SIGNIFICANCE DETERMINATION PROCESS OVERVIEW

SDP OBJECTIVES

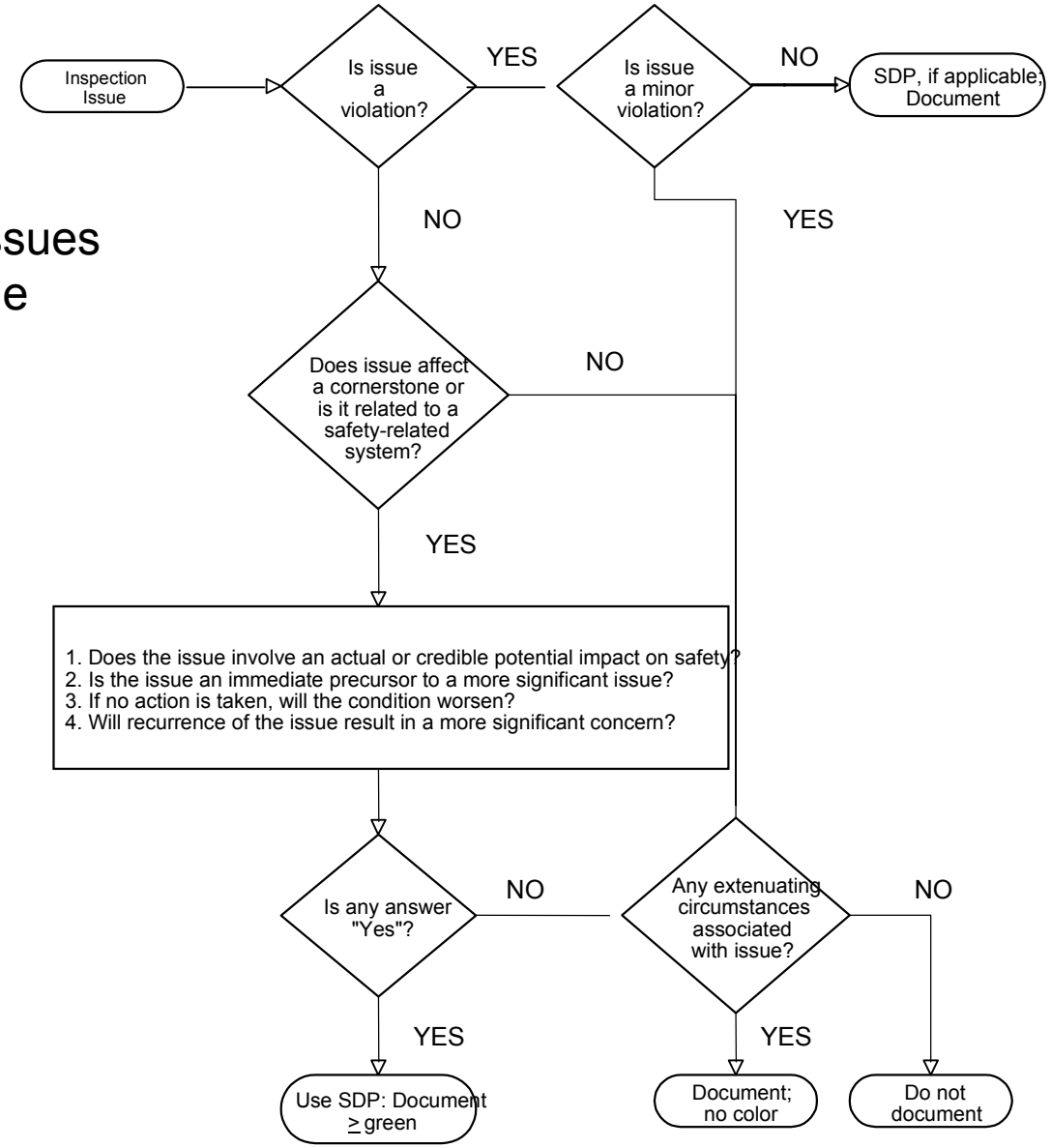
- To Characterize the Risk Significance of an Inspection Finding Consistent with the Regulatory Response Thresholds Used for Performance Indicators (PIs) in the NRC Licensee performance Assessment Process and for Entry into Enforcement.

