# Final Precursor Analysis

Accident Sequence Precursor Program --- Office of Nuclear Regulatory Research

**June 19, 2006**

| **Indian Point Generating Plant, Unit 2** | **Inoperable Train of ECCS Caused by Inoperable Safety Injection Pump** | |
|---|---|---|
| **Event Date: January 28, 2005** | **Licensee Event Reports (LER) - 247-2005-002-00 (LER) - 247-2005-001-01** | **ΔCDP = 3.5E-6** |

## Operating Condition Summary

Operating reactor problem 1 - On January 27, 2005, the licensee for Indian Point Unit 2 determined that the high pressure injection (HPI) 23 pump was inoperable for some duration due to gas accumulation in the common suction line of the safety injection (SI) system (Reference 1). This safety determination was based on a finding that a leakage from safety injection accumulator 24 into the suction and discharge piping of the SI system was first discovered and documented in a condition report on November 21, 2004. The finding represented an actual loss of safety function of a single train with HPI pump 23 for greater than the facility technical specifications-allowed outage time. On January 28, 2005, the licensee corrected the inoperable condition by venting the common suction line and the pump casing. The licensee also added a plant improvement (e.g., a new isolation check valve to terminate the accumulator 24 back leakage).

Because USNRC inspectors found that a violation of 10 CFR PART 50, Appendix B, Criterion XVI, “Failure to promptly identify and correct Emergency Core Cooling System (ECCS)-related safety problems and deviations ... ”, Region I generated and issued an inspection report (Reference 2). Later, Office of Enforcement issued a final significance determination process (SDP) finding letter (Reference 3) to the licensee for the same event.

Operating reactor problem 2 - On January 19, 2005, during a quarterly surveillance test of the 21 Auxiliary Component Cooling Water (ACCW) Pump, the 22 ACCW Pump discharge check valve (755A) failed to seat resulting in reverse flow through the 22 ACCW Pump. Engineering determined on February 9, 2005, that operability of valve 755A could not be positively demonstrated after the valve's maintenance in November 2004. The last successful performance of the quarterly surveillance test for the 22 ACCW pump was on October 14, 2004.

**Cause.** SI pump 23 failure - A failure mode involving a pre-existing leakage from safety injection accumulator 24 into the suction and discharge piping of the SI system existed since November 21, 2004. The leaking gas migrated from the common suction line into the pump casing which prohibited SI pump 23 to start on demand during testing. Another contributing

failure cause of this event was that the licensee failed to implement lessons learned from the industry operating experience related to the ECCS inoperability.

ACCW check valve 755A failure - The cause of the event was interference in the 22 ACCW discharge check valve hinge bushing/pin interface. The apparent cause was inadequate maintenance due to either damage during valve reassembly from a 10 year inspection in November 2004, or the relocation of an undetected pre-existing flaw to a more problematic location during or following the November 2004 reassembly. Contributing causes were insufficient valve maintenance procedure, wrong plug gasket, and inadequate post work test. Significant corrective actions included valve disassembly, repair, gasket replacement and verification of freedom of movement of the disc.

**Condition duration.**

Problem 1- On December 24, 2004, the licensee found that the HPI 23 pump failed to start on demand due to accumulated gas in the suction piping. The licensee removed gas accumulation problem by venting the suction piping and the pump casing on January 28, 2005. The HPI 23 pump was started successfully and declared to be operable. An operating problem existed for a duration of 17 days ( January 11, 2005 thru January 28, 2005. This problem was documented in LER 247-2005-002-00 (Reference 1).

Problem 2- The licensee also found that a different operating problem involving a failure of the Auxiliary Component Cooling Water (ACCW) Train B pump 21 discharge check valve 755A failure-to-open also existed during the overlapping operating period of the HPI pump 23 failure event. The CCW 755A check valve failure event existed during a period of 61 days between November 19, 2004 and January 19, 2005. This problem was documented in LER 247-2005-001-01 (Reference 1). Drawing details related to check valve 755A is shown in Figure 2. The reverse flow caused by the failure of check valve 755A to seat was not modeled in the SPAR3 model. The effect of the failure would be the unavailability of the CCW train that includes ACCW pump 21 and check valve 755B. The failure effect would be identical to check valve 755B failing to open (basic event CCW-CKV-CC-755B), and therefore this condition was modeled by setting CCW-CKV-CC-755B to TRUE. Throughout the rest of this document, the condition affecting check valve 755A is discussed in terms of the basic event CCW-CKV-CC-755B.

Since these 2 operating reactor problems extended and overlapped over a period of 70 days, an attempt was made to separate 2 problems into 3 continous operating conditions. Each of these 3 operating conditions existed during a separate and continuous time window interval. The separated operating conditions are summarized below:

Operating condition 1 - Time interval 11/19/2004 thru 01/11/2005 - The CCW pump 21 check valve 755B fail-to-open event existed. Condition duration was 53 days.

Operating condition 2 - Time interval 01/11/2005 thru 01/19/2005 - Both the CCW pump 21 check valve 755B fail-to-open event and a potential for start-failure of the HPI 23 pump on demand due to gas voids existed. Condition duration was 8 days.

Operating condition 3 - Time interval 01/19/2005 thru 01/28/2005 - A potential for start-failure of the HPI 23 pump on demand due to gas voids existed. Condition duration was 9 days.

**Recovery opportunity.** Given a steam generator tube rupture (SGTR) event, a small LOCA event, a transient, or a loss of offsite power event, the inoperable HPI 23 pump would not have been recovered since the licensee could not have accomplished in a timely manner venting of the ECCS common suction line.

