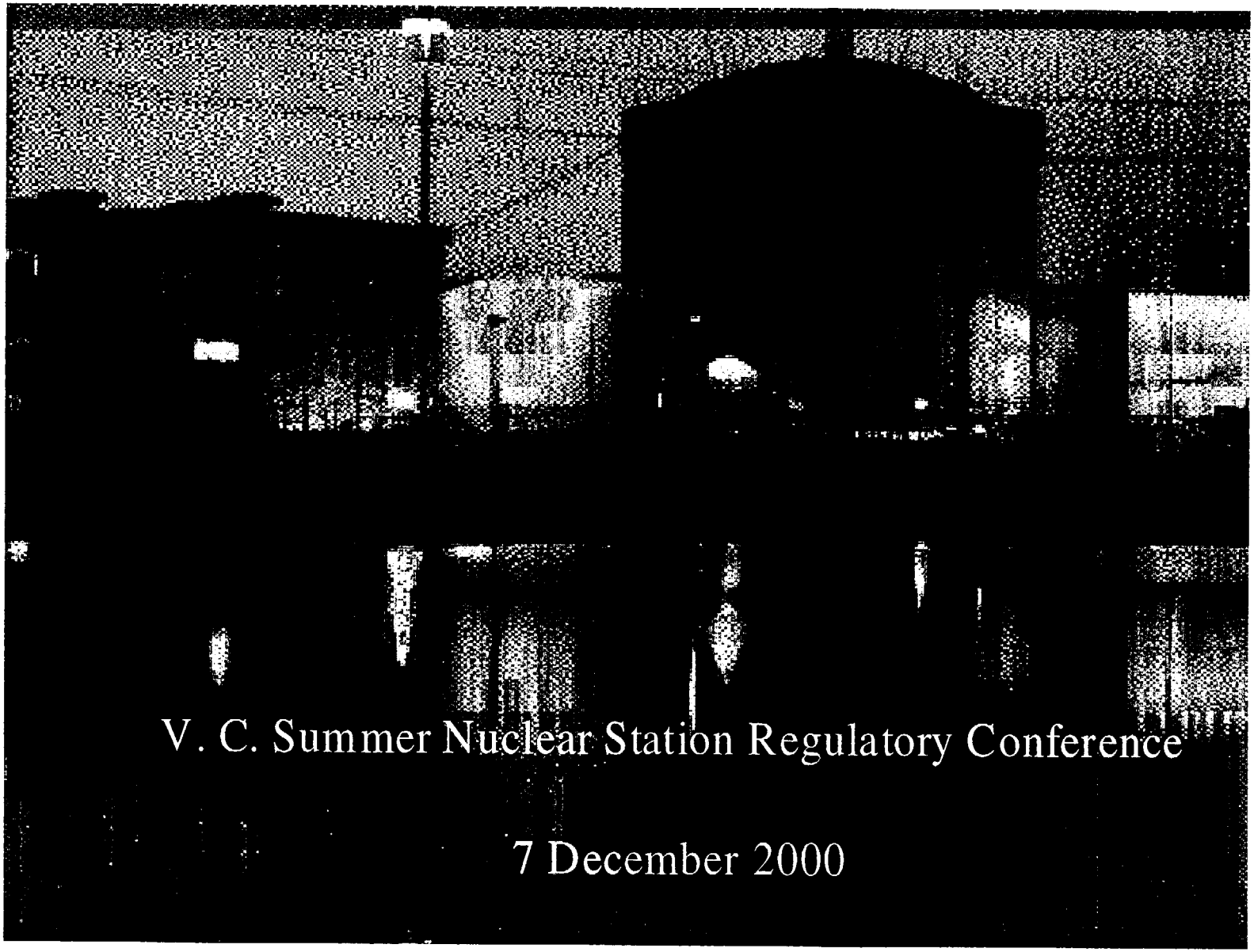

V. C. Summer Nuclear Station Regulatory Conference

7 December 2000

TDEFW Pump Isolation Significance Assessment

V. C. Summer Nuclear Station

Gerald A. Loignon, Jr.

