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#5

NUCLEAR POWER PLANT SIMULATORS

AND

THEIR USE IN OPERATOR TRAINING AND REQUALIFICATION

A SURVEY PERFORMED BY

MEMPHIS STATE UNIVERSITY/CENTER FOR NUCLEAR STUDIES

FOR

U. S. NUCLEAR REGULATORY COMMISSION

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PRIMARY GOALS

- ASSESS CAPABILITIES OF CURRENT SIMULATORS FOR TRAINING IN ABNORMAL/EMERGENCY EVENTS
- ASSESS CURRENT USE OF SIMULATORS IN TRAINING PROGRAMS
- MAKE RECOMMENDATIONS FOR IMPROVEMENT OF SIMULATORS AND THEIR USE IN TRAINING

SPECIAL EMPHASIS

- TMI-2 EVENT AND ITS IMPLICATIONS

ADDITIONAL TASKS

- REVIEW AND ASSESS EXISTING STANDARDS FOR SIMULATORS AND (AS THEY PERTAIN TO SIMULATORS) OPERATOR TRAINING
- REVIEW RELATED DOCUMENTS

  NUREG-0560
  GAO LETTER TO SENATOR SCHWEIKER
  INFORMATION REPORTS FOR COMMISSIONERS
  (SECY-79-330 SERIES)
  NUREG-0578
  .
  .
  .

RESOURCES

MSU/CNS STAFF EXPERIENCE

NRC (OLB) RECORDS, FILE MATERIAL

BID SPECS problems.

DISCUSSION WITH SITE OPERATORS AND VISITS

LER'S

UTILITY DOCUMENTS

NON-NUCLEAR INDUSTRY - REPORTS AND PERSONAL CONTACTS

CONSTRAINTS

Simulator capability and use in training

TIME AND SCOPE

AVAILABILITY OF VERIFIABLE INFORMATION

RAPIDLY CHANGING STATUS (POST-TMI TRAUMA)

(lights bells vs specification and software)

LACK OF CLEAR DEFINITION OF NEEDS

RESULTS TO DATE INCLUDE

COMPARATIVE SUMMARY, GENERAL SIMULATOR CAPABILITIES

CAPABILITIES TO SIMULATE TMI-2-RELATED PROBLEMS

COMPARATIVE SUMMARY, USE OF SIMULATORS IN TRAINING

BRIEF REVIEW OF SIMULATORS IN NON-NUCLEAR INDUSTRY

REVIEW OF STANDARDS

RECOMMENDATIONS FOR IMPROVEMENT, FURTHER WORK

W
B&W
GE
TVA } 4 Training Programs

TABLE 1.1 U. S. NUCLEAR POWER PLANT SIMULATORS

NO.	PLANT SIMULATED	REACTOR TYPE AND NSSS VENDOR	NPPS VENDOR	NPPS OWNER	NPPS LOCATION	SERVICE DATE	UNIQUE FEATURES
1	Dresden-2	BWR/3 (GE)	GE	GE	Morris, Illinois	1968	First Nuclear Power Plant Simulator
2	Browns Ferry	BWR/4 (GE)	S	TVA	Daisy, Tennessee	1976	Physically Large Control Room Boards
3	Susquehanna	BWR/4 (GE)	S	PP&L	Berwick, Pennsylvania	1979	PP&L Advanced Control Room
4	Perry-1	BWR/6 (GE)	S	GE	Oklahoma City, Oklahoma	1980	BWR/6 Compact Control Room
5	Black Fox-1	BWR/6 (GE)	S	GE	Oklahoma City, Oklahoma	1980	Nuclenet Control Room
6	Limerick	BWR/4 (GE)	S	GP	Pottstown, Pennsylvania	1980	Latest Link/Singer Contract
7	Rancho Seco	PWR (B&W)	S	B&W	Lynchburg, Virginia	1970	First Babcock and Wilcox Reactor Simulator
8	Zion-1	PWR (W)	W	AEP	Zion, Illinois	1972	First Westinghouse Reactor Simulator
9	Calvert Cliffs-1	PWR (CE)	S	CE	Windsor, Connecticut	1972	First Combustion Engineering Reactor Simulator
10	Indian Point-2	PWR (W)	S	Con Ed	Buchanan, New York	1973	Advanced Core Model
11	McGuire-1	PWR (W)	S	Duke	North Carolina	1976	Color CRT's
12	Sequoyah	PWR (W)	S	TVA	Daisy, Tennessee	1976	New Improved Core Model
13	Shearon Harris-1	PWR (W)	S	CP&L	Apex, North Carolina	1978	Advanced Instructor's Console
14	Surry-1	PWR (W)	EAI	VEPCO	Gravel Neck, Virginia	1978	Simulation of All Major Plant Systems
15	WNP-1	PWR (B&W)	S	WPPSS	Richland, Washington	1979	Advanced Control Room
16	Palo Verde	PWR (CE)	EAI	APS	Wintersburg, Arizona	1980	High Degree of Simulator Fidelity
17	Seabrook-1	PWR (W)	S	PSNH	Seabrook, New Hampshire	1981	Plant Processor Stimulated Rather Than Simulated