## Analysis Results

- **Importance**[1]

3 operating conditions were identified during a period of 70 days from November 19, 2004 thru January 28, 2005. These 3 operating conditions were observed during a period of 3 continuous time window intervals (11/19/2004 thru 1/11/2005, 1/11/2005 thru 1/19/2005, and 1/19/2005 thru 1/28/2005). A description of these 3 operating conditions and corresponding time intervals is documented in Table 6. Table 6 also lists condition duration for each operating condition (in days) and applicable analyses (analysis ID in cells) for each operating condition. One nominal case and 4 sensitivity cases were identified to bound the importance results of the 70-day operating reactor problem. 4 sensitivity cases were established based on the assumption of an assigned failure probability that HPI pumps 21 and 22 would have failed given a HPI pump 23 failure event. Table 6 also lists the nominal case and 4 sensitivity cases (in columns). Each analysis ID was evaluated for increase in core damage probability (importance) result. Table 7 documents importance results for 3 operating conditions by analysis ID for the nominal case and 4 sensitivity cases. Importance results for 3 operating conditions (a duration of 70 days) were added for each of 5 cases. The importance results are:

| | |
|---|---|
| Importance for nominal case | = 7.63E-07 |
| Importance for sensitivity case- 1 | = 1.17E-05 |
| Importance for sensitivity case- 2 | = 6.29E-06 |
| Importance for sensitivity case- 3 | = 3.49E-06 |
| Importance for sensitivity case- 4 | = 1.45E-06 |

Sensitivity case- 3 is considered to be the most realistic case (“Best case”) than the other cases. The nominal case represents the lowest credible outcome, and sensitivity case 1 represents the worst outcome.

Uncertainty results for Sensitivity case 3 were estimated based on the uncertainty analysis results of 3 contributing operating conditions. The 5% value, mean value, and 95% value were estimated to be 1.1E-7, 4.7E-6, and 2.0E-5 respectively (Table 5).

- **Dominant sequence**

[1] Since this condition did not involve an actual initiating event, the parameter of interest is the measure of the incremental change between the conditional probability for the period in which the condition existed and the nominal probability for the same period but with the condition nonexistent and plant equipment available. This incremental change or “importance” is determined by subtracting the CDP from the CCDP. This measure is used to assess the risk significance of hardware unavailabilities especially for those operating conditions where the baseline CDP is high with respect to the incremental change of the conditional probability caused by the hardware unavailability.

For sensitivity case 3, the dominant sequence is a steam generator tube rupture (SGTR) event followed by successful reactor trip, successful Auxiliary Feed Water system to steam generators, failure of the High Pressure Injection system, successful isolation of broken steam generator, successful secondary cooldown, and failure of RCS depressurization for low pressure injection system.

Sequence SGTR-23; Importance was estimated to be 1.9E-6. The events and important system failures in this sequence were as follows:

- Initiating event (SGTR)
- Mitigating system failures and successes
    - successful reactor trip
    - successful Auxiliary Feed Water system
    - failures of the High Pressure Injection system
    - successful isolation of broken steam generator
    - successful secondary cooldown
    - and failure of RCS depressurization for low pressure injection system
- Onset of potential core damage

Paths for dominant sequence SGTR-23 is shown Figure 1.

- **Results tables**

  – Table 1 provides the conditional probabilities for 2 dominant sequences (case 3).
  – Table 2a provides the event tree sequence logic for the dominant sequences listed in Table 1.
  _ Table 2b provides the definitions of fault trees used in event tree logic listed in Table 2a.
  – Table 3 provides the conditional (CCDP) cut sets for 2 dominant sequences (Case 3).
  – Table 4 provides the definitions and probabilities for added basic events and condition-affected basis events.

## Modeling Assumptions

- **Assessment summary**

Assessment type - The licensee found two separate operating reactor problems in safety-related components and documented them in 2 separate LERs.

Since 2 separate operating reactor problems extended and overlapped over a period of 70 days, an attempt was made to separate 2 problems into 3 continous operating conditions. Each of these 3 operating conditions existed during a separate and continuous time window interval. The separated operating conditions are summarized below:

Operating condition 1 - Time interval 11/19/2004 thru 01/11/2005 - The CCW pump 21 check valve 755B fail-to-open event existed. Condition duration was 53 days.

Operating condition 2 - Time interval 01/11/2005 hru 01/19/2005 - Both the CCW pump 21 check valve 755B fail-to-open event and a potential for start-failure of the HPI 23 pump on demand due to gas voids existed. Condition duration was 8 days.

Operating condition 3 - Time interval 01/19/2005 thru 01/28/2005 - Only, a potential for start-failure of the HPI 23 pump on demand due to gas voids existed. Condition duration was 9 days.

Since no other initiating events (e.g., loss of offsite power) occurred during the 70-days period, 3 separate conditions assessments (Time-window A, Time-window B, Time-window C) were performed in estimating the importance due to these 3 operating conditions. Importance due to these 3 operating conditions were added to estimate the importance of the 70-day operating problem (referred to as “Nominal case”). In this nominal case, HPI pumps 21 and 22, given the failure of the HPI 23 pump start-failure event, were assumed to succeed in providing coolant makeup to the reactor coolant system.

Condition modeling and related assumptions-

1. For SGTR and SLOCA events, a safety injection (SI) signal would have been generated and started all 3 HPI pumps automatically. The HPI 23 pump would have failed due to accumulated gas voids. The remaining pumps (HPI pumps 21 and 22) could have failed or succeeded in starting for coolant makeup to the reactor coolant system. If the remaining pumps would have also failed due to the same accumulated gas voids, then the operators might have tried to recover locally. Timely pump-start recovery would have also failed since LOCA conditions would have demanded prompt coolant makeup to the reactor coolant system.