Presentation Outline

- Overview of the process used
- Results
- Details of the process
- Conclusion

Significance Determination Process

- Phase 1 Screening: Does not screen - "actual loss of safety function of a single Train, for > its Tech Spec Allowed Outage Time."
- Phase 2 Screening: Does not screen - several sequences screen as White.
- Phase 3 Best Estimate Analysis: Confirms the appropriate significance level is White.

Phase 3 Results

The Phase 3 result is highly dependent on the HEP for recovery.

HEP	ICCDP	ICLERP
1.00	1.80E-05	1.30E-07
0.95		
0.90		
0.85		
0.80		
0.75	1.75E-05	1.25E-07
0.70		
0.65	1.51E-05	1.08E-07
0.60	1.39E-05	1.00E-07
0.55		
0.50	1.16E-05	8.33E-08
0.45	1.04E-05	7.49E-08
0.40	9.28E-06	6.65E-08
0.35	8.10E-06	5.82E-08
0.30		
0.25	5.78E-06	4.10E-08
0.20		
0.15		
[illegible]	2.28E-06	1.60E-08

HEP Calculation Methods

- CBDT Cognitive/THERP Execution
- THERP Dynamic Diagnosis (Table 20-16)
- ASP Human Error Worksheet
- NUREG 1150 Non-Procedural Innovative Recovery

CBDT/THERP

SCIENTECH Human Reliability Analysis Calculator

Version 1.0b

Calulate Pc Unrecovered | Calculate Pc Recovery | Calculate Pe Execution | Print Data | Print Report | Recalculate Summary | Delete Scenario

Scenario Id.	Scenario	Pc-unrec (Cognitive Unrecovered)	Pc-rec (Cognitive Recovered)	Execution	Total HEP	Notes
TDTUHRA	OPERATOR FAILS TO RECOVER EFW TDP FOLLOWING RESTORATION ERROR (DISCH ISOL CLOSED). ACTIONS IN THE CONTROL ROOM.	3.0E-3	1.5E-4	0.0E+0	1.5E-4	
TDTUHRA-LOCAL	OPERATOR FAILS TO RECOVER EFW TDP FOLLOWING RESTORATION ERROR (DISCH ISOL CLOSED) LOCAL ACTIONS	2.6E-1	1.1E-1	7.0E-2	1.747E-01	

Total HEP = 0.175

Phase 3 Results

ASP

NUREG-1150

THERP

CBDT/THERP

HEP	ICCDP	ICLERP
1.00	1.80E-05	1.30E-07
0.95		
0.90		
0.85		
0.80		
0.75	1.75E-05	1.25E-07
0.70		
0.65	1.51E-05	1.08E-07
0.60	1.39E-05	1.00E-07
0.55		
0.50	1.16E-05	8.33E-08
0.45	1.04E-05	7.49E-08
0.40	9.28E-06	6.65E-08
0.35	8.10E-06	5.82E-08
0.30		
0.25	5.78E-06	4.10E-08
0.20		
0.15		
0.10	2.28E-06	1.60E-08

Control Room Diagnosis Considerations

- Cutsets are dominated by station blackout sequences
  - The performance shaping factors for station blackout bound those of the other sequences
  - The 60 minute time window is based on the PRA model plant response analysis
  - The timeline is supported by prior EOP validation data and subsequent simulator data from another Westinghouse 3-loop PWR
- The diagnosis is procedure driven

Event Timelines

	Time		
Milestone	HRA Model	EOP Validation	Simulator
Initiating Event	0:00	0:00	0:00
Verify EFW Flow	10:00	2:20	4:05
Arrive at TDEFWP	15:00		8:53
Open Valve	45:00		10:53

SCIENTECH Human Reliability Analysis Calculator

Cognitive Unrecovered - Version 1.0b

Switch to Recovery | Switch to Pe- Execution | Print Data | Print Report | Return to Summary

Scenario: Reactor trip followed by Loss of Emergency Feedwater
Dominant scenario is following Loss of Offsite Power and EDG failure (SBO).
Dominant scenario quantified as a bounding case.

HI: **TDTUHRA - Control room diagnosis of EFW flow problems**
(TDTUHRA-LOCAL models Local actions)

Cue(s): Control Room cues: Low Feedwater Flow (primary cue), Low Steam Generator Levels

Duration of time window available for action (TW): [redacted] Min.

