Jerra

NUREG/CR-0979

Licensee Performance Evaluation Phase II

POOR ORIGINAL

Prepared by H. E. Chakoff, D. M. Speaker, S. R. Thompson, S. C. Cohen

Teknekron, Inc.

Prepared for
U. S. Nuclear Regulatory Commission

7910020338

~~1077 230~~

1072 123

Available from
National Technical Information Service
Springfield, Virginia 22161

NUREG/CR-0979

Licensee Performance Evaluation Phase II

Manuscript Completed: March 1979
Date Published: August 1979

Prepared by
H. E. Chakoff, D. M. Speaker, S. R. Thompson, S. C. Cohen

Teknekron, Inc.
1483 Chain Bridge Road
McLean, VA 22101

Prepared for
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Under Contract No. NRC-05-78-302

1079 125

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

1079 128

LIST OF TABLES

LIST OF TABLES (Continued)

1079 130

1. INTRODUCTION

This report details Teknekron's work during the second phase of Licensee Performance Evaluation. The Phase I report, NUREG/CR-0110, details our initial efforts on this contract including a review of previous work, a review of NRC's relevant data bases, and a feasibility analysis of performance evaluation for all classes of licensees. This introduction briefly summarizes the Phase I work, presents the new direction that the Office of Inspection and Enforcement requested we take after about one-third of the Phase II work had been accomplished, and discusses concepts essential to understanding the approach taken in the remaining sections of this report.

1.1 Summary of Phase I Work

The Request for Proposal on Licensee Performance Evaluation envisioned Phase I as a study of the feasibility of evaluating the performance of NRC's licensees; a methodology was to be devised and applied in Phase II. Teknekron agreed that the major portion of the actual evaluation logically fell in Phase II, but felt that Phase I must include a "feedback loop" of selecting a possible approach and testing it on actual case studies to see if it produced results that met NRC's needs. An evaluation method is feasible only if it works.

Feasibility

The issue of "feasibility" of performance evaluation was and is of critical importance to NRC. In its RFP, NRC identified several "Evaluation Considerations" against which any methodology was to be tested. Though not so organized in the RFP, these factors fell into three major groups:

- Support for NRC's mission and goals
  - The relationship between the evaluation criteria and safety. Each measure of licensee performance selected, including compliance with NRC requirements, must be strongly related to NRC's mission of insuring safety.
  - NRC's regulatory authority. Those evaluation methods proposed for near-term application must be consistent with NRC's existing regulatory authority. For example, it may not be appropriate to evaluate licensees on the basis of commercial productivity

1079 131

factors, unless it can be demonstrated that those factors relate to NRC requirements or to the safety of a licensed operation.

- Uniform application. The population of NRC licensees will be partitioned into homogeneous groups for the purpose of evaluating their performance. Evaluation methods will not discriminate against particular licensees in any given group.

- Licensee control over rating factors. To be fair, licensees must be evaluated on the basis of factors that they can directly influence.

- Staff concerns and differing viewpoints

  - Quantitative versus qualitative evaluation. Both types of measures must be considered. Quantitative evaluations are based upon measurable indicators such as numbers of items of noncompliance. Qualitative judgments involve subjective ratings by Regional Directors or other similar measures.

  - Relative versus absolute performance. The evaluations will consider a licensee's performance both in comparison to that of other similar licensees and as measured against reasonable absolute standards of acceptability.

  - Weighting. If licensee performance evaluations are to be based upon several independent factors, the relative importance of these factors must be reflected in the weights assigned to each. Also, the sensitivity of evaluation results to various choices of weights will be investigated.

  - Categories of evaluations. Two distinct aspects of licensee performance must be captured in the evaluation methodology--overall performance and performance in specific areas of responsibility.

- Usefulness and practicality

  - Analytical depth. For any class of licensees, the appropriate level of analytical depth permits identification of actual differences in licensee performance. While these insights may derive from a relatively simple, aggregated analysis of summary data, it may be judged necessary to evaluate performance on the basis of in-depth examinations of specific events, incidents or occurrences.

  - Data considerations. In quantitative evaluations, the lack of suitable data may limit the ability to evaluate licensees. Evaluation methods must be based on data currently available or upon data that are obtainable with reasonable effort. The contractor will identify data that should be made available and suggest appropriate methods for its collection.

The relationship of these groupings becomes clearer when one recognizes that within NRC (not only I&E) there is little agreement on whether licensee performance evaluation should be done at all, and that a few previous attempts have in fact been made. No one would disagree that any evaluation method must be uniform, be within NRC's regulatory scope, and be related to safety. Nor would anyone argue that a licensee should not be criticized for something he cannot control. But some on the staff feel that adequate evaluation will require a vast data collection effort for which resources are unavailable; others feel that all licensees are performing at least adequately, so that distinctions cannot easily be made.

Teknekron felt that this list of NRC considerations had to be addressed to make any methodology acceptable, not only to NRC, but to the licensees and to the public that inevitably will see the results of an evaluation. "Acceptability" is, in this political world, an important component of feasibility. We therefore interviewed NRC headquarters staff, regional directors and their assistants, the licensees, and one intervenor group. The feelings of each of these groups are summarized in Section 2.3 of the Phase I report.

Review of Other Related Work

We also reviewed previous NRC work in performance evaluation and related areas, since some staff concerns and different viewpoints were focused by these efforts.

We reviewed three documents:

- "A Statistical Evaluation of the Nuclear Safety-Related Management Performance of NRC Operating Reactor Licensees During 1976." This is an NRC-generated report dated February 1977.
- "Phase I Report: Utility of Incentive Systems for Licensees." This report was prepared by TRW under NRC sponsorship and is dated October 1977.
- "Benefit Cost Analysis of the Trial Inspection Program Involving Statistical Sampling Inspection Techniques Conducted at Metropolitan Edison Company's Three Mile Island Unit 1 during the Period July 1, 1975 to June 30, 1976." This is an NRC-generated report, dated January 1977.

Since the content of these documents and NRC's reactions to them strongly influenced our approach, the discussion in the Phase I report is summarized here.

"A Statistical Evaluation of the Nuclear Safety-Related Management Performance of NRC Operating Reactor Licensees During 1976"

This report describes a licensee performance assessment methodology based on the statistical treatment of noncompliance counts by category, numbers of LERs submitted, and other data that are ultimately combined into a single index (Z score). Its intent is to arrive at a numerical rating reflecting licensee performance, since the better performer is assumed to incur fewer noncompliances and issue fewer LERs. This report stimulated considerable comment within NRC, much of which focused on these issues:

- The problem of developing a broadly acceptable relative weighting system for the various noncompliance categories (violations, infractions and deficiencies) and weightings for LERs, effluent releases, and personnel exposures.
- The question of whether differences in the stringency of technical specifications applicable to different licensees may in themselves affect performance quality. This factor could prevent uniform application of any methodology.
- Licensee performance evaluations expressed as single numbers (aggregating several factors) inherently lend themselves to the relative ratings of licensees. NRC I&E generally feels that relative rankings of licensees are likely to generate misleading impressions and are therefore undesirable in terms of the interests of both industry and the public.
- A relatively high number of LERs may not necessarily indicate poorer performance: it could mean that the licensee is overly conscientious in his interpretation of what is considered reportable, and may be influenced by stringency of technical specifications.

NRC's development of a statistical methodology illuminated these specific factors as well as others that are independent of the evaluative method used. One of these latter factors is the effect of performance assessment on the licensee (will it motivate him to improve the quality of his performance, or might it have the reverse effect?). Another is the clear recognition that any evaluative approach should, to the degree possible, be based only on those performance factors that are within the licensee's control.

"Phase I Report: Utility of Incentive Systems for Licensees"

This TRW report ably identifies several aspects of the NRC enforcement process that seem to offer less-than-optimum incentive to improve performance. One concept of the TRW report of great value to our work was that licensee performance reflects a combination of attitude (willingness/desire to comply with NRC regulatory requirements or to improve the quality of operation), and capability (managerial and technical ability) to achieve compliance and improved operating quality. The first factor - attitude - reflects licensee motivation; the second - capability - reflects his capacity to translate his motivation into action.

The TRW report presents a graphic display classifying licensees who theoretically possess different attitude/capability combinations into four quadrants of "performance space." One quadrant represents good attitude/high ability, another good attitude/low ability, and so forth. In TRW's study context, this classification helps identify the forms of NRC enforcement/incentive actions that are appropriate to the attitude/capability combinations licensees exhibit. TRW's classification interested us because it helped direct us to the controlling causal factors behind performance, and in Phase II, the concept of "performance space" proved to be highly valuable and, we believe, realistic.

"Benefit Cost Analysis of the Trial Inspection Program Involving Statistical Sampling Inspection Techniques Conducted at Metropolitan Edison Company's Three Mile Island Unit 1 During the Period July 1, 1975 to June 30, 1976"

In the course of Phase I work, it became clear that, for certain classes of licensees, there were not enough data of any sort to allow their performance to be analyzed individually. When we considered statistical sampling as a possible means of analyzing the performance of these classes of licensees, we reviewed and analyzed this document.

The Statistical Sampling Inspection Program (SSIP) was conducted as an experimental project to determine whether it was feasible, through the use of a statistical sampling inspection methodology, to establish confidence levels for licensee compliance with all requirements. Three strata of inspectable regulatory requirements were established, based on how closely the requirements were related to safety.

1079 135

The authors of the report argue against further development of the SSIP on several grounds, the first two of which highlight the deeply held feeling that the ability of NRC inspectors and the quality of their insights are a valuable component of the NRC I&E program:

- Since the SSIP relies primarily on record audits and hardly at all on direct observation, an inspector might miss an important safety-related noncompliance item.
- Random sampling does not give the inspector an adequate overview of the quality of the licensee's operation.
- The SSIP is not cost effective. The average number of man-days required to identify a noncompliance is about 50% higher than under the regular inspection program.

Although the report does not favor extending the SSIP effort, we do not believe that sampling techniques should be completely dismissed. They could, for example, be independently applied in conjunction with the MC-2515 process as a check of the regular inspection program. Also, inspectable categories could be established on a system rather than a modular basis to ensure that no system having significant safety implications is ignored. This would require that samples be drawn from each system population of inspectables.

Teknekron's Approach to Performance Evaluation

NRC's issues of feasibility and staff reactions to previous evaluation schemes influenced the form our analysis took. We tried to focus on significant aspects of "licensee performance" and how their analysis could best support NRC's goals. We concluded that "performance" is fundamentally grounded in the structure and operation of the licensee; to provide insight into why one licensee is different from another, we had to devise a way to examine the licensees' ability and willingness to operate the facility to carry out the public safety intent of NRC's regulations. Therefore, the first step was to develop a general concept of a licensee - a "model" - and then examine the available data to see what information could illuminate the elements of that model. We began with a concept of a licensee's operation and structure, not with the data that the operation and structure produce.

Figure 1 shows the structure of the model. The three circles designated "F", "P" and "M" represent the facility, personnel and management respectively. The arrows designated "1" through "5" symbolize the relationships among these entities. The arrows outside the rectangle and pointing away from it represent the external indicators of performance quality - noncompliances, LERs, and other inspection findings. In causal terms, the interrelationships within the rectangle are essentially within the licensee's control, and performance deficiencies traceable to these interrelationships can validly be attributed to licensee action or inaction. However, some performance deficiencies could arise from causes that are not within the control of the licensee. These include certain external causes - a highly extreme case would be impact on the plant by a meteor - and inherently faulty components - components that are truly defective as opposed to those that became so through negligent or improper maintenance. Causes of these kinds are represented by the arrows to the left of the rectangle.

In this model, the terms facility, personnel and management have precise meanings:

Facility

This means the physical plant *in toto*, including not only the reactor and auxiliary plant, but also all instrumentation and test equipment. Thus the facility includes all physical components and structures relating to the licensed operation, but excludes associated human beings.

Personnel

This means all individuals who have a routine "hands on" relationship with any part of the facility. Personnel generally do not establish the procedures they implement.

Management

This means all individuals who are responsible for establishing policy, technical design, developing procedures, and training and supervising of personnel. These responsibilities implicitly include the assurance of facility safety. Management generally does not have a "hands on" relationship to the facility.

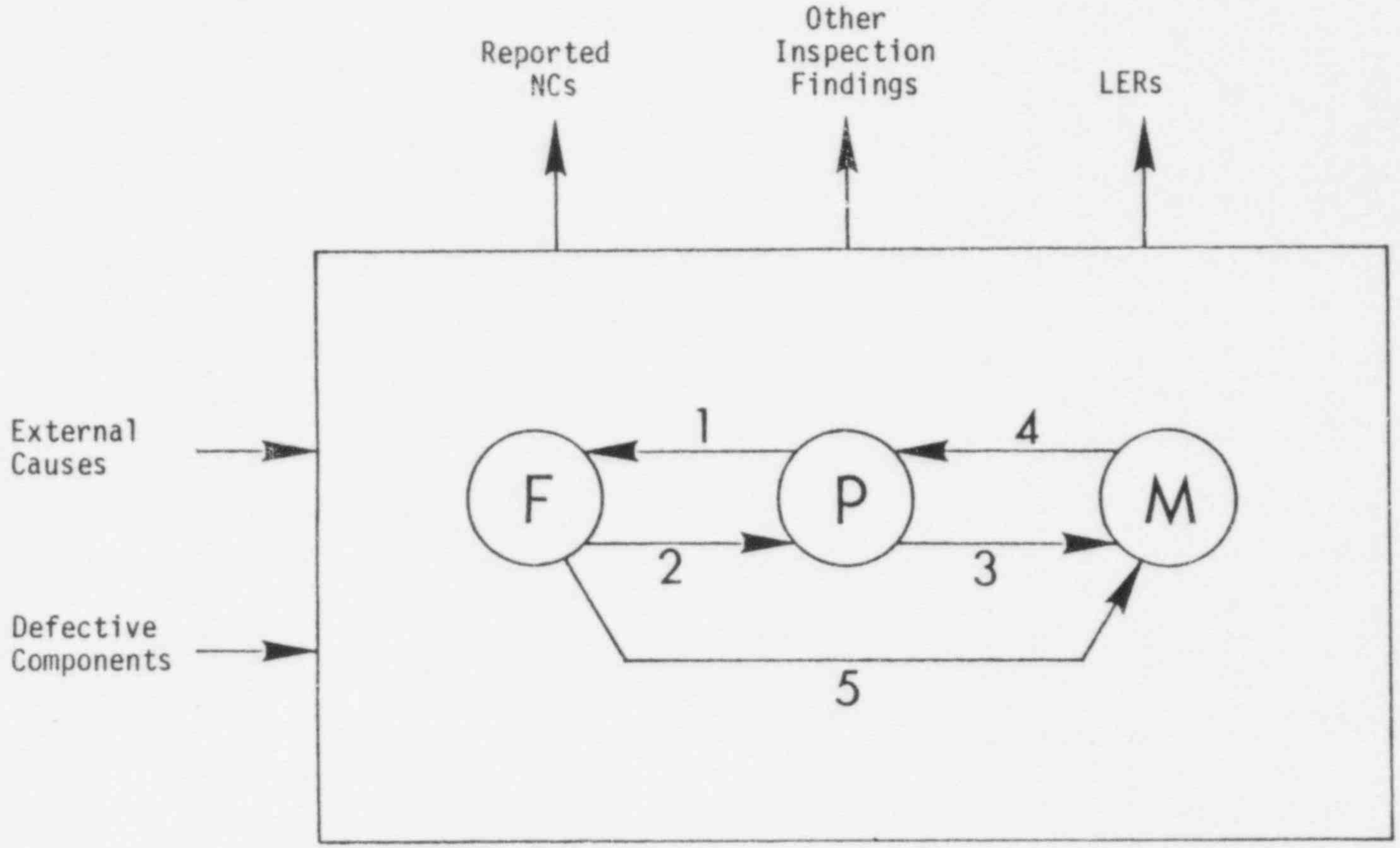


FIGURE 1
The FPM Model

As stated earlier, the arrows within the rectangle represent direct interrelationships among the facility, personnel, and management. These interrelationships act as information channels, with messages flowing in the directions shown by the arrowheads. The message content varies considerably among the arrows. Briefly,

Arrows 1 and 2 are channels between the Personnel and the Facility

Arrow 1 represents all procedures and actions performed by personnel for the "hands on" operation, control, and maintenance of the facility.

Arrow 2 represents all information and data originating from the facility of which personnel should be aware; it includes all information and data that requires a "hands on" response by personnel.

Arrows 3 and 4 are channels between Personnel and Management

Arrow 3 represents personnel's reporting function with respect to management.

Arrow 4 represents the supervisory and administrative functions of management with respect to personnel. Note that this relationship is the sole avenue through which management can implement its responsibilities for acceptable facility operation.

Arrow 5 is the channel from the Facility to Management

This arrow represents all the information and data originating from the facility that makes management directly aware of normal operation and deviations from normal operation. The relationship between management and the facility is represented by only one arrow, because management control of the facility is normally exercised through personnel rather than through direct "hands on" operation.

This brief discussion simply identifies the broad character of the interrelationships and messages symbolized by the arrows. The model and its use are described completely in the Phase I report. Our structural model is essentially simple, but a great deal of information about licensee performance is represented by the arrows themselves.

In theory, the performance of a licensee can be analyzed and the reasons for his performance determined by examining only the portion of the FPM model inside the rectangle, if all the required internal data are available. Unfortunately, complete and detailed internal information and data are generally not available to those outside the rectangle in the FPM model diagram.

Because of this, performance analysis must depend, at least at present, on external indicators such as LERs, reported noncompliances and other accessible data. Other approaches to licensee performance analysis have stressed numerical counts of these indicators over defined periods of time. The FPM methodology emphasizes analyzing the content of LERs and noncompliance reports. When keyed to the internal portion of the FPM model, this content analysis provides insight into the nature of the licensee's performance pattern and the causal factors underlying it.

The FPM methodology also differs from previous approaches in three other respects. First, we do not use the severity of reported events and noncompliances. The discussion of the statistical methodology developed within NRC pointed out the difficulty of finding a widely-acceptable weighting scheme, and we chose to weight violations, infractions, and deficiencies equally. Equal weighting is consistent with the fact that numbers of events or noncompliances are not central to the FPM approach.

Second, we emphasize the patterns of events and noncompliances over sufficiently long periods of time. Important pattern elements include event frequency, distribution, assigned cause, the occurrence of events that appear to have a common cause, and the number of repetitions of such events. Based on 12 case studies, these patterns appear to provide considerable insight into the quality of the licensee's operation and also into the personnel and management behavior that underlie that quality. We believe that the licensee performance patterns can be directly correlated with management and personnel actions symbolized in the FPM model, even though virtually no data on the information flowing along the numbered arrows is available for direct examination.

Third, in Phase I, we presented the analytic results in a graphic form that permitted immediate visual comparison of licensee performance patterns. The differences between the profiles of better and poorer performers were clearly evident. This initial decision not to attempt statistical manipulations of the analytical results was made soon after the model concept was first developed.

1079 140

We feel that graphic patterns are inherently more revealing than numbers, particularly when a perspective of licensee performance as a function of time provides insight into the factors that determine performance. The statistical presentation of results tends to blur causal relationships that could be readily inferred from graphic displays. Further, the perceptions of NRC, licensees, and intervenors made it clear that ranking of licensees, made easier by numerical results, could threaten the acceptability of licensee performance analysis. In Phase II, we have used non-parametric (distribution free) statistical tests to access the validity of particular performance indicators, but the indicators themselves are not the result of statistical manipulation.

The nine case studies performed in Phase II, together with the three licensees studied in Phase I, provided a data base that allowed us to develop and test several performance indicators. We tested a number of these for statistical validity, and the results of these tests are discussed fully in Section 3.

The Value of Available Data

A major finding of Phase I was that the content of LERs was a valuable source of information on licensee performance. The computerized inspection data was unfortunately less helpful, first because the noncompliance text was often too brief to provide an insight into the cause of the noncompliance, and second because the cause code often conflicted with the brief text. The inspection reports themselves generally did provide the needed insight, but it is impractical to use the written reports in evaluating the performance of even all operating power reactors, let alone NRC's several thousand other licensees. To be feasible, any performance evaluation method had to make use of computerized data.