Model use - The Revision 3.31 Standardized Plant Analysis Risk (SPAR) model for Indian Point Generating Plant, Unit 2 (Reference 4) was used for condition assessments performed under this precursor analysis.

- Model update to Revision 3.31 SPAR model

  No model change was performed to Revision 3.31 SPAR model for Indian Point Generating Plant, Unit 2.

- Sensitivity Assessment

  The licensee did not document their bases in the LER that HPI pumps 21 and 22 would have succeeded and provided adequate flow to the reactor coolant system, given a HPI pump 23 failure event due to gas accumulation problem. So, a few possible alternate analysis cases (4 sensitivity cases) were thought in estimating the importance due to the 70-day operating reactor problem.

  4 sensitivity cases were identified to bound the importance results of each operating condition. 4 sensitivity cases were identified based on the assumption of an assigned failure probability that HPI pumps 21 and 22 would have failed given a HPI pump 23 failure event. The 4 sensitivity case are:

Sensitivity case- 1 - A failure probability of 1.0 was assigned for start-failure of HPI pumps 21 and 22 (1.0 probability for each of the remaining pumps).

Sensitivity case- 2 - A failure probability of 0.5 was assigned for start-failure of HPI pumps 21 and 22 (0.706 probability for each of the remaining pumps).

Sensitivity case- 3 - A failure probability of 0.25 was assigned for start-failure of HPI pumps 21 and 22 (0.5 probability for each of the remaining pumps).

Sensitivity case- 4 - A failure probability of 0.0625 was assigned for start-failure of HPI pumps 21 and 22 (0.25 probability for each of the remaining pumps).

Table 6 lists these 4 sensitivity cases (in columns), including the nominal case for which the nominal failure probability was assigned for failure of HPI pumps 21 and 22. For each sensitivity case, the importance for each of 3 operating conditions was estimated. Importance results for 3 operating conditions (a duration of 70 days) were added for each case.

Table 7 documents importance results for 3 operating conditions by analysis ID for nominal case and 4 sensitivity cases. Importance results for 3 operating conditions (a duration of 70 days) were added for each case. The importance results are:

Importance for Nominal case- 1 = 7.63E-07
Importance for Sensitivity case- 1 = 1.17E-05
Importance for Sensitivity case- 2 = 6.29E-06
Importance for Sensitivity case- 3 = 3.49E-06
Importance for sensitivity case- 4 = 1.45E-06

- Basic event probability changes

Table 4 provides the basic events that were modified to reflect 3 operating conditions. The bases for these changes are as follows:

HPI-MDP-FS-23 (FAILURE OF HPI MDP-23 TO START)- This was set to TRUE for operating condition 2 and operating condition 3. HPI pump 23 would have been inoperable for nominal case and all 3 sensitivity cases. The gas voids accumulated in the common suction line would have prevented the pump from starting.

Nominal case- TRUE was assigned for start-failure of HPI pump 23.
Sensitivity case- 1 - TRUE was assigned for start-failure of HPI pump 23.
Sensitivity case- 2 - TRUE was assigned for start-failure of HPI pump 23.
Sensitivity case- 3 - TRUE was assigned for start-failure of HPI pump 23.
Sensitivity case- 4 - TRUE was assigned for start-failure of HPI pump 23.

HPI-MDP-FS-21 (FAILURE OF HPI MDP-21 TO START)-
Basic event probability was changed for operating condition 2 and operating condition 3:

Nominal case- HPI pump 21 was not affected.

Sensitivity case- 1 - a failure probability of 1.0 was assigned for start-failure of HPI pump 21.
Sensitivity case- 2 - a failure probability of 0.706 was assigned for start-failure of HPI pump 21.
Sensitivity case- 3 - a failure probability of 0.5 was assigned for start-failure of HPI pump 21.
Sensitivity case- 4 - a failure probability of 0.25 was assigned for start-failure of HPI pump 21.

HPI-MDP-FS-22 (FAILURE OF HPI MDP-22 TO START)-
Basic event probability was changed for operating condition 2 and operating condition 3:

Nominal case- HPI pump 22 was not affected.
Sensitivity case- 1 - a failure probability of 1.0 was assigned for start-failure of HPI pump 22.
Sensitivity case- 2 - a failure probability of 0.706 was assigned for start-failure of HPI pump 22.
Sensitivity case- 3 - a failure probability of 0.5 was assigned for start-failure of HPI pump 22.
Sensitivity case- 4 - a failure probability of 0.25 was assigned for start-failure of HPI pump 22.

CCW-CKV-CC-755B (FAILURE OF ACCW DISCHARGE CHECK VALVE FAILS TO OPEN) - This was set to TRUE to reflect the failure of the Aux. 1 train of the CCW system for operating condition 1 and operating condition 2.

Nominal case- TRUE
Sensitivity case- 1 - TRUE.
Sensitivity case- 2 - TRUE.
Sensitivity case- 3 - TRUE.
Sensitivity case- 4 - TRUE.

- Selecting a Best Case-

The RES staff completed an assessment of GSI-193. As part of GSI-193 resolution, the staff evaluated an assessment of the start-failure probability a high pressure emergency core cooling pump (e.g., the HPI 23 pump ) on demand. The staff evaluated also the conditional failure probability of the remaining pumps (HPI pumps 21 and 22) given the start-failure of one HPI pump on demand due to gas accumulation in the suction piping. The staff's findings were documented in NUREG/CR-2792, "An Assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions". NUREG/CR-2792 documented a pump performance curve (void fraction Versus pump failure probability) in displaying the pump failure characteristics during gas ingestion. This report indicated that the pump would fail at 15% void fraction and more. The curve assumed a linear-increase in pump failure probability from 0.0 to 1.0 between 2% and 15% gas void fraction. The pump would not fail at void fraction of 2% or below. The pump failure characteristics during air/gas ingestion is shown in Table 8.