Table 2.1 PWR Simulator in the United States

NO.	PLANT SIMULATED	NPPS VENDOR	TRAINING FEATURES	INITIAL CONDITIONS	SYSTEMS SIMULATED	PREPROGRAMMED MALFUNCTIONS	COMPUTER	SERVICE DATE
1	Rancho Seco	S	NA	NA	27	73	GP48	1970
2	Zion		3	16	NA	99	PDP 11/35	1972
3	Calvert Cliffs	S	NA	20	22	100	GP48	1972
4	Indian Point-2	S	NA	NA	26	NA	PDP 11/45	1975
5	McGuire	S	NA	19	22	256	PDP 11/45	1976
6	Sequoyah	S	9	21	29	140	SEL 85	1976
7	Shearon Harris	S	NA	NA	23	NA	SEL 32/77	1978
8	WNP 1,4	S	NA	NA	25	NA	SEL 32/55	1979
9	Surry-1	EAI	9	21	19	231	SEL 32/55	1978
10	SNUPPS	W						
11 ~~10~~	Palo Verde	EAI	9	21	28	214	SEL 32/55	1979
12 ~~11~~	Seabrook	S	NA	NA	24	152	SEL 32/55	1981

Table 2.2 BWR Simulators in the United States

NO.	PLANT SIMULATED	NPPS VENDOR	TRAINING FEATURES	INITIAL CONDITIONS	SYSTEMS SIMULATED	PREPROGRAMMED MALFUNCTIONS	COMPUTER	SERVICE DATE
1	Dresden-2	GE	-	21	33	107	GEP 4020	1968
2	Browns Ferry	S	9	18	47	149	SEL 85	1976
3	Susquehanna	S	6	26	34	100	SEL 32/55	1979
4	Black Fox	S	12	26	27	142	SEL 32/55	1980
5	Perry	S	NA	NA	25	NA	SEL 32/55	1980
6	Limerick	S	NA	NA	31	NA	SEL 32/55	1981

SUMMARY, TRAINING FEATURES

MAJOR FEATURES

- REAL TIME, FAST TIME, SLOW TIME, FREEZE, SNAPSHOT, BACKTRACK, CRY WOLF, RECALL, REPLAY, CONDITION OVERRIDE, DIAGNOSTICS

MAIN POINTS

- MOST SIMULATORS HAVE MOST FEATURES; OLDER ONES FEW, BUT CLAIM TO BE ABLE TO BE UPDATED
- OPTIONS AVAILABLE PERMIT GREAT VERSATILITY, BUT APPLICATION VERY MUCH DEPENDENT ON INSTRUCTOR
- CONDITION OVERRIDE IS ESPECIALLY IMPORTANT FOR SIMULATING ABNORMAL EVENTS
- CURRENT CAPABILITY CONSIDERED GENERALLY ADEQUATE FOR REQUIRED TRAINING
- SITE BY SITE EXAMINATION IN DETAIL NECESSARY TO SPOT SPECIFIC WEAKNESSES

