NUREG-1192

An Investigation of the Contributors to Wrong Unit or Wrong Train Events

U.S. Nuclear Regulatory Commission

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INTRODUCTION

The NRC has had a major concern with the high frequency of human error in nuclear power plants causing actions to be performed on the wrong train of systems with redundant trains or on the wrong unit of a multi-unit facility. This type of error was highlighted as a result of an incident that was discovered on April 19, 1983, at Florida Power and Light's Turkey Point Unit 3 wherein a nuclear turbine operator mistakenly closed isolation valves in the steam supply lines to the available auxiliary feedwater (AFW) pump B and C turbines rather than the desired isolation valves in the other AFW steam supply lines. This event was complicated by the fact that incorrect verifications of valve position were made for five subsequent days. Consequently, the Office of Nuclear Reactor Regulation (NRR) requested the Office for Analyses and Evaluation of Operational Data (AEOD) to undertake a study of similar events. In January 1984, AEOD published the results of its study entitled "Human Error in Events Involving Wrong Unit or Wrong Train" (Appendix A, Ref. 1). In that report, AEOD identified 26 additional events during the period January 1981 to approximately August 1983 that had characteristics similar to the Turkey Point Unit 3 event, that is, losses of safety system function that resulted because of human errors involving personnel actions performed on an incorrect train or unit. One finding of the report was that of the 27 events evaluated, 19 resulted from human error suggesting that these errors are major contributors to loss of safety system events. Subsequently, in a memorandum dated August 8, 1984, from Heltemes to Denton, AEOD noted that although IE issued Information Notices 84-51, "Independent Verification," and 84-58, "Inadvertent Defeat of Safety Function Caused by Human Error Involving Wrong Unit, Wrong Train or Wrong System," wrong unit/wrong train events were continuing to occur. From August 1983 to August 1984, an additional 13 events involving wrong unit/wrong train errors had occurred.

Although the intent of this study was to investigate wrong unit/wrong train errors, some events discussed involved "wrong component." In these cases, an action was performed on the correct train or unit but on the incorrect component. However, contributors to these events were judged to be the same as those contributing to wrong unit/wrong train events.

To address the concerns arising from wrong unit or wrong train events, NRR created Generic Issue 102, "Human Error in Events Involving Wrong Unit or Wrong Train," to be resolved as a specific task within the Division of Human Factors Technology's Maintenance and Surveillance Program Plan (MSPP). The plant maintenance activities addressed in the MSPP include those plant functions required to carry out a systematic maintenance program such as surveillance and testing, operations/maintenance interface, maintenance management, procedures, and technical documentation. During Phase I, a survey of maintenance practices at U.S. nuclear utilities was conducted and operational errors and events reviewed. The present study was conducted as part of the survey effort.

METHODOLOGY

Selection of Events

Events were chosen for inclusion in the study based on wrong unit/wrong train data provided in the Licensee Event Report (LER) database. An attempt was made to select utilities across a range of vendor types, number of units at a site, vintage, and size.

Table 1 provides a summary of the plants visited during this study, the LERs discussed, and any additional events discussed.

Table 1. SUMMARY OF PLANTS VISITED

Plant	NSSS	Architect Engineer	Date of Commercial Operation	Maximum Dependable Capacity (Net MWe)	Events Discussed
Dresden 2	GE	SL	June 9, 1970	772	LER 237-84-013
3	GE	SL	November 16, 1971	773	249-85-005
					237-84-012
Surry 1	W	SW	December 22, 1972	781	LER 281-81-001
2	W	SW	May 1, 1973	775	280-83-033
					280-82-072
					280-83-051
North Anna 1	W	SW	June 6, 1978	890	LER 339-85-006
2	W	SW	December 14, 1980	893	339-82-022
					Nonreportable event
Peach Bottom 2	GE	B	July 5, 1974	1051	278-81-008
3	GE	B	December 23, 1974	1035	278-85-008
Salem 1	W	PSEG	June 30, 1977	1079	LER 272-82-003
2	W	PSEG	October 13, 1981	1106	272-83-024
					2 Nonreportable events
LaSalle 1	GE	SL	January 1, 1984	1036	LER 373-83-140
2	GE	SL	October 19, 1984	1036	373-84-071
					374-85-012
					374-84-017
					374-85-020
D.C. Cook 1	W	AEPS	August 27, 1975	1020	LER 315-81-005
2	W	AEPS	July 1, 1978	1060	315-83-009
					315-83-048
					315-84-014
					Nonreportable event
McGuire 1	W	Duke	December 1, 1981	1180	LER 369-81-180
2	W	Duke	March 1, 1984	1180	370-84-021
					370-84-034
					370-85-010

Plant	NSSS	Architect Engineer	Date of Commercial Operation	Maximum Dependable Capacity (Net MWe)	Events Discussed
Turkey Point 3	W	B	December 14, 1972	666	LER 250-83-007
4	W	B	September 7, 1973	666	251-83-016
					250-84-003
					250-85-004
					250-85-017
Oconee 1	B&W	Duke/B	July 15, 1973	860	None
2	B&W	Duke/B	September 9, 1974	860	None