- To Provide a Risk-Informed Framework for Discussing and Communicating the Potential Significance of Inspection Findings.

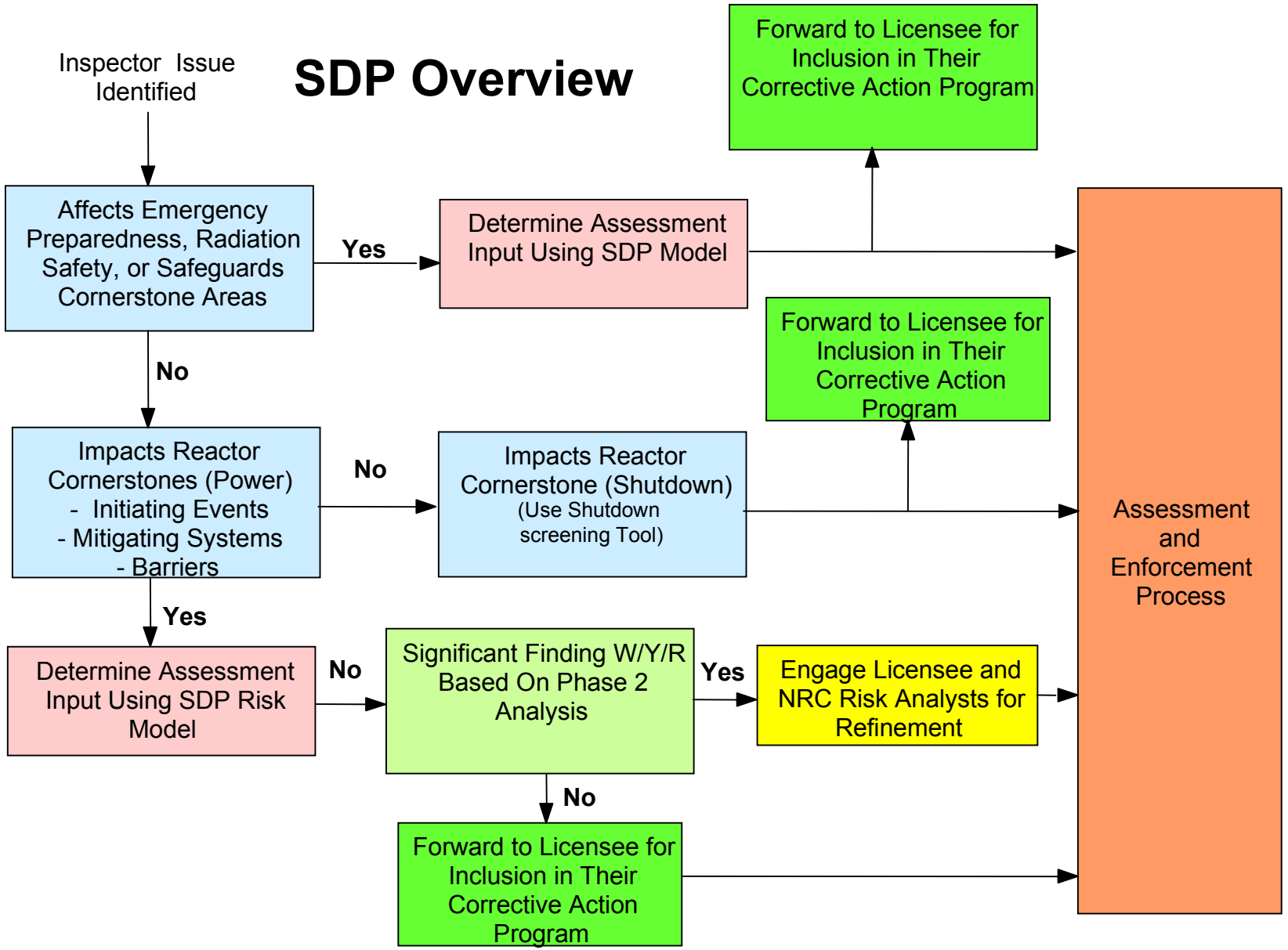
SDP DESCRIPTION

- The Inspection Finding Assessment Process (SDP) Is a Graduated Approach That Uses a Three-Phase Process to Differentiate Inspection Findings on the Basis of Their Actual or Potential Risk Significance. Findings That Pass Through a Screening Phase Will Proceed to Be Evaluated by the next Phase.