1.2 A New Direction for Phase II

Phase II was originally intended as a further test of the FPM model and methodology through performing 17 more case studies. But on September 13, 1978, when nine of the 17 case studies were complete, a letter from the project officer directed us to refocus our effort:

> Rather than complete the remaining eight case studies using the "FPM methodology," we would like you to devote your efforts to developing

1079 141

and applying methodology that takes full advantage of noncompliance findings and qualitative judgments of the Regions, as well as LERs. The product of these efforts should be a comprehensive, integrated methodology that can be immediately put to use by the IE staff. Specific guidance is offered below.

For noncompliance findings, you should try to develop methodology that is equivalent in its level of detail to your LER-based methodology. Recognizing that noncompliance findings may not prove as valuable as LERs in predicting safety-related problems or incidents, examine selected findings in enough detail to determine how much insight noncompliance data can provide. Because of the deficiencies you have noted in the computer noncompliance data, you will undoubtedly have to examine individual inspection reports for the several licensees you select to demonstrate the noncompliance methodology. We will appreciate any suggestions you might offer for improving the quality of data, defining data collection needs, or improving the definition of "cause codes" or their use by our inspectors.

In response to this request, we developed a set of revised noncompliance cause codes and tested them on two licensees. The results of this test are discussed fully in Section 4; the revised codes link the root causes of a noncompliance to one or more FPM model elements in order to show a pattern of regulatory performance over time.

1.3 Testing Hypotheses About "Better" and "Poorer" Performers

Much of the remainder of this report appears to assume that three of the 12 licensees we studied are "poorer" performers and that the other nine are therefore "better." This part describes how and why we made that categorization and how we tested its validity. As with any project that hopes to find significant differences between groups, one must begin with a categorization that seems reasonable based on available data, and then find a way to test whether that grouping is valid.

The intent of this project is to find a way to evaluate the performance of NRC's licensees that is reasonably within the scope of NRC's powers and resources and that allows both NRC and the licensees to function more effectively by offering insight into why a licensee's performance is what it is. In Phase I, we found the LER data highly useful in distinguishing between licensees - the two licensees that we eventually categorized as "better" performers had substantially fewer causally linked events due to human error

1079 142

than did the third licensee, the poorer performer. Unfortunately, at the close of Phase I we had found no insightful way to use the noncompliance data generated by NRC's inspection program: the only likely distinction was that the licensee considered "poorer" from the LER data was the only one (of three) to have sustained events due to human error that NRC also considered serious, in that they threatened human health and safety.

Thus at the beginning of Phase II, we proceeded to analyze the LER and noncompliance data for nine additional licensees, using the methodology we devised in Phase I. Our basic goals were to see if the LER data continued to be insightful, to search further in the noncompliance information, and to try, if possible, to present the LER analysis in a more concise form than the profiles. The differences in licensee LER profiles have immediate visual impact, but are somewhat unwieldy to use.

In the course of analyzing the LER and noncompliance data for nine additional licensees, we began to see specific potential "performance indicators" that might separate better and poorer performers. The most striking of these was that of the 12 licensees studied, representing 24 reactor-years of operation, three licensees had a total of six serious regulatory events or an average of one serious event per reactor-year. The average for the remaining nine plants was zero. Furthermore, the three licensees with serious events had large numbers of causally linked events; long chains of causally linked events, and linked events that occurred close together. The nine licensees that had no serious events did not seem to display these characteristics.

The occurrence of serious regulatory events formed the basis for our tentative "working hypothesis" classification of each of the 12 performers as either "better" or "poorer."* We had to make this working distinction to test whether other potential performance indicators - numbers of causally linked events, the length of event chains and the time between linked events - were in fact valid.

We tested the validity of these performance indicators by checking to see if the mean of a particular indicator for the better performers (for example, the mean number of causally linked events) was significantly different from the corresponding mean for the poorer performers. This is a well-known statistical practice. To perform the tests, we used the Wilcoxon-Mann-Whitney procedure (better known as the Mann-Whitney test), a distribution-free rank-sum test. We chose a non-parametric test for two reasons. First and most basic, we feel that a licensee's performance quality stems from his structure and operation and is in this sense unique to him. This idea is basic to our analysis, and it does not depend on or force a "normal distribution" of performance quality. All licensees could be "better" performers; our use of content analysis, rather than quantitative analysis of data, does not assume the existence of a bell-shaped curve of performance quality. Parametric analysis techniques are valid only when applied to a normal distribution.

Second, non-parametric techniques give valid results even in the presence of normally-distributed data. The Mann-Whitney procedure for testing whether

---

*Our working classification:

Better Performers	Poorer Performers
Point Beach Unit 1	Zion Unit 1
Prairie Island Unit 1	Duane Arnold Unit 1
Surry Unit 1	Millstone Unit 1
San Onofre Unit 1	
Trojan Unit 1	
Robinson Unit 2	
Quad Cities Unit 2	
Arkansas Unit 1	
Fort Calhoun Unit 1	

Obviously, performance quality is not uniform within each of these groupings. But our intent was to discover how the groups differed so that NRC might be able to help the poorer performers improve, not to search for the "best" or the "worst" performers.

1079 144

the means of two groups differ by a statistically significant amount is therefore safe to use, for it will not give false results in either case.

1.4 The Phase II Report

Section 2 of this report summarizes the data we obtained from the 12 case studies and how these data pointed to specific data elements that appeared to be particularly valuable indicators of performance. Section 3 describes the performance indicators that stem from the LER data, and Section 4 presents the performance indicators that result from applying the revised cause codes to noncompliance data. The final section combines the LER and noncompliance indicators into an integrated approach to licensee performance evaluation.

2. SUMMARY OF DATA AND INSIGHTS DERIVED FROM THE TWELVE CASE STUDIES

This section functions as a transition between the Phase I work and the Phase II results. For both the LER and noncompliance data, we briefly describe the positions we had reached at the end of Phase I. Part 2.1, covering noncompliance data, expands the Phase I data base by presenting the information we gained from nine more case studies. (As discussed in Section 4, at the direction of I&E management we investigated possible ways to use noncompliance data in performance evaluation. Our investigation resulted in a set of revised cause codes that allows the noncompliance data contained in the inspection reports to be transformed into the FPM domain and used to great advantage in performance evaluation.) Part 2.2, which discusses the LER data, sets out how we identified and tested several performance indicators based on the LERs.

2.1 Noncompliance Data

In Section 3.3.3 of our Phase I report (NUREG/CR-0110), we discussed the methodology we employed for analyzing noncompliance data, and presented analytic results for three nuclear power plant licensees--Point Beach Unit 1, Prairie Island Unit 1, and Zion Unit 1. As part of Phase II, we analyzed the noncompliance data for nine additional licensees, hoping to find patterns that would lead us to valid performance indicators based on the noncompliance information. This analysis for all 12 licensees is summarized in Table 1 and is discussed here.

766 File Data

The 766 File is a computerized data inventory that includes information on noncompliances and enforcement actions. It is primarily a management tool that tracks the conduct of the inspection process by logging time spent by inspection module, whether modules have been "closed" (work on the module completed), and noncompliances generated under each module. The 766 S (Statistical Data Supplement) portion of the file contains, among other items, a brief text of the cited noncompliance and a cause code that is intended to reflect the reason the noncompliance occurred.

The 766 file was not set up for use in performance evaluation, but it is much more feasible to use computerized data than to use hard copy reports in evaluating licensee performance. To evaluate licensees fairly and with insight into the reasons for performance, it is essential that each entry in the 766 File (a) be internally consistent, and (b) accurately reflect the information in the corresponding inspection report. We therefore examined the 766 File entries for 1976-1977 for the original three and nine additional licensees and compared them with the texts of the corresponding inspection reports to determine:

1) Whether the 766 File cause code assigned to each noncompliance appropriately reflected the File enforcement text, and
2) Whether the 766 File cause code was consistent with the description of the noncompliance in the inspection report.

The results of these comparisons are shown in rows 2 and 3 of Table 1.

Teknekron believes that the definition of the cause codes is the major cause of internal inconsistencies in the 766 File data. Some codes are ambiguous; others overlap (see Section 4 for further discussion). As a result, inspectors may code similar noncompliances in different ways. This makes it extremely difficult to use the existing 766 File cause codes in our analytic methodology, and limits the insight the cause codes may provide into the character of licensee performance. This factor was basic to our Phase II analytic approach to noncompliance data described in Section 4 of this report.

The Way in Which Noncompliances are Detected

Most noncompliances are detected directly by the NRC inspector as he observes activities and situations, as he audits licensee records, and tours the facility.

TABLE 1

NONCOMPLIANCE DATA FOR 12 LICENSEES

	POINT BEACH UNIT 1	PRAIRIE ISLAND UNIT 1	ZION UNIT 1	SURRY UNIT 1	SAN ONOFRE UNIT 1	TROJAN UNIT 1
TOTAL NONCOMPLIANCES*	16	18	68	37	10	17
DISAGREEMENT/AMBIGUITY BETWEEN IAE INSPECTION REPORT AND 766 FILE NON-COMPLIANCE CAUSE CODE	12%	20%	9%	31%	0%	12%
DISAGREEMENT/AMBIGUITY BETWEEN 766 FILE NONCOMPLIANCE CAUSE CODE AND 766 FILE ENFORCEMENT TEXT	44%	17%	47%	43%	50%	24%
NONCOMPLIANCES ASSOCIATED WITH INSPECTOR CUES (AS PERCENT OF TOTAL NONCOMPLIANCES)						
4a. LERs	0%	17%	32%	5%	0%	6%
4b. LICENSEE IDENTIFIED ITEMS	12%	11%	20%	16%	20%	59%
4c. TOTAL	12%	28%	52%	21%	20%	65%
NONCOMPLIANCE REMEDIES (AS PERCENT OF TOTAL NONCOMPLIANCES) SUGGESTED BY LICENSEES IN:						
5a. INSPECTION REPORT	36%	45%	50%	29%	0%	47%
5b. FOLLOWUP LETTER	' 5	33%	21%	71%	90%	12%
LICENSEE ACTION ON PREVIOUSLY IDENTIFIED ENFORCEMENT ITEMS	ALWAY' .iPLETE	COMPLETE (1 EXCEPTION)	DEFICIENT IN ONE OR MORE ITEMS 70% OF THE TIME THIS WAS REVIEWED BY INSP.	DEFICIENT IN ONE OR MORE ITEMS 29% OF THE TIME THIS WAS REVIEWED BY INSP.	COMPLETE (1 EXCEPTION)	DEFICIENT IN ONE OR MORE ITEMS 50% OF THE TIME THIS WAS REVIEWED BY THE INSP.
REPEAT NONCOMPL...CES	0	0	5 (IN 1976)	8	0	0
SERIOUS EVENTS DUE TO HUMAN ERROR	0	0	1	0	0	0

	ROBINSON UNIT 2	QUAD CITIES UNIT 2	DUANE ARNOLD UNIT 1	ARKANSAS UNIT 1	MILLSTONE UNIT 1	FORT CALHOUN UNIT 1
TOTAL NONCOMPLIANCES*	29	42	59	32	41	32
DISAGREEMENT/AMBIGUITY BETWEEN IAE INSPECTION REPORT AND 766 FILE NON-COMPLIANCE CAUSE CODE	27%	17%	19%	0%	34%	10%
DISAGREEMENT/AMBIGUITY BETWEEN 766 FILE NONCOMPLIANCE CAUSE CODE AND 766 FILE ENFORCEMENT TEXT	28%	33%	29%	0%	48%	7%
NONCOMPLIANCES ASSOCIATED WITH INSPECTOR CUES (AS PERCENT OF TOTAL NONCOMPLIANCES)						
4a. LERs	3%	15%	12%	0%	17%	0%
4b. LICENSEE IDENTIFIED ITEMS	7%	12%	9%	6%	7%	0%
4c. TOTAL	10%	27%	21%	6%	24%	0%
NONCOMPLIANCE REMEDIES (AS PERCENT OF TOTAL NONCOMPLIANCES) SUGGESTED BY LICENSEES IN:						
5a. INSPECTION REPORT	3%	51%	11%	16%	24%	0%
5b. FOLLOWUP LETTER	97%	49%	80%	53%	56%	81%
LICENSEE ACTION ON PREVIOUSLY IDENTIFIED ENFORCEMENT ITEMS	COMPLETE (1 EXCEPTION)	COMPLETE (1 EXCEPTION)	DEFICIENT IN ONE OR MORE ITEMS 64% OF THE TIME THIS WAS REVIEWED BY THE INSP.	DEFICIENT IN ONE OR MORE ITEMS 50% OF THE TIMES THIS WAS REVIEWED BY THE INSP.	COMPLETE (1 EXCEPTION)	DEFICIENT IN ONE OR MORE ITEMS 50% OF THE TIME THIS WAS REVIEWED BY THE INSP.
REPEAT NONCOMPL...CES	12	0	1	0	3	0%
SERIOUS EVENTS DUE TO HUMAN ERROR	0	0	2	0	1	0%

*...CLUDING NONCOMPLIANCES RELATED TO PHYSICAL PROTECTION

POOR ORIGINAL

1079 148

In some instances, however, an inspector may be alerted by the licensee to the occurrence of a noncompliance. This may happen in either of two ways:

1) The licensee informs the inspector that a new program or procedure has been instituted. The inspector checks the appropriateness or application of the program or procedure, and discovers a noncompliance.*

2) The noncompliance is identified by the inspector as a result of his investigative followup of a licensee event report (LER).

The fact that licensees volunteer information that may lead to a citation for noncompliance reflects well on the implementation of the inspection program and the generally constructive relationship between NRC and the licensees.

In our Phase I report, noncompliances of which the inspector became aware through the licensee were termed "cued". Line 4 of Table 1 shows the degree to which cues contributed to noncompliance citations. The numbers in line 4c ("Total") are cued citations as a percentage of the total numbers of citations shown in line 1 of the table. For Fort Calhoun Unit 1, this percentage appears as zero, meaning that all of the 32 cited noncompliances were identified by the inspector(s) alone without any prior information supplied by the licensee. In the other eleven cases, however, licensee cues played some role, although the magnitude of this role varies considerably. The range extends from a low of 6% to the quite high value of 65%, with an average (for the eleven) of 26%. The numbers in lines 4a and 4b of Table 1 show the breakdown of noncompliances due to items the licensee mentioned to the inspector and those due to inspector followup on LERs.

Noncompliance Remedies Proposed by Licensee

When a noncompliance is detected by the inspector, the licensee will generally propose some action designed to prevent its recurrence. Further, he will

* These are not licensee identified noncompliances, but noncompliances identified by the inspector when checking an area he would not have investigated if the licenee had failed to mention the item.

receive a letter from the NRC Regional Office notifying him of the nature of the noncompliance and of any enforcement action that may be taken, and, if he has not already done so, requiring that he set forth his proposed remedy in a followup letter. In our analysis, we determined separately the proposed actions identified in the inspection reports and in licensees' followup letters as percentages of the total number of noncompliances cited for each licensee. These results are listed in lines 5a and 5b of Table 1. These percentages may not always total 100%, primarily because a licensee may not be required to prepare and submit followup letters in all cases. If I&E determines that a noncompliance is relatively trivial or that it does not reflect a chronic problem, and if I&E is satisfied that appropriate corrective steps have been taken, the licensee may not need to submit a followup letter.

Licensee Action on Previously Identified Enforcement Items

During some inspection visits, the inspector checks on the licensees' implementation of the remedies he proposed to correct previously cited noncompliances. If the inspector determines that the licensee has dealt with a particular noncompliance satisfactorily, the item is regarded as "closed" and is so described in his report. If the inspector is not satisfied with the licensee's action, the item is considered "open" and it remains the licensee's obligation to take appropriate corrective steps. NRC requires that all noncompliance items be corrected.

The remedial action record of a licensee provides one viewpoint on the timeliness of his regulatory behavior. As line 6 of Table 1 shows, six of the twelve licensees had excellent records; they had completed (totally or with only one exception) all of their proposed remedial actions in a timely manner. The other six licensees were less prompt in taking remedial action.

Number of Repeat Noncompliances

The number of repeat noncompliances cited in an appropriate time interval (one to two years) has the potential to provide valuable insight into a licensee's willingness and capability for self-improvement in areas where regulatory performance weaknesses had been identified.* Unfortunately, repeat noncompliance data are currently difficult to use for two reasons:

1) It was not until November 1977 that the 766 forms, from which the 766 File data are encoded, were modified to include information on repeat noncompliances. Before November 1977, this information was sometimes provided in the inspection reports.

2) The instructions to be followed by the inspectors in entering the information into the 766 forms are imprecise. For example, the term "repeated noncompliance" is ambiguously defined. Inspectors interpret the term differently, so that the specific meaning of "repeat" as coded in the 766 File is unknown.

NRC is now in the process of defining "repeat noncompliance" more precisely so this data may soon be highly useful. To the extent that the data made possible, we determined the numbers of repeat noncompliances for the twelve licensees. The numbers of repeat noncompliances are shown in line 7 of Table 1. These figures are the total of noncompliances flagged in the 766 File as repeats, and those so mentioned in the inspection reports, excluding any duplication.

Serious Events Due to Human Error

"Serious events" are unscheduled happenings within the facility that pose identifiable threats to health or safety, whether or not these threats are actually realized. Such events are reported to NRC in Licensee Event Reports (LERs) and are discussed in inspection reports even though a noncompliance may not have been involved. These are events that no one would place in the

---

* The number of repeat noncompliances over a time interval may appear to be analogous to the number of causally linked events in a series, as determined through LER content analysis. However, they cannot be interpreted in equivalent terms, because the LER analysis provides a pattern that changes over time while repetitive noncompliance numbers are meaningful only in the aggregate.

1079 151

"grey area" of licensee event reporting and that NRC would uniformly consider a threat to health or safety.

In our analysis, we determined the total number of serious events for each licensee reviewed for 1976-1977. We looked for events that were serious and that met these other criteria as well:

1) The event was caused by human error rather than component failure or some other cause that did not appear to be within the control of the licensee.

2) Although a serious event need not necessarily stem from or result in a noncompliance, we counted only those events in which a non-compliance was directly involved. This ensured that the events were significant in terms of the regulatory performance of the licensee.

It is obvious that the occurrence of serious events which the licensee had the power to prevent is in itself a clear indicator of unfavorable safety-related performance. But the absence of such events does not necessarily imply that a facility poses a low risk. This interpretation may be valid for some licensees (those licensees known, on the basis of independent data, to maintain good management and personnel performance), but in other cases it could mean simply that the licensee was lucky -- the potential for the occurrence of a serious event appeared to be relatively high, but such an event had not actually materialized during the period reviewed. Thus, while the occurrence of serious events is an adverse performance indicator, their absence does not in itself demonstrate "good" performance.

Line 8 of Table 1 shows the number of serious events that were associated with detected noncompliances for each licensee. In the cases of nine licensees, no serious events were recorded during 1976 and 1977. The other three licensees each experienced one to three events. None of these three is considered to be one of the "better" performers.

2.2 Licensee Event Report Data

Brief Review of Phase I and Introduction to Phase II

In Phase I we identified the LER data as relevant and valuable in evaluating performance using the FPM model, and we developed a way to relate the ultimate responsibility for an unscheduled event (LER) to the appropriate FPM model element.

Transforming the LER data for each case study into the FPM domain required organizing each event in chronological order within the plant system in which the event occurred. Then we reviewed the description of each event, first by itself, and then in relation to previous events within the same plant system. Based on this review, an appropriate Event Responsibility Code (ERC) was assigned to the event. One of the most significant results of this effort was the development of the concept of "causally linked events," the inferred association of events within systems, and the association of these linked events with systematic defects in the performance of facility management or personnel.

We displayed the results of this analysis as graphic "profiles" which showed the ultimate responsibility for each event and when it occurred. We constructed two types of profiles. System profiles showed the ERC and time of occurrence for each event within a plant system and identified those events that were causally linked. The second type of profile showed the number of events for all plant systems as a function of time. Displaying the LER data over time allowed us to see changes in performance over the study period, an important dimension of performance evaluation.