Table 2.3 Typical PWR Initial Conditions*

INITIAL CONDI-TIONS	TEMP. °F	PRESS. PSIA	POWER LEVEL % FULL	XENON LEVEL	CRITICAL STATUS ΔK/K	FUEL BURNUP STATUS % MAX	COMMENTS
1	70	15	0	0	10% sub-critical	0	
2	70	15	0	0	1% sub-critical	0	
3	300	Norm	0	0	1% sub-critical	0	
4	565	Norm	0	0	1% sub-critical	0	
5	Norm	Norm	0	0	Critical	0	
6	Norm	Norm	10	0	Critical	0	Turbine not yet on line
7	Norm	Norm	20	0	Critical	0	Turbine on line, steady-state condition
8	Norm	Norm	50	EQ	Critical	0	Steady-state conditions
9	Norm	Norm	100	EQ	Critical	0	Steady-state conditions
10	Norm	Norm	0	75% peak	Critical	0	Xenon increasing
11	565	Norm	0	0	1% sub-critical	40	
12	565	Norm	0	Increasing from EQ	1% sub-critical	40	Hot startup condition
13	565	Norm	0	0	1% sub-critical	40	Hot reactor coolant system, cold turbine
14	Norm	Norm	50	EQ for 100% power	Critical	40	Steady-state conditions
15	Norm	Norm	100	EQ	Critical	40	Steady-state conditions
16	350	400	0	Increasing	1% sub-critical	40	Normal shutdown, cool-down after full-power run
17	Norm	Norm	0	75% peak	Critical	40	Xenon increasing
18	350	400	0	0	1% sub-critical	80	
19	Norm	Norm	0	75% peak	Critical	80	Xenon decreasing
20	Norm	Norm	10	0	Critical	80	Turbine not yet on line
21	Norm	Norm	100	EQ	Critical	80	Steady-state conditions
22	Snapshot	(or spare)					
23	Snapshot	(or spare)					
24	Snapshot	(or spare)					
25	Snapshot	(or spare)					
26	Snapshot	(or spare)					
27	Snapshot	(or spare)					
28	Snapshot	(or spare)					
29	Snapshot						
30	Snapshot						

* Sequoyah Power Plant Simulator operated by TVA.

SUMMARY, INITIALIZATION CONDITIONS

- TYPICALLY 30 SETS, APPROXIMATELY 20 PRE-SPECIFIED
  - EXTREMELY FLEXIBLE WITH USE OF FREEZE, BACKTRACK, SNAPSHOT
  - LITTLE CHANGE, OLDER TO NEWER SIMULATORS
  - CAPABILITY TO INITIATE WITH OFF-NORMAL CONDITIONS DOES EXIST } not demonstrated
  - CURRENT CAPABILITY CONSIDERED ADEQUATE FOR TRAINING NEEDS