Approximate start time for TW: [redacted] Min.

Procedure and step governing HI: EOP-1 transfers to EOP-6 at Step 3
EOP-6 (Loss of All AC) Step 4 for Loss EFW

A. Initial Estimate of Pc

	Pc Failure Mechanism	Branch	HEP	Reduce TW by
Pca:	Availability of Information: (Feed flow, SG level)	a	Neg.	min.
Pcb:	Failure of Attention: (Hi workload, check, front)	I	Neg.	min.
Pcc:	Misread/miscommunicate data	a	Neg.	min.
Pcd:	Information misleading	a	Neg.	min.
Pce:	Skip a step in procedure: (Graphically same, aids	c	3.0E-3	5 min.
Pcf:	Misinterpret instruction	a	Neg.	min.
Pcg:	Misinterpret decision logic	[redacted]	Neg.	[redacted] min.
Pch:	Deliberate violation	[redacted]	Neg.	[redacted] min.

Sum of Pca throught Pch = **Initial Pc** = 3.0E-3

Total reduction in TW = 5 min.

Effective TW = 55 min.

Check here if recovery credit clamed on page 2: [redacted]

Notes: Quantification done with a 60 minute time window. Success criteria calc showed worst case at 45 minutes (PORV stuck at 3 minutes) and most likely 90 minutes (PORV sticks open after Pzr fills) for Time to Core Uncovery.

Control Room Diagnosis - Unrecovered

Control Room Recovery Considerations

- Self Review by the BOP Operator
- Extra Crew Review by the NROATC, who has a low work load, in blackout sequences
- Extra Crew Review by the Shift Engineer for other sequences (procedurally directed)
- 5 minutes allotted in the timeline - same as the original diagnosis

SCIENTECH Human Reliability Analysis Calculation

Cognitive Recovery - Version 1

Switch to Pc Unrecovered | Switch to Pe Execution | Print Data | Print Report | Return to Summary

Scenario: Reactor trip followed by Loss of Emergency Feedwater
Dominant scenario is following Loss of Offsite Power and EDG failure (SBO).
Dominant scenario quantified as a bounding case.

HI: TDTUHRA - Control room diagnosis of EFW flow problems
(TDTUHRA-LOCAL models Local actions)

Recovery Factors Identified:
Self review is an option using the time available, extra crew also will help as
Reactor Operator has a low workload.

Pc Failure Mechanism	Initial HEP	Recovery Factor	Recovery Matrix	DF	Multiply HEP By	Override Value	Final Value	When Effective
Pca:	Neg.		1		1			
Pcb:	Neg.		1		1			
Pcc:	Neg.		1		1			
Pcd:	Neg.		1		1			
Pce:	3.0E-3	Self-Review, Extra Crew	1		1	5.0E-2	1.5E-4	10
Pcf:	Neg.		1		1			
Pcg:	Neg.		1		1			
Pch:	Neg.		1		1			

Sum of Pca throught Pch = **Initial Pc** = 1.5E-4

Time at which all recovery factors effective = 10

Notes: This sheet documents the Control Room actions for this HI. Local Operator Actions are modeled on sheet TDTUHRA-LOCAL.

Control Room Diagnosis - Recovered

Local Diagnosis Considerations

- Additional 5 minutes travel time and 15 minutes to walk down the entire flow path are accounted for in the timeline
- All components are in the same general area
  - pump discharge valves on mezzanine over pumps
  - Turbine driven pump flow path spatially separate from the motor driven pump flow path
- Lighting is available
  - flashlight
  - local emergency lighting for flow control valves

Local Diagnosis Considerations

- The valve has a rising stem with ~ 6 inches of travel
- There is an identical valve immediately adjacent for comparison
- Skill of the craft is relied upon rather than procedural direction
- All Auxiliary Operators are qualified in all building watch stations and many of them are RO or SRO licensed

SCE&G

SCIENTECH Human Reliability Analysis Calculator

Cognitive Unrecovered - Version 1.0b

Switch to Recovery | Switch to Pe Execution | Print Data | Print Report | Return to Summary

Scenario: Reactor trip followed by Loss of Emergency Feedwater
Dominant scenario is following Loss of Offsite Power and EDG failure (SBO).
Dominant scenario quantified as a bounding case.