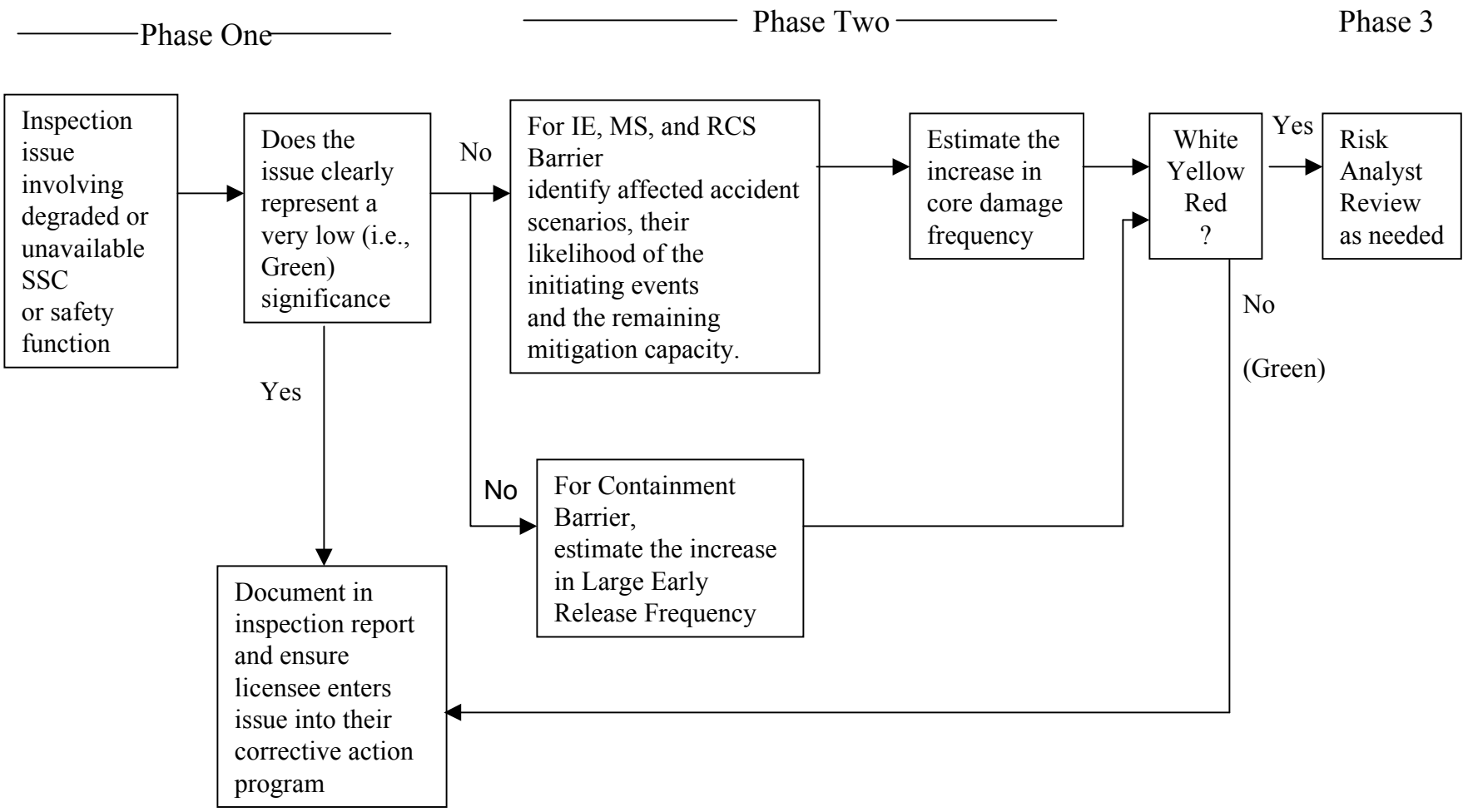
What issues go to the SDP?