APPENDIX A. PWR SYSTEMS AND MALFUNCTIONS SIMULATED

SYSTEM-MALFUNCTION	SYSTEM CROSS REFERENCE	PLANT SIMULATED: SURRY	RANCHO SECO	MCGUIRE	SEQUOYAH	CALVERT CLIFFS	ZION	PALO VERDE	INDIAN POINT	SHEARON HARRIS	OCONEE	SEABROOK	WNP
REACTOR COOLANT													
SG Tube Rupture		X		X	X	X	X	X				X	
RC Pipe Rupture		X		X		X	X	X				X	
Leak into Containment		X	X	X			X	X				X	
RV Head Flange Leak		X		X		X						X	
RC Pump Shaft Shear		X						X					
RCP Lube Oil Loss		X		X		X		X				X	
RCP High Oil Level		X		X								X	
RCP Flow Degradation		X		X									
RCP Seal Failure		X	X	X	X	X	X	X				X	
RCP Rotor Locked		X		X				X				X	
Loss of CCW to RCP	CCW	X		X	X	X	X	X				X	
Loss of RC Flow		X	X	X	X	X	X	X				X	
RCP High Vibration		X		X		X		X				X	
RTD Failure in Hot Leg	NI	X	X	X	X		X	X				X	
RTD Failure in Cold Leg	NI	X	X	X	X		X	X				X	
PZR Pressure Control-High		X		X	X		X	X				X	
PZR Pressure Control-Low		X		X	X			X					
PZR Level Control-High		X	X	X	X		X	X					
PZR Level Control-Low		X	X	X	X	X		X				X	
PZR Relief Valve Leak		X	X	X	X	X	X	X				X	
PZR Spray Valves Fail-Closed		X	X	X	X	X	X	X					
PZR Spray Valves Fail-Open		X	X	X	X	X	X	X				X	
PZR Heaters Fail On		X		X									
PZR Heaters Fail Off		X		X		X	X	X				X	
Fuel Leaks-Variable		X	X	X	X	X		X				X	
RCP Electrical Failure	Electrical	X	X	X		X		X					
Failure of RCP Seal Temp. Trans.								X					
Loss of RC Pressure												X	
COMPONENT COOLING WATER													
Loss of CCW to RCP	RC	X		X	X	X	X	X				X	
Loss of CCW to RHR HX	RHR	X				X	X	X				X	
Loss of CCW Pumps		X	X	X				X				X	
Loss of CCW to NR HX	CVCS	X		X		X	X	X				X	
Loss of CCW to SW HX	CVCS	X		X								X	

SYSTEMS SIMULATED

- PWR'S, 19-29; BWR'S, 25-47
- SELECTION BY OWNER, BASED ON TRAINING FOR NORMAL OPERATIONS PLUS ANSI/ANS 3.5 EVOLUTIONS AND EXERCISES
- IMPORTANT DIFFERENCE OLD VS. NEW IS TABLES VS. DYNAMIC MODELING. DYNAMIC MODELING MORE FLEXIBLE BUT MORE TIME CONSUMING; IMPROVEMENTS DESIRED IN MATH MODELS
- NUMBER OF SYSTEMS SIMULATED ACCURATELY LIMITED BY CURRENT COMPUTER CAPABILITY. SIGNIFICANT INCREASE IN NUMBER SYSTEMS OR ACCURACY WOULD REQUIRE ORDER MAGNITUDE INCREASE IN COST OF COMPUTER
- SYSTEMS (SUBSYSTEMS) MODULAR; EXTENT OF INTERACTION KEY TO FIDELITY. ANSI/ANS 3.5 REQUIREMENTS INDIRECTLY DO GOOD JOB OF REQUIRING INTERACTION No measure of how well do interact
- NO REG. GUIDES
  - FIDELITY, PERFORMANCE - INDUSTRY APPEARS TO BE SATISFYING ANSI/ANS 3.5 WITHOUT REG. GUIDES
  - UPDATING (FSAR DATA) - NOT ENOUGH VERIFIABLE INFO TO ASSESS INDUSTRY COMPLIANCE TO 3.5; SUGGEST INVESTIGATION

MALFUNCTIONS SIMULATED

not consistent with type

compounded abnormalities

- SIGNIFICANT SITE-TO-SITE VARIATION
- INCREASING NUMBER WITH TIME
- TYPICALLY 10-20 MULTIPLE MALFUNCTIONS (SEQUENTIALLY OR SIMULTANEOUSLY) ← multiple failure
- MALFUNCTIONS ARE USUALLY MODULAR SUBROUTINES, EASILY UPDATED, MODIFIED; DEGREE OF INTERACTION IMPORTANT; NOT READILY VERIFIABLE

MAJOR PROBLEM

- SPECIFICATION OF MALFUNCTIONS IS KEY TO TRAINING FOR ABNORMAL EVENTS, AND THERE IS NO CONSISTENT PROCEDURE NOR RESEARCH BASE FOR SELECTING THEM

COMPUTERS

- NEWER MODELS - MULTI-PROCESSOR, RAPID ACCESS, INCREASED SPEED OF DATA HANDLING ORDER MAGNITUDE
- NON-NUCLEAR INDUSTRY DOES NOT HAVE SIGNIFICANTLY ADVANCED COMPUTERS complexity is big factor
- NUCLEAR SIMULATORS MAKING REASONABLE USE OF STATE-OF-THE-ART - SIGNIFICANTLY INCREASED CAPABILITY WOULD REQUIRE ORDER OF MAGNITUDE INCREASE IN COST OF COMPUTERS; NOT CONSIDERED NECESSARY NOW UNLESS MAJOR INCREASE IN NUMBER SYSTEMS DESIRED (E.G., SIMULATE BOP)
- INCREASED USE OF DYNAMIC MODELING (DESIRABLE) WILL REQUIRE IMPROVED COMPUTERS; MULTIPLE COMPUTERS POSSIBLE NEAR-TERM REMEDY

use multiple processors.

