

September 27, 2001

Mr. Jeffrey S. Forbes
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SUBJECT: MONTICELLO NUCLEAR GENERATING PLANT - SITE-SPECIFIC
WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY COMMISSION'S
SIGNIFICANCE DETERMINATION PROCESS (TAC NO. MA6544)

Dear Mr. Forbes:

Enclosed please find the Risk-Informed Inspection Notebook which incorporates the updated Significance Determination Process (SDP) Phase 2 Worksheets that inspectors will be using to characterize and risk-inform inspection findings. This document is one of the key implementation tools of the reactor safety SDP in the reactor oversight process and will also be publically available through the Nuclear Regulatory Commission's (NRC's) external website at <http://www.nrc.gov/NRC/IM/index.html>.

The 1999 Pilot Plant review effort clearly indicated that significant site-specific design and risk information was not captured in the Phase 2 worksheets forwarded to you last spring. Subsequently, a site visit was conducted by the NRC to verify and update plant equipment configuration data and to collect site-specific risk information from your staff. The enclosed document reflects the results of this visit.

The enclosed Phase 2 Worksheets have incorporated much of the information we obtained during our site visit. The staff encourages further licensee comments where it is identified that the Worksheets give inaccurately low significance determinations. Any comments should be provided to the Document Control Desk, with a copy to the Chief, Probabilistic Safety Assessment Branch, Office of Nuclear Reactor Regulation. We will continue to assess SDP accuracy and update the document based on continuing experience.

J. Forbes

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While the enclosed Phase 2 Worksheets have been verified by the NRC staff to include the site specific data, we will continue to assess their accuracy throughout implementation and update the document based on comments by our inspectors and your staff.

Sincerely,

/RA/

Carl F. Lyon, Project Manager, Section 1
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-263

Enclosure: Risk-Informed Inspection Notebook

cc w/encl: See next page

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- 2 -

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**RISK-INFORMED INSPECTION NOTEBOOK FOR
MONTICELLO NUCLEAR GENERATING PLANT**

BWR-3, GE, WITH MARK I CONTAINMENT

Prepared by

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NOTICE

This notebook was developed for the NRC's inspection teams to support risk-informed inspections. The "Reactor Oversight Process Improvement," SECY-99-007A, March 1999 discusses the activities involved in these inspections. The user of this notebook is assumed to be an inspector with an extensive understanding of plant-specific design features and operation. Therefore, the notebook is not a stand-alone document, and may not be suitable for use by non-specialists. It will be periodically updated with new or replacement pages incorporating additional information on this plant. All recommendations for improvement of this document should be forwarded to the Chief, Probabilistic Safety Assessment Branch, NRR, with a copy to the Chief, Inspection Program Branch, NRR.

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ABSTRACT

This notebook contains summary information to support the Significance Determination Process (SDP) in risk-informed inspections for the Monticello Nuclear Generating Station.

The information includes the following: Categories of Initiating Events Table, Initiators and System Dependency Table, SDP Worksheets, and SDP Event Trees. This information is used by the NRC's inspectors to identify the significance of their findings, i.e., in screening risk-significant findings, consistent with Phase-2 screening in SECY-99-007A. The Categories of Initiating Event Table is used to determine the likelihood rating for the applicable initiating events. The SDP worksheets are used to assess the remaining mitigation capability rating for the applicable initiating event likelihood ratings in identifying the significance of the inspector's findings. The Initiators and System Dependency Table and the SDP Event Trees (the simplified event trees developed in preparing the SDP worksheets) provide additional information supporting the use of SDP worksheets.

The information contained herein is based on the licensee's Individual Plant Examination (IPE) submittal, the updated Probabilistic Risk Assessment (PRA), and system information obtained from the licensee during site visits as part of the review of earlier versions of this notebook. Approaches used to maintain consistency within the SDP, specifically within similar plant types, resulted in sacrificing some plant-specific modeling approaches and details. Such generic considerations, along with changes made in response to plant-specific comments, are summarized.

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1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

SECY-99-007A (NRC, March 1999) describes the process for making a Phase-2 evaluation of the inspection findings. In Phase 2, the first step is to identify the pertinent core damage scenarios that require further evaluation consistent with the specifics of the inspection findings. To aid in this process, this notebook provides the following information:

1. Estimated Likelihood Rating for Initiating Events Categories
2. Initiator and System Dependency Table
3. Significance Determination Process (SDP) Worksheets
4. SDP Event Trees.

Table 1, Categories of Initiating Events, is used to obtain the estimated likelihood rating for applicable initiating events for the plant for different exposures times for degraded conditions. This Table follows the format of the Table 1 contained in SECY-99-007A. Initiating events are grouped in frequency bins covering one order of magnitude. The table includes the initiating events that should be considered for the plant and for which SDP worksheets are provided. Categorization of the following initiating events is based on industry-average frequency: transients (Reactor Trip) (TRANS); transients without power conversion system (TPCS); large, medium, and small loss of coolant accidents (LLOCA, MLOCA, and SLOCA); inadvertent or stuck open relief valve (IORV or SORV); anticipated transients without scram (ATWS); interfacing systems LOCA (ISLOCA) and LOCA outside containment (LOC). The frequency of the remaining initiating events vary significantly from plant to plant, and accordingly, they are categorized using the plant-specific frequency obtained from the licensee. These initiating events include loss of offsite power (LOOP) and special initiators caused by loss of support systems.

The Initiator and System Dependency Table shows the major dependencies between frontline and support systems, and identifies their involvement in different types of initiators. This table identifies the most risk-significant systems; it is not an exhaustive nor comprehensive compilation of the dependency matrix, as shown in Probabilistic Risk Assessments (PRAs). This table is used to identify the SDP worksheets to be evaluated, corresponding to inspection findings on systems and components.

To evaluate the impact of an inspection finding on the core-damage scenarios, we developed the SDP worksheets. They contain two parts. The first part identifies the functions, the systems, and the combinations thereof that can perform mitigating functions, the number of trains in each system, and the number of trains required (success criteria) for each the initiator. It also characterizes the mitigation capability in terms of the available hardware (e.g., 1 train, 1 multi-train system) and the operator action involved. The second part of the SDP worksheet contains the core-damage accident sequences associated with each initiator; these sequences are based on SDP Monticello

event trees. In the parentheses next to each of the sequences the corresponding event tree branch number(s) representing the sequence is included. Multiple branch numbers indicate that the different accident sequences identified by the event tree are merged into one through the Boolean reduction.

SDP worksheets are developed for each initiating event, including "Special Initiators," which are typically caused by complete or partial loss of support systems. A special initiator typically leads to a reactor scram and degrades some front-line or support systems (e.g., Loss of Service water in BWRs). The SDP worksheets for initiating events that directly lead to core damage are different. Of this type of initiating events, only the interfacing system LOCA (ISLOCA) and LOCA outside containment (LOC) are included. This worksheet identifies the major consequential leak paths and the number of barriers that may fail to cause the initiator to occur.

For the special initiators, we considered those plant-specific initiators whose contribution to the plant's core damage frequency (CDF) is non-negligible and/or have the potential to be a significant contributor to CDF given an inspection finding on system trains and components. We defined a set of criteria for their inclusion to maintain some consistency across the plants. These conditions are as follows:

1. The special initiator should degrade at least one of the mitigating safety functions changing its mitigation capability in the worksheet. For example, a safety function with two redundant trains, classified as a multi-train system, degrades to an one-train system, to be classified as 1 Train, due to the loss of one of the trains as a result of the special initiator.
2. The special initiators, which degrade the mitigation capability of the accident sequences associated with the initiator from comparable transient sequences by two and higher orders of magnitude, must be considered.