HI: TDTUHRA-LOCAL - Local diagnosis of EFW TDP flow problems
(TDTUHRA - Control room diagnosis of EFW flow problems)

Cue(s): Control Room cues: Low Feedwater Flow (primary cue), Low Steam Generator Levels
Also, turbine speed is available; EFW flow and TDP steam valves have local stem indication.

Approximate start time for TW: 45 Min.

Procedure and step governing HI: EOP-6 (Loss of All AC) Step 4 for Loss EFW

A. Initial Estimate of Pc

Pca:	Availability of Information: (rising stem indicator)	a/b	0.0E+0	45	min.
Pcb:	Failure of Attention: (high load, check, back, not)	k	1.5E-3		min.
Pcc:	Misread/miscommunicate data:	a	0.0E+0		min.
Pcd:	Information misleading: (no procedure-directed cu	d	1.0E-1		min.
Pce:	Skip a step in procedure: (no specific step)	I	1.0E-1		min.
Pcf:	Misinterpret instruction: (potentially ambiguous)	g	6.0E-2		min.
Pcg:	Misinterpret decision logic: (no NOTs used)	l	Neg.		min.
Pch:	Deliberate violation		Neg.		min.

Sum of Pca throught Pch = **Initial Pc** = 2.6E-1

Total reduction in TW = 30 min.

Effective TW = 30 min.

Check here if recovery credit clamed on page 2: X

Notes: This quantification assumes an SBO situation with local emergency lighting in service,
Aux operators carry flashlights and routinely (shiftly) check the area of these valves.
There is no specific, procedure-directed steps to troubleshoot/review valves individually.
General training and system operation (skill of the craft) are used to walkdown each component.
Decision trees f-h assume the local operator is independently tasked from the Control Room.

Local Diagnosis - Unrecovered

Local Diagnosis Recovery Considerations

- The timeline allows ~30 minutes for recovery
- There is a second building operator with a low workload available to assist
- A moderate dependency is conservatively applied (30 minutes is the break point between moderate and low dependency)

SCE&G

SCIENTECH Human Reliablity Analysis Calculator

Cognitive Recovery Version 1.02

Switch to Pc Unrecovered | Switch to Pc Execution | Print Data | Print Report | Return to Summary

Scenario: Reactor trip followed by Loss of Emergency Feedwater
Dominant scenario is following Loss of Offsite Power and EDG failure (SBO).
Dominant scenario quantified as a bounding case.

HI: TDTUHRA-LOCAL - Local diagnosis of EFW TDP flow problems

(TDTUHRA - Control room diagnosis of EFW flow problems)
Control room team provides indication of SG level and EFW flow.
Ample time for recovery.

Pca:	0.0E+0		1	-	1		0.0E+0	
Pcb:	1.5E-3	Self-review	X	MD	0.14414		2.2E-4	
Pcc:	0.0E+0		1	-	1		0.0E+0	
Pcd:	1.0E-1	Extra crew	0.5	-	0.5		5.0E-2	
Pce:	1.0E-1	Extra crew, self-review	1	-	1	2.5E-1	2.5E-2	
Pcf:	6.0E-2	Extra crew	0.5	-	0.5		3.0E-2	
Pcg:	Neg.		1	-	1			
Pch:	Neg.		1	-	1			

Sum of Pca throught Pch = **Initial Pc** = 1.1E-1

Time at which all recovery factors effective = 60

Notes:

Local Diagnosis - Recovered

Execution Error Considerations

- Three distinct failure modes
  - misinterpret an oral instruction
  - select the wrong valve
  - fail to recognize it is closed
- Conservative inclusion of bounding failure modes doubles the execution error

Execution Errors

SCIENTECH Human Reliability Analysis Calculator

Pe Execution - Version 1.0b

Switch to Pc Unrecovered | Switch to Pc Recovery | Add Action Step Record | Add Summary Record | Recalculate Stress Factor | Print Data | Print Report | Return to Summary