After completing Phase I, we had the opportunity to discuss our methodology with members of I&E's Performance Appraisal Team (PAT). They made valuable suggestions, one of which was that identification of causally linked events within plant systems did not rule out defective performance in other plant systems.

1079 153

They suggested we produce a profile showing the number of causally linked events for all systems as a function of time. This suggestion led us to discard the individual system profiles identifying causally linked events in favor of a profile of causally linked events for all plant systems. These profiles of total causally linked events are included in each of the twelve case studies.

The Phase II Work

Our first activity in Phase II was to complete nine additional case studies. This substantially larger data base permitted us to identify and test potential performance indicators based on the LER data.

When we developed the profiles of total causally linked events for each licensee studied as suggested by the PAT Team, there appeared to be significant differences between those of the "better" and "poorer" performers* both in terms of:

- the numbers of events in a set of causally linked events and the duration of that set, and
- total numbers of causally linked events occurring over the two-year study period.

We eventually found that causally linked event sets reflect the extremes of performance in a given time period; these extremes permit NRC to assess whether a licensee has violated a "threshold" of acceptable performance. We also found that the total number of causally linked events in the two year case study period can be used to identify those performance thresholds by bounding the noise levels of acceptable performance. Total numbers of causally linked events, by integrating the event sets, provide an overall background performance level against which the impact of the extremes can be assessed. The next part discusses each of these performance indicators more fully, and describes how we tested their validity and sensitivity.

*Part 1.3 details how we made this "working" classification.

1079 154

Total Number of Causally Linked Events

Table 2 shows the total number of causally linked events in 1976 and 1977 for each licensee studied. As stated in Section 1.3, we used the Wilcoxon-Mann-Whitney procedure, a distribution free-rank-sum test, to see whether the total number of causally linked events (TNE-Total Number of Events) is a valid indicator of performance. The Mann-Whitney test shows the level of confidence at which the means of the TNEs of the better and poorer performers differ by a statistically significant amount. The mean TNE of the better performers is 7; the mean TNE of the poorer performers is 53. The rank sum test shows that the mean TNEs for the better and poorer performers differ by a statistically significant amount at the 95% level of confidence. In other words, we are 95% sure that the difference between the means of the total number of linked events for the two groups is not due to chance. Consequently, we can say that the total number of causally linked events sustained by a licensee over a given period is a vlid indicator of general "background" performance quality, capable of distinguishing better from poorer performers. It is an indicator that flows logically and observably from the case study profiles and can be expressed as a numerical indicator that is statistically valid with a very high degree of confidence.

The TNE "background" indicator thus helps set threshholds of acceptable performance. But this threshold is not a hard line; it is a band described by the "noise level" of performance. The "noise level" is essentially the mean number of causally linked events per month. For the poorer performers this mean is 53 events/24 months, or 2.2 causally linked events per month; and for the better performers, the "noise level" is 7 events/ 24 months, or .3 causally linked events per month.

It is obvious from these numbers that the noise level of the better performers is so low that nearly all events are caused by random personnel or management errors or component failure. The noise level of the poorer performers is

1079 155

TABLE 2

TOTAL NUMBER OF CAUSALLY LINKED EVENTS

(1976 and 1977)

Poorer Performers	Number of Causally Linked Events
Duane Arnold Unit 1	74
Zion Unit 1	54
Millstone Unit 1	32
Better Performers	
Quad Cities Unit 1	15
Arkansas Unit 1	12
Surry Unit 1	11
Trojan Unit 1	9
Prairie Island Unit 1	7
Fort Calhoun Unit 1	6
Robinson Unit 2	4
Point Beach Unit 1	2
San Onofre Unit 1	0

significantly higher. But what of the better performer who has two, three or even more linked events in a month (or an average of that magnitude over a few months)? Has he become a poorer performer because he has fallen temporarily into the noise level of the poorer performer? Whether these temporary overlaps are significant can be assessed by examining the extremes of performance of each group. Extremes are demonstrated by the sets of causally linked events.

Causally Linked Event Sets

Sets of causally linked events occur in plant systems and they result from systematic defects in performance: plant management and personnel may fail or be unable to identify the underlying causes of events, or they may fail or be unable to successfully implement a generic "fix" once the underlying cause is identified. Three parameters characterize sets of causally linked events:

- the number of events in the set,
- the length of time the set lasted, and
- the mean time between the events in the set.

As we analyzed the LERs for each licensee, we began to suspect that the poorer licensees (based on the occurrence of serious events, as discussed in Section 1.3) had:

- relatively large numbers of events within the event set, and
- a relatively short average time between events in the event set.

Examination of the "LER by System" tables in each case study in the appendix should lead the reader to the same conclusions. We therefore focused our analysis on sets that contained large numbers of events.

1079 157

Table 3 sets out the data we gathered for sets of causally linked events for each licensee. For each plant, we selected those event sets that contained large numbers of events and occurred over a small time span, so that the average time between events was as short as possible. In most cases, Table 3 includes two event sets per licensee. We included both if they were of equal maximum length, if the duration of sets of equal length was different, or if it appeared that the relation between set duration and number of events was ambiguous. We then tested each of the elements in Table 3 for validity and sensitivity.

Average Time Between Events

Our examination of the sets of events led us to suspect that poorer performers might in general have a smaller average time between events (ATBE) than the better performers. To see if this were the case, we calculated the means of the ATBE for the better and poorer performers. The results of these calculations are presented in Table 4. Two means are shown for each performance group, one based on the longest ATBE shown in Table 3 and the other based on the shortest ATBE shown in Table 3. Where only one ATBE appears in Table 3, it was used in calculating the means of both the longest and shortest ATBE.

Table 4 shows that both the long and short mean ATBE for the better performers are greater than the two means for the poorer performers. The ATBEs (long or short) for the poorer performers also vary less than those for the better performers, as evidenced by the fact that σ for the poorer performers varies from 14% to 36% of the mean whereas that of the better performers varies from 58% to 119% of the mean. This may indicate that the better performers could be further categorized, perhaps into "better" and "best" groups.

In order to determine if the difference between the mean ATBE for the better and poorer performers was statistically significant, we performed the Mann-Whitney procedure for each of the four possible combinations of longest and shortest ATBE presented in Table 4. Table 5 shows the results of this analysis. Each cell in the matrix presents the results of comparing the data for a column and row ATBE heading. Table 5 shows that if we compare the short mean ATBE for better performers with the long mean ATBE for the poorer performers, we can say that the two means are significantly different only at the 65% level of confidence. In other words, we can be only 65

TABLE 3

TIME DENSITY OF LARGEST CAUSALLY LINKED EVENT SETS

	Largest Number of Events in Causally Linked Set*	Associated Time Span (Months)	Average Time Between Events (Months)
Poorer Performers			
Zion Unit 1	7	15	2.1
	6	3	0.5
Millstone Unit 1	4	2	0.5
	3	5	1.6
Duane Arnold Unit 1	11	23	2.1
	7	6	0.9
Better Performers			
Prairie Island Unit 1	2	19	9.5
Point Beach Unit 1	1	12	12.0
	1	1	1.0
Fort Calhoun	3	1	0.3
	3	14	4.7
Arkansas Unit 1	4	14	3.5
	3	14	4.7
Trojan Unit 1	4	11	2.7
	1	2	2.0
Quad Cities Unit 1	4	16	4.0
	4	13	3.25
Surry Unit 1	4	11	2.75
	3	3	1.0
H.B. Robinson Unit 2	2	9.5	4.75
	1	0.25	0.25
San Onofre Unit 1	0	0	∞

* Not including events beyond licensee's control due to environmental causes. These appear mainly in the Ultimate Heat Sink System and the Circulating Water System.

1079 159

TABLE 4

MEANS OF THE AVERAGE TIME BETWEEN EVENTS*

	Long ATBE (months)	Short ATBE (months)
Better Performers	5.6 ± 3.3	2.6 ± 3.1
Poorer Performers	1.9 ± .28	.63 ± .23

*Data presented in table as $\overline{X} \pm \sigma$, where σ is calculated using an N-1 weighting.

TABLE 5

SUMMARY OF MANN-WHITNEY PROCEDURE APPLIED TO ATBE DATA(1)

	Poor Performers Long Mean ATBE	Poor Performers Short Mean ATBE
Better Performers Long Mean ATBE	99%	99%
Better Performers Short Mean ATBE	65%	88%

Note

(1) The means of the ATBEs are different and the difference is statistically significant at the indicated levels of confidence. At confidence levels greater than those given in the cells, the means of the ATBEs are not significantly different.

1079 161

percent sure that the difference in these means is not due to chance. At higher levels of confidence, for example at 80 percent, these two means are not significantly different. We have already recognized the fact that poorer preformers are distinguished by the characteristics they do not share with better performers; for this reason, the element of interest is the one which should show the greatest distinction. This element is the degree to which the short mean ATBE for poorer performers can be distinguished from both the long and short means of the better performers. The information shown in the last column in Table 5 ("Poor Performers Short mean ATBE") shows that we can be 88 percent sure that the difference between the short mean ATBE for poorer performers and the short mean ATBE of the better performers is not due to chance; we can be 99 percent confident that the difference between the short mean ATBE for poorer performers and the long mean ATBE for better performers is not due to chance.

We can therefore conclude that ATBE is a performance evaluation indicator that is both meaningful and sensitive in distinguishing a characteristic unique to poorer performers.

Largest Number of Events in a Causal Event Set

As stated earlier, the case studies had led us to suspect that the better performers generally had fewer events in their causally linked event sets than did the poorer performers, possibly because the better performers were both more willing and able to identify fundamental event causes and implement a generic "fix." We called this parameter LNE - the Largest Number of Events in a causally linked event set. Table 3 shows a single LNE for two of the better performers; for these licensees, there were no other useful data to include. For the other ten licensees, we could identify a largest and a second largest LNE. The methodology employed for the construction of Table 3 has been discussed previously.

1079 162

Table 6 shows the maximum mean and minimum mean LNE for the better and poorer performers.* To determine if the differences between these means are statistically significant, we again used the Mann-Whitney procedure on the LNE data in Table 3. The results of this procedure are presented in Table 7, and it is evident that both the mean LNE values for the poorer performers are significantly different from both mean LNE values for the better performers, at very high confidence levels.

On this basis, we can conclude that the LNE is a meaningful and sensitive indicator of performance, allowing long chains of causally linked events to be associated with poorer performance.

<u>Associated Time Span of the LNE</u>

The only remaining indicator in Table 3 is the time span over which a set of causally linked events occurred. This time period, given in months, is measured from the first random event to the last event in the set. It seems logical that the length of time (Associated Time Span-ATS) over which a licensee's LNE (greatest number of events in a causally linked set) occurs would be a valid measure of performance. A better performer should take less time to identify and correct the cause of his LNE.

As is the case with mean time between events, most of the licensees have two associated ATSs. Thus there is a maximum and minimum mean ATS for the better and poorer performers. Table 8 shows these means (where a licensee had only a single ATS, that value is used in both maximum and minimum calculations.)

We used the Mann-Whitney procedure to test whether any or all of the four possible combinations of means in Table 8 differed by a statistically significant amount. The results are shown in Table 9, and it is clear that the short mean ATS for the poorer performer cannot be distinguished from that of the better performers at a meaningful level of confidence. Nor are the long means signficantly different. The value of the short mean ATS for the

*Where only one LNE is shown in Table 3 for a licensee, that LNE was used to calculate both the maximum and minimum means shown in Table 6.

TABLE 6

MAXIMUM AND MINIMUM MEAN LNE*

	Maximum Mean LNE (events)	Minimum Mean LNE (events)
Better Performers	2.7 ± 1.5	2.0 ± 1.3
Poorer Performers	7.3 ± 3.5	5.3 ± 2.1

* Data presented in table as $\overline{X} \pm \sigma$, where σ is calculated using an N-1 weighting.

TABLE 7

SUMMARY OF MANN-WHITNEY PROCEDURE FOR LNE MEANS*

	Better Performers Maximum Mean LNE	Better Performers Minimum Mean LNE
Poorer Performers Maximum Mean LNE	99%	99%
Poorer Performers Minimum Mean LNE	96%	98%

* The means of the LNEs denoted by the matrix cells are different and the difference is statistically significant at the indicated level of confidence.

TABLE 8

MEANS OF SHORT AND LONG ATS FOR BETTER AND POORER PERFORMERS[1]

	ATS (Short)[2]	ATS (Long)
Better Performer	6.6 $\pm$ 7.4	13.3 $\pm$ 3.1
Poorer Performer	3.6 $\pm$ 2.1	14.3 $\pm$ 9.0

Notes:

(1) Data presented in table as $\overline{X} \pm \sigma$, where σ is calculated using an N-1 weighting.

(2) Matrix cells represent mean of the ATS in months.

TABLE 9

SUMMARY OF MANN-WHITNEY PROCEDURE FOR ATS MEANS*

	Short Mean ATS Better Performer	Long Mean ATS Better Performer
Short Mean ATS Poorer Performer	65%	99%
Long Mean ATS Poorer Performer	94%	65%

*The means of the ATSs denoted by the matrix cells are different and the difference statistically significant at the indicated level of confidence.

poorer performers (see Table 8) is 3.6 $\pm$ 2.1 months, and 6.6 $\pm$ 7.4 months for the better performers. The long means are 14.3 $\pm$ 9.0 months and 13.3 $\pm$ 3.0 months respectively. The "overlap" of these means when taken together with their standard deviations further supports the low confidence level (65%) and shows that the difference in the means is probably due to chance. We would intuitively expect the short ATS for the better performers to be very different from the long ATS for the poorer performers, since this should give the greatest "split" in the reaction time; Table 9 shows that this is the case at a 94 percent confidence level. But the 99 percent confidence that the short mean of the poorer performers is significantly different than the long mean of the better performers seems unreasonable. Table 8 and 9, when studied together, suggest that the periods of both quickest and slowest response to the limiting LNE for each group is approximately the same over our case study population. But while response times may be similar, it is essential to remember that the number of events occurring in that time is very different; the mean LNE values for the better and poorer performers were significantly different and the difference was statistically significant.

Since the result of the analysis of the ATS does not support what seems a logical distinction, it is important to determine why this is so. Table 3 was developed on the basis of first identifying those causally linked event sets which had the largest number of events and then identifying the associated time span for the particular event set. The event sets that were selected for display in Table 3 were those which:

- first, had the largest number of events and,
- second, had associated time spans that would, when divided by the number of events, produce the shortest ATBE for each case study.

Consequently, the ATS is a dependent variable, and for this reason can be expected to be a less sensitive indicator in the context of this analysis.

Thus, the ATS parameter developed in the context of this work and presented in Table 3 does not appear to be a useful performance evaluation indicator, and will not be treated further in this report.

1079 168

Conclusion

The key conclusions resulting from the analyses presented in this section are:

a) The total number of all causally linked events exhibited by a licensee within an appreciable time period (such as two years) is significant as an independent indicator of performance quality. This number is lower for better than for poorer performers.

b) The largest number of causally linked events in a single chain exhibited by a licensee in an appreciable time period (such as two years) is significant as an independent indicator of performance quality. This number is lower for better than for poorer performers.

c) The average time between events within a given causal chain is significant as an independent indicator of performance quality. This value is smaller for poorer than for better performers.

d) The length of the time span associated with the causally linked events in a given chain is not significant as an independent indicator of licensee performance. It is meaningful only in relation to the number of events comprising that chain. This relationship, however, is implicit in the average time between events.

3. USING LER PERFORMANCE INDICATORS

This section describes how we used the LER performance indicators discussed in Part 2.2 to devise a readily usable way to distinguish between "better" and "Poorer" licensees. We begin, in part 3.1, with a brief review of the type of information the LERs can provide. In part 3.2, we discuss how and why we classified the 12 case study licensees as "better" or "poorer." This topic was mentioned in Section 1, but the treatment here is more complete. The classification into better and poorer performance groups allowed us to test the LER performance indicators for validity, as described in Section 2. These valid indicators are used to create graphs that define a space of acceptable performance, and this is discussed in part 3.3. Part 3.4 covers two issues that could affect the usefulness of LERs as a source of data for use with the FPM model and methodology.

3.1 LERs Display the "Real Time" Actions of the Licensee

Each of NRC's licensees must, by law, report happenings that are unscheduled or are outside the bounds of his technical specifications and license conditions. As discussed in the Phase I Report, these Licensee Event Reports (LERs) are potential source of information on a licensee's performance

Several factors contribute to the LERs' relevance when used with the FPM model. First, an LER describes a real occurrence and how the licensee reacted to that occurrence. This reaction, as revealed in each LER event and cause description, is clearly a component of performance. The LERs provide "snapshots" of a licensee's reaction to real situations.

Fortunately, more than static single pictures can be gained through analyzing a licensee's LERs. A nuclear plant is a collection of systems, each with a specific role in the ongoing safe operation of the facility. The events described in LERs occur within these systems, and this common point of origin makes it possible to seek a pattern in the licensee's response to particular areas of plant operation. Furthermore, since LERs can easily be placed in chronological order within systems, that pattern can be examined for changes over time.

Events within a system may be random or they may be linked: they may involve similar components, similar subsystems, or similar human responses. Events related in one or more of these ways are causally linked. Causally linked events are more likely to be non-random and to involve a human failure* to identify and rectify the fundamental cause of the events.

It is intuitively clear that a long chain of causally linked events indicates some degree of human failure:

- The licensee has failed to see the connection between the events;
- The licensee sees a superficial connection but has not searched for a root cause;
- The licensee sees the cause but does not act to solve the problem.

Conversely, the absence of long chains of causally linked events means that the events that occurred were generally random or that the licensee had the awareness and will to prevent their recurrence. This is borne out in the twelve case studies presented in the Appendix.

In Phase I, we searched for causally linked events at the system level. To remain comparable with the first three case studies, the nine case studies performed in Phase II also were done on this basis. But in a number of these case studies, we began to notice that chains of highly similar events (particularly involving identical components or similar components manufactured by the same company) occurred in several systems. This "cross-system linkage," as well as suggestions by NRC PAT members, led us to examine the total number of causally linked events for each licensee, and this broader view proved fruitful.

---

*Long chains of events in such systems as the Circulating Water System and Ultimate Heat Sink Systems are only within the licensee's control to the extent that they can be ended through redesign.

3.2 How and Why We Classified Licensees Into Performance Groups

A major purpose of licensee performance evaluation is to enable I&E to use its resources with maximum effect: licensees thought to present higher risks to health and safety can be targeted for more intensive surveillance. But what constitutes - and how does one measure - "higher risk?" Obviously, the concept has meaning only in reference to some dividing line or threshold separating the licensees into smaller risk and greater risk categories.

We began to consider how to establish such a dividing line early in Phase II but did little until the data from all twelve case studies had been analyzed. Any criteria used to categorize licensees, to be logical and statistically supportable, depend on the distribution of the licensee sample population. For example, assume that the performance quality of sample members differs by relatively small gradations so that one sees an essentially continuous behavioral spectrum. In this case, the definition of a threshold is largely judgmental and semi-arbitrary in character. On the other hand, an obvious and identifiable gap in the spectrum might provide I&E with a threshold that could identify those licensees requiring more attention.

When the 12 case studies were complete, we began to seek an objective basis for establishing a higher/lower risk threshold. The reader should keep in mind that the findings and results of this report are based only on data associated with the 12 case studies, not on the entire power reactor licensee population. However, 12 licensees represent 20 percent of the population and our results were sufficiently definitive to imply a high order of credibility, and also to suggest that it could be highly useful and informative to test the methodology on on the balance of the operating reactor population.

The search for a performance threshold had two basic themes:

1. The Expected Character of a Possible Gap in the Performance Spectrum. Because the LER data had provided more useful information than the computerized noncompliance data, we felt that if a gap in the safety-related performance spectrum existed, it should, if it were to provide a useful threshold, be identifiable through the analysis of LER data.

1079 172

Section 2 showed that the LER data had several aspects. We did not assume that a gap would necessarily appear in all such aspects, but, if the gap were significant, it should appear in at least some parameters that were diagnostically important. In other words, we hoped to find a gap related to higher risk that could be measured by some key indicators, but we also expected that some overlap would exist. We believed, and hoped to be able to prove, that the significance of the gap would in no way be minimized by some degree of overlap between the categories.