L - Section
S - Simulator

Table 3.2 Westinghouse Cold License Training Program

SHIFT	SS	SS	SS	SS	SS	SS	SS	SS
Day	LLLLL' LL			LLLLLL		LL	LLLLL	
Swing		SSSSSSS				SSSSSSS		
Mid			SSSSSSS					

Table 3.3 Babcock and Wilcox Cold License Training

SHIFT	SS	SS	SS	SS	SS	SS	SS	SS	SS
Day	LLLLL	LLLLL	LLLLL	LLLLL	LLLLL	LLLLL		EEEEE	
Swing	SSSSS	SSSSS	SSSSS	SSSSS	SSSSS	SSSSS	SSSSS		
Mid							SSSSS		

Table 3.4 General Electric Cold License Training (10 weeks of 12)

SHIFT	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
Day	LLLLL			LLLLLL				LLLLLL	EEEEE	
Swing		SSSSSSS				SSSSSSS				
Mid			SSSSSSS				SSSSSSS			

Table 3.5 TVA Cold License Training Program (Last 10 weeks of 12)

SHIFT	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
Day	LLLLL'	LLLLL	SSSSSSS		SSSSSSS			SSSSSSS		EEEEE
Swing				SSSSSSS		SSSSSSS				
Mid										

SURVEY RESULTS - USE OF SIMULATORS
IN TRAINING NUCLEAR POWER PLANT OPERATORS

COLD LICENSE PROGRAMS

(1) SIMILAR PROGRAMS, ALL UTILITIES

- TOTAL 8-12 WEEKS
- 88-140 HOURS ON SIMULATOR
- APPROXIMATELY 30% ON EMERGENCY/ABNORMAL EVENTS
- TYPICALLY 3 OR 4 STUDENTS MAX AT SIMULATOR
- TRAINEES WORK IN SHIFTS TO SOME DEGREE

(2) EITHER NON-SITE-SPECIFIC, OR AT BEST, USE PSAR DATA CONSIDERED GENERALLY SATISFACTORY

(3) CLASSROOM LECTURES COMPLEMENT SIMULATOR TRAINING

(4) SIMULATOR TRAINING NOT REQUIRED, BUT RECOGNIZED BY NRC (PRE-TMI/2)

SURVEY RESULTS - USE OF SIMULATORS IN TRAINING NUCLEAR POWER PLANT OPERATORS

(CONTINUED)

HOT LICENSE PROGRAMS

(1) CONSIDERABLE VARIABILITY AMONG UTILITIES - DEPENDS LARGELY ON AVAILABILITY OF SITE-SPECIFIC SIMULATOR, COST AND SPECIFIC BACKGROUND OF OPERATOR

(2) SITE-SPECIFIC SIMULATION MUCH MORE IMPORTANT

(3) TYPICAL PROGRAM 4-6 WEEKS, 80-140 HOURS ON SIMULATOR, ONLY PART OF THAT ON EMERGENCY/ABNORMAL EVENTS

(4) PRE-TMI, NO REQUIREMENT FOR USE OF SIMULATOR

SURVEY RESULTS - USE OF SIMULATORS IN TRAINING NUCLEAR POWER PLANT OPERATORS

(CONTINUED)

REQUALIFICATION TRAINING

(1) TYPICALLY ONE WEEK

(2) MUCH OF TIME ON EMERGENCY/ABNORMAL EVENTS (SELECTION DEPENDS ON INDIVIDUAL NEEDS)