LEGEND:
W - Westinghouse
GE - General Electric
B - Bechtel
AEPS - American Electric Power Services
SW - Stone and Webster
SL - Sargent and Lundy
PSEG - Public Service Electric and Gas

Interviews

Once a particular plant and event(s) were selected, the utility was contacted and arrangements made to visit the site. The licensee's staff was briefed on the purpose of the visit and was provided an overview of the information the interview team was hoping to obtain. A protocol was developed and used as a general guide for maintaining consistency among the in-depth interviews conducted. Topics of discussion included those factors which the interview team felt may have contributed to the human error(s) that occurred in the wrong unit/wrong train event. The factors that were discussed during the interviews included, but were not limited to, labeling, procedures, shift manning schemes, and training and qualifications. Where possible, the team interviewed the individual(s) that was directly involved in the event, as well as other knowledgeable plant personnel involved in operations, maintenance, and training. In addition to questions of a general nature, each event was discussed in turn and a plant walk-through conducted.

Identification of Contributors

Information gained during the interviews and photographs taken during the walk-throughs are discussed in trip reports prepared for each site visited (see Appendix A, Ref. 2-10). These data were reviewed and a professional judgment made as to what were the contributors to the human error. These contributors were then categorized as either the primary contributor or as a secondary contributor. A primary contributor is defined as the most dominant contributor or the sole known contributor to the event. In most cases, it is felt that without this primary contributor, the error would likely not have occurred. Secondary contributors include those contributors to the human error that exacerbated the contribution of the primary contributor.

The NRC team identified 10 contributors to the wrong unit/wrong train human errors. These are defined as follows:

Labeling - inadequacy in the identification of controls, displays, valves, and other equipment items that must be located, identified, or manipulated.

Training/Inexperience - classified as a contributor when plant personnel identified it as such or when the NRC team concluded that additional experience or improved training could reasonably be expected to significantly reduce the likelihood of the wrong unit/wrong train human error.

Procedures - includes applicable administrative, operating, maintenance, test procedures, and both written and unwritten plant practices with technical and/or human factors deficiencies.

Mind Set - a fixed state of mind, e.g., the improper expectation that the next work assignment will not be dissimilar from the previous assignments, resulting in a context error.

Layout/Equipment Design - inconsistency of equipment layout and design with human engineering design principles.

Communications - inadequacies in the verbal and written communication of assignments and messages.

Physical Stress - includes fatigue, overtime work, high temperature and cramped surrounds.

Drawings - inadequacies, both in a technical and human factors sense, in drawings used by plant personnel.

Interruption of work flow - includes cases in which an individual was in the process of performing a task and was then interrupted. When the previously ongoing work was resumed, an error occurred.

Rushed - the sense of urgency, either real or imagined, to complete a task quickly.

RESULTS

Appendix B contains the results of the assessment of the contributors to the human errors in each of the 35 wrong unit/wrong train events investigated. Table 2 summarizes these data. The data is also presented in Figures 1 and 2. An examination of the data illustrates the following major findings.

- Inadequate labeling contributed to 54 percent of the 35 events evaluated. Labeling was the primary contributor in 32 percent of the events and a secondary contributor in 23 percent of the events.

- Inadequate training and staff inexperience contributed to 43 percent of the 35 events, being the primary contributor to the wrong unit/wrong train error in 14 percent of the events and a secondary contributor in 29 percent of the events.

- Poorly human factored or incorrect procedures contributed to 37 percent of 35 events. Procedures were the primary contributor in 14 percent of the events and the secondary contributor in 23 percent.

- When taken together, labeling, training, and procedures were the primary contributors to human error in 60 percent of the wrong unit/wrong train events investigated.

- Operations personnel were responsible for the wrong unit/wrong train errors far more often than any other group of plant personnel. Of the 32 events where the individual's affiliation was known, 24 (75 percent) of them involved operations personnel (18 nonlicensed, 5 licensed, 1 both licensed and nonlicensed). Often these errors occurred during activities in preparation for maintenance.

Table 2. Percentage and Frequency
of Primary and Secondary Contributors to Human Errors
in 35 Wrong Unit/Wrong Train Events

(Site Visit Data)

Contribution	Primary or Secondary Contributor	Primary Contributor Only	Secondary Contributor Only
Labeling (Lab)[1]	54[2](19)[3]	32 (11)	23 (8)
Training/Inexperience (T/I)	43 (15)	14 (5)	29 (10)
Procedures (Pro)	37 (13)	14 (5)	23 (8)
Physical Stress (Phy)	26 (9)	3 (1)	23 (8)
Communications (Com)	17 (6)	9 (3)	9 (3)
Mind Set (MS)	17 (6)	11 (4)	6 (2)
Layout/Equipment Design (Eq)	17 (6)	11 (4)	6 (2)
Rushed (Rush)	11 (4)	0 (0)	11 (4)
Drawings (Dwg)	6 (2)	3 (1)	3 (1)
Interruption of Work (Int)	6 (2)	3 (1)	3 (1)

[1] Abbreviations used in Figures 1 and 2
[2] Percent
[3] Number of events

Table 3 illustrates the association between primary and secondary contributors. For example, physical stress was a secondary contributor in three of the events in which labeling was the primary contributor. From an inspection of the table, the following relationships were noted:

Figure 1.