2. The Need for an Independent Criterion.

In searching for the existence of a performance gap, it was clear that there would be real advantage in identifying licensees presenting relatively high risks on the basis of some criterion wholly independent of the LER-based evaluation. Separating the groups by a non-LER criterion would let us test to what extent the LER results confirmed the existence of a threshold that supported the categorization. The noncompliance data for the twelve case studies suggested that we could categorize licensees in terms of presented risk on the basis of whether, during the case study period, they had experienced a serious event threatening health and safety. The occurrence of such an event would place a licensee in the higher risk category, using the rationale that the risk had already been demonstrated, and was not merely probable.

We carefully reviewed the 1976-1977 inspection reports (not the 766 File data) for each of the twelve licensees in order to identify serious events that were clearly attributable to human cause (not beyond licensee control). To assure that NRC considered the events to be serious, we recorded only events that were also cited as noncompliances. Three of the licensees--Duane Arnold, Zion and Millstone--were found to have experienced six events in six reactor-years of operation that were considered serious from a regulatory standpoint. These events, which included such occurrences as inadvertent criticality and radiation exposure, are described in the case studies in the Appendix. Apparently, I&E took quite a serious view of these events since all of them resulted in noncompliance citations which were cited as violations, and the agency imposed civil penalties on two of the licensees for these events. In

1079 173

contrast, the other nine licensees had experienced no serious events in eighteen reactor-years of operation.

Purely on the basis of their positive or negative serious event records, the licensees were categorized into two groups, which were termed "better" and "poorer." The "better" licensees, whose 24-month records were free of serious regulatory events, were:

San Onofre Unit 1
Point Beach Unit 1
Surry Unit 1
Prairie Island Unit 1
Trojan Unit 1
Robinson Unit 2
Quad Cities Unit 2
Arkansas Unit 1
Fort Calhoun Unit 2

The remaining three licensees, who experienced a total of six serious regulatory events, were:

Zion Unit 1
Millstone Unit 1
Duane Arnold Unit 1

This categorization did not in itself establish the existence of a gap in the spectrum of overall licensee performance: it identified two licensee classes whose performances were then compared (on the basis of LER data) in order to determine whether the performance differences were sufficiently large to demonstrate that a gap in fact existed.

We analyzed these performance differences as described in Section 2 of this report. We found that the gap between the two categories was most clearly defined by the aggregate numbers of causally linked events each licensee experienced during 1976-1977. In the case of other performance indicators, such as the average time between causally linked events in a set, we could still demonstrate that a gap existed, but with some areas of overlap between the groups. However, we had expected to find overlaps in some performance indicators.

1079 174

Categorizing these twelve licensees as better or poorer should not be interpreted as implying that the poorer performers are all equally poor, or that the better performers are all equally good. In fact, the LER data show that this is not the case. What can be stated definitively is that the "better" performers as a class differ less among themselves than they do from the poorer performers as a class, and conversely. It is precisely because of this fact that a gap in the licensee performance spectrum can be demonstrated.

3.3 Using the LER Performance Indicators to Define a "Performance Space"

In Section 2, we tested the performance indicators that resulted from analyzing the LER data using the FPM model and methodology. These indicators are:

- The total number of causally linked events (TNE) that occurred in the study period.
- The average time between events (ATBE) for the longest set of causally linked events
- The largest number of events (LNE) in a causally linked event set.

The analysis in Section 2 showed that we can be highly confident that the mean values of each of these indicators for the better and poorer performers differ by an amount that is not due to chance: these differences indicate that a real gap in performance exists.

Table 10 is a summary of the mean and standard deviation of these indicators for the case study population. The mean values for the better and poorer performers are clearly different. However, the σ range ($\overline{X} \pm \sigma$) shows the performance "overlap" for ATBE and LNE. No overlap is associated with TNE.

1079 175

TABLE 10

SUMMARY OF LER PERFORMANCE INDICATORS FOR THE SAMPLE POPULATION

Indicator	Better Performers			Poorer Performers		
	$\overline{X}$	σ	σ_1 range	$\overline{X}$	σ	σ_1 range
TNE	7.3	5.0	2.3-12.3	53.3	21	32.3-74.3
TNE per month (events/month)	0.30	0.20	0.1- .5	2.2	0.875	1.3- 3.09
ATBE (months)[a]	5.[illegible]	3.3	2.3-8.9	1.9	0.28	1.62-2.18
	2.6	3.1	0.5-5.7	0.63	0.23	0.4 -0.86
LNE (events)[a]	2.7	1.5	1.2-4.2	7.3	3.5	3.8-10.8
	2.0	1.3	.7-3.3	5.3	2.1	3.2-7.4

Notes:

a) Two sets of parameters provided when "maximum" and "minimum" means were needed for the analysis.

b) The σ_1 range is $\overline{X} \pm \sigma$.

The TNE - total number of causally linked events over the study period - is a time-integrated result of performance and for this reason the influence of transient performance "peaks" (as described by the indicators in Table 10 that show an "overlap" between the better and poorer performers) does not obscure the difference between these two performance groups. It is this quality of permitting an unambiguous distinction to be drawn between the two performance groups that makes the TNE a valuable performance indicator.

The TNE, an end product performance indicator by itself, can be expressed as the summation of the products of the number of causally linked events in an event set and the frequency of occurrence of that size event set:

$$TNE = \sum_{n=1}^{LNE} n \cdot f_n$$

where: n = number of events in set, after the first

f = the frequency with which set of size n occurs

LNE = the number of events in the largest set, excluding the first event.

Figure 2 displays these data for each of the case study plants for 1976 and 1977. If we define an area on Figure 2 that excludes only points belonging to the three licensees that had serious regulatory events, then the space outside the shaded area* is a performance space inhabited by the poorer performers alone. The shaded area is inhabited by both the better and the poorer performers. This suggest that the poorer performers share some attributes with better performers. But it is the attributes that the better performer does not share with the poorer performer that permit the latter to be distinguished from the former.

Thus Figure 2 is a device created by means of a heuristic model which, when used with historical data, permits the empirical definition of a performance space. This space defines two areas:

*The boundary of the shaded area shown on Figure 2 is obviously not the only boundary that could be established and still exclude only the poorer performers. But the existence of some such boundary is supported at the 95 percent confidence level, since it is at that level that the difference between the mean TNE for better and poorer performers is statistically significant.

1079 177

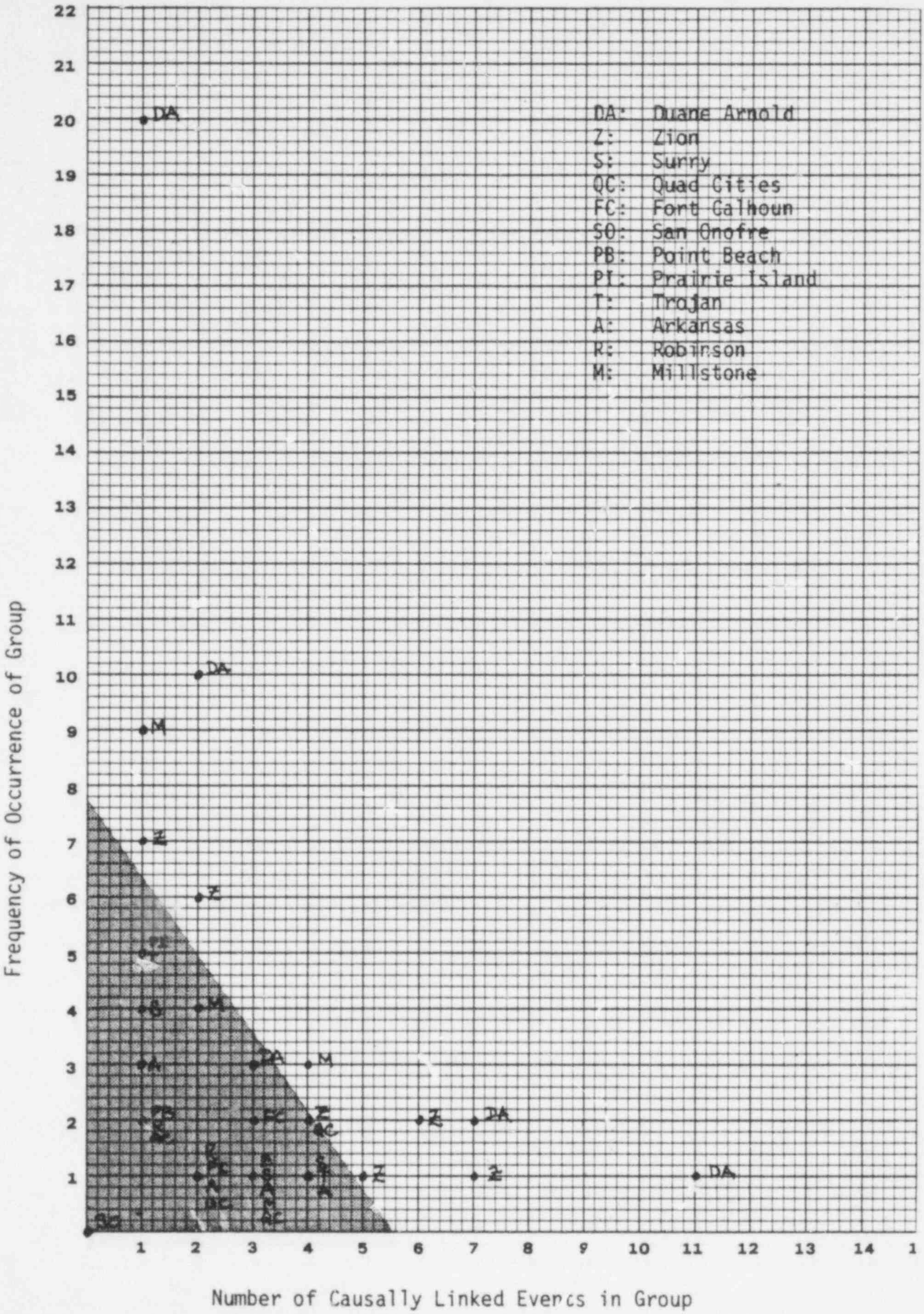


FIGURE 2

ELEMENTS OF TNE

1079 178

- one which is inhabited largely by better performers who, at least for this sample population, had no serious events in 18 reactor-years of operation, and
- one which is inhabited only by poorer performers who, in this sample, had six events in six reactor-years of operation.

In principle, Figure 2 is analogous to a tensile test diagram in mechanical engineering, which represents the relation between a load (P) and the extension (δ) of the specimen under test. The tensile test diagram provides important observable characteristics such as yield point, ultimate strength, and the amount of plastic elongation that can be obtained. Note that these basic data are derived from direct measurement rather than from any analytic process, so that these data are wholly empirical. The data, while uniquely derived from a particular test specimen (or group) can be applied in analyzing the performance of other structural shapes with similar material and treatment history.

It is possible to use the TNE indicator to review both the "overall" performance at the end of a 12 or 24 month period as well as use the "TNE per month" to assess the average rate of causally linked event occurrence on a continual basis. Portraying TNE in terms of its elements, as in Figure 2, permits an insight into whether the licensee's performance is characterized by long chains of causally linked events, excessive numbers of short causally linked event chains, or some combination of these.

Since TNE, TNE per month, and Figure 2 are based on the time integrated results of performance, they provide a sensitive assessment of "steady state" performance but offer no mechanism for analyzing "transient" performance. Transient performance is the occurrence of a set of causally linked events (or two or more sets close together in time) which results in a TNE per month (or for the time period in question) that either falls in the TNE per month range of the poorer performers or falls between the upper limit of the better performers and the lower limit of the "poorer" performers (these TNE per month ranges are shown in the σ_1 range columns in Table 10).

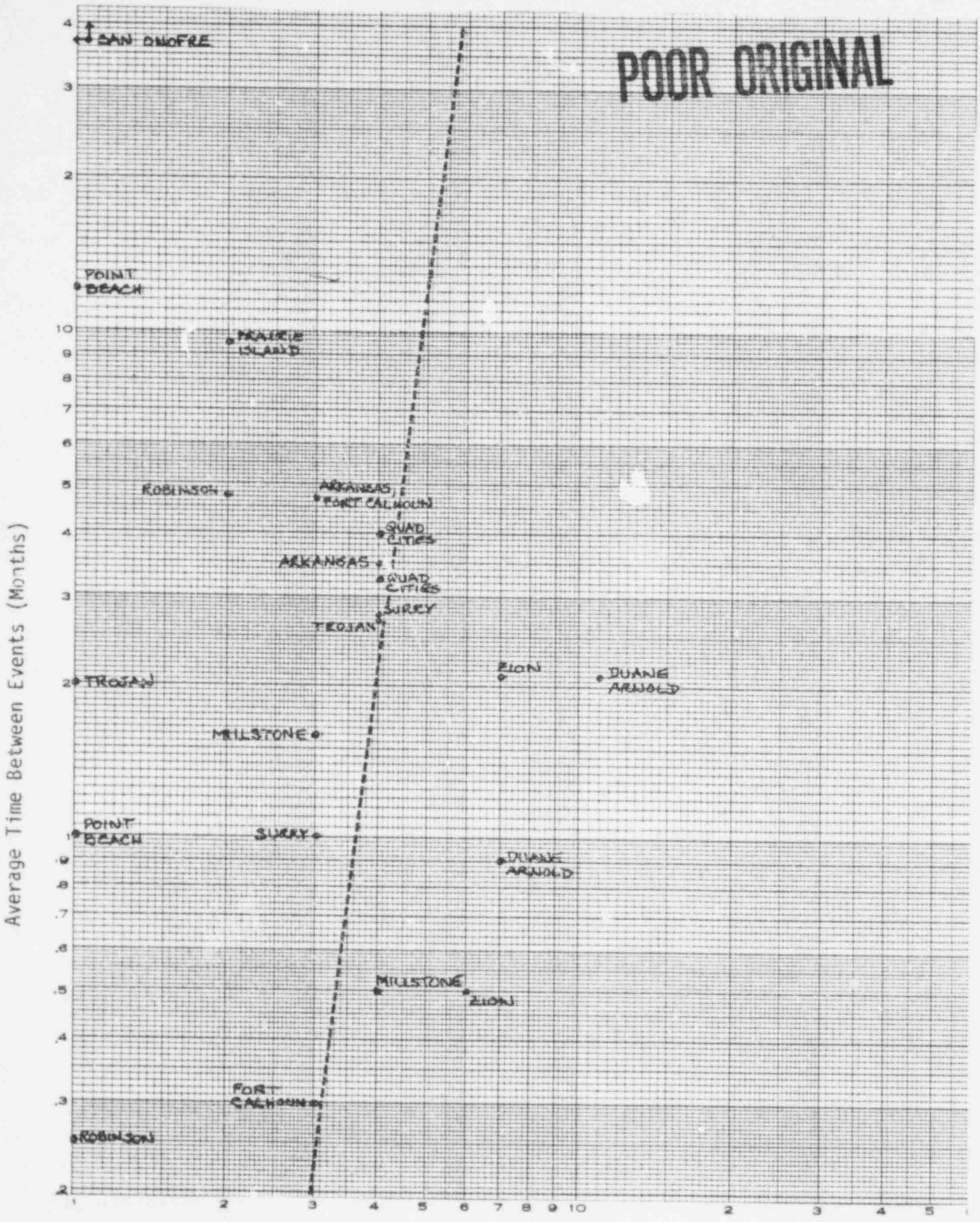
A review of Table 3 in Section 2 indicates that a "better" performer could have a causally linked event set which on the basis of the LNE alone might indicate a "better" licensee in the process of transit to the "poorer" performance category. To assess this transient performance condition we can use the performance indicators ATBE and LNE. The Wilcoxon-Mann-Whitney rank sum test showed these indicators are valid at a high level of confidence.

Table 10 shows that the σ_1 ranges of ATBE and LNE for the better and poorer performers overlap somewhat, blurring the distinction between the performance groups. However, if we plot ATBE as a function of its related LNE to produce Figure 3, the statistical overlap disappears. By drawing a line, we can define an area on Figure 3 that contains only points belonging to the poorer performers.* (The line shown represents the "worst" performance of the better performers.) The fact that both ATBE and LNE are valid indicators of performance at high confidence levels (in excess of 95% for LNE and 88% for ATBE) is a measure of the significance of this performance threshold.

Figure 3 complements Figure 2 by providing a measure of the significance of a licensee's transient performance. Figure 2 reflects the integrated results of performance over a 24 month period, but it does not provide any insight into the rate at which these event sets accumulated. We would expect, on the basis of simple logic, that poorer performers would have a shorter ATBE for a given number of causally linked events than the better performers. For example, during the study period, Millstone Unit 1 had three sets of four causally linked events, while Zion Unit 1 and Quad Cities Unit 1 each had two sets of four event sets and Surry Unit 1, Trojan and Arkansas Unit 1 each had one set. The ATBEs associated with the event sets for each of these facilities are presented in Table 11. A review of this table shows the ATBEs for one event set at Zion Unit 1 and one event set at Millstone Unit 1 to be smaller than the threshold value of 2.75 months between events for a set of four causally linked events. This value is shown on Figure 3 by the

---

*The fact that Millstone has a point in the performance space inhabited by better performers is consistent with the observation made for Figure 2: better and poorer performers have some common attributes, but the attributes they do not share makes it possible to distinguish them.



Largest Number of Events in Set

FIGURE 3

LNE and ATBE

position of Surry. The remaining event sets for the other facilities had longer ATBEs. Thus, of the three event sets at Millstone Unit 1, one could have provided a clue that the facility was a poorer performer. Of the two event sets at Zion Unit 1, one would have provided an indication of poorer performance. It is interesting to note the similarity in ATBEs for the better and poorer performers, but there is no instance, at least in this sample of twelve licensees, where a better performer would have crossed the threshold.

Thus Figure 3 provides a mechanism for the "real time" interpretation of transient peaks in performance.

3.4 Two Concerns about LERs

Some of the NRC comments on our Phase I report centered on two issues: how technical specification stringency may influence the number of LERs a licensee files, and how faithfully the licensees adhere to the requirements of Regulatory Guide 1.16 - in other words, how well they report. These issues must be settled, since the use of the FPM model thus far has depended primarily on the LER data.

The Influence of Technical Specifications

Some NRC staff members feel that the quantity of LERs occurring in a licensed facility is heavily influenced by the stringency and number of the technical specifications. Consequently, they feel that using LER data to measure differences in performance between facilities is more a measure of differences in technical specification severity than any other factor. The FPM model and methodology do not depend on, or use directly, the number of LERs or noncompliances a licensee sustains; we began by using the content of LERs and noncompliances. Numbers of causally linked LERs did turn out to be a valid performance indicator, but the issue of technical specification severity did not play a part in that analysis. The influence of technical specifications should be investigated, since if it can be demonstrated that severity of technical specifications is an issue it could cast doubt on performance evaluation using LERs in the context of the FPM methodology.

1079 182

TABLE 11

ATBE FOR CAUSALLY LINKED SET OF FOUR EVENTS

Facility	Months/Event
Millstone (3 sets)	0.5
	3.75
	5.25
Quad Cities (2 sets)	4.0
	3.25
Arkansas	3.5
Surry	2.75
Zion (2 sets)	3.0
	2.5
Trojan	2.7

In Phase I, we made an effort to select the three case study plants so that the differences in their technical specifications were minimized. This permitted us to focus on evaluating the usefulness of the FPM model and methodology in licensee performance analysis. But to respond to NRC concerns, we calculated the proportion of LERs due to violation of Technical Specifications to total LERs reported. Our approach centered on the fact that if the differences in the number of reported events were primarily due to differences in technical specifications, those facilities with the more stringent technical specifications should have a higher percentage of LERs due to violation of technical specifications. Regulatory Guide 1.16 requires the licensee to report all technical specification violations as well as all unscheduled events that occur, including matters for which reporting is not demanded by existing technical specifications and events that did not result in a violation of a technical specifications. We did not include LERs that report violation of environmental technical specification limits for two reasons:

- Violations of environmental technical specifications were due in part to seasonal variations in weather and to fish migration patterns. These factors cannot be totally controlled by management and personnel action, short of shutting down the facility.
- Violations of environmental technical specifications generally are less related to plant operating safety than are violations of technical specifications applicable to major facility safety and balance-of-plant systems.