SDP Overview



Reactor Safety Significance Determination Process (IE, MS, and Barrier)



REACTOR SAFETY SDP (IE, MS, B) Bases

- Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment (PRA) in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Bases”

- NUREG/CR-5499, “Rates of Initiating Events at U.S. Nuclear Power Plants: 1987 - 1995”

- NUREG/CR-4674, “Precursors to Potential Severe Core Damage Accidents.”

- Generic equipment unavailability values.

SDP PHASE 1

- Phase 1 – **Definition and Initial Screening of Findings**: Precise Characterization of the Finding and an Initial Screening Out of Low-Significant Issues.

SDP PHASE 1 SCREENING WORKSHEET FOR IE, MS, and B CORNERSTONES

Reference/Title (LER #, Inspection Report #, etc):

Performance Deficiency (concise statement clearly stating the deficient licensee performance):
Factual Description of Identified Condition (statement of facts known about the finding, without hypothetical failures included):
System(s) and train(s) degraded by identified condition:
Licensing Basis Function of System(s) or Train(s) (as applicable):
Other Safety Function of System(s) or Train(s) (as applicable):
Maintenance Rule category (check one): ___ risk-significant ___non-risk-significant
Time that identified condition existed or is assumed to have existed:

Functions and Cornerstones degraded as a result of this identified condition (check T)

INITIATING EVENT CORNERSTONE

_____ Transient initiator contributor (e.g., reactor/turbine trip, loss offsite power)
_____ Primary or Secondary system LOCA initiator contributor
(e.g., RCS or main steam/feedwater pipe degradations and leaks)

MITIGATION SYSTEMS CORNERSTONE

_____ Core Decay Heat Removal Degraded

_____ Initial Injection Heat Removal Degraded
_____ Primary (e.g., Safety Inj)
____ Low Pressure
____ High Pressure
_____ Secondary - PWR only (e.g., AFW)

_____ Long Term Heat Removal Degraded (e.g., ECCS sump recirculation, suppression pool cooling)
_____ Reactivity Control Degraded
_____ Fire/Flood/Seismic/Weather Protection Degraded

BARRIERS CORNERSTONE

_____ RCS LOCA Mitigation Boundary Degraded
(e.g., PORV block valve, PTS issue)

_____ Containment Barrier Degraded
_____ Reactor Containment Degraded
_____ Actual Breach or Bypass
_____ Heat Removal, Hydrogen or Pressure Control Degraded

_____ Control Room, Aux Bldg, or Spent Fuel Bldg Barrier Degraded
_____ Fuel Cladding Barrier Degraded

If the finding is assumed to degrade:

1. fire protection defense in depth (DID), detection, suppression, barriers, fire brigade. **STOP. Go to** IMC 0609, Appendix F
2. the safety of a shutdown reactor. **STOP. Go to** IMC 0609, Appendix G
3. the safety of an operating reactor, identify the degraded areas:
   [] Initiating Event [] Mitigation Systems [] RCS Barrier [] Fuel Barrier [] Containment Barriers
4. **Two or more** of the above areas degraded - **STOP. Go to Phase 2**
5. If **only one** of the above areas is degraded, continue **only** in the **appropriate** column below.

<u>Initiating Event</u>

1. Does the finding contribute to the likelihood of a Primary or Secondary system LOCA initiator?

[ ] **If YES-Stop. Go to Phase 2**

[ ] If NO, continue

2. Does the finding contribute to both the likelihood of a reactor trip AND the likelihood that mitigation equipment or functions will not be available?

[ ] **If YES-Stop. Go to Phase 2**

[ ] If NO, continue

3. Does the finding increase the likelihood of a fire or internal/external flood?

[ ] **If YES** - Use the IPEEE or other existing plant-specific analyses to identify core damage scenarios of concern and factors that increase the frequency. Provide this input for **Phase 3** analysis.

[ ] If NO, screen as Green

<u>Mitigation Systems</u>

1. Is the finding a design or qualification deficiency confirmed not to result in loss of function per GL 91-18 (rev 1)?

[ ] **If YES** -screen as Green

[ ] If NO, continue

2. Does the finding represent an actual loss of safety function of a System?

[ ] **If YES-Stop. Go to Phase 2**

[ ] If NO, continue

3. Does the finding represent an actual loss of safety function of a single Train, for > its Tech Spec Allowed Outage Time?