(3) PLANT-SPECIFIC SIMULATION IMPORTANT

(4) LIMITED EVIDENCE OF FEEDBACK OF OPERATING EXPERIENCE

(5) PRE-TMI, NO REQUIREMENT FOR USE OF SIMULATORS

SURVEY RESULTS - USE OF SIMULATORS IN TRAINING NUCLEAR POWER PLANT OPERATORS

(CONTINUED)

GENERAL POINTS

(1) TRAINING PROGRAMS HAVE DEVELOPED HISTORICALLY WITHOUT COMPREHENSIVE STUDY EMPLOYING FUNDAMENTAL HUMAN FACTORS PRINCIPLES - NOT OBJECTIVE ORIENTED

(2) SIMULATOR USAGE (TIME AND SCOPE) IS RELATIVELY LIMITED IN NUCLEAR INDUSTRY

FOR EXAMPLE, COULD USE FULL-SCOPE HIGH FIDELITY SIMULATORS FOR:

- CERTIFICATION
- CONTINUOUS TRAINING, REVIEW OF OPERATING EXPERIENCE
- HUMAN FACTORS RESEARCH
- DEVELOPMENT, TESTING IMPROVED PROCEDURES, INSTRUMENTATION, ETC.

TMI-2 RELATED EVENTS/ISSUES

(1) MULTIPLE MALFUNCTIONS/COMPOUNDED ABNORMALITIES

DIDN'T DO?/CAN DO/WILL DO

NO BASIS FOR SELECTION of combination of abnormalities

STRONGLY DEPENDENT ON INSTRUCTOR ← how clever is the instructor

(2) SATURATED CONDITIONS IN PWR PRIMARY SYSTEM

NONE DID PRIOR TO TMI-2

MOST HAVE ATTEMPTED, LIMITED SUCCESS

MODEL DEVELOPMENT NECESSARY

(3) FEEDWATER TRANSIENTS

"NORMAL" CASE - CAPABILITY EXISTS, COMMONLY PRACTICED

COMPOUNDED ABNORMALITIES NOT STRESSED PRIOR TO TMI-2

COMPLETE SIMULATION SHOULD INCLUDE SATURATED CONDITIONS

(4) NATURAL CIRCULATION

NOT MODELED OR INCLUDED IN TRAINING <u>EXPLICITLY</u> PRIOR TO TMI-2

VENDORS INDICATE NOW ARE MODELING (UNVERIFIED)

TMI-2 RELATED EVENTS/ISSUES

(CONTINUED)

(5) PRESSURIZER LEVEL CONTROL, INTERPRETATION
- GENERALLY TAUGHT ONLY AS PART OF OTHER EXERCISES
- SPECIFIC EXERCISES COULD/SHOULD BE DEVELOPED
- COMPLETE MODELING DEPENDS ON SUCCESS OF MODELING SATURATED CONDITIONS

(6) INITIAL BOARD CHECKS
- NOT GENERALLY DONE PRIOR TO TMI-2
- CAN USE TRAINING FEATURES TO INITIALIZE INCORRECTLY, TRAIN OPERATORS

(7) PLANT SPECIFIC SIMULATION
- COMPREHENSIVE STUDY OF NUCLEAR OPERATOR TASKS, TRAINING OBJECTIVES SHOULD BE MADE. WE ARE CERTAIN RESULTS WILL INDICATE NEED FOR SITE-SPECIFIC SIMULATION - FOR MANY APPLICATIONS OF SIMULATOR

FUNDAMENTAL PROBLEMS, NUCLEAR POWER PLANT SIMULATORS AND THEIR USE IN TRAINING FOR ABNORMAL/EMERGENCY EVENTS

I. TRAINING PROGRAMS, USE OF SIMULATORS, DEVELOPMENT AND SPECIFICATION OF EXERCISES HAVE GROWN HISTORICALLY WITHOUT THE BENEFIT OF COMPREHENSIVE RESEARCH, ANALYSIS AND PLANNING. CONSEQUENTLY THERE IS LITTLE "SCIENTIFIC BASIS" FOR EVALUATION, OPERATION, REGULATION OR IMPROVEMENT.