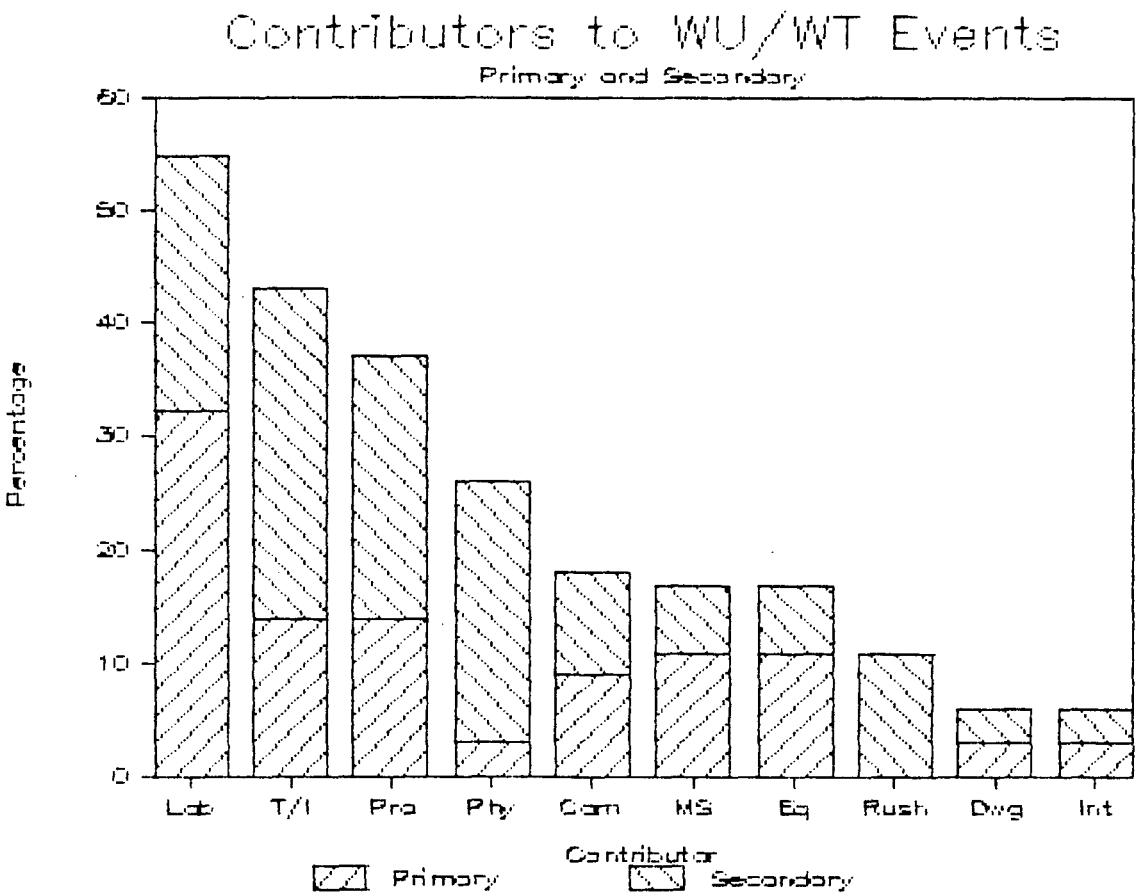
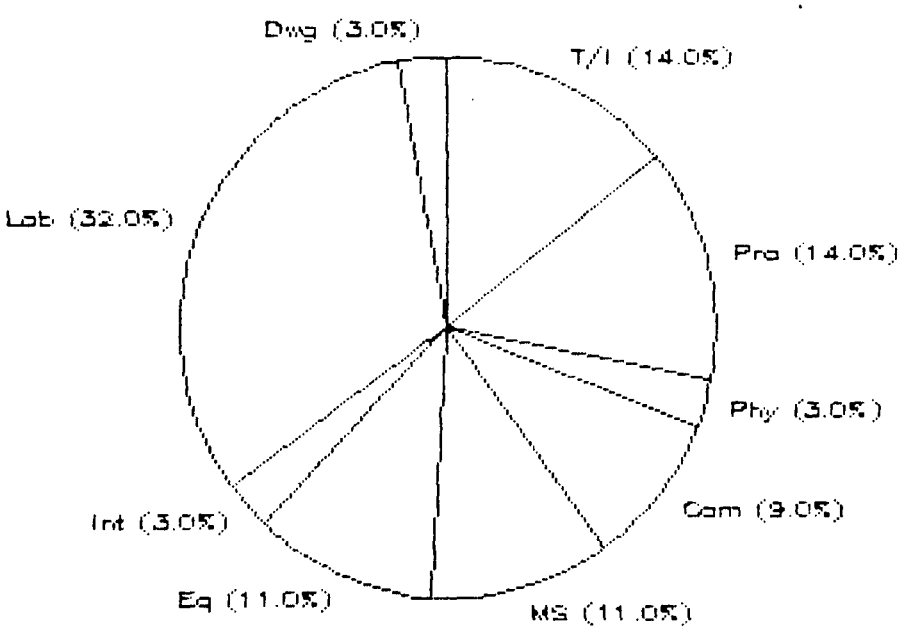


Figure 2.