Scenario:	Reactor trip followed by Loss of Emergency Feedwater
	Dominant scenario is following Loss of Offsite Power and EDG failure (SBO).
HI:	TDTUHRA-LOCAL - Local diagnosis of EFW TDP flow problems
Procedure:	EOP-6 (Loss of All AC) Step 4 for Loss EFW

Step		Omission					Commision					Total		Comments
No.	Actions	HEP	Table Ref.	Ite m	Stress E/M/O	Stress Value	HEP	Table Ref.	Ite m	Stress E/M/O	Stress Value	Over Ride	Per Step	
--	Open XVG-1036 locally	1.3E-3	20-8	5	Ext.	5	6.3E-3	20-13	5	Ext.	5		3.8E-2	Oral instructions
							6.3E-3	20-14	3	Ext.	5		3.2E-2	
Pe Execution													7.0E-2	

Summary of Pe Execution Values with Recovery:

	Calculation	Total

Total Human Error Probability for Execution 7.0E-2

CBDT/THERP - Best Estimate

HEP	ICCDP	ICLERP
1.00	1.80E-05	1.30E-07
0.95		
0.90		
0.85		
0.80		
0.75	1.75E-05	1.25E-07
0.70		
0.65	1.51E-05	1.08E-07
0.60	1.39E-05	1.00E-07
0.55		
0.50	1.16E-05	8.33E-08
0.45	1.04E-05	7.49E-08
0.40	9.28E-06	6.65E-08
0.35	8.10E-06	5.82E-08
0.30		
0.25	5.78E-06	4.10E-08
0.20		
0.15		
0.10	2.28E-06	1.60E-08

THERP Dynamic Diagnosis

- Alternative approach to Crew Diagnosis
  - Table 20-16 item 7 lists a nominal HEP for dynamic diagnosis by an individual under extremely high stress.
  - Since this would be a crew diagnosis, recovery by an additional crew member is modeled with the appropriate dependency.
- Execution error is the same as the previous method.

ASP - Second Alternative Estimate

HEP	ICCDP	ICLERP
1.00	1.80E-05	1.30E-07
0.95		
0.90		
0.85		
0.80		
0.75	1.75E-05	1.25E-07
0.70		
0.65	1.51E-05	1.08E-07
0.60	1.39E-05	1.00E-07
0.55		
0.50	1.16E-05	8.33E-08
0.45	1.04E-05	7.49E-08
0.40	9.28E-06	6.65E-08
0.35	8.10E-06	5.82E-08
0.30		
0.25	5.78E-06	4.10E-08
0.20		
0.15		
0.10	2.28E-06	1.60E-08

NUREG 1150 Non-Procedural Innovative Recovery

- The HEP is given as 0.3.

NUREG 1150 - Third Alternative Estimate

HEP	ICCDP	ICLERP
1.00	1.80E-05	1.30E-07
0.95		
0.90		
0.85		
0.80		
0.75	1.75E-05	1.25E-07
0.70		
0.65	1.51E-05	1.08E-07
0.60	1.39E-05	1.00E-07
0.55		
0.50	1.16E-05	8.33E-08
0.45	1.04E-05	7.49E-08
0.40	9.28E-06	6.65E-08
0.35	8.10E-06	5.82E-08
0.30		
0.25	5.78E-06	4.10E-08
0.20		
0.15		
0.10	2.28E-06	1.60E-08

HEP Comparisons

Method	Result	Strengths/Weaknesses
CBDT/THERP	1.75E-01	rigorous, consistent with model, conservatively applied
THERP	2.70E-01	less rigouous, somewhat subjective, less consistent with model
ASP	5.00E-01	screening estimate, somewhat subjective, not consistent with model
NUREG-1150	3.00E-01	ball park estimate, more subjective, not consistent with model

Phase 3 Results

HEP	ICCDP	ICLERP
1.00	1.80E-05	1.30E-07
0.95		
0.90		
0.85		
0.80		
0.75	1.75E-05	1.25E-07
0.70		
0.65	1.51E-05	1.08E-07
0.60	1.39E-05	1.00E-07
0.55		
0.50	1.16E-05	8.33E-08
0.45	1.04E-05	7.49E-08
0.40	9.28E-06	6.65E-08
0.35	8.10E-06	5.82E-08
0.30		
0.25	5.78E-06	4.10E-08
0.20		
0.15		
0.10	2.28E-06	1.60E-08

ASP

NUREG-1150
THERP
CBDT/THERP

Other Qualitative Considerations

- The EFW Safety System Unavailability Performance Indicator is still Green.
- The SDP Phase 2 results indicate that the appropriate significance level is White.