Since a variation in conditional failure probability of the remaining HPI pumps existed given a HPI pump 23 failure event, a sensitivity assessment was performed. 4 sensitivity cases were identified to bound the importance risk results of 3 operating conditions over a period of 70 days. Inputs to these 4 sensitivity cases were based on 4 selected inputs for the pump failure probabilities at 4 corresponding values of gas void fraction of the pump performance curve (independent variable).

The licensee did not document in their LER the amount of gas ingestion level from the accumulator check valve leakage when HPI pump 23 was tested and found to be inoperable. The LER documented that some gas ingestion level was observed in suction lines of HPI pumps 21 and 22. Region I noted in their inspection report that the HPI pump vendor at Indian Point Unit 2 established a failure criterion that the HPI pump would start failing when ingestion level (gas by volume) due to accumulator check value failure would accumulate at 5% or more. This 5% ingestion level corresponded to a failure probability of 0.25 for the remaining HPI pumps (two pumps). Sensitivity case- 3 assessment uses an assumed input value of 0.25 failure probability for the remaining two HPI pumps (a probability of 0.5 for each of the two remaining pumps). So, sensitivity case- 3 is considered to be a more realistic case (“Best case”) to represent the 70-day operating condition than the other sensitivity cases, including the nominal case.

- <u>Uncertainty analysis and range for total importance due to operating condition-</u>

The parameter estimates and the uncertainties regarding the numerical estimates of the parameters used in the model (parameter uncertainty) are calculated. These data and uncertainty distributions are then propagated through the modified version of the Revision 3.31 SPAR model for Indian Point Generating Plant, Unit 2 (Reference 4) to produce uncertainty estimates.

Uncertainty analysis of the operating condition along with parameters was performed using the SAPHIRE code (Version 7.26). Default distribution types for applicable initiating events (e.g. steam generator tube rupture event) and basic events for components were documented in the Revision 3.31 SPAR model for Indian Point Generating Plant, Unit 2. These uncertainty estimates and applicable uncertainty estimates for condition-affected basic events (HPI punps 21 and 22) were used in estimating mean condition-CDP values and mean condition-CCDP values. Other statistical values such as point estimates, 5% estimates, and 95% estimates were also calculated for CDP and CCDP analysis cases. Estimated statistical values for sensitivity case 3 are shown in Table 5.

## References


1 Entergy Nuclear North East, "Technical Specifications Prohibited Condition Due to Exceeding the Allowed Completion Time for One Inoperable Train of ECCS Caused by inoperable Safety Injection Pump - Licensee Event Report 2005-002-00", dated April 14, 2005. ADAMS ACCESSION NUMBER ML051180141

Entergy Nuclear North East, "Technical Specification Prohibited Condition Due to Exceeding the Allowed Completion Time for One Inoperable Train of ECCS Caused by an Inoperable Auxiliary Component Cooling Water Check Valve 2 - Licensee Event Report 2005-001-01", dated August 03, 2005. ADAMS ACCESSION NUMBER ML052220118

2 USNRC, Region I, "INDIAN POINT GENERATING PLANT, UNIT 2, NRC INSPECTION REPORT 050002472005006" dated June 17, 2005. ADAMS ACCESSION NUMBER ML051680119

3 USNRC Office of Enforcement, "FINAL SIGNIFICANCE DETERMINATION FOR A WHITE FINDING (NRC Engineering Team Inspection Report 05000247/2005006) Indian Point Nuclear Generating Unit 2 - EA-05-102" dated August 1, 2005. ADAMS ACCESSION NUMBER ML052130518

4 John Polosi, et al., "Standardized Plant Analysis Risk (SPAR) Model for Indian Point Generating Plant, Unit 2 (ASP PWR-B)" by Idaho National Engineering and Environmental Laboratory, Version 3.31, dated 5/10/2006.

Table 1. Conditional probabilities (point values) for dominant sequences

| Event tree name | Sequence no. | Conditional core damage probability (CCDP) | Core damage probability (CDP) | Importance (CCDP - CDP)[2] |
|---|---|---|---|---|
| SGTR | 23 | 1.9E-6 | 9.8E-10 | 1.9E-6 |
| SGTR | 21 | 2.3E-7 | 1.1E-10 | 2.3E-7 |
| Total (all sequences)[1] | | 5.2E-6 | 1.7E-6 | 3.5E-6 |

Notes:
1. Total CCDP and CDP includes all sequences (including those not shown in this table).
2. Importance is calculated using the total CCDP and total CDP from all sequences of all applicable event trees. Sequence level importance measures are not additive.
3. Dominant sequences and probabilities are listed for sensitivity case 3.

**Table 2a.** Event tree sequence logic for dominant sequences

| Event tree name | Sequence No. | Logic<br>("/" denotes success; see Table 2b for top event names) |
|---|---|---|
| SGTR | 23 | (/RPS) * (/AFW) * (HPI) * (/SGI1) * (/SSC) * (PZR1) |
| SGTR | 21 | (/RPS) * (/AFW) * (HPI) * (/SGI1) * (/SSC) * (/PZR1) * (/LTHR) * (RHR) |

**Table 2b.** Definitions of fault trees used in event tree logic listed in Table 2a

| | |
|---|---|
| SGTR | STEAM GENERATOR TUBE RUPTURE |
| RPS | REACTOR TRIP FAILS |
| AFW | AUXILIARY FEEDWATER |
| HPI | HIGH PRESSURE INJECTION |
| SGI1 | FAILURE TO ISOLATE FAULTED STEAM GENERATOR |
| SSC | SECONDARY SIDE COOLDOWN |
| PZR1 | RCS DEPRESS. FOR LPI (PORVs, ETC. ) |
| LTHR | ALTERNATE LONG TERM HEAT REMOVAL |
| RHR | RESIDUAL HEAT REMOVAL |

Notes:
1. "/" Iindicates that top event is a success event in the event tree logic.