Following the above considerations, the classes of initiators that we consider in this notebook are:

1. Transients with power conversion system (PCS) available, called Transients (Reactor trip) (TRANS),
2. Transients without PCS available, called Transients w/o PCS (TPCS),
3. Small Loss of Coolant Accident (SLOCA),
4. Inadvertent or Stuck-open Power Operated Relief Valve (IORV or SORV),
5. Medium LOCA (MLOCA),
6. Large LOCA (LLOCA),
7. Loss of Offsite Power (LOOP)
8. Anticipated Transients Without Scram (ATWS).

Section 1.3 lists the plant-specific special initiators addressed in this notebook. Examples of special initiators are as follows:

1. LOOP with failure of 1 Emergency AC (LEAC) bus or associated EDG (LEAC),

2. LOOP with stuck open SORV (LORV),
3. Loss of 1 DC Bus (LDC),
4. Loss of component cooling water (LCCW),
5. Loss of instrument air (LOIA),
6. Loss of service water (LSW).

The worksheet for the LOOP may include LOOP with emergency AC power (EAC) available and LOOP without EAC, i.e., Station Blackout (SBO). LOOP with partial availability of EAC, i.e., LOOP with loss of a bus of EAC, is covered in a separate worksheet to avoid making the LOOP worksheet too large. LOOP with stuck open SORV is also covered in a separate worksheet, when applicable. In some plants, LOOP with failure of 1 EAC bus and LOOP with stuck-open SORV are large contributors to the plant's core damage frequency (CDF).

Following the SDP worksheets, the SDP event trees corresponding to each of the worksheets are presented. The SDP event trees are simplified event trees developed to define the accident sequences identified in the SDP worksheets. For special initiators whose event tree closely corresponds to another event tree (typically, the Transient(Reactor trip) or Transients w/o PCS event tree) with one or more functions eliminated or degraded, a separate event tree may not be drawn.

We considered the following items in establishing the SDP event trees and the core-damage sequences in the SDP worksheets; Section 2.1 gives additional guidelines and assumptions.

1. Event trees and sequences were developed such that the worksheet contains all the major accident sequences identified by the plant-specific IPEs or PRAs. The special initiators modeled for a plant is based on a review of the special initiators included in the plant IPE/PRA and the information provided by the licensee.
2. The event trees and sequences for each plant took into account the IPE/PRA models and event trees for all similar plants. Any major deviations in one plant from similar plants typically are noted at the end of the worksheet.
3. The event trees and the sequences were designed to capture core-damage scenarios, without including containment-failure probabilities and consequences. Therefore, branches of event trees that are only for the purpose of a Level II PRA analysis are not considered. The resulting sequences are merged using Boolean logic.
4. The simplified event-trees focus on classes of initiators, as defined above. In so doing, many separate event trees in the IPEs often are represented by a single tree. For example, some IPEs define four or more classes of LOCAs rather than the three classes considered here. The sizes of LOCAs for which high-pressure injection is not required are some times divided into two classes; the only difference between them being the need for reactor scram in the smaller break size. Some consolidation of transient event tree may also be done besides defining the special initiators following the criteria defined above.

5. Major actions by the operator during accident scenarios are credited using four categories of Human Error Probabilities (HEPs). They are termed operator action =1 (representing an error probability of $5E-2$ to 0.5), operator action=2 (error probability of $5E-3$ to $5E-2$), operator action=3 (error probability of $5E-4$ to $5E-3$), and operator action=4 (error probability of $5E-5$ to $5E-4$). An human action is assigned to a category bin, based on a generic grouping of similar actions among a class of plants. This approach resulted in designation of some actions to a higher bin, even though the IPE/PRA HEP value may have been indicative of a lower category. In such cases, it is noted at the end of the worksheet. On the other hand, if the IPE/PRA HEP value suggests a higher category than that generically assumed, the HEP is assigned to a bin consistent with the IPE/PRA value in recognition of potential plant-specific design; a note is also given in these situations. Operator's actions belonging to category 4, i.e., operator action=4, may only be noted at the bottom of worksheet because, in those cases, equipment failures may have the dominating influence in determining the significance of the findings.

The four sections that follow include the Categories of Initiating Events Table, Initiators and System Dependency Table, SDP Worksheets, and the SDP Event Trees for the Monticello Nuclear Generating Plant.

1.1 INITIATING EVENT LIKELIHOOD RATINGS

Table 1 presents the applicable initiating events for this plant and their estimated likelihood ratings corresponding to the exposure time for degraded conditions. The initiating events are grouped into rows based on their frequency. As mentioned earlier, loss of offsite power and special initiators are assigned to rows using the plant-specific frequency obtained from individual licensees. For other initiating events, industry-average values are used, as per SECY-99-007A.

Table 1 Categories of Initiating Events for Monticello Nuclear Generating Plant

| Row | Approximate Frequency | Example Event Type | Estimated Likelihood Rating | | |
|-----|--|---|---|-----------|----------|
| | | | A | B | C |
| I | > 1 per 1-10 yr | Reactor Trip (TRANS), Loss of Power Conversion System (TPCS) | A | B | C |
| II | 1 per 10-10 ² yr | Loss of offsite power ⁽¹⁾ (LOOP), Inadvertent or stuck open SRVs (SORV) , LOIA | B | C | D |
| III | 1 per 10 ² - 10 ³ yr | LDCA, LDCB , LSW ⁽²⁾ | C | D | E |
| IV | 1 per 10 ³ - 10 ⁴ yr | Small LOCA (RCS rupture), Medium LOCA (RCS rupture), | D | E | F |
| V | 1 per 10 ⁴ - 10 ⁵ yr | Large LOCA (RCS rupture), ATWS ⁽³⁾ | E | F | G |
| VI | less than 1 per 10 ⁵ yr | ISLOCA | F | G | H |
| | | | > 30 days | 3-30 days | < 3 days |
| | | | Exposure Time for Degraded Condition | | |

Notes:

1. The LOOP frequency per updated PSA ,received as a part of licensee’s comments, is 2.3 E-2 per year. The original frequency was 7.9E-2 per year.
2. The LSW frequency per updated PSA, received as a part of licensee’s comments, is 9.0E-3 per year, it was therefore transferred from Row II to Row III.
3. The SDP worksheets for ATWS core damage sequences assume that the ATWS is not recoverable by manual actuation of the reactor trip function or by ARI (for BWRs). Thus, the ATWS frequency to be used by these worksheets must represent the ATWS condition that can only be mitigated by the systems shown in the worksheet (e.g., boration).

1.2 INITIATORS AND SYSTEM DEPENDENCY

Table 2 provides the list of the systems included in the SDP worksheets, the major components in the systems, and the support system dependencies. The system involvements in different initiating events are noted in the last column.