In Phase I, we considered that an LER was due to a violation of technical specifications if it was identified as such in the LER event description. Before extending this analysis to all twelve case studies, we made a spot check of LERs to determine whether most LERs were correctly identified as resulting from a violation of technical specifications. This spot check cast serious doubt on relying on the licensee's identification of an LER as a violation of technical specifications. In fact, only in July of 1977 did the instructions for submitting LERs require that licensees state exactly what - technical specification or license condition - had been violated. For this reason we reviewed the LER files of each of the twelve case study licensees to identify accurately those LERs that involved violations of technical specifications. In many instances, technical specification violations were in fact tagged

1079 184

as such by the licensees, and the event description included the identification number assigned to the technical specification in question. In several cases, we noted events which could possibly have been technical specification violations, although they were not identified as such in the LER event descriptions. This was true for virtually all twelve of the licensees. These potential technical specification violations were identified by using two criteria:

- Failure to Adhere to a Numerical Limit
  In most instances, functional numerical limits are defined in the technical specifications as limiting conditions of operation (LCOs). In several cases, however, it was not clear from the information provided in the LER whether the limit in question was (a) an LCO, in which case a technical specification would have been involved automatically, or (b) a numerical limit established by the licensee or recommended by the equipment vendor. (When the LER texts included such words as "specified limit" or "required limit," we assumed (and the NRC confirmed) that the referenced limits were in fact LCOs and that the event did involve a technical specification violation).

- Component/Equipment Nonoperability
  Component/equipment operability is a common technical specification reporting requirement, particularly when proper function is essential to the proper performance of a safety-related system. However, there is some variation among technical specification requirements for reporting operability status, particularly when redundancy is involved. For example, a given system may include two relief valves that perform the same function. The technical specifications of some licensees may require that both valves be concurrently operable; for others, the failure of one valve would not constitute a technical specification violation, provided that the second valve was satisfactorily operable and the defective valve was repaired or replaced within a specified time. If an LER mentioned a loss of component/equipment operability in a critical system, including instances in which redundancy was a factor, we considered it a potential violation of technical specification.

These two criteria were most frequently used as the bases for identifying LERs that might have represented technical specification violations, even though they were not identified as such in the LER event descriptions. In addition, we included LERs that mentioned failures to perform certain actions or delays in implementing actions beyond a certain time period. In most cases, deficiencies of this type were identified as technical specifications violations in the LERs, but there were a few instances of this type in which we suspected the possibility of a technical specification violation, although the LER text was not explicit on this point.

After reviewing the LERs for each licensee and identifying LERs potentially attributable to technical specification violation, we contacted either the responsible NRC I&E inspector or the NRR Division of Operating Reactors reactor engineer. We discussed each LER we had identified with the knowledgable NRC contact and accepted his decision on whether or not the LER was a technical specification violation. We thus could determine the number of LERs due to technical specification violations for each of the twelve licensees; this information is presented in Table 12, which shows the LERs due to technical specification violations as a percentage of the total LERs filed.

If there is a bias in this grouping due to stringency of technical specifications, the Mann-Whitney procedure should be able to demonstrate it. The outcome of the Mann-Whitney procedure is a statistical statement as to whether or not the mean percentage of LERs due to technical specification violations for better and poorer performance groups differs by a greater amount than one would expect from random variation. The mean percentage of LERs due to technical specification violations for the better performers is 37%; for the poorer performers it is 42%. Using the Wilcoxon-Mann-Whitney procedure, we can say that at the 95% confidence level, the difference between the means of the two groups is due to random variation. Put another way, we are 95% sure that stringency of technical specifications is not a significant factor in the number of causally linked events a licensee sustains.

The Quality of LER Reporting

Both NRC and licensees are aware of differences in licensee attitude toward LER reporting. Conversations with licensees leave no doubt that some follow a policy of "if in doubt, file an LER," while others report only events that

1079 186

TABLE 12

LERs DUE TO VIOLATIONS OF TECHNICAL SPECIFICATIONS

	Percent of LERs Due to Technical Specification Violation*
Poorer Performers	
Duane Arnold	60
Zion Unit 1	28
Millstone Unit 1	39
Better Performers	
Quad Cities Unit 1	42
Arkansas Unit 1	49
Surry Unit 1	60
Trojan	32
Prairie Island Unit 1	25
Fort Calhoun	53
Point Beach Unit 1	10
H. B. Robinson Unit 2	57
San Onofre Unit 1	5

*Not including those involving environmental technical specifications.

1079 187

clearly must be reported. There are also differences in the thoroughness with which licensees describe and analyze events. We attempted to investigate NRC's impression of the quality of LER reporting through our review of the inspection reports for each licensee.

When we reviewed inspection reports associated with items of noncompliance identified in the 766 File, we noted the number of LERs investigated by the inspector and whether the inspector agreed with the adequacy of the licensee's reporting of each of these LERs.* This gave us an indication of the quality of the reported LER data. A summary of the data for the twelve cases studied is presented in Table 13, which lists the percentage of LERs with which the inspector disagreed. This disagreement most often concerned the timeliness of reporting or the completeness of the event or cause description. The percentages shown in Table 13 are zero or generally low, indicating good agreement with licensee reporting.

For two of the licensees, Prairie Island Unit 1 and Zion Unit 1, the percentage disagreement was considerably more than 10 percent. For Zion, the LERs with which the inspector found fault were spread over four of ten inspection reports. For Prairie Island, the inspector disagreed only with the LERs he checked in a single inspection; this may have represented a substantial disagreement over reporting requirements, the "grey area" of licensee/NRC interaction. But since this single area of disagreement was discovered in one of 11 reviews of LERs, we do not feel that this relatively high percentage disagreement necessarily reflects a consistent reporting style or attitude. In general, we believe that the LER data reasonably reflect what is actually happening in the facility for both "good" and "poor" performers.

---

* NRC inspectors review all the LERs submitted by the licensees for whom they are responsible. If the inspector is satisfied with the LER, he is not required to further investigate 30-day LERs. He <u>is</u> required to investigate all 14-day LERs.

TABLE 13

INSPECTOR DISAGREEMENT WITH REPORTED LERs

	Percentage Disagreement[1]
Millstone, Unit 1	8
Fort Calhoun	5
San Onofre	0
Duane Arnold	5
Arkansas Unit 1	0
Trojan	0
Quad Cities Unit 1	6
Surry Unit 1	0
H. B. Robinson	0
Prairie Island Unit 1	18[2]
Zion Unit 1	15
Point Beach Unit 1	0

Notes:

(1) Covers the 24-month period of 1976 and 1977. Data are based on information presented in the case study matrices summarizing the review of the 766 File and Inspection Reports.

(2) All LERs represented by this percentage were identified in one inspection report.

1079 189

4. PERFORMANCE INDICATORS FROM THE NONCOMPLIANCE DATA

Most of the analysis thus far has been directed at assessing performance quality using indicators based on LER data. However, the question of why this performance quality, for any given licensee, is what it is has not yet been discussed. In terms of I&E's interests, it would be very useful to identify the factors underlying a licensee's operating pattern that cause him to fall into the poorer rather than the better category of performers. It is precisely in this area that the FPM model, if appropriately used, can provide insights. While the LER data can indicate whether a licensee is a better or poorer performer, the noncompliance information, if suitably cause coded for use with the FPM model, becomes a diagnostic tool, providing valuable insights into the underlying causes of observed licensee performance.

This section presents our Phase II work on noncompliance data. Part 4.1 summarizes the difficulties in using the noncompliance data that we faced in Phase I, and the solution - revising the noncompliance cause codes - that was suggested. Part 4.2 presents the revised codes.

Part 4.3 presents the results of testing the revised cause codes on Duane Arnold and Zion Unit 1 over the case study period, and the insights about the licensee and the inspection process that can be gained by using this new tool.

4.1 Problems with Noncompliance Data and Potential Solution

In Phase I, we found the noncompliance data to be less helpful than LER data in analyzing licensee performance using the FPM model. Noncompliance data were difficult to use with the FPM model for two basic reasons:

- the format of the inspection process, and
- the data in the computerized 766 File.

NRC's inspection process is organized into modules, which are generally performed on a scheduled basis throughout an annual cycle. While the inspector

1079 190

always has sometime for free-ranging obervation and investigation, the detection of the majority of noncompliances is largely governed by the timing of the modules, not necessarily by tne date of their occurrence. Furthermore, the inspection modules cut across plant systems. This could be an advantage, but the data collected under any one module is usually too sparse to reveal patterns in the licensee's behavior. These factors shape the data so that a real-time sense of licensee performance is difficult to obtain.

Even more difficult, the data in the computerized 766 File are a pale reflection of the information contained in the written inspection reports. The reports often contain valuable insights into the causes of noncompliance and into licensee bahavior. But these insights are difficult to obtain from the computerized information, since the 766 File was set up to function as a management information and accounting tool, not to collect performance evaluation data.

As mentioned in Section 1 of this report, we were asked to try to overcome these difficulties, so that the noncompliance data could be used with a level of detail equivalent to the use of the LERs.

In trying to devise an effective methodology for using noncompliance data, we faced several constraints. First, the structure of the present modularized inspection process should not be altered. Second, the content of the 766 File had to be accepted as it stands; the file could not be expanded to include the insights present in the inspection reports. The remaining course of action was to try to make the cause codes more useful. We felt this approach could be fruitful if the cause codes could be made to link noncompliances to the elements of the FPM model. This effort, if successful, would not resolve the difficulty of placing noncompliances in "real time", but could help make the data

1079 191

much more useful in licensee performance evaluation. We proceeded to review the Primary Cause Codes to identify problems in their application; then we developed a new derivative cause code structure that was compatible with the FPM model. We tested the revised codes by reanalyzing and recoding the inspection reports for two licensees for 1976 and 1977. The next part presents the revised codes, and the subsequent part sets out the results of our analysis for the two licensees.

4.2 The Revised Cause Codes

Introduction

In our Phase I work, we transferred the noncompliance Primary Cause Codes to the FPM domain by assigning each to an appropriate structural component of the FPM model, namely, management (M), personnel (P), or facility (F). Table 4 in the Phase I report sets out this conversion. The results of this conversion were of limited usefulness for reasons that became clear only in the course of work. During our review of the 766 File data and the corresponding inspection reports for both the three licensees studied in Phase I and the nine licensees studied in Phase II, we found significant differences in the way in which different inspectors interpreted the cause codes. For example, we found several instances in which the cause codes presented in the 766 file did not appear to be consistent with the file descriptions of the cited noncompliances, as well as others in which the codes did not seem to agree with the texts of the source I&E reports.

Careful study of the primary cause codes as defined by NRC strongly suggested that much of the observed nonuniformity in their application stemmed from the code definitions. These definitions, which are frequently generic, are in some instances overlapping and in others ambiguous. For example, the Primary Cause Code "M", which is defined as "safety devices not maintained," would

1079 192

ordinarily be interpreted a failure on the part of personnel (FPM model element P.) But cause code "M" could also be validly applied to a case in which safety devices were not maintained not through laxity of personnel, but through managerial failure to provide personnel with required maintenance plans, schedules and instructions. In a case such as this, review of the limited information presented in the 766 File could leave it unclear as to whether the noncompliance was the fault of personnel or management; the original I&E report must be consulted to determine the fault.

When we revised the Primary Cause Codes we had two key objectives:

- By reducing the ambiguity or generality of the cause codes, to correspondingly reduce the amount of judgment required of an inspector in assigning a code to a given noncompliance. The codes should be defined so that the details of the situation itself would dictate the appropriate code. Attainment of this objective would significantly heighten the uniformity of inspector cause coding, so that three inspectors in three different regions would code the same noncompliance situation in precisely the same way.
- By improving uniformity in cause coding and by defining the cause codes more specifically, the value of the codes in analyzing licensee performance would be greatly increased, without altering the I&E inspection process.

In revising the Primary Cause Codes we attempted to retain as much of their general format as possible. For example, code "F" still denotes "Improper or Inadequate Calibration," but it has been more comprehensively defined to include managerial as well as personnel lapse. To attain the degree of explicitness that is required to eliminate ambiguity and to assist in transforming the codes to the FPM domain, the Primary Cause Codes were disaggregated into sub-codes where necessary and appropriate. Each sub-code relates to one and only one specific element of the FPM model. The net result is a far more precise assignment of noncompliance responsibility than is possible using the Primary Cause Codes alone.

In the detailed presentation that follows, each Primary Cause Code is identified by its NRC code letter and its existing code definition. Then any sub-codes that fall under the Primary Code are individually defined and explained and the FPM model element appropriate to each is identified. This element may be either structural (F, P or M) or functional (Arrow #1, Arrow #4, etc.). Thus each sub-code is identified by two symbols:

a) A capital letter indicating the NRC Primary Cause Code under which it falls, and
b) A capital letter or a number that designates the appropriate FPM model element to which the sub-code relates.

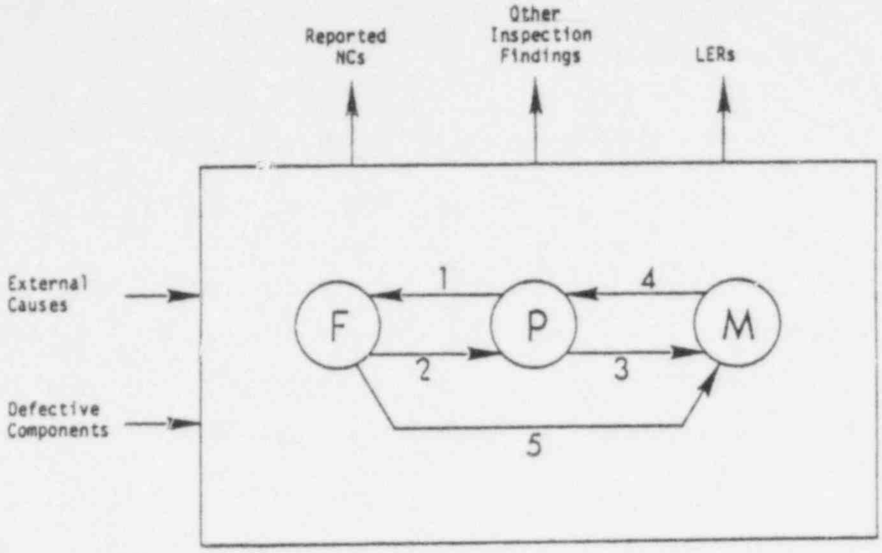
Based on our review of a large number of inspection reports, we believe that the logic underlying the revised cause codes is similar to the logic that inspectors follow when analyzing the causes of the noncompliances they detect. Because of this, we do not think that applying the sub-code system will require any significant reorientation on the part of the I&E field personnel. The sub-codes may in fact make it easier for inspectors to assign cause codes by providing a framework that reflects their own perceptions.

The Codes

The Primary Cause Codes A, B and W, denoting unavoidable or indeterminate causal factors, are all assigned the event responsibility code "O" for "other." However, this category does not apply to the FPM model and is not used in assessing licensee performance. The rationale for this is that noncompliances classified as ERC-O arise from causes beyond the control of the licensee and, therefore, should not be considered in analyzing his performance.

For easy reference, the FPM model is reproduced here:

1079 194



The FPM Model

C - Improper or Inadequate Design

The ultimate responsibility for a design deficiency rests with management, even though the error may have been made by the A&E firm retained by the licensee or applicant. Because the A&E operates as the licensee's agent, assignment of responsibility is not altered. The appropriate FPM model element is M, and the code is C-M.

D- Improper or Inadequate Construction

Two questions are involved:

a) Why did the construction deficiency occur?
b) Why was it not detected early and rectified?

With respect to (a), there are two possibilities:

1) The design plans and drawings were correct, but not properly followed. The appropriate FPM element is Arrow #1, denoting the operational relationship between personnel and the facility. The sub-code is D-1.
2) The design plans and drawings were properly followed, but they were deficient or contained errors. This is "improper or inadequate design," which is code C. The appropriate FMP element is M. The code is C-M.

1079 195

In the case of (b), there are three possibilities, based on different modes of QA failure:

1) Management failed to develop an adequate construction QA plan. (This is admittedly a remote possibility, since QA plans are thoroughly reviewed by the NRC as part of the permitting/licensing process). The appropriate FPM model element is M. The sub-code is D-M.
2) The QA plan was satisfactory, but was not fully explained to the personnel responsible for its implementation. The appropriate FPM element is Arrow #4, which represents the channel through which management communicates with personnel. The sub-code is D-4.
3) The QA plan was satisfactory and transmitted to the responsible personnel. However, it was not satisfactorily implemented. The appropriate FPM element is Arrow #1. The sub-code is D-1.

E - Improper or Inadequate Maintenance

Code E should be used only when the cited maintenance failure relates to an item that is not a safety device. If the item is a safety device, Code M should be applied (see discussion under Code M). In general, Code E applies to any non-safety related item or device that can be maintained and for which either a defined maintenance program is required or could reasonably be expected to exist.

Depending of the details of the particular case, any of the following may apply:

1) Management failed to prepare adequate maintenance plans and instructions. The appropriate FPM model element is M. The cause sub-code is E-M.
2) Management prepared adequate plans and instructions. However, these were either incompletely or incorrectly transmitted to and/or explained to the responsible personnel. The appropriate FPM element is Arrow #4. The sub-code is E-4.

3) Adequate maintenance plans and instructions were prepared by management and were properly transmitted to personnel. However, personnel did not properly follow them. In this case, the appropriate FPM model element is Arrow #1. The sub-code is E-1.
4) As above, adequate plans were prepared and transmitted to personnel. But personnel failed to take any action at all. The appropriate FPM element is P; the sub-code is E-P.

G - Inadequate Plans or Procedures

The term "procedures" in this code definition is somewhat ambiguous. Ordinarily, the term is interpreted to mean a description of a procedure or operation - a set of instructions or directions. However, it can also be interpreted as meaning implementation. For consistency, cause code G should never be used to denote deficient procedural performance. It should be cited only when the plan or method is at fault. Inadequate or incorrect performance is addressed specifically by other codes (for example, E, L, M, N, P).

The responsibility for inadequate plans and procedures rests directly with licensee management. The appropriate FPM element is M, and the code is G-M. However, code G-M does not specify the precise situation in which management failed to prepare adequate plans and procedures.

Other sub-codes, such as E-M, describe this failure in specific areas. To maximize the value of the cause codes as performance analysis tools, the case-specific code should be used whenever it is applicable. The general G-M code should be cited only when none of the specific sub-codes is appropriate.

H - Inadequate Management

This primary code was originally even more general than code G-M, which it subsumes. This generality limits its value in licensee performance analysis, because it does not suggest the character of the management inadequacy. We have redefined code H to mean "failure to take adequate and timely corrective action," a specific area of management responsibility that is not covered by other codes. The code is H-M.

J - Poor Housekeeping or Arrangement

As is the case with certain other Primary Cause Codes, the appropriate assignment of responsibility to an FPM model element can vary. Depending on the circumstances, either personnel or management could be at fault. The possible circumstances are:

1) Management has failed to develop a satisfactory housekeeping program (or has failed to formulate satisfactory arrangement plans). The appropriate FPM element is M. The sub-code is J-M.
2) Management has prepared satisfactory programs and/or plans. However, it has failed to transmit these adequately to personnel. The appropriate FPM element is Arrow #4. The sub-code is J-4.
3) Personnel have been fully informed of the housekeeping/arrrangement plans. However, they carried them out improperly. The appropriate FPM element is Arrow #1. The sub-code is J-1.
4) Personnel are informed of the housekeeping/arrangement plans but they failed to take any action at all. The appropriate FPM element is P; the sub-code is J-P.

L - Safety Devices Not Provided

The responsibility for this lapse rests wholly with management. Two possible situations can be identified:

1) Management has failed to procure safety devices. The appropriate FPM element is M. The sub-code is L-M.
2) Safety devices were procured, but not provided to personnel. This seems a very unlikely situation, but it could occur. The appropriate FPM element is Arrow #4. The sub-code is L-4.

R - Personnel--Poor Selection or Improper Training for Job

Poor personnel selection represents a faulty internal management decision. The appropriate FPM element is thus M, and the sub-code is R-M.