**Table 3a. CCDP cut sets for SGTR Sequence 23**

| CCDP | Percent contribution | Minimal cut sets[1] |
|---|---|---|
| **Event Tree: SGTR, Sequence 23** | | |
| **4.000E-5** | **100.00** | **HPI-MDP-FS-21 * HPI-MDP-FS-33 * OPR-XHE-XM-RDEP1** |
| | | |
| **4.200E-5** | Total[2] | |

**Table 3b. CCDP cut sets for SGTR Sequence 21**

| CCDP | Percent contribution | Minimal cut sets[1] |
|---|---|---|
| **Event Tree: SGTR, Sequence 21** | | |
| **1.000E-6** | **19.90** | **HPI-MDP-FS-21 * HPI-MDP-FS-33 * LPI-MOV-OO-882** |
| **1.000E-6** | **19.90** | **HPI-MDP-FS-21 * HPI-MDP-FS-33 * LPI-MOV-CC-730** |
| **4.700E-7** | Total[2] | |

1. See Table 4 for definitions and probabilities for the basic events.
2. Total CCDP includes all cut sets (including those not shown in this table). CCDP and total CCDP are expressed in events per year
3. Dominant sequences, sequence cutsets, and cutset probabilities are listed for sensitivity case 3.

Table 4 - Definitions and probabilities for added basic events and condition-affected basis events

| Basic event name | Description | Added to base Model | Probability | Modified to reflect condition | Note |
|---|---|---|---|---|---|
| SGTR | STEAM GENERATOR TUBE RUPTURE | NO | 4.000E-3 | NO | Note 1 |
| OPR-XHE-XM-RDEP1 | OPERATOR FAILS TO RAPIDLY DEPRESSURIZE RCS | NO | 4.000E-2 | NO | |
| LPI-MOV-OO-882 | RHR RWST SUCTION MOV (882) FAILS TO CLOSE | NO | 1.000E-3 | NO | |
| LPI-MOV-CC-730 | FAILURE OF RHR SUCTION MOV 730 | NO | 1.000E-3 | NO | |
| HPI-MDP-FS-21 | FAILURE OF HPI MDP-21 TO START | NO | Note 4 | YES | Note 2 |
| HPI-MDP-FS-22 | FAILURE OF HPI MDP-22 TO START | NO | Note 4 | YES | Note 2 |
| HPI-MDP-FS-23 | FAILURE OF HPI MDP-23 TO START | NO | TRUE | YES | Note 2 |
| CCW-CKV-CC-755B | FAILURE OF ACCW DISCHARGE CHECK VALVE 755B FAILS TO OPEN | NO | TRUE | YES | Note 3 |

NOTE:
1. Initiating event frequency is in units of event per year.

2. Basic event probability was changed to reflect the operating conditions 2 and 3. Bases for change was documented in Basic event probability changes section of this report.

3. Basic event was set to TRUE for operating conditions 1 and 2. Bases for change was documented in Basic event probability changes section of this report.

4. Basic event probability was assigned a value depending on the sensitivity case. Table 6 documented these values.

**Table 5 - Uncertainty estimates for the operating condition**

**Plant: Indian Point Generating Plant, Unit 2**
**IR ID: 0500002472005006**
**SDP: EA-05-012**
**LER ID : 247-2005-002-00**

**Analysis type = Monte Carlo**
**Samples = 10000; Seeds = 97453**

| Case- 3 | probability | duration (Days) | duration (Hours) | Point estimate | Mean estimate | 5% estimate | 50% estimate | 95% estimate |
|---|---|---|---|---|---|---|---|---|
| Case- 3 - Baseline | CDP for 1 year | 365 | 8760 | 9.0E-06 | 8.6E-06 | 1.5E-06 | 5.2E-06 | 2.6E-05 |
| Case- 3 - Time-Window A | CCDP for 1 year | 365 | 8760 | 1.3E-05 | 1.3E-05 | 1.8E-06 | 6.9E-06 | 4.2E-05 |
| Case- 3 - Time-Window B250 | CCDP for 1 year | 365 | 8760 | 7.4E-05 | 9.9E-05 | 3.2E-06 | 2.8E-05 | 4.1E-04 |
| Case- 3 - Time-Window C250 | CCDP for 1 year | 365 | 8760 | 7.0E-05 | 9.5E-05 | 2.7E-06 | 2.4E-05 | 4.0E-04 |
| | | | | | | | | |
| Case- 3 - Time-Window A | Importance for 53 days | 53 | 1272 | 5.9E-07 | 6.1E-07 | 4.0E-08 | 2.5E-07 | 2.3E-06 |
| Case- 3 - Time-Window B250 | Importance for 8 days | 8 | 192 | 1.4E-06 | 2.0E-06 | 3.7E-08 | 5.0E-07 | 8.5E-06 |
| Case- 3 - Time-Window C250 | Importance for 9 days | 9 | 216 | 1.5E-06 | 2.1E-06 | 3.0E-08 | 4.6E-07 | 9.3E-06 |
| Case- 3 - 1680 Hours | Importance for 70 days | 70 | 1680 | 3.5E-06 | 4.7E-06 | 1.1E-07 | 1.2E-06 | 2.0E-05 |