Table 2 Initiators and System Dependency Table for Monticello Nuclear Generating Station

| Affected System | Major Components | Support Systems | Initiating Event Scenarios |
|---------------------------------------|--|--|---|
| Safety Relief Valves (SRVs) | 8 Relief Valves, including 3 Automatic Depressurization (ADS) valves | 120 V-AC, 125 V-DC, Instrument Air/Nitrogen | All but LLOCA (see Note 3) |
| Main Steam (MS) | 8 MSIVs, 4 Main Steam Lines, Turbine Bypass Valves | MSIV Remain Open, Main Condenser, 480 V-AC, Instrument AC, 125 V-DC, Service Water, Instrument Air/Nitrogen, Steam Tunnel Cooling ⁽⁴⁾ | TRANS, SLOCA, LDCA, LDCB |
| Feedwater (FW) | 2 MD Pumps | Offsite Power, Condensate, 4160 V-AC (BOP), 480 V-AC (BOP), 125 V-DC (BOP), Service Water | TRANS, SLOCA, MLOCA, SORV, ATWS, LDCA, LDCB |
| Condensate(CDS) | 2 MDPs, MOVs, Condenser Hotwell, 2 FW Reg. AOVs, 1 Startup Reg. AOV | Offsite Power, Condenser Hotwell, 4160 V-AC (BOP), 120/240 VAC (Instrument AC), Instrument Air | TRANS, SLOCA, MLOCA, SORV, ATWS, LDCA, LDCB |
| High Pressure Coolant Injection(HPCI) | 1 ASD Pump, MOVs | SRVs/ADS (to remain closed), 250 V-DC, 125 V-DC, Instrument AC, ECCS Initiation Logic, CSTs (Note 4) | All except LLOCA, LDCB |
| Reactor Core Isolation Cooling (RCIC) | 1 ASD Pump, MOVs | SRVs/ADS (to remain closed), 250 V-DC, 125 V-DC, Instrument AC, ECCS Initiation Logic, CSTs (Note 4) | TRANS, TPCS, LOOP, LSW, LOIA, LDCB |
| Control Rod Drive Hydraulics(CRDH) | 2 MD Pumps, MOVs | CSTs, 4160 V-AC, 125 V-DC, RBCCW, IA | TRANS, TPCS, SLOCA., LOOP, LDCA, LDCB |

Table 2 (Continued)

| Affected System | Major Components | Support Systems | Initiating Event Scenarios |
|--|---|---|----------------------------|
| Low Pressure Coolant Injection(LPCI) | 2 Loops: 2 MD RHR pumps, and MOVs per loop | 4160 V-AC, 480 V-AC, 125 V-DC, ECCS Initiation Logic (Note 4) | All |
| Core Spray(CS) | 2 MD Pumps, MOVs | 4160 V-AC, 480 V-AC, 125 V-DC, ECCS Initiation Logic (Note 4) | All |
| RHR Service Water(RHRSW) | 2 Loops (2 MD Pumps per loop), MOVs | 4160 V-AC, 120 V-AC, 125 V-DC, Instrument AC | All |
| Torus Cooling (SPC) | 2 Loops (2 MD RHR Pumps and 1 Heat Exchanger per loop), MOVs | RHRSW, 4160 V-AC, 480 V-AC, 125 V-DC | All |
| Containment Venting (CV) | 2 18" Vent Lines, 8" Hard Pipe Vent, Duct work (See Note 5) | Instrument AC, Instrument Air | All except ATWS, LSW, LOIA |
| Onsite AC Power 4160 V-AC 480 V-AC 120/240 V-AC | 2 EDGs, Day tank and fuel transfer pumps, 4160 V-AC Buses, 480 V-AC Load Centers 120/240 V-AC Panels | EDG-ESW, ECCS Initiation Logic, 125 V-DC | LOOP |
| Onsite AC power DG#13 | 480 VAC self contained DG for extending Battery life by aligning to charger | None | LOOP |

Table 2 (Continued)

| Affected System | Major Components | Support Systems | Initiating Event Scenarios |
|---|--|--|----------------------------|
| DC Power 250 V-DC 125 V-DC | 2 Divisions 250 V-DC, 2 Divisions 125 V-DC, Battery Chargers | 480 V-AC | All |
| Service Water (SW) | 3 MD pumps | 480 V-AC, 125 V-DC | LSW |
| Reactor Building Closed Cooling Water (RBCCW) | 2 MD pumps, 3 Heat Exchangers (See Note 6) | 480 V-AC, Service Water | All |
| Emergency Service Water (ESW) | 2 MD Pumps (See Note 4) | 480 V-AC, 125 V-DC | All |
| EDG Emergency Service Water (EDG-ESW) | 2 MD Pumps, AOVs (See Note 7) | 480 V-AC, 125 V-DC | LOOP |
| Instrument Air and Nitrogen (IA) | 3 MD Compressors, Air Supply Header, Liquid Nitrogen Tank, 2 Compressed Nitrogen Banks, Control Valves | 480 V-AC, Instrument AC, Service Water | LOIA |
| Room Cooling (HVAC) | Fans, Cooling Units (See Note 4) | 480 V-AC, 125 V-DC, Service Water | All but LLOCA |
| ECCS Initiation Logic | Instrumentation, Transmitters, Logic Circuits, Control Circuits | 125 V-DC, 250 V-DC | All |

Table 2 (Continued)

| Affected System | Major Components | Support Systems | Initiating Event Scenarios |
|---|--|-----------------------------------|--------------------------------|
| Recirculation Pump Trip / Alternate Rod Injection (RPT/ARI) | Logic Circuits, Transmitters | 125 V-DC, 250 V-DC, Instrument AC | ATWS |
| Standby Liquid Control (SLC) | 2 MD Pumps, Explosive Valves | 480 V-AC | ATWS |
| Fire Water as a source of LI and for SBO scenarios | 1 DG Driven Fire Pump | None | All except ATWS, LOIA, and LSW |
| | 2 MD fire pumps | Normal AC | |
| Vacuum Breakers (EC) | 8 Vacuum Breakers (passive components) | None | LLOCA |

Notes:

- Information herein initially was developed from the Monticello Nuclear Generating Plant IPE Response to Generic Letter 88-20, submitted to the NRC by letter dated February 27, 1992. Updated information has been incorporated into this document to reflect modifications to the Monticello facility and PSA model which have occurred subsequent to the IPE submittal.
- The original baseline IPE core damage frequency (CDF) from internal events is 1.9E-5 events/Rx year, excluding external flooding. With internal flooding, there is an increase of 0.7E-5 events/Rx year to a total of 2.6E-5 events/Rx year. The current Power Update PRA has a CDF due to internal events of 1.59E-5 events/Rx year. (See MONT IPE Fig. 1.4-1).
- Because the emergency operating procedures direct manual control of reactor depressurization, inhibiting ADS and manually initiating SRVs is assumed. The ability of the SRVs to open on reactor pressure above the safety set point is not affected by operator actions to control individual valves manually. (See MONT IPE page 3.1-11).
- ESW provides support to RHR and CS pump room coolers. However, MONT IPE assumes that Room Cooling is important only for steam tunnel cooling. A loss of steam tunnel cooling results in significant heat up and MSIV isolation. No impact is assumed on pump operation upon loss of

Table 2 (Continued)

room cooling during 24 hour mission time. Since most of the PRA scenarios are terminated within 24 hours mission time, room coolers are not modeled in the MONT Power Update PSA of 1998.

5. Containment venting is a method of last resort which is initiated by venting through the hard pipe vent. The smaller 2" containment atmospheric system valves and progressively opening larger penetrations until containment pressure can be maintained below the EOP Drywell Pressure Limit. In this SDP worksheet only the 8" hardened vent pipe is credited.
6. RBCCW provides support to RHR and CS pump shaft seals. No impact is assumed during 24 hour mission time in MONT IPE. (See MONT IPE page 3.2-33).
7. Service Water (SW) provides backup support for Emergency Service Water (ESW).