II. REGULATORY REQUIREMENTS ON SIMULATORS AND THEIR USAGE HAVE NOT EXISTED TO PROVIDE CONSISTENT BASIS IN LIEU OF DESIRED SCIENTIFIC BASIS.

RESULT

LESS THAN OPTIMUM USE OF SIMULATORS, ONE OF POTENTIALLY MOST POWERFUL TRAINING TOOLS AND PROBABLY ONLY VIABLE APPROACH FOR TRAINING FOR ABNORMAL/EMERGENCY EVENTS.

RECOMMENDATION

NRC SHOULD SUPPORT, ENCOURAGE, PARTICIPATE IN, COOPERATE WITH, COMPREHENSIVE PROGRAMS NECESSARY; AND INCORPORATE RESULTS INTO A CONSISTENT REGULATORY POLICY FOR TRAINING ON ABNORMAL EVENTS WHICH RECOGNIZES COMPLETE SCOPE OF TRAINING PROGRAM.

SPECIFIC PROBLEMS

(1) THERE IS NO CONSISTENT BASIS FOR SELECTION OF MALFUNCTIONS, WHICH IS KEY TO CURRENT TRAINING ON ABNORMAL EVENTS

(2) ADEQUACY OF TRAINING FOR ABNORMAL/EMERGENCY EVENT IS STRONGLY DEPENDENT ON INSTRUCTOR CAPABILITIES; YET NO NRC REQUIREMENTS EXIST (PRE-TMI)

(3) MUCH OF INDUSTRY USES NON SITE-SPECIFIC SIMULATORS FOR ALL TRAINING; SITE-SPECIFIC SIMULATION IMPORTANT FOR HOT LICENSE, REQUALIFICATION not Cold

(4) RELATIVELY SMALL PORTION OF TRAINING TIME IS ALLOTTED TO SIMULATOR TRAINING; ONLY PART OF THAT TO ABNORMAL EVENTS. TIME AND FINANCIAL CONSTRAINTS PLUS OVERALL TRAINING GOALS MUST BE CONSIDERED. THERE IS NO CONSISTENT BASIS FOR SETTING PRIORITIES

(5) VERIFICATION OF SIMULATOR FIDELITY APPARENTLY LEFT TO BUYER THROUGH ACCEPTANCE TESTING; NO NRC VERIFICATION EXISTS(?)

SPECIFIC PROBLEMS

(CONTINUED)

(6) NO NRC PROCEDURES TO VERIFY UPDATE TO REFERENCE PLANT DATA

(7) NO NRC ASSURANCE OF INCORPORATION OF OPERATING EXPERIENCE, LESSONS LEARNED IN TRAINING PROGRAMS(?)

(8) TMI-2 SPECIFICS - NEED TO MODEL SATURATED CONDITIONS, NATURAL CIRCULATION

(9) CURRENT COMPUTER TECHNOLOGY PLACES CONSTRAINTS ON USE OF DYNAMIC MODELING AND NUMBER OF SYSTEMS THAT CAN BE MODELED ACCURATELY

(10) MAJOR INCREASE IN SIMULATOR USAGE WILL REQUIRE TIME FOR DEVELOPMENT, CONSTRUCTION; PLUS SIGNIFICANT COST IMPACT

RECOMMENDATIONS

(1) A TASK ANALYSIS AND COMPREHENSIVE STUDY OF TRAINING GOALS SHOULD BE UNDERTAKEN TO DEVELOP SPECIFIC GOAL-ORIENTED TRAINING OBJECTIVES AND ESTABLISH BEST USE OF SIMULATORS, NECESSARY EXERCISES TO DEVELOP SKILLS

(2) DEVELOP A CONSISTENT PROCEDURE FOR SELECTION OF MALFUNCTIONS. THIS PROCEDURE CAN BE USED TO:

- EVALUATE EXISTING SIMULATORS, TRAINING PROGRAMS
- EVALUATE, DEVELOP STANDARDS OR REGULATORY REQUIREMENTS FOR SIMULATION
- DEVELOP IMPROVED SIMULATORS, PROGRAMS