[ ] **If YES - Stop. Go to Phase 2**

[ ] If NO, continue

4. Does the finding represent an actual loss of safety function of one or more non-Tech Spec Trains of equipment designated as risk-significant per 10CFR50.65, for >24 hrs?

[ ] **If YES - Stop. Go to Phase 2**

[ ] If NO, continue

5. Does the finding screen as potentially risk significant due to a seismic, fire, flooding, or severe weather initiating event, using the criteria on page 3 of this Worksheet?

[ ] **If YES-** Use the IPEEE or other existing plant-specific analyses to identify core damage scenarios of concern and provide this input for **Phase 3** analysis.

[ ] If NO, screen as Green

<u>RCS Barrier</u> or <u>Fuel Barrier</u>

1. RCS Barrier

Stop. Go to Phase 2

2. Fuel Barrier

screen as Green

<u>Containment Barriers</u>

1. Does the finding <u>only</u> represent a degradation of the radiological barrier function provided for the control room, or auxiliary building, or spent fuel pool, or SBGT system (BWR)?

[ ] **If YES-** screen as Green

[ ] If NO, continue

2. Does the finding represent a degradation of the barrier function of the control room against smoke or a toxic atmosphere?

[ ] **If YES- Stop. Go to Phase 3**

[ ] If NO, continue

3. Does the finding represent an actual open pathway in the physical integrity of reactor containment or an actual reduction of the atmospheric pressure control function of the reactor containment?

[ ] **If YES- Stop. Go to Appendix H of IMC 0609**

[ ] If NO, screen as Green

SDP PHASE 1 SCREENING WORKSHEET FOR IE, MS, and B CORNERSTONES

Seismic, Fire, Flooding, and Severe Weather Screening Criteria

- Does the finding involve the loss or degradation of equipment or function **specifically** designed to mitigate a seismic, flooding, or severe weather initiating event (e.g., seismic snubbers, flooding barriers, tornado doors)? (Equipment and functions for the mitigation or suppression of fire initiating events, such as thermal wrap or sprinkler systems, should be evaluated using IMC 0609 Appendix F and are not evaluated here)
- []**If YES** -continue to question 2
- []If NO - skip to question 3
- If the equipment or safety function is assumed to be completely failed or unavailable, are ANY of the following three statements TRUE? The loss of this equipment or function by itself, during the external initiating event it was intended to mitigate
- a) would cause a plant trip or any of the Initiating Events used by Phase 2 for the plant in question;
- b) would degrade **two or more** Trains of a multi-train safety system or function;
- c) would degrade one or more Trains of a system that supports a safety system or function.
- []**If YES** - the finding is potentially risk significant due to external initiating event core damage sequences - return to page 2 of this Worksheet
- []If NO, screen as Green
- Does the finding involve the total loss of any safety function, identified by the licensee through a PRA, IPEEE, or similar analysis, that contributes to external event initiated core damage accident sequences (i.e., initiated by a seismic, fire, flooding, or severe weather event)?
- []**If YES** - the finding is potentially risk significant due to external initiating event core damage sequences - return to page 2 of this Worksheet
- []If NO, screen as Green

Result of Phase 1 screening process:

[] **Screen as Green** [] **Go to Phase 2** [] **Go to Phase 3**

Important Assumptions (as applicable):

Page 3 of 3

SDP Phase 2

- The Phase 2 SDP Is Based on a Simplified PRA Model.

- For Each Plant a Notebook Has Been Constructed and Consists of Tables that are used to
  - Identify the Initiating Event(s) Impacted by the Finding
  - Identify the Functional Level Accident Sequences(s) Affected
  - Identify the Systems Available to perform the Critical Safety Functions
  - Determine the Change to CDF Implied by the Finding.

- The SDP Tables Use Order of Magnitude Values for Unavailabilities of Mitigating Systems and Initiating Event Frequencies.

SDP Phase 2

- The Functional Accident Sequences and Mitigating Systems Are Determined on a Plant-Specific Basis.

- It Is Intended Solely as a Screening Tool for Use by Inspectors. A More Detailed Evaluation Would Be Performed by Risk Analysts.