Primary \ Secondary	Labelling	Training/Inexp.	Procedures	Mind Set	Layout/ Eq. Design	Communication	Physical Stress	Drawings	Interruption of Work	Rushed	None
Labelling		2	2		1	2	3				3
Training/Inexp.	3		1	2			1			1	1
Procedures	1	2			1				1	1	1
Mind Set	1		2			1	1				1
Layout/ Eq. Design	1	3	2				1			1	
Communication		2	1				1	1		1	1
Physical Stress											1
Drawings	1	1					1				
Interruption of Work	1										

Table 3. Frequency of Secondary Contributors Associated With Each Primary Contributor

- As expected, the human error involved in wrong unit/wrong train events often results from the interaction of several contributors. For example, the effects of inadequate labeling appear to have been exacerbated by a number of different secondary contributors. Conversely, inadequate labeling was implicated as a secondary contributor across a broad spectrum of primary contributors.

- Training/inexperience was a sole contributor to a wrong unit/wrong train error in only one of the events investigated, whereas in eight events where training/inexperience was the primary contributor, secondary contributors also existed.

- When inadequate procedures was the primary contributor, it was often compounded by a number of different secondary contributors, including labeling, training/inexperience, layout/design problems, interruption of work, and being rushed.

- The contributor "mind set" interacted with several secondary contributors. Inadequacies in those areas which may have been able to "wake up" the individual were considered secondary contributors. These included labeling, procedures and communications. Physical stress also was a secondary contributor in one event investigated.

- Although physical stress was identified as the primary contributor to a wrong unit/wrong train error in only one of the events investigated, stress was a secondary contributor in eight other events whose primary contributors included inadequate labeling, training/inexperience, mind set, layout/design, communications, and drawings. Physical stress, then, tends to increase the likelihood that other inadequacies will result in an error.

- Labeling, training/inexperience, procedures, mind set, communication, and physical stress are able to cause a wrong unit/wrong train event individually without any secondary contributors. Because of the limited

sample of events discussed, it is possible that the other contributors have the potential to create a wrong unit/wrong train event without secondary contributors as well.

Labeling

The findings from this study illustrate the consequences of inadequate labeling. Poor labeling was more often implicated in the wrong unit/wrong train events investigated than any other contributor. Some plants have undertaken programs to address the need for labeling in the plant. Those of particular note are discussed below.

Tagging Request and Inquiry System. The Tagging Request and Inquiry System (TRIS) is in place at Salem (as well as Hope Creek). This computerized system features labels unique to each plant component and can ensure that the operator's worksheet and equipment tags correspond to the equipment labels. Some standard tagging requests have been programmed into the computer. Both the worksheet and equipment tags are printed out by the computer including, for example, desired component switch location. TRIS keeps track of normal and current switch or valve positions as well as inoperable equipment. At the end of every shift, the operators request the printout of inoperable equipment to permit them to monitor system status. TRIS relies on operator input to keep the system accurate. Currently at Salem, there are about 30,000 items in TRIS, with labels on all major equipment. Additional information is provided in the Salem trip report (Appendix A, Ref. 5).

Critical Equipment Monitoring System (CEMS). The Peach Bottom facility is in the process of implementing the CEMS to address the needs of operations personnel. The CEMS labels use a unique code description for each component and a computer-readable bar code. To this point, implementation of the system has been limited to the assignment and installation of component labels, primarily on valves. Of approximately 40,000 manual valves, 13,000

have been labeled. When fully implemented, the CEMS will include breakers using the existing breaker numbers but adding unit and system designations. A plant operator will be able to verify that he has located the proper piece of equipment in the plant by utilizing a hand-held computer terminal capable of reading bar codes. The CEMS will be used during surveillance and blocking activities. It will also be utilized in monitoring system status because the hand-held terminal will have the capability of receiving input on component positions (e.g., valve open or breaker closed) from the plant operator as he varies component status in the plant. The status of automatic systems will have to be manually fed into the CEMS upon actuation. The CEMS will also eventually be used to actually generate permits for blocking tasks. The licensee is, however, encountering some difficulties in implementing CEMS. CEMS is discussed in more detail in the Peach Bottom trip report (Appendix A, Ref. 4).

Plant Labeling at D. C. Cook. The D. C. Cook staff indicated that systems and components on flow prints as well as any other equipment items that have a human interface will be labeled in the plant. Cook has selected color-coded aluminum tags with color contrasted lettering for labeling components in nonadverse environments outside containment. For labeling mechanical components inside both containments, or in adverse environments outside containments, stainless steel tags are used. Electrical cabinets are in the process of being provided with bold color-coded identification.

The facility database contains the official noun name of devices which will be used on all labels, procedures and drawings, and uses the list of standard abbreviations developed during the control room design review. The Cook personnel see the plant labeling process as an on-going, iterative process. A procedure exists for maintaining labels, and plant maintenance procedures include a check-off for the adequacy of labels on the equipment being maintained.

D. C. Cook's labeling effort is described here because it illustrates the sharp contrast between "old" and "new" plant labeling philosophies. During the tour of the facility, the NRC staff was stunned by the gross lack of permanent labels in some areas of the plant and yet impressed at the stark difference between those areas that had been upgraded and those yet to be done. Components in areas where permanent labels had not yet been installed were identified with duct tape and magic marker lettering, whereas the upgraded labeling program features highly readable, color-coded identification.