Initiating Event/Likelihood	Sequence Number	Remaining Capability/Rating	Total	Color
Transient/A	1	MDEFW(1 multi-train system)/3 + HPR(OA)/2	5	White
	2	MDEFW(1 multi-train system)/3 + FB(OA)/2	5	White
Small LOCA/C	1	NA		
	2	MDEFW(1 multi-train system)/3 + HPR(OA)/2	5	Green
	3	MDEFW(1 multi-train system)/3 + FB(OA)/2	5	Green
	4	NA		
	5	NA		
	6	NA		
Stuck Open PORV/C	1	NA		
	2	BLK(OA)/2 + MDEFW(1 multi-train system)/3 + HPR(OA)/2	7	Green
	4	NA		
	5	NA		
	6	NA		
LOOP/B	1	MDEFW(1 multi-train system)/3 + HPR(OA)/2		Green
	2	MDEFW(1 multi-train system)/3 + FB(OA)/2	5	Green
	3	MDEFW(1 multi-train system)/2 + FB(OA)/2	5	Green
	4	NA		
	5	NA		
	6	NA		
	7	EAC(1 multi-train system)/3 + FB(OA)/2	5	Green
	8	EAC(1 multi-train system)/3 + REC2(OA-high stress)/1	4	White
SGTR/C	1	NA		
	2	NA		
	3	MDEFW(1 multi-train system)/3 + HPR(OA)/2 + LTMS(OA)/2	7	Green
	4	MDEFW(1 multi-train system)/3 + FB(OA)/2	5	Green
	5	MDEFW(1 multi-train system)/3 + EQ(OA)/2	5	Green
	6	MDEFW(1 multi-train system) + HPR(1 multi-train system)		Green
ATWS/F	1	NA		
	2	none	0	White
	3	NA		
	4	NA		

Other Qualitative Considerations

- The recovery of off-site power probability is a generic number with no credit taken for the black start capability of the hydro units.
- The loss of off-site power initiating event frequency is a generic number with no consideration for the 1E busses being powered from diverse switchyards.

THERP Dynamic Diagnosis

- Un-recovered cognitive error = 0.403
- Recovered Cognitive error (moderate dependence)= 0.20
- Execution error = 0.07
- Total HEP = 0.27

THERP Dynamic Diagnosis

- Alternative approach to Crew Diagnosis
  - Table 20-16 item 7 lists a nominal HEP for dynamic diagnosis by an individual under extremely high stress.
  - Since this would be a crew diagnosis, recovery by an additional crew member is modeled with the appropriate dependency.
- Execution error is the same as the previous method.

ASP Human Error Worksheet

- Uses a base HEP of 0.01
- Adjusts base with a multiplier for each of eight performance shaping factors
- The Region II SRA determined the HEP to be 0.5.

Revised ASP Worksheet

10/12/98

ASP Human Error Worksheet (Page 1 of 3)

DIAGNOSES

Plant: VCS #5 Scenario: Station Blackout Sequence Number: _____

Task Error Description: Failing to diagnose failure of open TDAFW pump discharge valve

Does this task contain a significant amount of diagnosis activity? YES ✓ NO ____

If Yes, Use the table below to evaluate the PSFs for the Diagnosis portion of the task before going to page 2. If NO, go directly to page 2.