Improper or inadequate training constitutes a deficiency in the management/ personnel relationship. For this reason, the appropriate FPM element is Arrow #4. The sub-code is R-4.

T - Personnel--Insufficient Supervision

This situation represents a failure in the relationship of management to personnel, as in the case of R-4 above. Consequently, the appropriate FPM model element is Arrow #4. The sub-code is T-4.

"Personnel" includes subcontractors (for example, dairy farms that provide milk samples) as well as on-site employees.

F - Improper or Inadequate Calibration

This situation can have various causes:

1) Management failed to develop appropriate calibration procedures or did not procure adequate reference standards. In such cases, the appropriate FPM model element is clearly M. The sub-code is F-M.
2) Management made appropriate provisions as identified above. However, there was a deficiency or failure in the transmittal of procedures/ standards to personnel. The appropriate FPM element is Arrow #4. The sub-code is F-4.
3) Personnel were adequately instructed and prepared, but carried out the procedures improperly. The appropriate FPM element is Arrow #1. The sub-code is F-1.
4) Personnel were adequately instructed, but failed to act. The FPM is P, and the sub-code is F-P.

M - Safety Devices Not Maintained

As is clear from its definiton, Code M (not Code E) should always be applied whenever a deficiency in safety device maintenance is the cause of a cited noncompliance. Safety devices fall under one of two categories:

1079 199

a. Devices that are integral components of the facility (e.g., dry well pressure switches). In the case of power reactors, these are identified in the licensee's SAR.
b. Protective or warning devices that are issued to personnel to assure their safety (e.g., portable radiation monitors).

Code M applies to both of these categories. As is the case with Code E, there are four ways in which safety device maintenance deficiency or failure could occur:

1) Management failed to prepare adequate safety device plans and/or instructions. The appropriate FPM element is M. The sub-code is M-M.
2) Management prepared adequate plans and/or instructions. However, these were not effectively transmitted or adequately explained to personnel. The appropriate FPM element is Arrow #4. The sub-code is M-4.
3) Adequate safety device plans and instructions were prepared by management and transmitted to personnel. However, personnel improperly followed them. The appropriate FPM element is Arrow #1. The sub-code is M-1.
4) Personnel were adequately prepared, but they failed to carry out the maintenance. The appropriate FPM element is P; the sub-code is M-P.

N - Operator Error or Incorrect Operation

Code N should be cited only when the noncompliance involves an improper control action, as opposed to maintenance, housekeeping, or other non-control activities. This code is usually invoked when the operator is considered to be directly at fault. However, this need not necessarily be the case, and, for that reason, the code definition has been expanded to include "incorrect operation" with no implication of ultimate fault. Two types of conditions can exist under the revised definition of Code N:

1) The operator performed incorrectly because of the lack of proper information. For example, he may have caused a particular system to operate outside of the limits imposed by a revised technical specification with which he was not made familiar or was made inaccurately familiar. This is really a management deficiency for which the operator should not be faulted. If the information had not been transmitted to him at all, the appropriate FPM model element would be M. The sub-code would be N-M, reflecting a failure on the part of management to impelement its function. If incorrect information had been transmitted to the operator, this would constitute a breakdown in the management-personnel relationship. In this case the appropriate FPM element would be Arrow #4 and the sub-code N-4.

2) The operator was familiar with the correct procedure and/or the revised technical specification. However, he made an error in execution. In this case the concept of "operator error" validly applies and the appropriate FPM element is Arrow #1. The sub-code is N-1. If he failed to act at all, the FPM element is P, and the code is N-P.

P - Failure to Follow Procedures

This code is generally applied to personnel, as defined in the FPM model. But it can be more broadly interpreted to include management as well.

1) Management may fail to follow procedures, include those required of it by the NRC or by the self-imposed plan it may have formulated. If the "failure to follow procedures" meant inaction, the appropriate FPM element would be M and the sub-code would be P-M. If, in its relationship to personnel, management had followed a procedure incorrectly (as opposed to inaction), the deficiency would then apply to FPM model element Arrow #4. The sub-code would be P-4. If management incorrectly performs a function that is wholly its responsibility and that does not in any way involve personnel (such as reporting to NRC), the deficiency should be attributed to FPM element M; the sub-code is P-M.

2) Personnel may improperly follow procedures that apply to the operation control, or maintenance of the facility. Since deficiencies of this

type impact the facility directly, the appropriate FPM model element is Arrow #1. The sub-code is P-1. If personnel fail to act, the FPM element is P, and the sub-code is P-P.

3) Personnel may fail to follow procedures that establish requirements for or govern their reporting to management. Whether such reporting is verbal or written is immaterial. In the event of a total failure to report, the appropriate FPM model element is P. The sub-code is P-P. If a required report has been made, but it is in some way deficient (incomplete, erroneous, or delayed beyond the end of a required reporting period), the appropriate FPM element is then Arrow #3. The sub-code is P-3.

As is true of Primary Cause Code G (Inadequate Plans or Procedures), Code P is generic and does not indicate the particular area of activity to which a cited noncompliance relates. Other codes, such as E, F, or J, which specifically denote the type of action with which the noncompliance was associated, should always be used in preference to P whenever possible.

Q - Improper or Inadequate Functional or Surveillance Testing

This code is not one of NRC's original Primary Cause Codes; we suggest its inclusion to fill the gap that now exists in the codes' coverage of major activities within a facility. Code E covers maintenance activities; code G covers plans and procedures; Code F covers calibration. Without the addition of Code Q, noncompliances generated through improper or inadequate testing would be coded as P, the general code for failure to follow procedures. More information on the point of breakdown within the facility will be gained by using Code Q for noncompliances related to testing.

We can identify four sub-codes:

1) Management failed to prepare adequate plans and instructions for functional or surveillance testing. The appropriate FPM model element is M; the sub-code is Q-M.
2) Management prepared adequate plans and instructions, but these were either incorrectly or incompletely transmitted to personnel. The appropriate FPM element is Arrow #4, and the sub-code is Q-4.

3) Management prepared adequate plans and properly transmitted them to personnel. Bur personnel did not properly follow them. In this case, the appropriate FPM element is Arrow #1. The sub-code is Q-1.
4) As in 3), adequate plans were prepared and transmitted to personnel, but personnel failed to take any action at all. The appropriate FPM element is P; the sub-code is Q-P.

S - Carelessness

The original definition of the S code included the word "personnel." This word has been deleted because in the FPM model, "personnel" has a specialized meaning, applying only to those members of the licensee staff who have a direct hands-on relationship with the facility. But any level of the licensee staff, including management, can be careless. In this reformulation of the primary noncompliance codes, carelessness is considered as a symptom rather than as an underlying cause in itself. Since it can be an element in improper actions expressed by arrow # 4 and arrow #1, other cause codes more adequately pinpoint the problem. We recommend that the S code should not be used.

K - Equipment Failure or Faulty Equipment

Before assigning a K sub-code, the inspector must consider two factors: whether the equipment or component failure stemmed from a human cause such as inadequate maintenance or abuse, and who detected the failure.

For example, it may be incorrect to apply a K sub-code in the case of a valve that originally functioned properly, but had finally developed a leak due to a worn seat. Valve seats normally wear in use and it is reasonable to expect timely seat replacement. In this case, a maintenance failure sub-code may be more appropriate than a K sub-code. The inspector can often decide which code to use by asking two questions:

a) Is it reasonable to expect the licensee to have an inspection and maintenance program that includes the failed component; and
b) Has that program been conscientiously conducted?

If the answer in the first question is "yes" and the second answer "no," then the K code is clearly not applicable, since maintenance is the problem.

If no maintenance and inspection program is feasible, the situation is more clear cut. For example, the spontaneous failure of a relay coil under normal operating conditions generally indicates an internal defect that would not have been previously evident under any reasonable inspection and maintenance program, so that a K code would be applicable.

It is valid to ask why, in the case of a correct K code assignment, the component or equipment failure should constitute a noncompliance, since the occurrence was beyond the control of the licensee Here, who detected the failure is crucial. As a general rule, if the licensee had detected the failure, corrected it and reported the occurrence to the inspector, the licensee would not be charged with a noncompliance. If, however, the component fault had initially been identified by the inspector, the licensee could be charged with a non-compliance on the basis of his own failure to have detected the fault and taken corrective action.

To devise sub-codes that are useful in the context of the FPM model, we can think of facility components as falling into two broad categories:

a) Components that perform operational, control or structural functions. Examples are valves, piping, wiring or cabling, and supports.
b) Components that supply information about the status and operation of the facility (indicating devices). Examples are meters, gauges, oscilloscopes, and chart recorders.

When a device may fit into either category (a particular relay may exercise a control function, while another may energize an alarm system), the appropriate category is determined by function. Based on the two categories, three sub-codes are immediately identifiable:

1) There has been a failure of an operational, controlling or structural component which the inspector does not believe is due to human cause or neglect. The appropriate FPM model element is F (facility). The sub-code is K-F.

2) There has been a failure of an indicating device which the inspector does not believe is due to human cause or neglect. If the failure is total (the device provides no indication at all), the appropriate FPM model element is F. The sub-code is K-F.
3) If the device indicates (or records), but does so erroneously or eratically, then the appropriate FPM model element is Arrow #2 (the pathway along which facility data and information are transmitted to personnel). The sub-code is K-2. In those instances in which management might have been the information reciepient, the appropriate FPM model element would be Arrow #5. The sub-code in this case is K-5.

4.3 The Results of Testing the Revised Cause Codes on Two Licensees

We tested the revised cause codes by reanalyzing the inspection reports and recoding the noncompliances for both Duane Arnold Unit 1 and Zion Unit 1 for 1976 and 1977. The elements that became meaningful for display after the recoding would be difficult to present in isolation, so the discussion of the form in which the data is (re)presented is combined with and illustrated by the case studies themselves.

The reader should keep in mind that both these licensees were considered, first on the basis of serious regulatory events and second, on the basis of the LER analysis, to be poorer performers. This choice was dictated by the substantial quantity of data available for these licensees, and by the fact that project resources had not been originally intended to cover a redefinition and wholesale test of new cause codes. It would be highly desirable to have included a better performer as well, but project constraints would not permit this. However, the results we obtained from a reanalysis of Duane Arnold and Zion are extremely encouraging; we hope they can be extended.

Collecting inspection data using the revised cause codes provides an understanding of which elements or functions of a licensee organization (e.g., management or FPM arrow 1 or 2) are responsible for deficient performance as well as the program area (e.g., calibration, maintenance) affected by that performance. This information is a fundamental prerequisite to a meaningful diagnosis of a licensee's performance by I&E management. A diagnosis based on this kind of information can allow I&E to identify an appropriate enforcement strategy.

1079 205

The Licensee Elements Responsible for Deficient Performance and What they Reveal

Based on previous studies by I&E and our ongoing efforts, we recognize that the major factors in a licensee's perormance are:

- his attitude, and
- his ability.

The FPM model element definitions and their application through the revised cause codes can help make the distinction between attitude and ability as reflected in licensee activities:

- Noncompliances due to incorrect licensee action are associated with the FPM arrows and represent deficient performance in functional relationships. These noncompliances indicate deficient ability.
- Noncompliances due to an absence of licensee action are associated with the FPM circles and represent a lack of desire to implement the agreed-to conditions of licensing. These noncompliances indicate deficient attitude.

Consequently, a predominance of noncompliance items assignable to either an FPM circle or arrow can indicate the character of the deficient performance. If most noncompliances are assignable to the circles F or P, the problem is one of attitude; if most are related to arrows, ability is in question. Furthermore, the deficient performance can be precisely located within the licensee's organizational structure. Hence an important representation of the aggregate noncompliance data is a priority ordering of FPM circles or arrows based on total associated noncompliance items, from most to least deficient area. The insights that can be gained from this type of ordering will become clearer when we examine the case study results.

1079 206

For Zion Unit 1, the priority ordering of FPM elements for 1976 was:

FPM Element	Total Associated Noncompliance Items
M	18
P	6
1	6
4	3
3	2

From this listing, we can say that:

- The primary area of licensee performance deficiency in 1976 clearly rested with management. Since the circle M had by far the majority of noncompliances, the deficiency can be characterized as poor attitude.
- The secondary area of licensee performance deficiency rested with personnel. The deficiency was equally prevalent in the circle P and the arrow 1, which means that both personnel attitude and personnel ability to perform were also in question.
- The remaining five noncompliance items (associated with arrows 3 and 4) comprise less than 15 percent of the total and as such play a minor role in the diagnosis. But it is interesting that these arrows link management and personnel,the major problem areas.

In 1977, the second year of the Zion Unit 1 case study, the results changed somewhat:

FPM Element	Total Associated Noncompliance Items
M	16
1	8
4	3
P	2

These results indicate that:

- the primary area of licensee performance deficiency still rests with management and this deficiency can still be characterized as poor attitude.

- the secondary area of licensee performance deficiency rested with personnel. This deficiency can be characterized as the lack of ability in the performance of functions related to facility operation.
- The remaining five noncompliance items comprise seventeen percent of the total and as such constitute a minor role in the diagnosis.

The second year (1977) of the Zion Unit 1 case study is an interesting contrast to the 1976 results. While the dominant factor in the deficient performance (management attitude) did not change, personnel attitude improved while personnel ability to correctly carry out functional duties did not. Consequently, it is reasonable to infer that one of the factors in Zion's secondary performance deficiency (personnel) improved, but the primary area of performance deficiency (poor management attitude) remained unchanged for the two-year period.

We also tested the cause codes on Duane Arnold Unit 1. Here are the priority orderings for that licensee:

FPM Element	Total Associated Noncompliance Items
M	14
4	11
1	7
P	3

We can interpet these results as follows:

- The primary area of licensee performance deficiency rest with management (M and 4). This deficiency is almost equally prevalent in two areas: first, poor management attitude toward implementing the conditions of licensing (circle M) and second, an ability to communicate with personnel in implementing procedural requirements (arrow 4).

- The secondary area of performance deficiency is an inability of personnel to correctly perform their "hands on" functions.

1079 208

The results for Duane Arnold for 1977 are:

FPM Element	Total Associated Noncompliance Items
M	12
1	8
4	3

For this year:

- The primary area of licensee performance deficiency rests with management, and can be characterized as resulting from a poor attitude toward implementing the conditions of licensing.
- The secondary area of performance deficiency is seen as an inability of personnel to correctly perform their "hands on" functions.

These two years of noncompliance data show that Duane Arnold's primary area of performance deficiency rests with management for both 1976 and 1977. The licensee did show improvement in management ability to administer the facility and communicate with personnel, but little change could be noted in attitude. Personnel inability to perform "hands on" functions was a secondary area of performance deficiency in both years.

We feel that these case study results show that it is both practical and possible to identify the primary and secondary licensee organizational elements and relationships responsible for deficient performance. This process can provide a useful way to view a licensee's pattern of performance deficiencies from year to year (or more frequently) and allow I&E to focus its attention on the areas of greatest weakness.

Program Areas Affected by Deficient Performance

While the previous discussion shows how I&E can identify the licensee organizational elements and functions that are responsible for performance, it does not identify those licensee program areas that are affected by that deficient performance. In fact, the affected program areas are indicated by the noncompliance cause codes; a similar prioritization of affected program areas can be compiled for each licensee. As an example, the three program areas that were the most affected for each licensee in the two years were:

Zion Unit 1	Duane Arnold Unit 1
Failure to Follow Procedures (P):27	Failure to Follow Procedures (P):25
Inadequate Plans or Procedures (G):12	Improper or Inadequate Functional and Surveillance Testing (Q):13
Improper or Inadequate Functional and Surveillance Testing (Q):6	Improper or Inadequate Maintenance (E):6

For Zion, these areas accounted for 71 percent of the noncompliances; for Duane Arnold, 73 percent of the noncompliances fell in the listed areas.

Combining Responsible Elements and Affected Areas to Gain an Insight into Licensee Regulatory Performance

It should be clear that these two types of information - which licensee elements are responsible for deficient performance and which program areas are affected by that performance - can together provide a sound base for I&E action in helping the licensee to improve the quality of his operations. They tell what is wrong, and why it is wrong by revealing who is responsible.

Before discussing how we combined these elements using the case study data, one further point must be mentioned. It became clear during the course of the twelve case studies that the amount of time I&E spends in inspecting each licensee varies, sometimes considerably. For example, in 1976, about 39* percent more time was spent at Duane Arnold than at San Onofre; 63 percent more time was spent at Zion than at San Onofre. In 1977, those figures were 42 percent and 35 percent respectively. When one checks the total number of noncompliances for those plants for 1976 and 1977 - Zion, 68; Duane Arnold, 59; San Onofre, 10 - it is immediately obvious that noncompliances at San Onofre were substantially harder to detect; in fact, over four times as many hours were required to find a noncompliance at San Onofre than at either Zion or Duane Arnold. To obtain

*Hours and noncompliances attributable to physical protection not included.

1079 210

a meaningful perspective on deficient performance we had to deal with this difference in detectability.

The detection of deficient performance by the inspection process depends on two things:

- the module(s) under inspection since this largely determines the licensee program area in which deficient performance could be detected, and
- the number of inspection hours spent at the facility.

All licensees are exposed to the same modularized inspection program; however, the total time of this exposure varies from licensee to licensee and for any given licensee varies from time to time. The table below summarizes the inspection hours for the two case study plants, broken down into six-month periods:

	Duane Arnold*		Zion Unit 1*	
1976				
A	444		522	
B	292		340	
Total		736		862
1977				
A	660		438	
B	400		594	
Total		1060		1032

Notes: A - first six months of the year
B - second six months of the year
* - hours presented do not include physical protection activities.

The differences in inspection hours from year to year and from first half to second half of the year for these two licensees are substantial. For example, the hours spent at Duane Arnold increased 44 percent in 1977. When we recall that the noncompliance items assignable to management (M) at Duane Arnold were 14 in 1976 and 12 in 1977, a decrease of 15 percent, it is clear that these items were considerably harder to find. While the overall inspection effort increased, the detectability of noncompliances due to deficient management performance decreased.

This puts the 14 noncompliance items for 1976 and 12 for 1977 in a different light.

The previous discussions should make it clear that the impact of differences in the application of the inspection program must in some way be factored into the evaluation. We chose to handle the differences in detectability by dividing the total noncompliance items associated with each FPM model element and relationship for a given time period by total inspection hours for the given time period. This gives the detected responsibility for deficient performance. Similarly, detected impact is given by the quotient of noncompliances assigned to each program area and the number of inspection hours for the period. Presenting the detected responsibilities and impacts of deficient licensee performance in this way will assure at least approximately that differences in the application of the inspection program are accounted for, particularly when performing a year-to-year or licensee-to-licensee relative assessment.

We can now combine the recoded noncompliance data on detected responsibility and detected impact to determine licensee organizational elements or functions responsible for deficient performance in specific licensee program areas of activities. For Duane Arnold and Zion Unit 1, this information is presented in Tables 14 and 15 in matrix format. The rows show licensee organizational elements and functions as keyed to the FPM model; the columns show licensee programs or activity areas expressed by the noncompliance cause codes.

The matrix cells display the data derived from analyzing and converting the noncompliance items identified in the inspection reports into the FPM domain using the revised cause codes. (Recall that the revised codes present noncompliance information in the form (program area-responsible element).) These data are tabulated in the cell that corresponds to the portion of the new code, multiplied by 100 and divided by the total inspection hours for the particular inspection period. Neither hour totals nor noncompliance totals include physical protection data.

An example will clarify the presentation of the data in each cell and aid in following the discussion of Tables 14 and 15. Here is the cell from the Duane Arnold matrix (Table 14) that summarizes all the noncompliances coded "Failure to Follow Procedures" (Noncompliance Code P) when the fault was management's inaction (FPM element M):

FPM Element \ Noncompliance Cause Code		P	year total
M	1976 A	.90	
	B	.34	.67
	1977 A	.45	
	B	.25	.37

The data for each year is broken down into six-month periods: the numbers opposite "A" (.90 for 1976; .45 for 1977) represent the detected noncompliances in this category for the first half of each year, while the numbers opposite "B" in each year apply to the last half of that year. The numbers in the right half of each cell represent year totals (.67 for 1976; .37 for 1977).