Plant Labeling at Turkey Point. Turkey Point has begun a program of "Area Information Striping" to help get people to the right location and to reduce wrong unit errors. In this program, color-coded stripes are being applied to walls, electrical cabinets, equipment bases and pedestals and curbing around equipment. Turkey Point is also instituting a valve tagging program using color-coded fiberglass tags that contain information on the valve number and name as well as the normal operating position. There are plans to modify procedures to include a check-off or verification that the correct tags are in place during system alignment checks and maintenance. Recommendations have also been made to provide location maps at the entrance to low access areas (e.g., inside containment) to aid personnel in locating equipment.

The labeling programs summarized above illustrate some of the positive steps being taken by licensees to improve the performance of their staff. However, very poor labeling was also observed during plant walk-throughs. Examples of such poor labeling practices include: 1) nonexistent labels; 2) replacing virtually unreadable brass component identification tags with aluminum embossed tags, thus only marginally improving the readability of the component tags; 3) the lack of unique component identification numbers between units; 4) the lack of consistent use of nomenclature and abbreviations; and 5) the lack of an adequate label maintenance program to replace missing or damaged labels.

Training/Inexperience

Performing on-the-job training only on one unit, working previously on a fossil unit and not being made aware of the differences in plant layout, using drawings during training which are not up to date, and not understanding what is required when performing independent verifications are examples of training deficiencies which contributed to wrong unit/wrong train events.

Often improved training was the corrective measure taken after a wrong unit/wrong train event had occurred. However, many times a more direct contributor to the error exists (e.g., no label, poor human factors equipment design, inadequate procedures). In these cases, the direct cause of the event should be remedied in order to obtain the largest reduction in the probability of recurrence.

The combination of experience level and training should equal the desired level of competence. It is felt that a reduction in wrong unit/wrong train events can be accomplished by the use of an effective performance-based training program. Most of the events discussed in this study occurred prior to receiving INPO training accreditation. Wrong unit/wrong train event frequency which can be attributed to training/experience should be monitored subsequent to plants receiving INPO accreditation in order to assess the effectiveness of this training in reducing these types of events.

Procedures

The three main reasons why wrong unit/wrong train errors resulted from procedures are: 1) the procedure was generic, that is, it applied to both units, multiple trains or multiple plant conditions, 2) the procedure contained flaws from a human factors viewpoint (other than applicability to multiple units, trains or conditions) in the way the procedure was written, and 3) plant personnel needed to generate valve and switch numbers each time a procedure was used.

In cases where one procedure applied to multiple units, trains or plant conditions, the individual committing the error often accidentally referred to the wrong unit or train within the procedure. Often, corrective actions taken by a licensee included separating combined procedures into separate procedures. However, when asked whether separating combined procedures was done for all combined procedures or just the one involved in the event, the answer often given was that only the procedure involved in the event was separated.

In events where poor procedures resulted in wrong unit/wrong train events, the procedures were complicated, required the user to flip back and forth within a procedure, were long, did not have enough detail, did not include caution notes, or included diagrams of both trains on one page.

In those events where plant personnel were required to copy or generate a list of valve or switch numbers each time the procedure was to be performed, the wrong information was generated or copied. Some licensees have pre-printed sheets containing this information to reduce the probability of this type of error occurring.

One program of note regarding procedure improvement has been undertaken by Florida Power and Light. Realizing that poor procedures contribute to wrong unit/wrong train errors, Florida Power and Light has undertaken a comprehensive review of procedures at its Turkey Point facility. The review is concentrating on improving procedure quality and technical content, making all common procedures unit specific and improving the human factors of the procedures.

Incident Investigations

LERs and other incident reports often do not contain sufficient information to fully understand the contributors to wrong unit/wrong train events. In the present study, interviews were conducted during 10 site visits and information obtained on 35 events.

Through discussion with licensees, it was learned that additional wrong unit/wrong train events have occurred at many of these sites; however, since no technical specifications were violated, these events were not reportable to the NRC. As a result, many licensees were reluctant to discuss these events or to discuss them in sufficient detail to be of use in any analyses. Nonreportable events should not be considered trivial. For example, one nonreportable event which was discussed in detail with the NRC team involved burning up a reactor coolant pump motor with great risk to the safety of the operator who made the error.

Many of those interviewed in this study felt that human errors involving wrong unit/wrong train just happen and there is little which can be done to prevent them. This belief is exhibited in the resulting actions taken after a wrong unit/wrong train event. In the vast majority of events, the resulting action consisted of disciplining or counseling those involved rather than attempting to fully understand the underlying cause. It should be noted, however, that some licensees do attempt to go beyond disciplinary actions, that is, to understand the contributors to the event and take resulting actions to prevent future occurrences. In particular, Virginia Electric Power Company (VEPCO) is a participant in INPO's Human Performance Evaluation System (HPES) wherein all plant events caused by human error are investigated using guidelines and methodologies established by INPO and the results transmitted to INPO for use in an HPES database. Unfortunately, only five domestic utilities participate in the HPES. (See North Anna/Surry trip report (Appendix A, Ref. 2) for more discussion of the HPES.)