**Table 6 - A list of operating conditions, time interval, analysis ID, and cases studied**

**Plant: Indian Point, Unit 2**
**subject: Combo Operating conditions**
**Year: 2004**

| | | | | | Nominal case | Sensitivity case 1 | Sensitivity case 2 | Sensitivity case 3 | Sensitivity case 4 |
|---|---|---|---|---|---|---|---|---|---|
| Time-interval | operating condition | from | to | duration (days) | nominal failure probability for HPI pumps 21 & 22 given HPI pump 23 failure | probability of 1.0 failure for HPI pumps 21 & 22 given HPI pump 23 failure | probability of 0.5 failure for HPI pumps 21 & 22 given HPI pump 23 failure | probability of 0.25 failure for HPI pumps 21 & 22 given HPI pump 23 failure | probability of 0.0625 failure for HPI pumps 21 & 22 given HPI pump 23 failure |
| 1 | CCW pump 21 CKV-755B inoperability | 11/19/04 | 1/11/05 | 53.00 | Time-window A | Time-window A | Time-window A | Time-window A | Time-window A |
| 2 | CCW pump 21 CKV-755B inoperability & SI pump 23 inoperability & some failure probability for SI Pumps 21 & 22 | 1/11/05 | 1/19/05 | 8.00 | Time-window B | Time-window B1000 | Time-window B500 | Time-window B250 | Time-window B625 |
| 3 | SI pump 23 inoperability | 1/19/05 | 1/28/05 | 9.00 | Time-window C | Time-window C1000 | Time-window C500 | Time-window C250 | Time-window C625 |
| | Combined operating conditions | 11/19/04 | 1/28/05 | 70.00 | | | | | |

**Table 7 - A list of operating conditions and importance results for 5 cases**

**Plant: Indian Point, Unit 2**
**subject: Combo Operating conditions**
**Year: 2004**

| | | | | | Nominal case | Sensitivity case 1 | Sensitivity case 2 | Sensitivity case 3 | Sensitivity case 4 |
|---|---|---|---|---|---|---|---|---|---|
| Time-interval | operating condition | from | to | duration (days) | nominal failure probability for HPI pumps 21 & 22 given HPI pump 23 failure | probability of 1.0 failure for HPI pumps 21 & 22 given HPI pump 23 failure | probability of 0.5 failure for HPI pumps 21 & 22 given HPI pump 23 failure | probability of 0.25 failure for HPI pumps 21 & 22 given HPI pump 23 failure | probability of 0.0625 failure for HPI pumps 21 & 22 given HPI pump 23 failure |
| 1 | CCW pump 21 CKV-755B inoperability | 11/19/04 | 1/11/05 | 53.00 | 5.90E-07 | 5.90E-07 | 5.90E-07 | 5.90E-07 | 5.90E-07 |
| 2 | CCW pump 21 CKV-755B inoperability & SI pump 23 inoperability & some failure probability for SI Pumps 21 & 22 | 1/11/05 | 1/19/05 | 8.00 | 1.30E-07 | 5.30E-06 | 2.70E-06 | 1.40E-06 | 4.50E-07 |
| 3 | SI pump 23 inoperability | 1/19/05 | 1/28/05 | 9.00 | 4.30E-08 | 5.80E-06 | 3.00E-06 | 1.50E-06 | 4.10E-07 |
| | Combined operating conditions | 11/19/04 | 1/28/05 | 70.00 | 7.63E-07 | 1.17E-05 | 6.29E-06 | 3.49E-06 | 1.45E-06 |

**Table 8 - ECC Pump Test Performance Curve**

**Plant: Indian Point Generating Plant, Unit 2**
**IR ID: 0500002472005006**
**SDP: EA-05-012**
**LER ID : 247-2005-002-00**
**Curve: ECC Pump Test Performance Curve (Air Void Fraction Vs Pump Start-Failure Probabiltiy)**

| No. | void fraction ( % ) | probability | remark |
|---|---|---|---|
| 0 | 0.02 | 0.000 | pump would not be expected to fail below this void fraction. |
| 1 | 0.03 | 0.077 | |
| 2 | 0.04 | 0.154 | |
| 3 | 0.05 | 0.231 | this void fraction corresponds to a pump failure criterion recommended by the pump vendor for Indian Point 2. |
| 4 | 0.06 | 0.308 | |
| 5 | 0.07 | 0.385 | |
| 6 | 0.08 | 0.462 | |
| 7 | 0.09 | 0.538 | |
| 8 | 0.1 | 0.615 | |
| 9 | 0.11 | 0.692 | |
| 10 | 0.12 | 0.769 | |
| 11 | 0.13 | 0.846 | |
| 12 | 0.14 | 0.923 | |
| 13 | 0.15 | 1.000 | pump would be expected to fail with 100% certainty above this void fraction. |

Figure 1 - Indian Point Generating Plant, Unit 2 - Steam Generator Tube Rupture Event Tree Showing Sequence 23