1.2 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the Monticello Nuclear Generating Plant. The SDP worksheets are presented for the following initiating event categories:

1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Stuck Open Relief Valve (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Anticipated Transients without Scram (ATWS)
9. Loss of Service Water (LSW)
10. Loss of Instrument Air (LOIA)
11. Loss of DC Bus A (LDCA)
12. Loss of DC Bus B (LDCB)
13. Interfacing System LOCA (ISLOCA) and LOCA Outside Containment (LOC)

Table 3.1 SDP Worksheet for Monticello — Transients (Reactor Trip) (TRANS)

| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
|---|---------------------------------|--|-----------------------|
| <u>Safety Functions Needed:</u> Power Conversion System (PCS) High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) | | <u>Full Creditable Mitigation Capability for Each Safety Function:</u> ½ main feed pumps and ½ condensate pumps and CSTs (operator action = 3) ⁽¹⁾ HPCI (one ASD train) or RCIC (one ASD train) 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) ⁽²⁾ 1/4 RHR pumps in two trains in LPCI Mode (one multi-train system) or 1/2 CS pumps (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) Containment Venting through 8" hard piped vent (operator action = 2) ⁽³⁾ Depressurization through 1/8 SRVs and injection via 1/2 CRD pumps or 1/2 condensate pumps or [1/2 RHR SW pumps (Loop A) and LPCI path] or 1/3 fire pumps and LPCI Loop A (operator action = 2) | |
| <u>Circle Affected Functions</u> | <u>Recovery of Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 TRANS - PCS - CHR - LI (4, 8) | | | |
| 2 TRANS - PCS - CHR - CV (5, 9) | | | |
| 3 TRANS - PCS - HPI - LPI (10) | | | |
| 4 TRANS - PCS - HPI - DEP (11) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Notes:

1. The operator failure rate for this action per updated PSA is $2.4E-3$ per demand. This is consistent with generic HEP credit of 3 which is used in the SDP worksheet.
2. The HEP per updated PSA for Depressurization is $1.4 E-3$. A HEP credit of 2 is generically used in the SDP worksheet.
3. The operator failure per demand for CV per updated PSA is $3E-5$ per demand. In this case the hardware failure would dominates the failure of the function. The hardware failure would be equivalent to one train since venting through 18" containment vent lines is not credited since contamination of reactor building is likely. The worksheet therefore is assigning a generic HEP credit of 2 for CV.

Table 3.2 SDP Worksheet for Monticello — Transients without PCS (TPCS)

| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
|---|---------------------------------|--|-----------------------|
| Safety Functions Needed: High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) | | Full Creditable Mitigation Capability for Each Safety Function: HPCI (one ASD train) or RCIC (one ASD train) 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) 1/4 RHR pumps in two trains in LPCI Mode (one multi-train system) or 1/2 CS pumps (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) Containment Venting through 8" hard piped vent (operator action = 2) Depressurization through 1/8 SRVs and injection via 1/2 CRD pumps or 1/2 RHR SW pumps (Loop A) and LPCI path or 1/3 fire pumps and LPCI Loop A (operator action = 2) | |
| <u>Circle Affected Functions</u> | <u>Recovery of Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 TPCS - CHR - LI (3, 7) | | | |
| 2 TPCS - CHR - CV (4, 8) | | | |
| 3 TPCS - HPI - LPI (9) | | | |
| 4 TPCS - HPI - DEP (10) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Table 3.3 SDP Worksheet for Monticello — Small LOCA (SLOCA)

| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
|--|---------------------------------|--|-----------------------|
| Safety Functions Needed: Power Conversion System (PCS) High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) | | Full Creditable Mitigation Capability for Each Safety Function: 1/2 condensate pumps, 1/2 main feed pumps and CSTs (operator action =) ⁽¹⁾ HPCI (one ASD train) ⁽²⁾ 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) 1/4 RHR pumps in two trains in LPCI Mode (one multi-train system) or 1/2 CS pumps (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SP ^c) mode in two trains] (operator action = 2) Containment Venting through 8" hard piped vent (operator action = 2) Depressurization through 1/8 SRVs and injection via 1/2 CRD pumps or 1/2 condensate pumps or [1/2 RHR SW pumps (Loop A) and LPCI path] or 1/3 fire pumps and LPCI Loop A (operator action = 2) | |
| <u>Circle Affected Functions</u> | <u>Recovery of Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 SLOCA - PCS - CHR - LI (4, 8) | | | |
| 2 SLOCA - PCS - CHR - CV (5, 9) | | | |
| 3 SLOCA - PCS - HPI - LPI (10) | | | |
| 4 SLOCA - PCS - HPI - DEP (11) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Note:

1. The HEP credit for PCS is assigned generically based on BWR/4 average operator error rate during SLOCA.
2. RCIC is not credited for a SLOCA in the MONT PSA. RCIC is sufficient for small steam breaks, but not for all small pressurized water breaks. A stuck open relief valve (SORV) is considered a MLOCA in the MONT Power Update PSA.

Table 3.4 SDP Worksheet for Monticello — Stuck Open Relief Valve (SORV)

| | | | |
|---|---------------------------------|--|-----------------------|
| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
| Safety Functions Needed: High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI)⁽²⁾ | | Full Creditable Mitigation Capability for Each Safety Function: HPCI (one ASD train) or [1/2 condensate pumps and 1/2 main feed pumps and CSTs] (operator action = 2) ⁽¹⁾ 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) 1/4 RHR pumps in two trains in LPCI Mode (one multi-train system) or 1/2 CS pumps (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) Containment Venting through 8" hard piped vent (operator action = 2) Depressurization through 1/8 SRVs and injection via 1/2 condensate pumps or [1/ 2 RHR SW pumps (Loop A) and LPCI path] or 1/3 fire pumps and LPCI Loop A (operator action = 2) | |
| <u>Circle Affected Functions</u> | <u>Recovery or Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 SORV - CHR - LI (3) | | | |
| 2 SORV - CHR - CV (4) | | | |
| 3 SORV - LPI (5,8) | | | |
| 4 SORV - HPI - CHR (7) | | | |

Table 3.5 SDP Worksheet for Monticello — Medium LOCA (MLOCA)

| | | | |
|---|--|--|------------------------------|
| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
| Safety Functions Needed: High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI)⁽²⁾ | | Full Creditable Mitigation Capability for Each Safety Function: HPCI (one ASD train) or [1/2 condensate pumps and 1/2 main feed pumps and CSTs] (operator action = 2) ⁽¹⁾ 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) 1/4 RHR pumps in two trains in LPCI Mode (one multi-train system) or 1/2 CS pumps (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) Containment Venting through 8" hard piped vent (operator action = 2) Depressurization through 1/8 SRVs and injection via 1/2 condensate pumps or [1/2 RHR SW pumps (Loop A) and LPCI path] or 1/3 fire pumps and LPCI Loop A (operator action = 2) | |
| <u>Circle Affected Functions</u> | <u>Recovery or Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 MLOCA - CHR - LI (3) | | | |
| 2 MLOCA - CHR - CV (4) | | | |
| 3 MLOCA - LPI (5,8) | | | |
| 4 MLOCA - HPI - CHR (7) | | | |

Table 3.6 SDP Worksheet for Monticello — Large LOCA (LLOCA)

| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
|--|---------------------------------|---|-----------------------|
| Safety Functions Needed: Early Containment Control (EC) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) | | Full Creditable Mitigation Capability for Each Safety Function: Vapor Suppression system- passive operation of suppression pool - 6/8 vacuum breakers remain closed (one multi-train system) 1/4 RHR pumps in two trains in LPCI mode (one multi-train system) or 1/2 CS trains (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action) Containment Venting through 8" hard piped vent (operator action = 2) Injection via 1/2 condensate pumps or [1/ 2 RHR SW pumps (Loop A) and LPCI path] or 1/3 fire pumps and LPCI Loop A (operator action = 2) | |
| <u>Circle Affected Functions</u> | <u>Recovery or Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 LLOCA - CHR - LI (3) | | | |
| 2 LLOCA - CHR - CV (4) | | | |
| 3 LLOCA - LPI (5) | | | |
| 4 LLOCA - EC (6) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Table 3.7 SDP Worksheet for Monticello — Loss of Offsite Power (LOOP)