Affected System	Major Components	Support Systems	Initiating Event Scenarios
AFWS	AFWTDP/Valves Control I&C	125 V-DC 115 V-AC Control air	Transient, LOOP, MSLB (Outside Containment), SGTR, SLOCA from PORV/SRV/RCP, MFLB, MSLB (Inside Containment), SLOCA from pipe breaks, ATWS
	AFWMDP Control I&C	4 KV bus A&B 125 V-DC, 28 V-DC, 115 V-AC, and HVAC	
HHSI	Pumps Valves I&C including DC for 4.16 KV breakers	4.16 KV, and 125 V-DC, 28 V-DC, SW, CCW, and HVAC	Transient, LOOP, MSLB (Outside Containment), SGTR, SLOCA from PORV/SRV/RCP, MFLB, MSLB (Inside Containment), SLOCA from pipe breaks, ATWS
HHSI (Recirculation)	Pumps Valves	4.16 KV, and 125 V-DC, 28 V-DC, SW, CCW, and HVAC	Transient, LOOP, MSLB (Outside Containment), SGTR, SLOCA from PORV/SRV/RCP, MFLB, MSLB (Inside Containment), SLOCA from pipe breaks, ATWS
LPSI/RHR/ (Recirculation)	Pumps Valves	4.16 KV, and 125 V-DC, 28 V-DC, SW, CCW, and HVAC	Transient, LOOP, MSLB (Outside Containment), SGTR, SLOCA from PORV/SRV/RCP, MFLB, MSLB (Inside Containment), SLOCA from pipe breaks, M/L LOCA
CS (Recirculation)	Pumps Heat Exchanger Valves	4.16 KV, 125 V-DC, CCW, 28 V-DC, HVAC, SW	Transient, LOOP, MSLB (Outside Containment), SGTR, SLOCA from PORV/SRV/RCP, MFLB, MSLB (Inside Containment), SLOCA from pipe breaks, M/L LOCA
EDG	Cooling (unit 1 only) HVAC Start system Fuel system	Service Water, 125 V-DC, 28 V-DC, and HVAC	LOOP

Table 1 - Categories of Initiating Events for Generic PWR Nuclear Power Plant

Row	Approximate Frequency	Example Event Type	Initiating Event Likelihood (IEL)		
I	> 1 per 1-10 yr	Loss of Power Conversion System (TPCS)	1	2	3
II	1 per 10-10^2 yr	Loss of offsite power (LOOP), Loss of Class 1E 125V DC Bus A or B (LODC)	2	3	4
III	1 per 10^2 - 10^3 yr	Steam Generator Tube Rupture (SGTR), Stuck open PORV/SRV (SORV), Small LOCA including RCP seal failures (SLOCA), Main Steam Line Break Outside Containment (MSLB)	3	4	5
IV	1 per 10^3 - 10^4 yr	Medium LOCA (MLOCA), LOOP with Loss of One Class 1E 4.16-kV Bus (LEAC)	4	5	6
V	1 per 10^4 - 10^5 yr	Large LOCA (LLOCA), Loss of Component Cooling Water (LCCW)	5	6	7
VI	less than 1 per 10^5 yr	ATWS(1)	6	7	8
			> 30 days	3-30 days	< 3 days
			Exposure Time for Degraded Condition		

Initiating Event Likelihood	Remaining Mitigation Capability Rating (with Examples)						
	6	**5**	**4**	**3**	**2**	**1**	**0**
	3 diverse trains OR 2 multi-train systems OR 1 train + 1 multi-train system + recovery of failed train	1 train + 1 multi-train system OR 2 diverse trains + recovery of failed train	2 diverse trains OR 1 multi-train system + recovery of failed train	1 train + recovery of failed train OR 1 multi-train system OR Operator action + recovery of failed train	1 train OR Operator action OR Operator action under high stress + recovery of failed train	Recovery of failed train OR Operator action under high stress	none
A	Green	White	Yellow	Red	Red	Red	Red
B	Green	Green	White	Yellow	Red	Red	Red
C	Green	Green	Green	White	Yellow	Red	Red
D	Green	Green	Green	Green	White	Yellow	Red
E	Green	Green	Green	Green	Green	White	Yellow
F	Green	Green	Green	Green	Green	Green	White
G	Green	Green	Green	Green	Green	Green	Green
H	Green	Green	Green	Green	Green	Green	Green