Appendix C contains the results of an assessment performed during this study of the contributors to the human errors in events described in the AEOD special report (AEOD/S401). Although not discussed during the site visits, the results are in general agreement with the results obtained from the 35 events discussed during the site visits. Labeling and procedural deficiencies are the leading contributors to errors in events discussed in the AEOD report. Because these events were not discussed in the same detail

as were those during the site visits, the information available and insight obtained into the contributors is limited.

Although the purpose of this study was to identify those factors that contributed to the occurrence of wrong unit/wrong train human errors and make recommendations for reducing their incidence, part of the wrong unit/wrong train event sequence involves promptly discovering the error after it has occurred. One method of accomplishing this is through the licensee's independent verification efforts. NRC guidance on independent verification has been provided in NUREG-0737, Item I.C.6, issued in November 1980 and IE Information Notice 84-51 issued on June 26, 1984. However, based on the interviews conducted, it is clear that the independent verification programs are subject to misunderstanding and should be reevaluated. Four of the events discussed which occurred in 1983-1984 involved a misunderstanding of independent verification. Dual instead of independent verification was performed and in other cases, the verification performed was based on an incorrect indicator (e.g., verifying valve position by looking at locks on valves).

SUMMARY

Summary of Findings

The major findings from this study of 35 wrong unit/wrong train events investigated are as follows:

1. Inadequate labeling of plant equipment, components and areas was the leading contributor to wrong unit/wrong train errors when both primary and secondary contribution is considered. Training/inexperience ranked second with inadequate procedures third.

2. As a primary contributor, labeling accounted for more than twice the number of events than the next nearest contributor. When taken together, inadequacies in labeling, training and procedures were the

primary contributors to human error in 60 percent of the wrong unit/wrong train events investigated.

3. Operations personnel were responsible for the wrong unit/wrong train errors far more often than any other group of plant personnel. Of the 32 events where the individual's affiliation was known, 24 (75 percent) of them involved operations personnel (18 nonlicensed, 5 licensed, 1 both licensed and nonlicensed). Often these errors occurred during activities in preparation for maintenance.

4. Although most events involved a combination of contributors, eight events occurred as a result of only one known contributor. These 8 events encompassed 6 of the 10 categories of contributors. Consequently, when considering the limited sample, it is believed that any of the contributors have the potential to cause a wrong unit/wrong train event by themselves.

5. Information provided in LERs does not fully describe all of the contributors to wrong unit/wrong train errors. In addition, the scope and level of detail of the information provided varies greatly among LERs.

Observations

1. Currently, there is no NRC requirement for labeling of controls, valves, electrical and other equipment which must be located, identified or manipulated by plant personnel. Additionally, there is no NRC requirement for area labeling to assist in identifying units, rooms, areas and component location. Such area labeling includes color-coded unit signs on doors to rooms identifying the room and associated unit, signs identifying trains if components in a given room or area are train specific, and location maps showing component locations within a given room or area (see LaSalle and Turkey Point trip reports (Appendix A, Ref. 6, 9)).

General guidance or examples regarding labeling in conformance with good human engineering principles can be found in: 1) EPRI Report NP-1567, "Human Factors Review of Power Plant Maintainability", 2) EPRI Report NP-4350, "Human Engineering Design Guidelines for Maintainability", 3) NUREG-0700, "Guidance for Control Room Design Reviews", and 4) INPO 84-007, "System and Component Labeling." Knowledge regarding good labeling has already been obtained by each licensee as part of the control room design review process. Some licensees have upgraded labeling of components outside of the control room using knowledge gained during the control room design review process.

2. An effective peformance-based training program will recognize that part of one's work in the plant (particularly in operations) is to locate equipment and will ensure that plant personnel are trained and tested on mastering that task as part of the training program. Such training will include such knowledge, skills and abilities as labeling conventions, drawing reading and physical locations within the plant.

3. Nonemergency plant procedures do not reflect the knowledge gained during the emergency procedure upgrade program. The procedures discussed during the site visits which contributed to the wrong unit/wrong train events investigated were often poorly written and/or applicable to multiple units or multiple trains. Feedback from licensed and nonlicensed operators regarding degree of complication, length and format would assist in determining which procedures warrant improvement. The procedures element of the Human Factors Program Plan addresses the issue of the quality of plant procedures.

4. Individual utilities are investigating the range and acceptability of labeling materials and schemes to arrive at an environmentally acceptable label that conforms with good human engineering principles. During the site visits, it was found that little communication is evident between utilities and even within the same utility on this topic.

5. Participation in the "Human Performance Evaluation System (HPES)": 1) creates a heightened awareness by plant personnel about human error, and 2) provides knowledge regarding methods to prevent and investigate events involving human error to plant personnel. Although information regarding wrong unit/wrong train errors has been conveyed to individual utilities primarily through IE Information Notices and Bulletins, an information gap still exists among licensees about the details of such events and methods which can prevent them from occurring. Participation in HPES would close this gap.

NRC Initiatives

Guidance

1. The NRC should provide clarifying guidance regarding independent verification. Definitions of independent verification (e.g., verifying actions through differences in location or time), qualifications of an independent verifier, training on independent verification and what to observe when conducting independent verification should be included in this clarification.