| | | | |
|---|---------------------------------|---|-----------------------|
| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
| Safety Functions Needed: Emergency Power (EAC) High Pressure Injection (HPI) Depressurization (DEP) AC recovery in 6 hours (RLOOP4/6) Small Emergency AC (DG13) Alternative LPI for SBO (DEP/LPIA) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) AC recovery in 24 hours | | Full Creditable Mitigation Capability for Each Safety Function: 1/2 EDGs (1 multi-train system) HPCI (one ASD train) or RCIC (one ASD train) ⁽¹⁾ 1/8 safety relief valves (3 ADS SRVs and 5 safety valves) manually opened (operator action = 2) ⁽³⁾ Recovery of offsite power in four to six hours (operator action = 2) ⁽²⁾ Operation of the EDG-13 and operator action for back feeding battery chargers (operator action = 1) ⁽⁴⁾ Depressurization through 1/8 SRVs and injection via 1/1 DG fire pump through LPCI path A (operator action = 0) ⁽¹⁾ [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) Containment Venting through 8" hard piped vent (operator action = 2) Depressurization through 1/8 SRVs and injection via 1/2 CRD pumps or [1/ 2 RHR SW pumps (Loop A) and LPCI path] or 1/3 fire pumps and LPCI Loop A (operator action = 2) Recovery of offsite power or a source of emergency AC in 24 hours after successful operation of DG#13 (operator action = 2) | |
| <u>Circle Affected Functions</u> | <u>Recovery or Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 LOOP - CHR - LI (1,2) | | | |
| 2 LOOP - CHR - CV (1,2) | | | |

| | | | |
|--------------------------------------|--|--|--|
| 3 LOOP - HPI - LPI (1,2) | | | |
| 4 LOOP - HPI - DEP (1,2) | | | |
| 5 LOOP - EAC - RLOO24 - CHR (4) | | | |
| 6 LOOP - EAC - RLOOP24 (5) | | | |
| 7 LOOP - EAC - RLOOP4/6 - DG13 (6,9) | | | |
| 8 LOOP - EAC - HPI - DEP/LPIA (10) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Notes:

1. Core damage during SBO could result if HPCI and RCIC fails in about 25 minutes. This does not provide enough time for operator to depressurize and use LPIA. An operator credit of 0 is given to DEP/LPIA in this worksheet even though the related sequence is shown (sequence 10).
2. The batteries are assumed to last 4 hours with no load shedding and slightly longer with load shed. Recovery of AC power in six hours assumes that core damage occurs two hours after battery depletion.
3. The licensee indicated that the SRV pneumatic supply valves are no longer dependent on AC.
4. The smaller EDG-13 could be manually aligned to back feed the battery chargers per licensee's comment. An operator action of credit of one is currently assigned to this manual action. Plant specific HEP value for this action per updated PSA is 0.5 .

Table 3.8 SDP Worksheet for Monticello — Anticipated Transients without Scram (ATWS) ⁽¹⁾

| Estimated Frequency (Table 1 Row) _____ | | Exposure Time _____ | | Table 1 Result (circle): A B C D E F G H | | | | | | | |
|---|---------------------------------|--|--|--|--|--|--|-----------------------|--|--|--|
| Safety Functions Needed: Overpressure Protection (OVERP) Recirculation Pump Trip (RPT) High Pressure Injection (HPI) Inhibit ADS (INH) Reactivity Control (SLC) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) | | | | Full Creditable Mitigation Capability for Each Safety Function: 7/8 SRVs and safety valves must open (one multi-train system) Manual or automatic trip of 2/2 recirculation pumps (1 train) 1/1 HPCI train (1 ASD train) or 1/2 main feed water pumps and 1/2 condensate pumps (operator action = 2) ⁽²⁾ Inhibit the auto ADS actuation (operator action = 1) ⁽³⁾ Level control at TAF and injection from 1/2 SLC pumps (operator action = 2) ⁽⁴⁾ 1/8 ADS SRVs manually opened (operator action = 2) 1/4 RHR pumps in two trains in LPCI mode (one multi-train system) or 1/2 CS pumps (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) ⁽⁵⁾ | | | | | | | |
| <u>Circle Affected Functions</u> | <u>Recovery or Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | | | | | | <u>Sequence Color</u> | | | |
| 1 ATWS - CHR (2,5) | | | | | | | | | | | |
| 2 ATWS - SLC (3,7) | | | | | | | | | | | |
| 3 ATWS - HPI - LPI (6) | | | | | | | | | | | |
| 4 ATWS - HPI - DEP (8) | | | | | | | | | | | |

Table 3.9 SDP Worksheet for Monticello — Loss of Service Water (LSW) ⁽¹⁾

| | | | |
|---|--|---|------------------------------|
| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
| Safety Functions Needed: High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) | | Full Creditable Mitigation Capability for Each Safety Function: HPCI (one ASD train) or RCIC (one ASD train) 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) 1/4 RHR pumps in two trains in LPCI Mode (one multi-train system) or 1/2 CS pumps (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) NA NA | |
| <u>Circle Affected Functions</u> | <u>Recovery of Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 LSW - CHR (3, 4, 7, 8) | | | |
| 2 LSW - HPI - LPI (9) | | | |
| 3 LSW - HPI - DEP (10) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Note:

1. Total loss of Service water frequency is $9E-3$. Upon loss of SW, cooling to the FW pumps, recirc pump, MG set, instrument air compressor, and IA after coolers would be lost. Loss of instrument air will cause a transient with loss of PCS including tripping of the circulating pumps, and no containment venting. Loss of air also causes the mini flow valves in RHR, HPCI, and RCIC to fail. This will result in a 10% flow diversion. A 10% flow diversion is assumed to have no impact on these systems. The room cooling for HPCI and RHR/CS is provided by ESW. However, room cooling for RCIC would be lost and some manual action would be required for continued RCIC operation. CRD will lose pump cooling and the CRD control valves will fail close however the bypass valves could be manually open (note LI is not credited in this worksheet). The TPCS event tree is used for this initiator with no credit for CV and LI.

Table 3.10 SDP Worksheet for Monticello — Loss of Instrument Air (LOIA)

| | | | |
|---|--|---|------------------------------|
| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
| Safety Functions Needed: High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) | | Full Creditable Mitigation Capability for Each Safety Function: HPCI (one ASD train) or RCIC (one ASD train) 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) 1/4 RHR pumps in two trains in LPCI Mode (one multi-train system) or 1/2 CS pumps (one multi-train system) [1/4 RHR pumps in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) NA NA | |
| <u>Circle Affected Functions</u> | <u>Recovery or Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 LOIA - CHR (3, 4, 7,8) | | | |
| 2 LOIA - HPI - LPI (9) | | | |
| 3 LOIA - HPI - DEP (10) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Note:

1. This worksheet is for Loss of Instrument Air (LOIA). The IE frequency is $6.3E-2$ events per Rx year. LOIA causes a loss of the PCS. The circulating water pump level control sensors fail low, tripping the circulating water pumps. The outboard MSIVs eventually close when the accumulators bleed down (after at least 30 minutes). The RHR, HPCI, and RCIC minimum flow valves fail open on air loss. This will result in a 10% flow diversion to the suppression pool. A 10% flow diversion is assumed to have no impact on these systems. The CRD system flow control valves fail closed on LOIA. Per procedure, the test bypass valve can be manually opened to inject into the vessel. However LI function is not credited if CHR has failed in this worksheet. No credit is also given to CV. The TPCS event tree is used for this initiator.