Each of the numbers were obtained by totalling the relevant noncompliances (in this case P-M) for each six-month period (or year, for the year totals), multiplying that number by 100, and dividing by the number of inspection hours in that period. For example, in the first six months of 1976 there were four noncompliances assignable to P-M, in 444 hours of inspection, so that:

$$\frac{4 \times 100}{444} = .90$$

Where no entry appears in any part of a cell (or in an entire cell), there were no noncompliances assignable to that category in that period. Shaded cells mean that there is no corresponding cause code: for instance: there is no such revised cause code as H-3.

With this example in mind, we can now interpret the information presented in Tables 14 and 15. These tables summarize which elements of a licensee's organization are responsible for deficient performance in specific program areas.

Table 14

DUANE ARNOLD 1976 & 1977

NONCOMPLICANCE CAUSE CODE (PROGRAM AREAS) / FPM ELEMENT	Year		G	Year Total	H	Year Total	P	Year Total	F	Year Total	E	Year Total	T	Year Total	L	Year Total	Q	Year Total	N	Year Total	R	Year Total	Σ ELEMENT FOR ALL CODES	Year Total
M	1976	A	.22		.22		.90				.22												1.56	
		B		.13	.68	.40	.34	.67			.34	.27					.68	.27			.34	.13	2.38	1.87
	1977	A					.45		.15		.30						.60						1.50	
		B					.25	.37		.09		.18					.25	.47					.50	1.11
4	1976	A					.22						.22				.22						.66	
		B					1.36	.67	.34	.13			.34	.27			.34	.27					2.38	1.34
	1977	A					.15														.30		.45	
		B						.09														.18	--	.27
3	1976	A																						
		B																						
	1977	A																						
		B																						
P	1976	A					.22																.22	
		B					.68	.40															.68	.40
	1977	A																						
		B																						
1	1976	A					.90										.22		.22				1.34	
		B						.54	.34	.13								.13		.13			.34	.93
	1977	A					.15		.15								.30						.60	
		B					.25	.18	.25	.18	.25	.09					.25	.28					1.00	.73
2	1976	A																						
		B																						
	1977	A																						
		B																						
Σ CODE FOR ALL ELEMENTS	1976	A	.22		.22		2.24				.22		.22				.44		.22					
		B		.13	.68	.40	2.63	2.28	.68	.26	.34	.27	.34	.27			1.02	.67		.13	.34	.13		
	1977	A					.60		.30		.30						.9				.30			
		B					.50	.64	.25	.27	.25	.27					.50	.75				.18		

A = FIRST SIX MONTHS

B = SECOND SIX MONTHS

POOR ORIGINAL

1079 214

POOR ORIGINAL

Table 15

ZION UNIT 1 1976 & 1977

NONCOMPLICANCE CAUSE CODE (PROGRAM AREAS) / FPM ELEMENT		G	G Year Total	H	H Year Total	P	P Year Total	F	F Year Total	E	E Year Total	Y	Y Year Total	L	L Year Total	Q	Q Year Total	N	N Year Total	R	R Year Total	Σ ELEMENT FOR ALL CODES	Σ Year Total
M	1976 A	.38		.19		.76		.19														1.52	
	1976 B	.58	.46	.58	.34	.88	.81	.29	.23	.58	.23											2.91	2.07
	1977 A	1.59		.45		.91																2.95	
	1977 B	.16	.77		.19	.33	.58															.49	1.54
4	1976 A											.19		.19								.38	
	1976 B									.29	.11		.11		.11							.29	.33
	1977 A															.22						.22	
	1977 B																.09	.16	.09			.16	.18
3	1976 A					.38																.38	
	1976 B						.23																.23
	1977 A																						
	1977 B																						
P	1976 A					.76																.76	
	1976 B					.29	.58															.29	.58
	1977 A					.45																.45	
	1977 B						.19																.19
1	1976 A					.57		.19								.38						1.14	
	1976 B					---	.34		.11								.23	.29	.11			.29	.79
	1977 A					.45										.45						.90	
	1977 B						.19			.16	.09					.16	.29	.33	.19			.65	.76
2	1976 A																						
	1976 B																						
	1977 A																						
	1977 B																						
Σ CODE FOR ALL ELEMENTS	1976 A	.38		.19		2.47		.38				.19		.19		.38							
	1976 B	.58	.46	.58	.34	1.17	1.96	.29	.34	.87	.34		.11		.11		.23	.29	.11				
	1977 A	1.59		.45		1.81										.67							
	1977 B	.16	.77		.19	.33	.96		[illegible]	.16	.09					.16	.38	.49	.28				

A = FIRST SIX MONTHS

B = SECOND SIX MONTHS

1079 215

Duane Arnold Unit 1 - Table 14

Management Problems (Rows M and 4)

Looking at the data in these two rows, we see fairly large entries over the better part of the two year period in two areas: "failure to follow procedures (P) and "improper or inadequate functional and surveillance testing (Q)." The first problem area stemmed from both poor management ability (row 4) and attitude (row M); however, there was general improvement toward the end of the two year period. The second problem area was primarily due to poor management attitude (row M) which had not been resolved by the end of the case study period; poor management ability (row 4) was a small contributor to the problem area in 1976 but was not a discernable factor in 1977

Other problem areas traceable to poor management attitude (row M) in 1976 were:

1) Inadequate plans and procedures (code G),
2) Failure to take adequate and timely corrective action, in response to I&E inspector identified items (code H),
3) Improper or inadequate maintenance of equipment not classified as safety devices (code E),
4) Improper or inadequate calibration (code F), and
5) Poor selection and training of personnel (code R)

Items 1, 2, and 3 did not recur in 1977. Items 4 and 5 recurred as a management ability problem (row 4) in 1977. One problem due to management ability (row 4) occurred in "personnel - insufficient supervision (code T)" in 1977.

Personnel Problems (Rows 3, P, and 1)

With one exception, all program areas that were affected by deficient personnel performance were affected because of poor ability (row 1). The areas affected during the two year case study were:

1) failure to follow procedures (Code P) (also due to poor attitude),
2) Improper or inadequate calibration (Code F),
3) Improper or inadequate maintenance of equipment that is not a safety device (Code E),

1079 216

4) Improper or inadequate functional and surveillance testing (Code Q), and
5) Improper control action with respect to the facility (Code N).

Of these, only items 1 and 5 showed a reduced impact from 1976 to 1977, while items 2 and 4 showed an increased impact from 1976 to 1977. Item 3 was detected in 1977 only.

The areas of major and minor impact for the case study period are summarized in this table, where X indicates a major impact and * a minor impact:

	Management		Personnel	
	Ability	Attitude	Ability	Attitude
Inadequate Plans or Procedures		*		
Inadequate Management (failure to take timely corrective action)		*		
Failure to Follow Procedures	X	X	X	X
Improper or Inadequate Calibration	*	*	*	
Improper or Inadequate Maintenance		*	*	
Personnel-Insufficient Supervision	*			
Improper or Inadequate Functional or Surveillance Testing	X	X	*	
Operator Error			*	
Personnel-Poor Selection or Training	*	*		

While the impact of deficient management performance on the facility can only be inferred, the impact by personnel is direct: personnel's poor performance was due to deficient ability in several areas.

For management, both improvement and decline can be seen over the study period: management attitude improved toward following procedures (Code P), selecting and training personnel (Code R), maintenance (Code E), general plans and procedures (Code G), and taking adequate corrective action (Code

H); attitude declined toward calibration (Code F) and functional or surveillance testing (Code Q). Management ability improved in following procedures (Code P), devising adequate calibration requirements (F), supervising personnel (T), and in devising functional or surveillance test procedures (Q); their ability declined in selecting and training personnel (R).

But while management made significant improvement in both attitude and ability, in 1977 as compared to 1976, the impact of this improved management performance on personnel appeared to have limited effect. Personnel improved in their ability to follow procedures (P) and to operate the facility (N), but their ability to properly calibrate (F) and test (Q) the facility declined and a new inability to properly maintain equipment taht is not a safety device was noted. Essentially, some of management's improvements in performance appear to have shifted the basic problem from overt operational risk toward the latent risk or undetected maloperation of systems.

Zion Unit 1 - Table 15

Management Problems (Rows M and 4)

During 1976 and 1977, the activities highly affected by poor management attitude (Row M) were:

- Inadequate plans and procedures (Code G),
- Failure by management to take adequate and/or timely corrective action (Code H), and
- Failure to follow procedures (Code P).

Over the study period, management's attitude toward plans and procedures (G) worsened, but it improved in 1977 in the latter two areas.

To a lesser degree, management attitude also affected these areas:

- Improper or inadequate calibration (Code F), and
- Improper or inadequate maintenance (Code E).

1079 218

During 1976, the areas affected by poor management ability were:

- Improper or inadequate maintenance of non-safety devices (E) - also noted under poor attitude,
- Insufficient supervision of personnel, including subcontractors, (Code T), and
- Safety devices not provided (Code L).

These areas were not affected in 1977, but poor management ability affected two new areas, though to a rather small extent. These areas were improper or inadequate functional and surveillance testing (Code Q) and improper control action with respect to the facility (Code N).

Personnel Problems (rows 3, P, and 1)

In 1976, poor personnel attitude (row P) and ability (row 1) had a major impact in "failure to follow procedures (Code P)." Note that there were also deficiencies in the communication from personnel to management in terms of seeking information, as shown by the moderate impact in row 3, which represents arrow 3. The poor attitude exhibited by management in this activity area may have resulted in personnel's failure to seek information from management about procedures.

Most of the noncompliances attributable to personnel stemmed from poor ability (row 1). This lack of ability primarily affected:

- Failure to follow procedures (Code P), and
- Improper or inadequate functional and surveillance testing (Code Q).

To a lesser extent, poor ability showed up in:

- Improper or inadequate calibration (Code F), and
- Operator error and improper control action with respect to the facility (Code N).

Personnel's ability to "follow procedures" (Code P) improved somewhat in 1977, but ability worsened in the areas of operator error (Code N) and functional and surveillance testing (Code Q). A new area of deficiency - improper or inadequate maintenance (Code E) - was detected.

The relationship of management's and personnel's deficient performance is clearer for Zion than for Duane Arnold. In 1976, managements' poor attitude toward procedures and their implementation obviously affected personnels' attitude and ability in this area. Other areas of deficient personnel activity may be related to those areas about which management had a poor attitude or poor ability; however, it is important to note that management clearly showed a poor ability to sufficiently supervise the personnel.

The worsening of management's attitude toward the adequacy of plans and procedures (Code G) during 1977 seemed to offset the general improvement in management attitude toward functional performance of procedures (P) as well as the timeliness of that performance (H). Management also began to show inability in areas of supervision, providing safety devices, functional and surveillance testing, and facility operation. It seems as though management followed general procedures more promptly, but with reduced quality or ability showing up in other areas. However, the improvements in general management performance do not appear to be reflected in an improvement of personnel ability to operate the facility correctly (N) or to assure that the latent risks identifiable in surveillance testing (2) were reduced. Thus while the licensee's management appears to have improved, the licensee's personnel have not. It would appear that management's improvement in some areas have helped to lower operational and latent risks; however, the thrust of the inspector's attention must be given to personnel's ability to achieve any additional risk reduction.

We believe that the results of this analysis for both Duane Arnold and Zion Unit 1 demonstrate the feasibility of using the revised cause codes as a diagnostic tool for performance evaluation. These case study results offer insight that can result in a qualitative assessment of the various risk components presented by licensee performance. Unfortunately, due to the limited resources available for our work on the revised cause codes, we cannot come to any broad conclusions as to whether this approach would permit "threshold" analyses similar to those developed for the LERs. However, this analysis demonstrates that the underlying causes of poor performance differ from licensee to licensee.

The Interaction of the Inspection Process and the Licensee

While LERs are generated by the licensee himself, it is important to recognize that noncompliance data result from an external measurement process. This process produces data which, when converted into the FPM domain by means of the revised cause codes, can be used for performance evaluation.

In many physical measurements, the interaction of the measuring device with the quantity being measured is insignificant. But here, the measuring device (the I&E inspector and the inspection process) is <u>intended</u> to have an effect on the subject being measured (the licensee). The objective of the inspection process is to identify noncompliant activity within a licensed facility and bring this to the attention of both I&E management and the licensee organization.

The items of noncompliance identified in an inspection report are <u>negative</u> statements to both the licensee and I&E management. The negative statements provide both a source of data for performance evaluation and information to the licensee about the program areas and activities <u>requiring corrective action</u>. Since this corrective action is an intended effect of the measurement process, any performance analysis using data gathered through the inspection process must consider the degree to which the inspection process responds to the licensee and the licensee to the inspection process. This interaction is an indicator of

- the way in which the inspection process views the licensee (Is the inspector artificially "running up the score" or is he ignoring certain problems? This bias may or may not be intentional.), and
- the responsiveness of the licensee to negative inspection process findings--over a period of time, <u>does</u> or <u>can</u> the licensee <u>react</u> to reduce negative findings?

The first issue--how the inspection process views the licensee--is a factor in "detectability" of noncompliances.

What would be appropriate measures of whether or not the inspector is "running up the score"? The answer to this question lies in the total number of noncompliance items that are associated with any of the FPM model elements (licensee organization elements or relationships) and the rate at which these items are detected. An inspector spends a large fraction of his time inspecting the licensee according to a standard schedule for conducting the inspection modules. The time the inspector spends inspecting against a module as well as the number of noncompliances identified as a result of the inspection are recorded in the 766 System by module number. Because each module is inspected relatively infrequently, the noncompliance data resulting from any one module (even over two years) is too sparse to yield meaningful information. But since most of the modules direct the examination of the specific elements of a licensee's organization, the noncompliance items identified under each module reflect the licensees organizational elements (management, personnel, facility) and/or relationships under inspection. Assigning the revised cause codes to each identified noncompliance item permits the identification of the licensee organizational element or relationship responsible for the noncompliance item. The total number of Ms, Ps, 1s, or 4s detected across all modules in a period can provide data of sufficient density and is firmly related to the licensee's structure and operation.

By determining the total number of Ms, Ps, 1s, or 4s detected by all modules inspected in a period, and dividing that number by the total time it took to detect them, we can arrive at a rate (noncompliance items/hour) of detection for each FPM element. An example will show how we made these calculations.

Suppose for a given six month period a licensee has nine noncompliance items in three modules, as shown in this chart.

1079 222

	Module A	Module B	Module C
Module Hours	8	9	12
NC's	one "M" one "P"	three "M"	three "M" one "3"

Because the 766 file does not record how long it took the inspector to find <u>each</u> noncompliance, we can only apportion the time for a module equally over all the related noncompliances. If we are interested in determining a rate for "M", the FPM element representing management, the hours to detect the seven "M" noncompliances in the chart are:

4 hours from Module A
9 hours from Module B
9 hours from Module C
Total: 22 hours to detect seven "Ms".

Therefore, for this six month period, "M" had a rate of 0.3 noncompliance items/hour for 7 items. To simplify further discussion, we will define a noncompliance rate and the associated number of noncompliance items, calculated as discussed above, as the DEP (detection efficiency/deficiency prevalence) parameter for any FPM element or relationship. The DEP can be expressed as:

DEP = [FPM element/relationship] (noncompliance rate [n.c.'s/hour], total noncompliance items);

for the previous example:

DEP = M (.3, 7)

Since project resources did not permit the revised cause codes to be tested on more than two case studies, it is not possible at this time to say what levels of DEP are high or low. However, we can discuss the DEP concept in relative terms. Table 16 shows the four possible combinations of <u>relative</u> noncompliance rates and noncompliance item totals. This table is self-explanatory and describes the interaction between the inspection process (the measurement process) and licensee performance (the measured quantity). The full implications of this Table will be appreciated in the light of the discussion which follows.

1079 223

Table 16

Detection Efficiency/Deficiency Prevalence (DEP)

Total Noncompliance Items		Rate (noncompliance items/hour): High	Rate (noncompliance items/hour): Low
	Small	Inspector may be on the verge of identifying a problem area	• Licensee's organizational element is performing well (assuming the licensee is a "better" performer according to the LER indicators) • The inspection process is not operating properly (assuming the licensee is a "poorer" performer according to the LER indicators)
	Large	Inspector has found a serious problem area that requires licensee and I&E management attention	The inspection process is artificially "running up" the total noncompliance count by over-inspecting

1079 224

The responsiveness of the licensee to the negative findings of the inspection process is both relative and time dependent. If we are to analyze this responsiveness we must find a way to present the DEP data so that it can be viewed as a function of time. To do this, we must select a time span for the DEP to represent, and this time span will dictate the sensitivity with which licensee responsiveness can be measured. Two factors influenced our choice of time span:

- A review of MC-2515, "Light Water Reactor Inspection Program - Operations Phase" reveals that the inspection modules are generally implemented either annually, quarterly, "when required," "once on startup of facility, then on a rotational basis," or at refueling. The bulk of the modules that have the potential to be performed more often than quarterly are those that are dependent upon facility operating conditions.
- A review of the data obtained by applying the revised cause codes to the Duane Arnold and Zion Unit 1, for the two year period.

These factors lead us to believe that both the actual and potential density of noncompliance items would not provide a meaningful or reliable DEP if compiled for less than six months. For this reason, we established the convention of breaking the year under analysis into two six month periods, the first six months designated as "A" and the second six months designated as "B". So the DEP for management for the latter half of 1977, for example, is labeled as M(1977B).

The DEPs were calculated for both Duane Arnold and Zion Unit 1 for the 1976-1977 case study period. These results are presented graphically in Figures 4 through 9. The graphical presentation made it unnecessary to list the noncompliance rate and total, but the remaining information (FPM element, year, and half year) needed to fully describe each DEP data point is noted on the figures. To aid the reader in understanding the licensee responsiveness as presented in these figures, we have connected the four sequential DEPs for each licensee organization element with "arrows" to show the responsiveness of the licensee.

Duane Arnold

Figure 4 shows the net change from 1976 to 1977 for four licensee organizational elements and relationships, M, 4, 1, and P. Figures 5 and 6 provide far more insight into how these changes--reduction of the detection rate for each element, and reduction in total noncompliance items in three of the four elements--occurred.

Figure 5 shows the changes in FPM elements "4" and "M." Element "4"--management's ability and their communication of procedures to personnel--showed improvement only after the 1976 inspection period. 1976A is characterized by inspector identification of problems due to management ability (see Table 16). 1976B evidenced both a higher noncompliance rate and total, indicating inspector recognition of a problem and his focus of inspection time and effort on the problem area (see Table 16). The licensee response to this increased inspector attention resulted in a lower noncompliance rate and total--licensee improvement--for 1977A; during 1977B, there were no detected deficiencies in management ability.

Element M on Figure 5 is an indicator of performance deficiencies due to licensee management attitude. 1976A and 1976B do not indicate a direct focusing of inspector attention on this area since the noncompliance totals remained the same for both periods and the rate increased, indicating reduced inspector attention in this area (the inspector spent less time to find the same number of noncompliances). However, the increased inspector attention on management ability, (FPM element "4") most probably had some effect on this factor. 1977A shows a marked increase in total noncompliances at a rate lower than the previous two periods which indicates that the inspector was aware of and focusing on the problem area in association with the licensee attempting to improve his performance in this area. 1977B results tend to confirm that the movement of the previous period represented mutual recognition and reaction by licensee and inspector alike.