(3) USE RESULTS OF 1 AND 2 TO SPECIFY REQUIREMENTS FOR SITE-SPECIFIC SIMULATION. IT IS OPINION OF MSU/CNS THAT SITE-SPECIFIC SIMULATION IS NECESSARY FOR HOT LICENSE AND REQUALIFICATION, PROBABLY NOT FOR COLD LICENSE

(4) A CONSISTENT FRAMEWORK OF REGULATORY POLICY ASSOCIATED WITH THE ENTIRE TRAINING PROCESS SHOULD BE DEVELOPED TO ADDRESS WEAKNESSES NOTED IN THIS AND OTHER NRC, GOVERNMENT AND INDUSTRY STUDIES. SPECIFICALLY EMPHASIZED FROM THIS STUDY:

- MINIMUM QUALIFICATIONS FOR, POSSIBLY CERTIFICATION OF, INSTRUCTORS
- REQUIREMENTS FOR VERIFICATION OF FIDELITY OF SIMULATORS
- VERIFICATION OF UPDATING, USE OF REFERENCE DATA
- PROCEDURES FOR ASSURING INCORPORATION OF OPERATING EXPERIENCE

RECOMMENDATIONS

(CONTINUED)

(5) TMI-2 "FIXES" - IMPROVED MODELING SATURATED CONDITIONS, NATURAL CIRCULATION

(6) RESEARCH SHOULD BE CARRIED OUT IN FOLLOWING AREAS:

- HUMAN FACTORS ANALYSIS OF CONTROL ROOM TASKS; TRAINING NEEDS; OBJECTIVES
- ASSESSMENT, VERIFICATION OF EFFECTIVENESS OF SIMULATOR TRAINING FOR SKILLS IN ABNORMAL EVENTS
- MATH MODELING

(7) KEEP SIMULATOR TRAINING, ENTIRE TRAINING PROGRAM, IN PERSPECTIVE

(3) RECOGNIZE CONSIDERABLE SUCCESS WITHOUT DETAILED REGULATORY CONTROLS, PERMIT FLEXIBILITY

Summary of Safety criteria

Class

1. In tech spec no more than one active at a time ①

2. Orderly S/O / C/D of plant ②

3. Reactor trip ③④

4. Release of radioactivity < 10CFR20 ①②

5. " " " may > 10CFR20 ③

6. " " " > 10CFR20 ④

7. Resume operation + malfunction corrected ②

8. Outage > time required to fix malfunction ④

9. Plant outage may be required to fix ⑤

General Classes

A MAJOR PROBLEM IDENTIFIED IS

LACK OF CONSISTENT PROCEDURE FOR DETERMINING WHICH MALFUNCTIONS TO INCLUDE WITHIN CONSTRAINTS OF TRAINING PROGRAM

WORK HAS BEEN INITIATED TO PROVIDE SUCH A PROCEDURE

- DETAILED STUDY OF LER'S (OPERATING EXPERIENCE)
- ASSESSMENT OF DIRECT SAFETY IMPACT OF MALFUNCTIONS
- ASSESSMENT OF AVAILABILITY IMPACT OF MALFUNCTIONS
- ASSESSMENT OF POTENTIAL AS ACCIDENT PRECURSOR

PROCEDURE RANKS EVENTS BY THESE FOUR FACTORS, PRIORITY FOR INCLUDING IN TRAINING PROGRAMS DEPENDS ON RANKING

NEED

- MORE RIGOROUS METHOD FOR RANKING
- MORE RIGOROUS METHOD FOR IDENTIFICATION
- JUDGEMENT ON RELATIVE WEIGHTING OF FACTORS

Develope and test criteria for use in selecting specific Equipment Malfunctions for Simulator

Use of Criteria

A. Selection of specific Malfunctions for simulator
B. Evaluation of Facilities and programs.

Trial Criteria

Safety Related Malfunctions

class	pts
1	5
2	7
3	12
4	15
~~5~~	

Frequently Occurring Malfunctions 0 - 3 pts

Precursor to Safety-related events

(One that causes event)	Class A	5
(One that makes it worse)	B	5

Malfunctions that result in plant outage 3 pts