Table 3.11 SDP Worksheet for Monticello — Loss of DC Bus A (LDCA) ⁽¹⁾

| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
|---|---------------------------------|---|-----------------------|
| <u>Safety Functions Needed:</u> Power Conversion System (PCS) High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) | | <u>Full Creditable Mitigation Capability for Each Safety Function:</u> 1/2 main feed pumps and 1/2 condensate pumps and CSTs (operator action = 3) HPCI (one ASD train) 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) 1/2 RHR pumps in one train in LPCI Mode (1 train) or 1/1 CS pumps (one train system) [1/2 RHR pumps through 1/1 RHR HX in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) Containment Venting through 8" hard piped vent (operator action = 2) Depressurization through 1/8 SRVs and injection via 1/1 CRD pumps (operator action = 1) | |
| <u>Circle Affected Functions</u> | <u>Recovery of Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 LDCA - PCS - CHR - LI (4, 8) | | | |
| 2 LDCA - PCS - CHR - CV (5, 9) | | | |
| 3 LDCA - PCS - HPI - LPI (10) | | | |
| 4 LDCA - PCS - HPI - DEP (11) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Note:

1. Loss of DC bus A is considered as a special initiator with a frequency of $1.2E-3$ per year. No automatic trip is initiated as a result of loss of DC. This event requires manual shutdown in 10 hours if the DC bus is not recovered. The credit for recovery action is folded in the initiator frequency. It affects RCIC, two LPCI/RHR pumps, one RHR Heat Exchanger and the associated RHR SW, and one CS train. The running pumps could continue to run, therefore one CRD pump and the feed pumps are credited. All means of injection as a part of LI which relies on LPCI loop A are not credited. Therefore the credit for LI was reduced to 1 from 2. TRANS event tree is used for this initiator.

Table 3.12 SDP Worksheet for Monticello — Loss of DC Bus B (LDCB)

| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
|---|---------------------------------|--|-----------------------|
| <u>Safety Functions Needed:</u> Power Conversion System (PCS) High Pressure Injection (HPI) Depressurization (DEP) Low Pressure Injection (LPI) Containment Heat Removal (CHR) Containment Venting (CV) Late Inventory (LI) | | <u>Full Creditable Mitigation Capability for Each Safety Function:</u> 1/2 main feed pumps and 1/2 condensate pumps and CSTs (operator action = 3) RCIC (one ASD train) 1/8 safety relief valves (3 ADS SRVs and 5 SRVs) manually opened (operator action = 2) 1/2 RHR pumps in one train in LPCI Mode (1 train) or 1/1 CS pumps (1train) [1/2 RHR pumps through 1/1 RHR HX in Suppression Pool Cooling (SPC) mode in two trains] (operator action = 2) Containment Venting through 8" hard piped vent ⁽³⁾ (operator action = 2) Depressurization through 1/8 SRVs and injection via 1/1 CRD pumps or 1/ 1 RHR SW pumps (Loop A) and LPCI path or 1/3 fire pumps and LPCI Loop A (operator action = 2) | |
| <u>Circle Affected Functions</u> | <u>Recovery of Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Sequence</u> | <u>Sequence Color</u> |
| 1 LDCB - PCS - CHR - LI (4, 8) | | | |
| 2 LDCB - PCS - CHR - CV (5, 9) | | | |
| 3 LDCB - PCS - HPI - LPI (10) | | | |
| 4 LDCB - PCS - HPI - DEP (11) | | | |

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Note:

1. Loss of DC bus B is considered as a special initiator with a frequency of $1.2E-3$ per year. No automatic trip is initiated as a result of loss of DC. This event requires manual shutdown in 10 hours if the DC bus is not recovered. The credit for recovery action is folded in the initiator frequency. It affects HPCI, two LPCI/RHR pumps, one RHR Heat Exchanger and the associated RHR SW, and one CS train. The running pumps could continue to run, therefore one CRD pump and the feed pumps are credited. The credit for LI was not reduced for this initiator. TRANS event tree is used for this initiator.

Table 3.13 SDP Worksheet for Monticello Nuclear Power Station, Unit1 — Interfacing System LOCA (ISLOCA) and LOCA Outside Containment (LOC)

| Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H | | | |
|---|---------------------------------|---|-----------------------|
| Initiation Pathways: HPCI Line RCIC Line RWCU Water Line Feedwater Lines (FWLs) Main Steam Lines (MSLs) | | Mitigation Capability: Ensure Component Operability for Each Pathway | |
| <u>Circle Affected Component in Pathways</u> | <u>Recovery of Failed Train</u> | <u>Remaining Mitigation Capability Rating for Each Affected Pathway</u> | <u>Sequence Color</u> |
| | | | |
| Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: | | | |
| If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use. | | | |

Notes:

1. This worksheet contains pathways for LOC (LOCAs Outside Containment). Licensees typically analyze these events separately. The initiation pathways defined are primarily based generic BWR information and some from the Monticello IPE.
2. This worksheet is different from the other worksheets, in that ISLOCA is typically an unmitigated initiating event in most PRAs. Therefore the SDP notebook for this worksheet is such that the right side of the worksheet contains valves, whose failure may lead to an ISLOCA or LOC rather than mitigating systems to address an event in progress. As such, it is not intended to be referenced by the last column of Table 1.2, Initiators and System Dependency Table. We note, however, that Monticello IPE has prepared a separate event tree for LOC in the IPE.

1.4 SDP Event Trees

This section provides the simplified event trees, called SDP event trees, used to define the accident sequences identified in the SDP worksheets in the previous section. The event tree headings are defined in the corresponding SDP worksheets.

The following event trees are included:

1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Medium LOCA (MLOCA)
5. Large LOCA (LLOCA)
6. Loss of Offsite Power (LOOP)
7. Anticipated Transients without Scram (ATWS)

| TRANS | PCS | HPI | DEP | LPI | CHR | CV | LI | # | STATUS |
|-------|-----|-----|-----|-----|-----|----|----|----|--------|
| | | | | | | | | 1 | OK |
| | | | | | | | | 2 | OK |
| | | | | | | | | 3 | OK |
| | | | | | | | | 4 | CD |
| | | | | | | | | 5 | CD |
| | | | | | | | | 6 | OK |
| | | | | | | | | 7 | OK |
| | | | | | | | | 8 | CD |
| | | | | | | | | 9 | CD |
| | | | | | | | | 10 | CD |
| | | | | | | | | 11 | CD |

Plant Name Abbrev.: MONT

| TPCS | HPI | DEP | LPI | CHR | CV | LI | # | STATUS |
|------|-----|-----|-----|-----|----|----|----|--------|
| | | | | | | | 1 | OK |
| | | | | | | | 2 | OK |
| | | | | | | | 3 | CD |
| | | | | | | | 4 | CD |
| | | | | | | | 5 | OK |
| | | | | | | | 6 | OK |
| | | | | | | | 7 | CD |
| | | | | | | | 8 | CD |
| | | | | | | | 9 | CD |
| | | | | | | | 10 | CD |

Plant Name Abbrev.: MONT

| SLOCA | PCS | HPI | DEP | LPI | CHR | CV | LI | # | STATUS |
|-------|-----|-----|-----|-----|-----|----|----|----|--------|
| | | | | | | | | 1 | OK |
| | | | | | | | | 2 | OK |
| | | | | | | | | 3 | OK |
| | | | | | | | | 4 | CD |
| | | | | | | | | 5 | CD |
| | | | | | | | | 6 | OK |
| | | | | | | | | 7 | OK |
| | | | | | | | | 8 | CD |
| | | | | | | | | 9 | CD |
| | | | | | | | | 10 | CD |
| | | | | | | | | 11 | CD |

Plant Name Abbrev.: MONT

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| MLOCA | HPI | DEP | LPI | CHR | CV | LI | # | STATUS |
|-------|-----|-----|-----|-----|----|----|---|--------|
| | | | | | | | 1 | OK |
| | | | | | | | 2 | OK |
| | | | | | | | 3 | CD |
| | | | | | | | 4 | CD |
| | | | | | | | 5 | CD |
| | | | | | | | 6 | OK |
| | | | | | | | 7 | CD |
| | | | | | | | 8 | CD |
| | | | | | | | 9 | CD |