Table 4 - Risk Significance Estimation Matrix

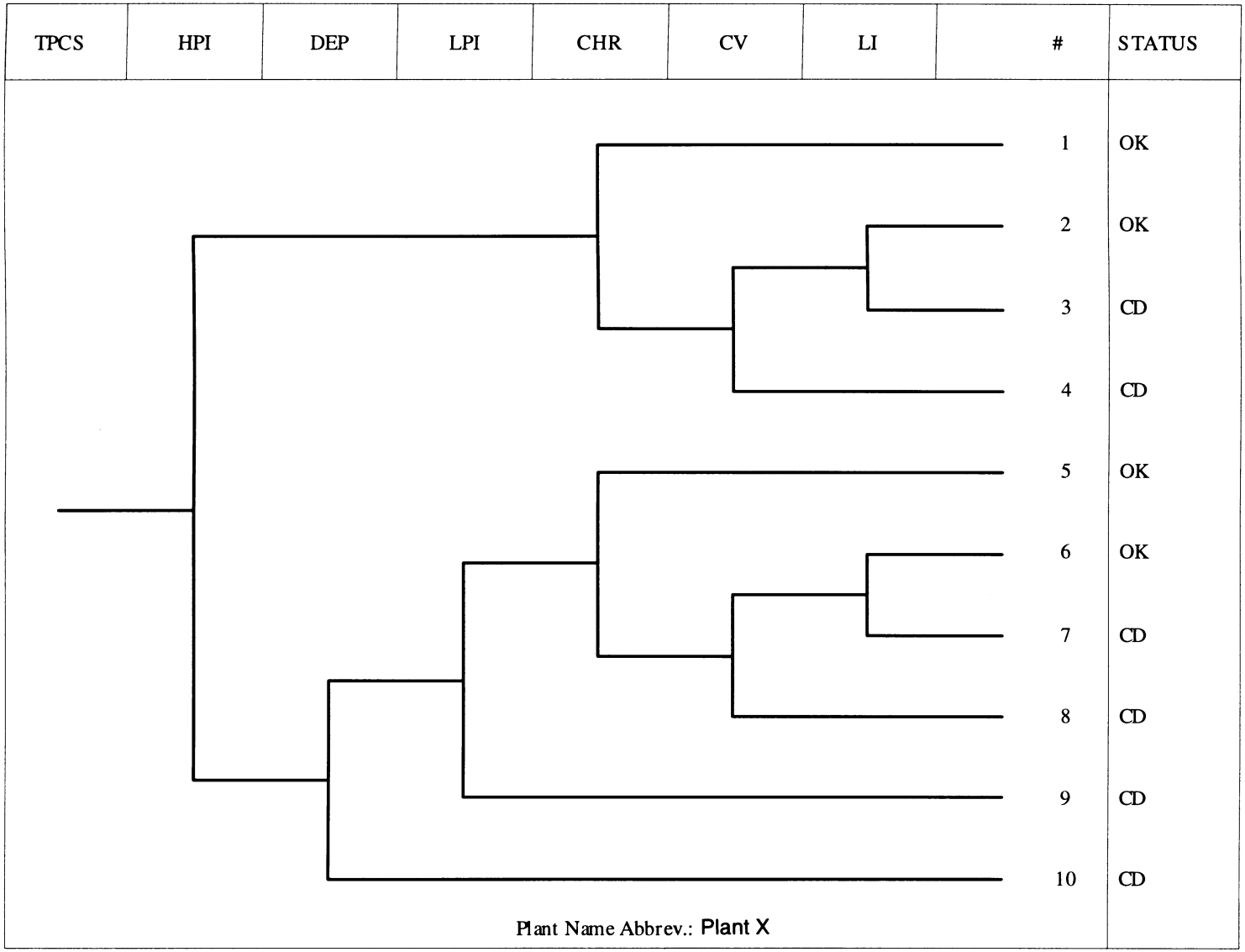

TPCS
HPI
DEP
LPI
CHR
CV
LI
#
STATUS
1
OK
2
OK
3
CD
4
CD
5
OK
6
OK
7
CD
8
CD
9
CD
10
CD
Plant Name Abbrev.: Plant X