2. No guidance currently exists for NRC inspectors' use in evaluating the adequacy of plant labeling schemes and implementation. NRR should provide input for developing an Inspection Module on plant labeling schemes and implementation.

3. NRC's evaluation of the performance-based training programs being implemented in the nuclear industry should include an assessment of whether learning objectives relevant to wrong unit/wrong train issues are included. Specifically, such training programs should require that operations personnel demonstrate their ability to properly locate plant components both from verbal instructions and from plant drawings, and their knowledge of the plant labeling conventions.

4. As a result of information obtained during the site visits, it is evident that, in most instances, information provided in LERs does not fully describe all of the contributors to wrong unit/wrong train errors. In addition, the scope and level of detail of the information provided varies greatly among LERs. Consequently, LER requirements involving human error should be revised by the staff so that information provided by the licensee is comprehensive in identifying contributors to an event. This would assist AEOD in evaluating events involving human error. As part of the Human Performance element of the Human Factors Program Plan, DHFT intends to provide input to AEOD for improving the reporting of human performance issues in LERs.

5. The NRC, through the Office of AEOD, should continue to monitor events involving wrong unit/wrong train/wrong component and determine their frequency over time. AEDO data through 1985 indicated that plants with less than 2 years of operations may experience a disproportionately large number of these types of events. The data indicates that wrong unit/wrong train events are continuing to occur.

Regulatory Analysis

1. Currently, there is no NRC requirement for labeling of controls, valves, electrical and other equipment which must be located, identified or manipulated by plant personnel nor is there any requirement regarding area labeling (e.g., doors, rooms, units). The NRC should perform a regulatory analysis to determine whether a requirement should be established that locations which involve a man-machine interface (e.g., controls, displays, valves, electrical equipment) and plant areas be labeled in conformance with good human engineering principles.

2. The NRC is evaluating the need to develop technical guidance for the industry to use to upgrade normal operating procedures and abnormal operating procedures as the staff has done for emergency operating

procedures. Future work in this area should include conducting a regulatory analysis to determine what regulatory action for other plant procedures is warranted.

ACKNOWLEDGEMENTS

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1. Memorandum from Heltemes (AEOD) to Denton (NRR) dated January 13, 1984, Subject: Special Study Report - Human Error in Events Involving Wrong Unit or Wrong Train.

2. Letter from Chan (NRC) to Stewart (VEPCo) dated February 7, 1986, Subject: Surry and North Anna WU/WT Trip Reports.

3. Letter from Zwolinski (NRC) to Farrar (CECo) dated March 6, 1986, Subject: Dresden WU/WT Trip Report.

4. Letter from Gears (NRC) to Daltroff (PECo) dated March 13, 1986 Subject: Peach Bottom WU/WT Trip Report.

5. Letter from Fischer (NRC) to McNeill (PSEG) dated March 17, 1986 Subject: Salem WU/WT Trip Report.

6. Letter from Bournia (NRC) to Farrar (CECO) dated March 17, 1986 Subject: LaSalle WU/WT Trip Report

7. Letter from Wigginton (NRC) to Feinstein (AEPS) dated March 13, 1986 Subject: D. C. Cook WU/WT Trip Report.

8. Letter from Hood (NRC) to Duke Power dated March 12, 1986 Subject: McGuire WU/WT Trip Report.

9. Letter from McDonald (NRC) to Woody (FPL) dated March 20, 1986 Subject: Turkey Point WU/WT Trip Report.

10. Letter from Hood (NRC) to Duke Power dated March 12, 1986 Subject: Oconee WU/WT Trip Report.

Site	Event Number	Title	Unit or Train or Comp.	Labelling							Procedures	Communication	Training or Inexp.	Physical Stress	Mind Set	Interruption of Work	Layout/Equip. Design	Rushed	Drawings	Equipment Involved	Principal Pos. Involved	Comments
				Non-Existent	Poor Readability	Not Unique	Poor Placement	Consistency	Non-QA Labels	Other												
Dresden	237-84-013	EHC Valve	U			S							P		S			S		valve	non-licensed oper.	
	249-85-005	Diesel Generator	U			P					S	S								electrical switches	non-licensed oper.	
	237-84-012	RPS Trip	T								S		S				P			instrument	instrument mechanic	
Surry	281-81-001	Boric Acid Valve	U		P								S	S						valve	non-licensed oper.	
	280-82-072	S. I. Accumulator	T										S				P			control room switch	licensed control room operator	
	280-83-033	MOV Torque Switch	U		S								P							electrical switch	electrician	
	280-83-051	Containment Vacuum Pump Line	T									P	S						S*	piping/ valve	licensed reactor operator	*drawings were out of date; not taken into the field; no training on design change
North Anna	339-82-022	Quench Spray Subsystem	T								S			S	P					electrical cabinet	engineer electrician	*overtime
	339-85-006	De-energization of 120V AC vital Bus	T	S*		P							S							electrical breakers	non-licensed oper.	*load list missing in breaker cabinet
	Non-reportable event	Lube Oil Pump	T	P*										S	**					pump	maintenance mechanics	*label not obvious; pump running lights broken **noise