PSFs	PSF Levels	Multiplier for Diagnosis	If non-nominal PSF levels are selected, please add specific reasons in this column
Available Time	Inadequate time	P(failure) = 1.0	
	Barely adequate time = 20 min	x0	
	Nominal time = 30 min	1	1
	Extra time > 60 min	0.1	
	Expansive time = 24 hrs	0.01	
Stress	Extreme	5	
	High	2	1
	Nominal	1	
Complexity	Highly complex	5	
	Moderately complex	2	2
	Nominal	1	
Experience/Training	Low	10	
	Nominal	1	1
	High	0.5	
Procedures	Not available	50	
	Available, but poor	5	5
	Nominal	1	
	Diagnostic/Symptom oriented	0.5	
Ergonomics	Missing/Misleading	50	
	Poor	10	5
	Nominal	1	
	Good	0.5	
Fitness of Duty	Unfit	P(failure) = 1.0	
	Degraded Fitness	5	
	Nominal	1	1
Work Processes	Poor	2	
	Nominal	1	1
	Good	0.8	

Conclusion

White is the appropriate level of significance to assign to this event.

- The best estimate HEP leads to ICCDP/ICLERP numbers supporting a White assessment.
- Alternate HRA methods, when considering their strengths and weaknesses, support that assessment.
- Other qualitative information supports the White level of significance directly or shows areas of conservatism in the Phase 3 evaluation.

OPEN REGULATORY CONFERENCE

V. C. SUMMER NUCLEAR STATION

DECEMBER 7, 2000
NRC REGION II OFFICE, ATLANTA, GA.

I. OPENING REMARKS, INTRODUCTIONS AND MEETING INTENT
B. Mallett, Deputy Regional Administrator

II. NRC REGULATORY CONFERENCE POLICY
A. Boland, Enforcement Officer

III. STATEMENT OF THE ISSUE WITH RISK AND VIOLATION PERSPECTIVES
V. McCree, Deputy Director, Division of Reactor Projects

IV. LICENSEE RISK AND REGULATORY PERSPECTIVE PRESENTATION

V. BREAK / NRC CAUCUS
B. Mallett, Deputy Regional Administrator

VI. CLOSING REMARKS
B. Mallett, Deputy Regional Administrator

Apparent Violation

A. Technical Specification (TS) 3.7.1.2.b, requires, in part, that at least three independent steam generator emergency feedwater pumps and flow paths shall be OPERABLE with one steam turbine driven emergency feedwater pump capable of being powered from an OPERABLE steam supply system. Action Statement 3.7.1.2(a) states that with one emergency feedwater pump inoperable, restore the required emergency feedwater pumps to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in HOT SHUTDOWN within the following 6 hours.

On August 7, 2000, the turbine driven emergency feedwater pump flow path was inoperable (e.g., isolated) for greater than 72 hours and the unit was not placed in HOT STANDBY within the next 6 hours. The flow path was not operable due to its manual isolation, XVG1036-EF, being locked closed. This valve was isolated for approximately 48 days between August 4 and September 21, 2000.

Note: The apparent violations discussed at this Regulatory Conference are subject to further review and are subject to change prior to any resulting enforcement action.

Apparent Violation

B. Technical Specification (TS) 6.8.1.c requires, in part, that procedures shall be implemented covering surveillance and test activities. In addition, TS 6.8.1.a requires, in part, that procedures in Appendix A of Regulatory Guide 1.33, Revision 2, February 1978, be implemented. Section 1.c of Appendix A addresses procedures for equipment control.

Surveillance Test Procedure, STP-120.004, "Emergency Feedwater Valve Operability Test," Revision 13C, Attachment 11C, required the operator to position manually operated valve, XVG01036-EF, the turbine driven emergency feedwater pump discharge isolation valve, to the locked open position at the conclusion of the surveillance test.

Station Administrative Procedure, SAP-153, "Independent Verification," Revision 1, provides verification instructions for equipment control. Specifically, Step 6.4.2.B.2 required that the initial positioner to manipulate the component to the required position and Step 6.4.2.B.4 required that the independent verifier to physically check the position of the component.

On August, 4, 2000, the above procedures were not implemented, in that:

1. Valve XVG-1036-EF was not locked open as required by STP-120.004. The operator locked the valve closed.

2. Valve XVG-1036-EF was not manipulated to the required open position and was not properly physically checked as required by SAP-153. The operator failed to position the valve in the required position and the independent verifier failed to physically check the position of the component.

Note: The apparent violations discussed at this Regulatory Conference are subject to further review and are subject to change prior to any resulting enforcement action.