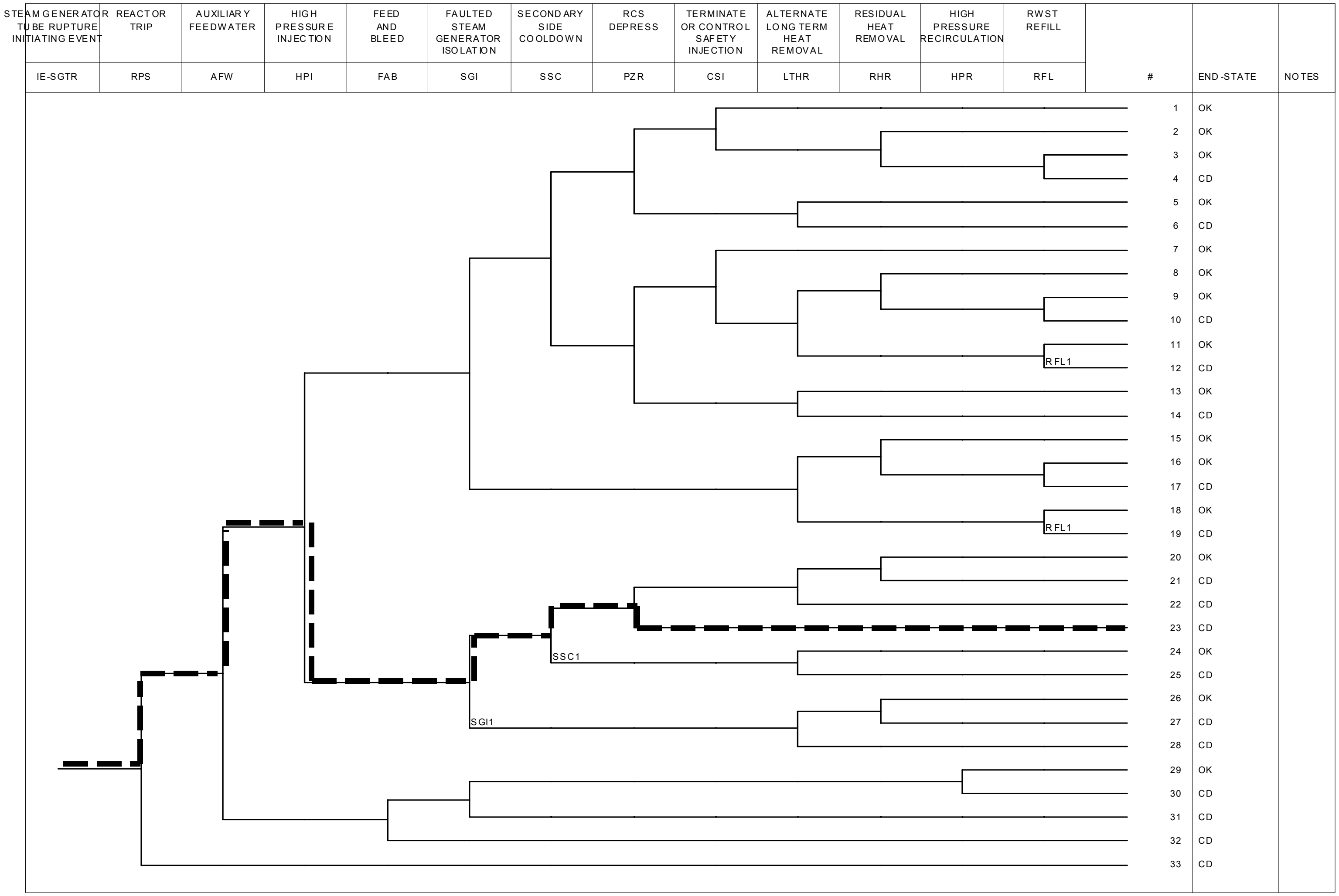


Figure 2 - Indian Point Generating Plant, Unit 2 - Drawing details related to Safety Injection pumps 21, 22 and 23

