDPs/ICLERPs for One EDG and Startup Transformer OOS

<u>Case</u>	<u>ICCDP</u>
Corrective Maintenance (CM)	3.9E-05
Preventive Maintenance (PM)	3.5E-05

<u>Case</u>	<u>ICLERP</u>
Corrective Maintenance (CM)	3.0E-08
Preventive Maintenance (PM)	2.6E-08

External Events

Fire

- Analysis showed ICCDP $< 1E-07$, ICLERP $< 1E-08$ due to fire.

External Floods / High Winds

- Qualitative discussion regarding precautionary steps taken in preparation for severe weather

Reg Guide 1.177 (Tier 2)

- “The licensee has demonstrated that there are appropriate restrictions on dominant risk-significant configurations associated with the change....”

Tier 2 Restrictions

- If an EDG is unavailable, an EDG on the opposite unit will be removed from service only for corrective maintenance, i.e., maintenance required to ensure or restore operability.
- If the blackout crosstie is unavailable, an EDG will be removed from service only for corrective maintenance, i.e., maintenance required to ensure or restore operability.
- If an EDG is unavailable, the blackout crosstie will be removed from service only for corrective maintenance, i.e., maintenance required to ensure or restore operability.
- If a condition is entered in which both an EDG and the blackout crosstie are unavailable at the same time, restore the EDG or blackout crosstie to service as soon as possible.

Tier 2 Restrictions (cont.)

- If an EDG is unavailable, the startup transformer will be removed from service only for corrective maintenance, i.e., maintenance required to ensure or restore operability.
- If the startup transformer is unavailable, an EDG will be removed from service only for corrective maintenance, i.e., maintenance required to ensure or restore operability.

Tier 2 Restrictions for External Events

- If a hurricane warning has been issued in an area which may impact the FPL grid, i.e., within the FPL service area, an EDG or the blackout crosstie will be removed from service only for corrective maintenance, i.e., maintenance required to ensure or restore operability.
- If an EDG or the blackout crosstie is unavailable when a hurricane warning in an area that may impact the FPL grid is issued, the unavailable component(s) will be restored to service as soon as possible.

Tier 2 Restrictions for External Events

- If a tornado warning has been issued for an area which includes the Turkey Point Plant site, and/or the substations and transmission lines serving the Turkey Point Plant switchyard, an EDG or the blackout crosstie should be removed from service only for corrective maintenance, i.e., maintenance required to ensure or restore operability.
- If an EDG or the blackout crosstie is unavailable when a tornado warning is issued for an area which includes the Turkey Point Plant site, and/or the substations and transmission lines serving the Turkey Point Plant switchyard, restore the unavailable component(s) to service as soon as possible.

Tier 2 Restrictions for External Events (OOS Time > 72 hours)

- Conduct a plant fire protection walkdown of the areas that could impact EDG availability, offsite power availability or the ability to use the station blackout crosstie to entering the extended AOT,
- Perform a thermographic examination of high risk potential ignition sources in the cable spreading room and the control room,
- Restrict planned hot work in the cable spreading room and control room during the extended AOT; and
- Establish a continuous fire watch in the cable spreading room when in the extended AOT.

Reg Guide 1.177 (Tier 3)

“The licensee has implemented a risk-informed plant configuration control program. The licensee has implemented procedures to utilize, maintain, and control such a program....”

- Addressed by the configuration risk management program implemented in response to Section (a)(4) of the Maintenance Rule.

EDG AOT Extension Chronology

- 7/99 Turkey Point requests a one-time extension to the Unit 3 EDG AOT from 3 days to 7 days in order to replace the radiator assemblies.
- 10/99 One-time extension is granted.
- 3/01 Turkey Point submits request for EDG AOT Extension from 3 days to 14 days.
- 8/01 Turkey Point receives SER for EDG AOT Extension.

Lessons Learned

- ICCDP will almost certainly be the most limiting factor.
- If you have any weaknesses in your case for the extended AOT, use Tier 2 restrictions to address the weaknesses.
- If you have other pending AOT extensions, do an analysis of the cumulative effect.

Questions?