Table 3. 2 SDP Worksheet for Plant X — 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:	Full Creditable Mitigation Capability for Each Safety Function:
High Pressure Injection (HPI)	HPCI (1 ASD train) or RCIC (1 ASD train)
Depressurization (DEP)	Depressurize with 2/11 SRVs (operator action = 2)
Low Pressure Injection (LPI)	1/4 RHR pumps in 1/2 trains in LPCI Mode (1 multi-train system) or 1/2 CS pumps (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps, associated RHR HX and 1/4 RHRSW pumps in 1/2 trains in SPC or drywell spray (1 multi-train system)
Containment Venting (CV)	Manual venting through SP vent path (operator action = 2)
Late Injection (LI)	1/2 CRD pumps (operator action = 2); or 1/4 RHRSW pumps cross-tied to inject via 1/2 LPCI paths (operator action = 1)

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 TPCS - CHR - LI (3, 7)			
2 TPCS - CHR - CV (4, 8)			
3 TPCS - HPI - LPI (9)			
4 TPCS - HPI - DEP (10)			

Type of Remaining Mitigation Capability	Remaining Mitigation Capability Credit $X = - \log_{10}(\text{failure prob})$
Recovery of Failed Train Operator action to recover failed equipment that is capable of being recovered after an initiating event occurs. Action may take place either in the control room or outside the control room and is assumed to have a failure probability of approximately 0.1 when credited as "Remaining Mitigation Capability." Credit should be given only if the following criteria are satisfied: (1) sufficient time is available; (2) environmental conditions allow access, where needed; (3) procedures describing the appropriate operator actions exist; (4) training is conducted on the existing procedures under similar conditions; and (5) any equipment needed to perform these actions is available and ready for use.	1
1 Automatic Steam-Driven (ASD) Train A collection of associated equipment that includes a single turbine-driven component to provide 100% of a specified safety function. The probability of such a train being unavailable due to failure, test, or maintenance is assumed to be approximately 0.1 when credited as "Remaining Mitigation Capability."	1
1 Train A collection of associated equipment (e.g., pumps, valves, breakers, etc.) that together can provide 100% of a specified safety function. The probability of this equipment being unavailable due to failure, test, or maintenance is approximately 1E-2 when credited as "Remaining Mitigation Capability."	2
1 Multi-Train System A system comprised of two or more trains (as defined above) that are considered susceptible to common cause failure modes. The probability of this equipment being unavailable due to failure, test, or maintenance is approximately 1E-3 when credited as "Remaining Mitigation Capability," regardless of how many trains comprise the system.	3
2 Diverse Trains A system comprised of two trains (as defined above) that are not considered to be susceptible to common cause failure modes. The probability of this equipment being unavailable due to failure, test, or maintenance is approximately 1E-4 when credited as "Remaining Mitigation Capability."	4 (=2+2)
Operator Action Credit Major actions performed by operators during accident scenarios (e.g., primary heat removal using bleed and feed, etc.). These actions are credited using three categories of human error probabilities (HEPs). These categories are Operator Action = 1 which represents a failure probability between 5E-2 and 0.5, Operator Action = 2 which represents a failure probability between 5E-3 and 5E-2, and Operator Action = 3 which represents a failure probability between 5E-4 and 5E-3.	1, 2, or 3

Final Significance Assessment

- Solve all of the appropriate initiating event worksheets
- Sum results of affected sequences to determine final result
- All greater than Green findings are validated by an SRA

SDP PHASE 3

Risk Significance Finalization and Justification

- Phase 3 performed:
  - Notebooks don't apply
  - Challenges from Licensee
- Phase 3 is a more refined Risk Analysis
  - Based on additional plant specific information
  - Consider Internal and External risk contributors
- Phase 3 evaluations performed by an NRC Risk Analyst

SDP CHALLENGES

- Process
  - Relatively low frequency of use by inspectors leads to a lack of comfort with the process
  - One solution is to provide pre-solved worksheets
- Technical
  - Findings associated with degradation (e.g., Davis Besse, D.C. Cook) are difficult to translate into unavailabilities or increases in initiating event frequencies
  - Results have large uncertainties and lead to untimeliness in determination of ‘color’