Plant Name Abbrev.: MONT

| LLOCA | EC | LPI | CHR | CV | LI | # | STATUS |
|-------|----|-----|-----|----|----|---|--------|
| | | | | | | 1 | OK |
| | | | | | | 2 | OK |
| | | | | | | 3 | CD |
| | | | | | | 4 | CD |
| | | | | | | 5 | CD |
| | | | | | | 6 | CD |

Plant Name Abbrev.: MONT

| LOOP | EAC | HPI | DEP/LPIA | RLOOP4/6 | DG13 | RLOOP24 | CHR | # | STATUS |
|------|-----|-----|----------|----------|------|---------|-----|----|--------|
| | | | | | | | | 1 | TPCS |
| | | | | | | | | 2 | TPCS |
| | | | | | | | | 3 | OK |
| | | | | | | | | 4 | CD |
| | | | | | | | | 5 | CD |
| | | | | | | | | 6 | CD |
| | | | | | | | | 7 | OK |
| | | | | | | | | 8 | OK |
| | | | | | | | | 9 | CD |
| | | | | | | | | 10 | CD |

Plant Name Abbrev.: MONT

| ATWS | OVERP | RPT | INH | HPI | DEP | SLC | LPI | CHR | # | STATUS |
|------|-------|-----|-----|-----|-----|-----|-----|-----|----|--------|
| | | | | | | | | | 1 | OK |
| | | | | | | | | | 2 | CD |
| | | | | | | | | | 3 | CD |
| | | | | | | | | | 4 | OK |
| | | | | | | | | | 5 | CD |
| | | | | | | | | | 6 | CD |
| | | | | | | | | | 7 | CD |
| | | | | | | | | | 8 | CD |
| | | | | | | | | | 9 | CD |
| | | | | | | | | | 10 | CD |
| | | | | | | | | | 11 | CD |

Plant Name Abbrev.: MONT

2. RESOLUTION AND DISPOSITION OF COMMENTS

This section is composed of two subsections. Subsection 2.1 summarizes the generic assumptions that were used for developing the SDP worksheets for the BWR plants. These guidelines were based on the plant-specific comments provided by the licensee on the draft SDP worksheets and further examination of the applicability of those comments to similar plants. These assumptions which are used as guidelines for developing the SDP worksheets help the reader better understand the worksheets' scope and limitations. The generic guidelines and assumptions for BWRs are given here. Subsection 2.2 documents the plant-specific comments received on the draft version of the material included in this notebook and their resolution.

2.1 GENERIC GUIDELINES AND ASSUMPTIONS (BWRs)

Initiating Event Likelihood Rating Table

1. Assignment of plant-specific IEs into frequency rows:

Transient (Reactor trip) (TRANS), transients without PCS (TPCS), small, medium, and large LOCA (SLOCA, MLOCA, LLOCA), inadvertent or stuck-open SRVs (IORV), anticipated transients without scram (ATWS), interfacing system LOCA (ISLOCA), and LOCA outside containment (LOC) are assigned into rows based on consideration of industry-average frequency. Plant-specific frequencies can be different, but are not considered. Plant-specific frequencies for LOOP and special initiators are used to assign these initiating events.

2. Inclusion of special initiators:

The special initiators included in the worksheets are those applicable for the plant. A separate worksheet is included for each of the applicable special initiators. The applicable special initiators are primarily based on the plant-specific IPEs. In other words, the special initiator included are those modeled in the IPEs unless it is shown to be a negligible contributor. In some cases, in considering plants of similar design, a particular special initiator may be added for a plant even if it is not included in the IPE if such an initiator is included in other plants of similar design and is considered applicable for the plant. Except for the interfacing system LOCA (ISLOCA) and LOCA outside containment (LOC), if the occurrence of the special initiator results in a core damage, i.e., no mitigation capability exists for the initiating event, then a separate worksheet is not developed. For such cases, the inspection focus is on the initiating event and the risk implication of the inspection finding can be directly assessed. For ISLOCA and LOC, a separate worksheet is included noting the pathways that can lead to these events.

3. Inadvertent or stuck open relief valve as an IE in BWRs:

Many IPEs/PRA model this event as a separate initiating event. Also, the failure of the SRVs to re-close after opening can be modeled within the transient tree. In the SDP worksheet, these events are modeled in a separate worksheet (and, are not included in the transient worksheets) considering both inadvertent opening and failure to re-close. We typically consider a single valve is stuck or inadvertently open. The frequency of this initiator is generically estimated for all BWR plants. This IE may behave similar to a small or medium LOCA depending on the valve size, and the mitigation capability is addressed accordingly.

4. LOCA outside containment (LOC):

A LOCA outside of containment (LOC) can be caused by a break in a few types of lines such as Main Steam or Feedwater. LOC is treated differently among the IPEs. Separate ETs are usually not developed in the IPEs for LOCs. Thus, credit is usually not taken for mitigating actions. LOC

sequences typically have a core damage frequency in the E-8 range. As such, LOCs are included together with ISLOCAs in a separate summary type SDP worksheet. Plant specific notes are included to explain how the particular IPE has addressed LOCs.

Initiating Event and System Dependency Table

1. Inclusion of systems under the support system column:

This table shows the support systems for the support and frontline systems. Partial dependency, which usually is a backup system, is not expected to be included. If included, they should be so noted. The intent is to include only the support system and not the systems supporting the support system, i.e., those systems whose failure will result in failure of the system being supported. Sometimes, some subsystems on which inspection findings may be noted have been included as a support system, e.g., EDG fuel oil transfer pump as a support system for EDGs.

2. Coverage of system/components and functions included in the SDP worksheets:

The Initiators and System Dependency Table includes systems and components which are included in the SDP worksheets and those which can affect the performance of these systems and components. One to one matching of the ET headings/functions to that included in the Table was not considered necessary.

SDP Worksheets and Event Trees

1. Crediting of non-safety related equipment:

SDP worksheets credit or include safety-related equipment and also, non-safety related equipment as used in defining the accident sequences leading to core damage. In defining the success criteria for the functions needed, the components included are typically those covered under the Technical Specifications (TS) and the Maintenance Rule (MR). No evaluation was performed to assure that the components included in the worksheets are covered under TS or MR. However, if a component was included in the worksheet, and the licensee requested its removal, it may not have been removed if it is considered that the components is included in either TS or MR.

2. No credit for certain plant-specific mitigation capability:

The significance determination process (SDP) screens inspection findings for Phase 3 evaluations. Some conservative assumptions are made which result in not crediting some plant-specific features. Such assumptions are usually based on comparisons with plants of similar design and to maintain consistency across the SDP worksheets of similar plant designs.

3. Crediting system trains with high unavailability

Some system component/trains may have unavailability higher than 1E-2, but they are treated in a manner similar to other trains with lower unavailability in the range of 1E-2. In this screening

approach, this is considered adequate to keep the process simple. An exception is made for steam-driven components which are designated as automatic steam driven (ASD) train with a credit of 1, i.e., an unavailability in the range of $1E-1$.

4. Treating passive components (of high reliability) same as active components:

Passive components, namely isolation condensers in some BWRs, are credited similar to active components. The reliability of these components are not expected to differ (from that of active components) by more than an order of magnitude. Pipe failures have been excluded in this process except as part of initiating events where appropriate frequency is used. Accordingly, a separate designation for passive components was not considered necessary.