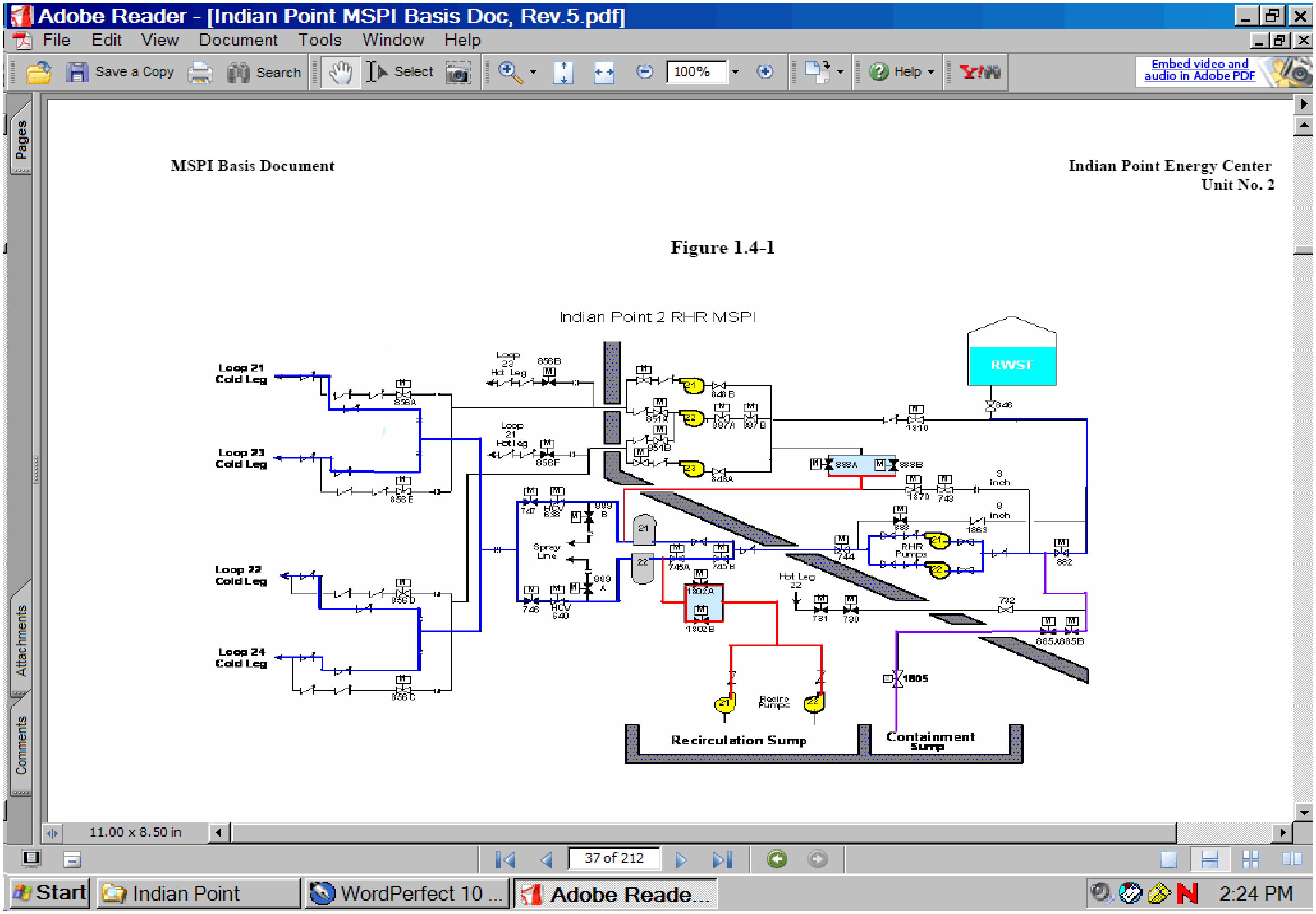
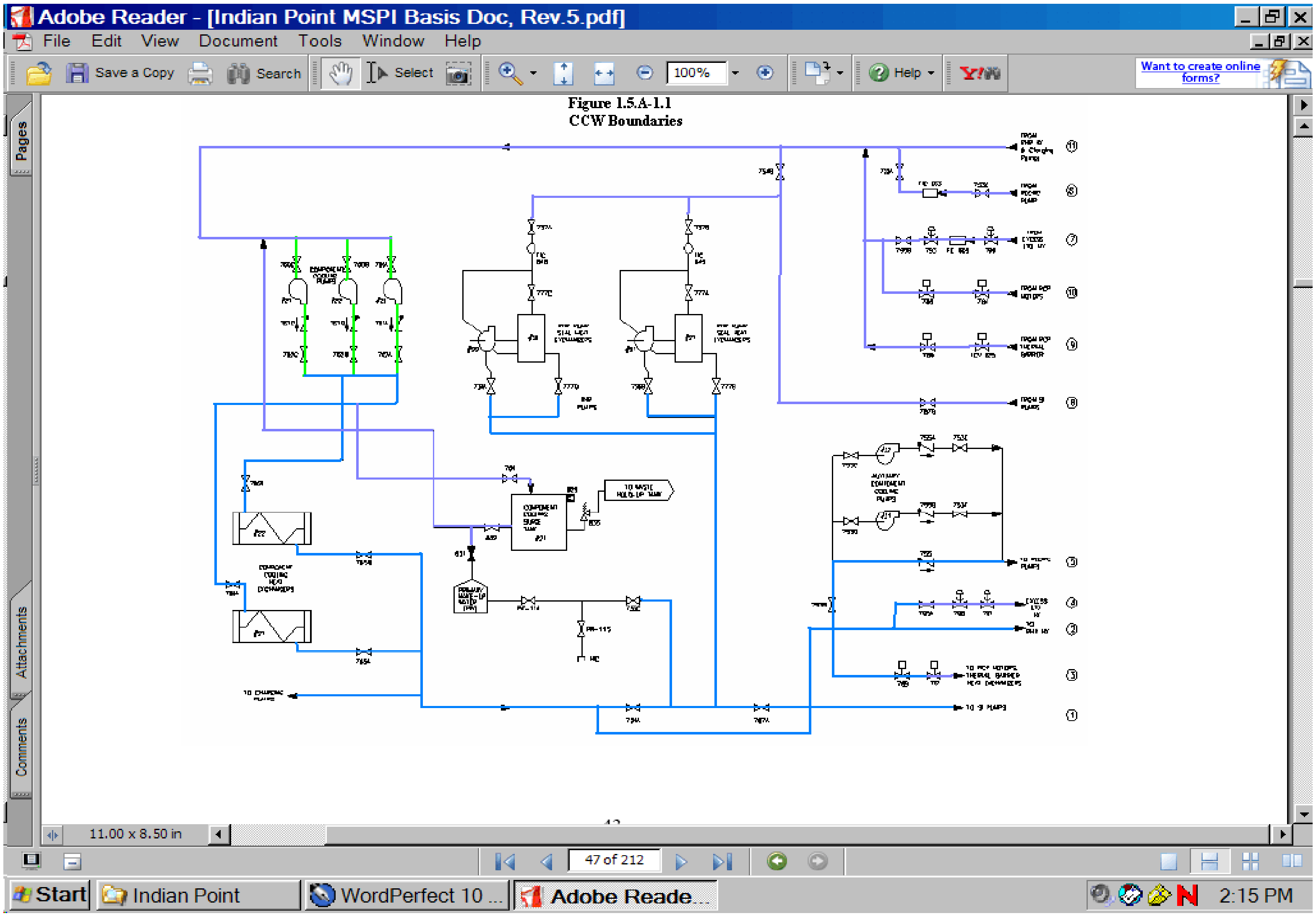


Figure 3 - Indian Point Generating Plant, Unit 2 - Drawing details related to Component Cooling Water pumps 21 and 22 and discharge check valves 755A and 755B



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