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				Non-Existent	Poor Readability	Not Unique	Poor Placement	Consistency	Non-OA Labels	Other													
Salem	272-82-003	Diesel Generator	T					P*													diesel generator switch	non-licensed oper.	*inconsistent with annunciator and procedure; misleading labels
	272-83-024	Vital Instrument Inverter	U										S			P					electrical inverter	licensed control room operator	
	non-reportable event	Reactor Coolant Pump	U											P	S*						electrical breaker	non-licensed oper.	*overtime
	non-reportable event	Wrong Transformer											P								electrical transformer	non-licensed oper.	
Peach Bottom	278-81-008	CAD Line	T	P								S*						S			pipe		*check-off list
	278-85-008	Torus Test Bypass Valve	C											P							control room switch	licensed control room operator	
LaSalle	373-83-140	Jumper Installation	U	S*								P		S	**						electrical panel	electrician	*non-existent on back of panel **independent verification not understood
	373-84-071	RWCU.Valve	C									P									electrical breakers	non-licensed oper.	incorrect list of valve breakers generated from electrical drawings
	374-84-017	Loss of Feedwater	C		S					S*	S			P									*caution label could have been used
	374-85-012	RHR Shutdown Cooling Isolation	C	P*										S							valve	instrument maint. technician	*although labels existed they were never used because they were untrustworthy

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				Non-Existent	Poor Readability	Not Unique	Poor Placement	Consistency	Non-QA Labels	Other												
LaSalle	374-85-020	Service Water Sample	C												P						rad chem foreman	
DC Cook	315-81-005	SI Valve Breaker	U						S*							P				electrical breakers	non-licensed oper.	*magic marker labels
	315-83-009	Spray Additive Tank Outlet Valve	U								S*						P			valve	non-licensed oper.	*independent verification procedures emphasized recording seal number and not verifying position
	315-83-048	Containment Spray Heat Exchange	T						S*				S	S	**		P	S		valve	non-licensed oper licensed operator	*magic marker labels with no train designation **fatigue
	315-84-014	SI Pumps	T								S	P	S	S*				S		valve	non-licensed oper	*hot (100^{0}F) contamination clothing fatigue
	non-reportable event	Containment Spray	U											P*						valve	non-licensed oper.	*overtime
McGuire	369-81-130	Containment Ventilation Isolation Valve	U					P*												valve	non-licensed oper.	*lack of control for consistency between labels and drawings following station modifications; label was incorrect
	370-84-021	High Flux Rate Signal	T				P								S*					instrument	instrument and electrical tech.	*mind was on plant conditions
	370-84-034	Inverter	U								P**		S*					S		inverter	licensed oper. non-licensed oper.	*dual verifier confused by procedure **procedure was generic to eight inverters for both units

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				Non-Existent	Poor Readability	Not Unique	Poor Placement	Consistency	Non-QA Labels	Other												
McGuire	370-85-010	Upper Head Injection Piping	C						P*					S**						valve		*incorrect temporary label (magic marker) **area is cramped
Turkey Point	250-83-007	Aux Feedwater System	T		S								S*	S**					P	valve	non-licensed oper	*training on independent verification - operator only looked at locks rather than valve position **overtime (7 days/8 hours, 9 days/12 hrs - no days off)
	251-83-016	Containment Spray	U			S					S*				P					valve	non-licensed oper	*did not have tagout sheet with him resulting in action not initialed as complete; combined procedures for two units
	250-84-003	Reactor Trip Breaker	T								P					S				electrical breaker	licensed operator	
	250-85-004	MG sets	U	P*																MG sets	non-licensed oper	*room markings removed to install fire doors; lacked use of color coding and enhanced labels
	250-85-017	ESF Actuation	T								P						S			electrical breakers	non-licensed oper	

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			Non-Existent	Poor Readability	Not Unique	Poor Placement	Consistency	Non-QA Labels	Other												
Big Rock Point	155-81-022	T	P																electrical switch	non-licensed operator	rooms and equipment not identified
Conn. Yankee	213-81-008	T								P									valve		surveillance procedure had valve nos. reversed
Browns Ferry	259-82-032	T								S	P								electrical breakers		safety system out of service while another train was removed for T.S. surv.
Robinson	261-81-003	T								P									electrical breakers		procedures said "open" circuit EI instead of "fuses removed"
Point Beach	Insp. Report 50-266/82-12	U				S					P			S					valves	non-licensed oper.	Unit 1 dwgs used to give instructions on Unit 2; operator was assigned to Unit 1 visual alarms poorly placed
Calvert Cliffs	318-82-018	U							S*	S				P					electrical programmer panels	electricians	*not clearly identified as Unit 1 or 2
	318-83-007	T	S													P*			switch	licensed oper.	*mirror image
Sequoyah	327-81-073	T								P*									relief valve	maintenance personnel	*wrong location on MWO
Fitzpatrick	333-82-041	T							P*										elec. fuse board		*faulty -- method not clear
	333-81-038	T							P*										inst. modules	maintenance personnel	*faulty

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			Non-Existent	Poor Readability	Not Unique	Poor Placement	Consistency	Non-QA Labels	Other												
Hatch	366-82-095	T							P*										valve		*faulty
	366-82-118	U	P																		diesel generator
Susquehanna	387-83-026	T										P						S*	elec		*poor quality, hard to follow