5. Defining credits for operator actions:

The operator's actions modeled in the worksheets are categorized as follows: operator action=1 representing an error probability of $5E-2$ to 0.5 ; operator action=2 representing an error probability of $5E-3$ to $5E-2$; operator action=3 representing an error probability of $5E-4$ to $5E-3$; and operator action=4 representing an error probability of $5E-5$ to $5E-4$. Actions with error probability > 0.5 are not credited. Thus, operator actions are associated with credits of 1, 2, 3, or 4. Since there is large variability in similar actions among different plants, a survey of the error probability across plants of similar design was used to categorize different operator actions. From this survey, similar actions across plants of similar design are assigned the same credit. If a plant uses a lower credit or recommends a lower credit for a particular action compared to our assessment of similar action based on plant survey, then the lower credit is assigned. An operator's action with a credit of 4, i.e., operator action=4, is noted at the bottom of the worksheet; the corresponding hardware failure, e.g., 1 multi-train system, is defined in the mitigating function.

6. Difference between plant-specific values and SDP designated credits for operator actions:

As noted, operator actions are assigned to a particular category based on review of similar actions for similar design plants. This results in some differences between plant-specific HEP values and credit for the action in the worksheet. The plant-specific values are usually noted at the bottom of the worksheet, when available.

7. Dependency among multiple operator actions:

IPEs or PRAs, in general, account for dependencies among multiple operator actions that may be applicable. In this SDP screening approach, if multiple actions are involved in one function, then the credit for the function is designated as one operator action considering the dependency involved.

8. Crediting late injection (LI) following failure of containment heat removal (CHR), i.e., suppression pool cooling:

Following successful high or low pressure injection, suppression pool cooling is modeled. Upon failure of suppression pool cooling, containment venting (CV) is considered followed by late injection. Late injection is credited if containment venting is successful. Further, LI is required following CV success. The suction sources for the LI systems credited are different from the suppression pool. HPCI, LPCI, and CS are not credited in late injection. No credit is given for LI following failure of CV. The survival probability is low and such details are not considered in the screening approach here.

9. Combining late injection (LI) with low pressure injection (LPI) or containment venting (CV):

In some modeling approaches, LI is combined with LPI or CV. In the SDP worksheet approach here, these functions are separate. As discussed above, LPI and LI use different suction sources, and CV and LI may be two different categories of operator actions. In these respects, for some plants, SDP event trees may be different than the plant-specific trees.

10. Crediting condensate trains as part of multiple functions: power conversion system (PCS), low pressure injection (LPI), and late injection (LI):

Typically, condensate trains can be used as an LPI and LI source in addition to its use as part of the power conversion system. However, crediting the same train in multiple functions can result in underestimation of the risk impact of an inspection finding in the SDP screening approach since it does not account for these types of dependencies in defining the accident sequences. To simplify the process and to avoid underestimation, condensate train is not credited in LPI, but may be credited in LI.

11. Modeling vapor suppression success in different LOCA worksheets:

Vacuum breakers typically must remain closed following a LOCA to avoid containment failure and core damage. Some plants justify that vapor suppression is not needed for SLOCA. These sequences typically have low frequency and are not among the important contributors. However, an inspection finding on these vacuum breakers may make these sequences a dominant contributor. Accordingly, success of vapor suppression is included in the SDP worksheets. It is included for all three LOCA worksheets (LLOCA, MLOCA, and SLOCA); for plants presenting justification that they are not needed in a SLOCA appropriate modifications are made.

12. ATWS with successful PCS as a stable plant state:

Some plants model a stable plant state when PCS is successful following an ATWS. Following our comparison of similarly designed plants, such credits are not given.

13. Modeling different EDG configurations, SBO diesel, and cross-ties:

Different capabilities for on-site emergency AC power exist at different plant sites. To treat them consistently across plants, they are typically combined into a single emergency AC (EAC) function. The dedicated EDGs are credited following the standard convention used in the worksheets for

equipment (1 dedicated EDG is 1 train; 2 or more dedicated EDGs is 1 multi-train system). The use of the swing EDG or the SBO EDG requires operator action. The full mitigating capability for emergency AC could include dedicated Emergency Diesel Generators (EDG), Swing EDG, SBO EDG, and finally, nearby fossil-power plants. The following guidelines are used in the SDP modeling of the Emergency AC power capability:

1. Describe the success criteria and the mitigation capability of dedicated EDGs.
2. Assign a mitigating capability of "operator action=1" for a swing EDG. The SDP worksheet assumes that the swing EDG is aligned to the other unit at the time of the LOOP (in a sense a dual unit LOOP is assumed). The operator, therefore, should trip, transfer, re-start, and load the swing EDG.
3. Assign a mitigating capability of "operator action=1" for an SBO EDG similar to the swing EDG. Note, some of the plants do not take credit for an SBO EDG for non-fire initiators. In these cases, credit is not given.
4. Do not credit the nearby power station as a backup to EDGs. The offsite power source from such a station could also be affected by the underlying cause for the LOOP. As an example, overhead cables connecting the station to the nuclear power plant also could have been damaged due to the bad weather which caused the LOOP. This level of detail should be left for a Phase 3 analysis.

14. Recovery of losses of offsite power:

Recovery of losses of offsite power is assigned an operator-action category even though it is usually dominated by a recovery of offsite AC, independent of plant activities. Furthermore, the probability of recovery of offsite power in "X" hours (for example 4 hours) given it is not recovered earlier (for example, in the 1st hour) would be different from recovery in 4 hours with no condition. The SDP worksheet uses a simplified approach for treating recovery of AC by denoting it as an operator action=1 or 2 depending upon the HEP used in the IPE/PRA. A footnote highlighting the actual value used in the IPE/PRA is provided, when available.

15. Mitigation capability for containment heat removal:

The mitigation capability for containment heat removal (CHR) function is considered dominated by the hardware failure of the RHR pumps. The applicable operator action is categorized as an operator action with a credit 4, i.e., operator action=4. For this situation, the function is defined as 1 multi-train system since the operator action involved is considered routine and reliable, and is assigned a credit of 4. No other operator action in the worksheets is generically assigned this high credit.

16. Crediting CRD pumps as an alternate high pressure injection source:

In many plants, CRD pumps can be used as a high pressure injection source following successful operation of HPCI or RCIC for a period of time, approximately 1 to 2 hours. In some plants, CRD system is enhanced where it can be directly used and does not need the successful operation of other HPI sources. In the worksheets, if the CRD pumps require prior successful operation of HPCI or RCIC as a success criteria, then CRD is not credited as a separate high pressure injection source. If the CRD can be used and does not require successful operation of HPCI or RCIC, then it is credited as a separate success path within the HPI function.

2.2 RESOLUTION OF PLANT-SPECIFIC COMMENTS

Comments received on previous version of the Notebook were used to prepare this version of the Notebook (Dated April 14, 2000). The Notebook has improved significantly because of the useful comments received from the licensee. A summary of the major comments and any deviation from the comments is noted below.

1. Licensee's comments on the Initiators and System Dependency Table were used to modify the Table.
2. Licensee's comments that were annotated on the worksheets were all implemented.
3. The initiator frequencies from updated PSA as reported by the licensee were incorporated to the SDP worksheet.
4. The HEP values associated with the major operator actions as provided by licensee were denoted in the worksheets.
5. RCIC credit were removed from SLOCA per updated licensee comments on the success criteria.
6. Major support system initiators were modeled and the updated initiator frequency were used. However, the development of these worksheets were made mostly based on the dependency tables and information in the original IPE since the licensee's comments did not include the system impact and the associated event trees.
7. Importance measures were provided by the licensee however, the definition of basic events are not known at this time so no comparison was made.

REFERENCES

1. NRC SECY-99-007A, Recommendations for Reactor Oversight Process Improvements (Follow-up to SECY-99-007), March 22, 1999.
2. Northern States Power Company, "Monticello Nuclear Generating Plant Individual Plant Examination Report," February 1992.