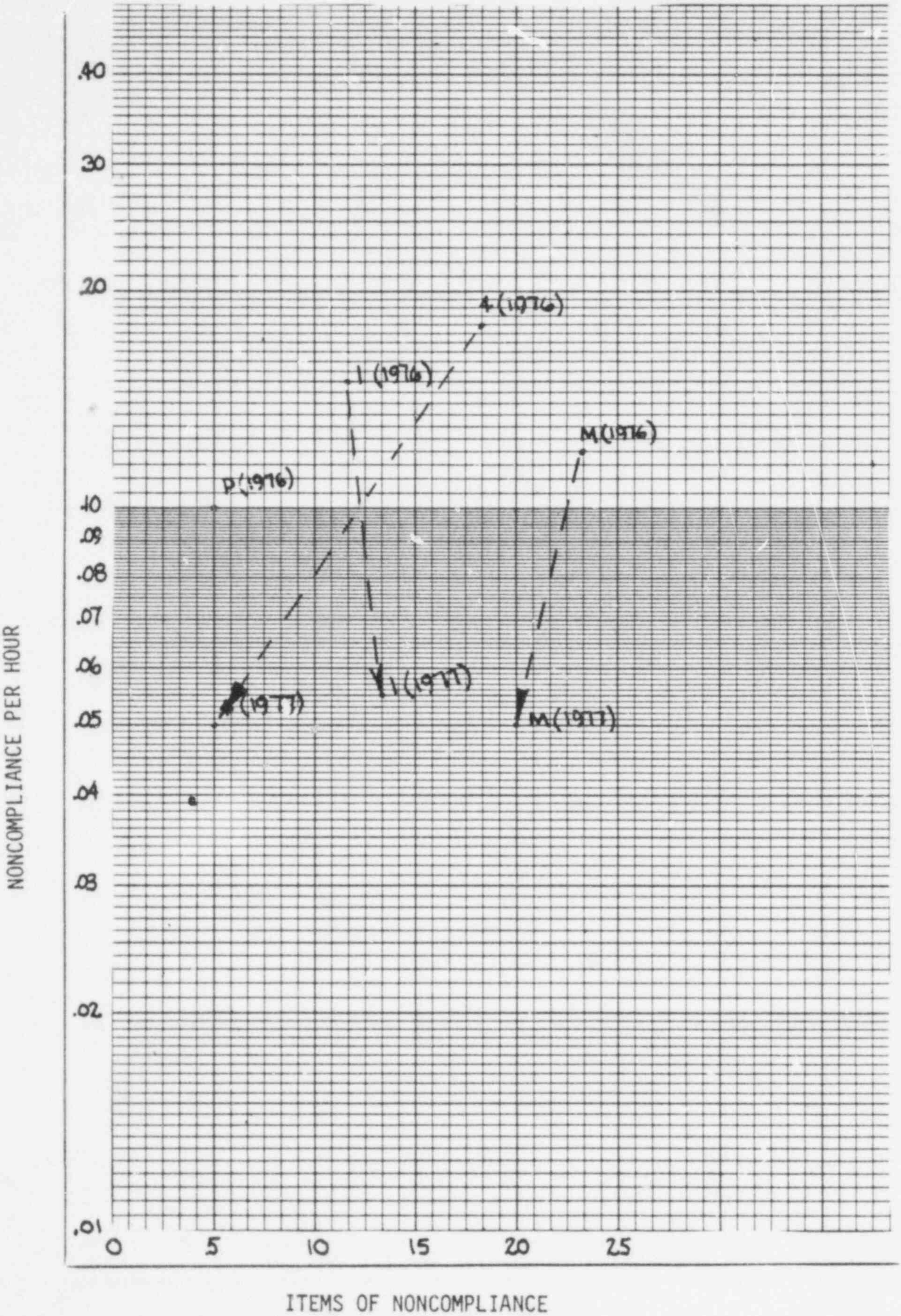
Figure 6 shows the DEPs for FPM elements "P" and "1" The high rate and low total for P(1976A) indicate that the inspector recognized a problem with

1079 226

Duane Arnold

Figure 4

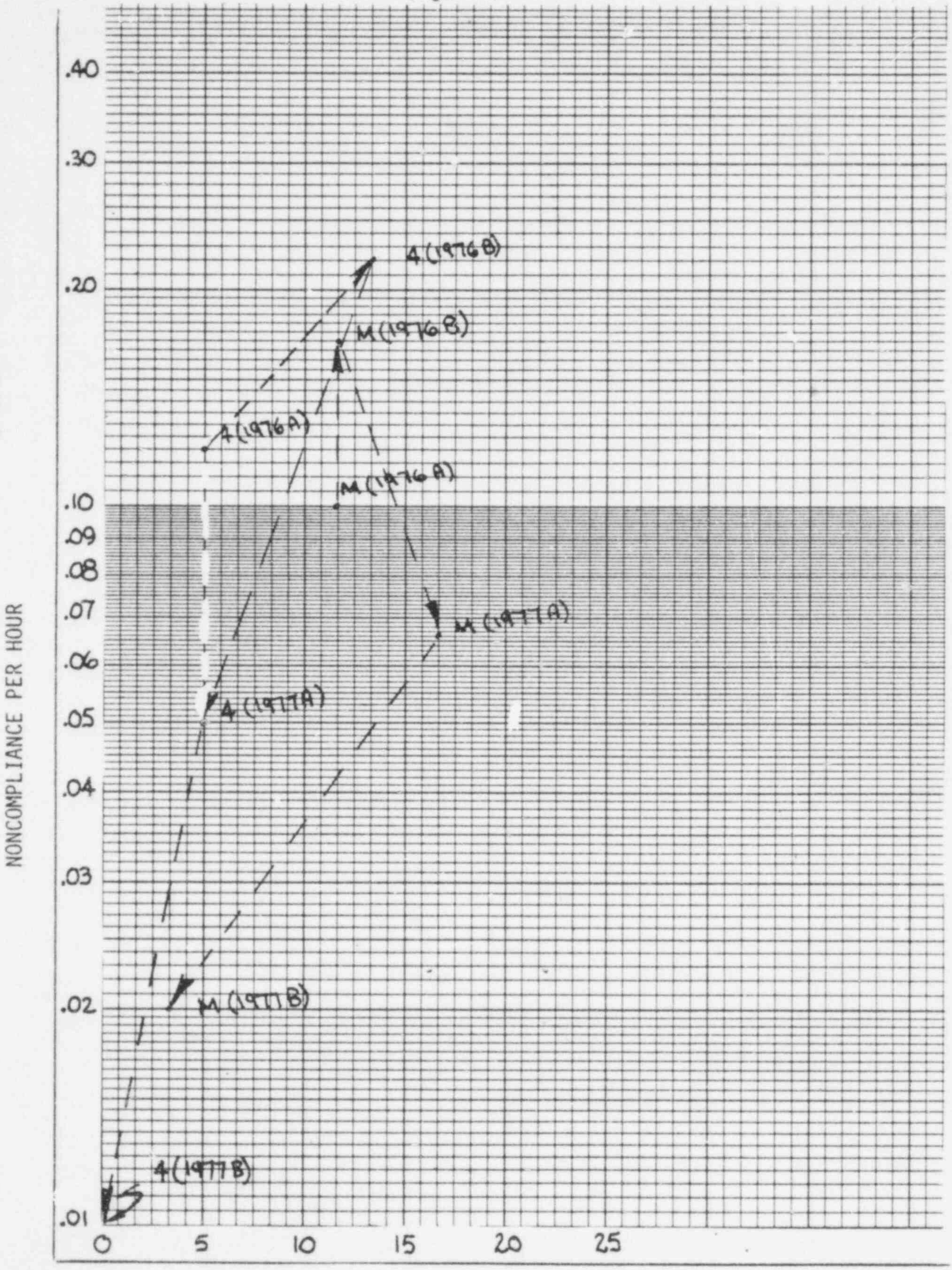
POOR ORIGINAL



1079 227

Duane Arnold

Figure 5

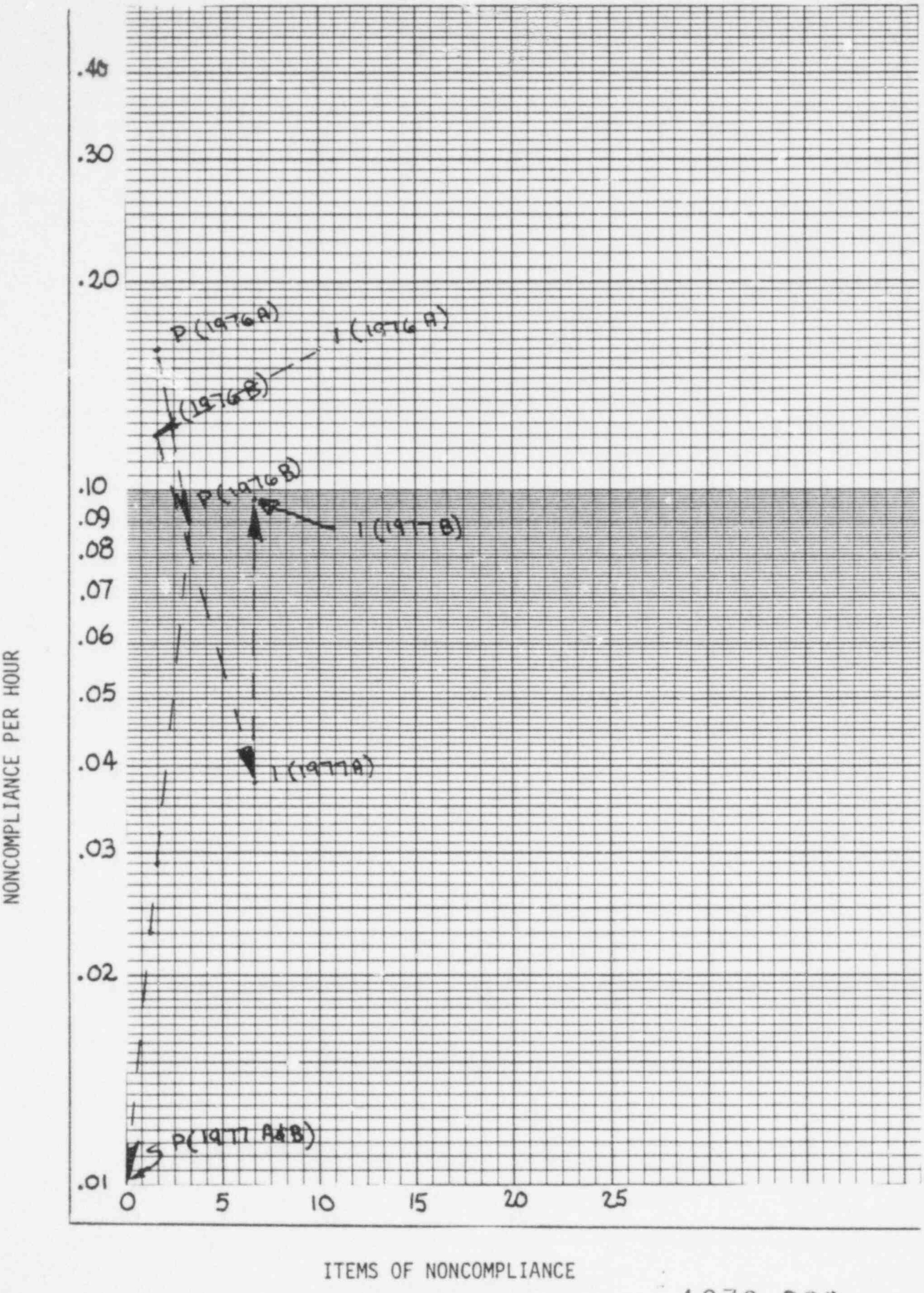


1079 228

Duane Arnold

Figure 6

POOR ORIGINAL



1079 229

licensee personnel attitude. P(1976B) indicates that the inspector increased his inspection effort in this area and the licensee was responding to this increased attention with improved performance. P(1977A & B) tend to confirm the improvement in licensee personnel attitude.

1(1976A) indicates inspector detection of a problem with personnel ability. The lower rate and lower total for 1(1976B) indicates reduced inspector attention to this area. 1(1977A) indicates inspector attention to the area with increased inspection effort, since the noncompliances increased, but at a lower rate. 1(1977B) indicates a reduced inspector attention to this problem area and no licensee improvement in this area--if anything, the performance worsened in comparison with 1977A and 1976B.

In summary, the inspector for Duane Arnold during 1976 showed a clear recognition and identification of problem areas within the licensee's organization. During 1977 the licensee demonstrated a strong improvement in the areas of management ability and attitude as well as personnel attitude. However, there appeared to be no improvement in personnel's ability during 1977; although the inspector appeared to recognize the problem in early 1977, there was a reduction of inspection effort in the latter half of 1977. It is possible that improvement in licensee personnel attitude in 1977 "masked" the lack of improvement in ability during the same period.

Zion Unit 1

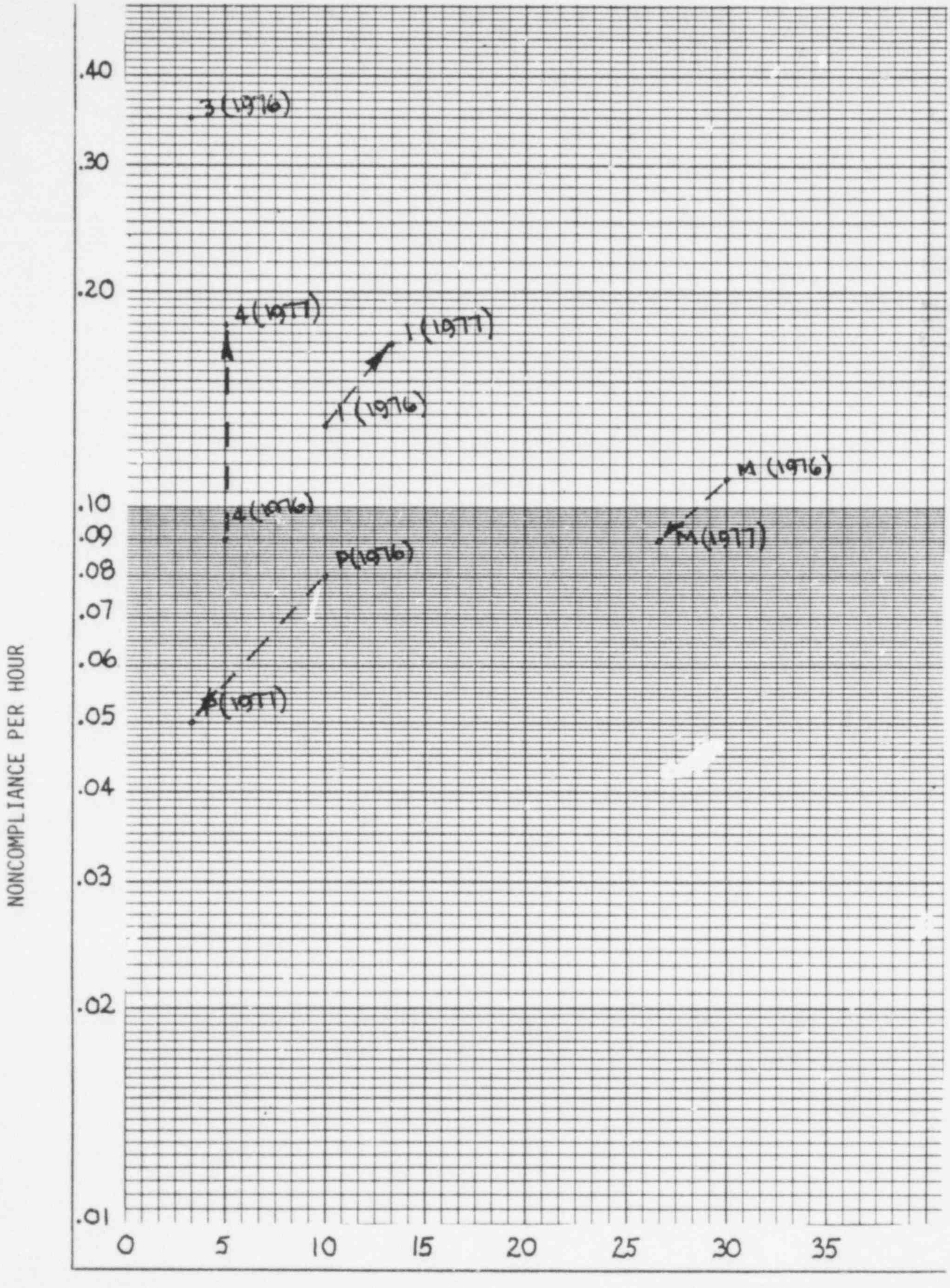
Figure 7 shows the net change from 1976 to 1977 for all licensee organizational elements and relationships at Zion Unit 1. As can be seen, the licensee showed overall improvement in the attitude of both management and personnel; however, there was at best no improvement in either management or personnel ability. Figure 7 alone cannot fully display the interactions occurring between the licensee and the inspector during the two year period, and the trends that may be developing in the licensee's interaction with the inspection process.

Figure 8 shows the DEPs for FPM elements "M" and "4", the elements that respectively characterize management attitude and ability. M(1976A) and

1079 230

Zion

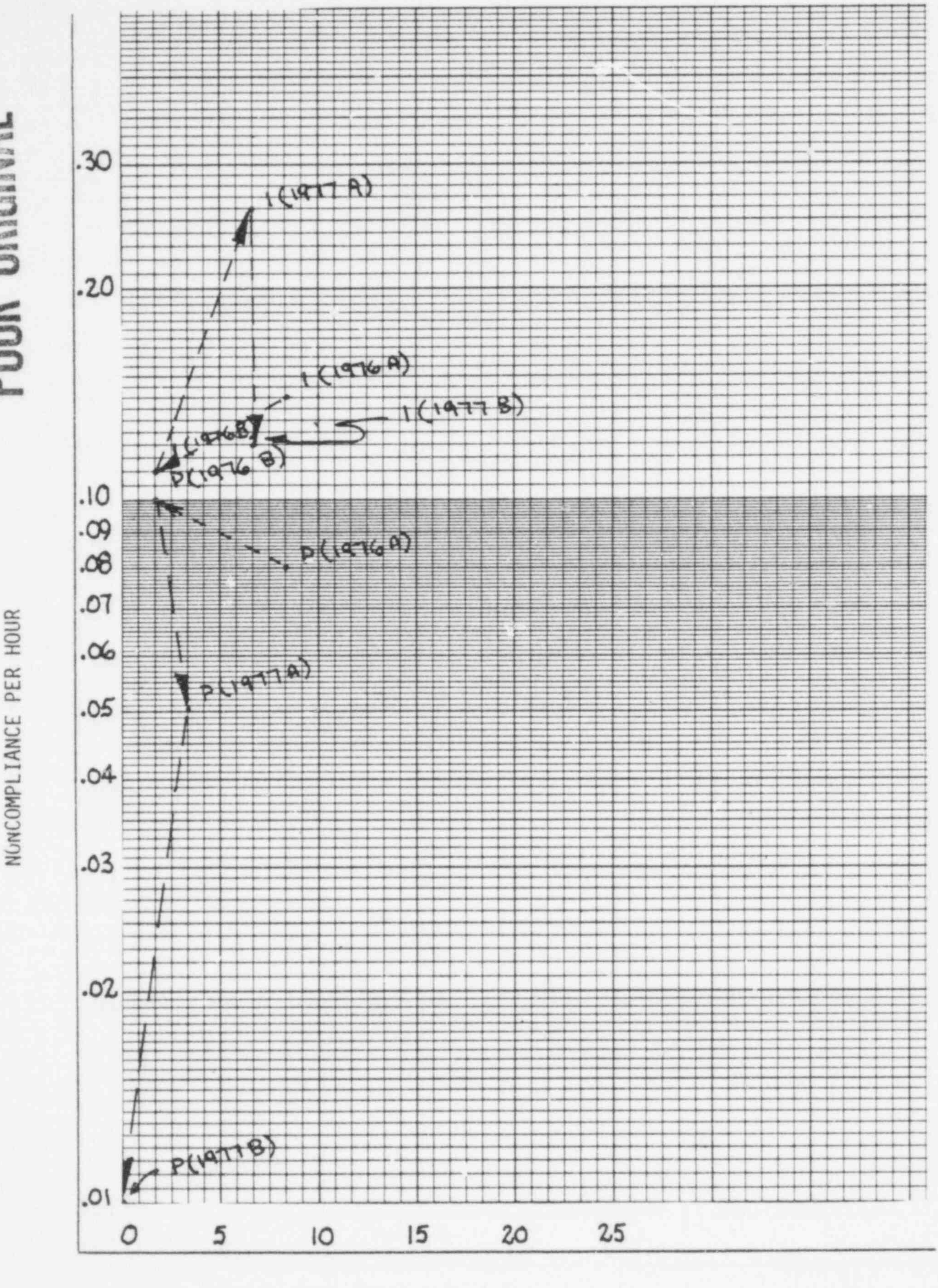
Figure 7



1079 231

Zion

Figure 8



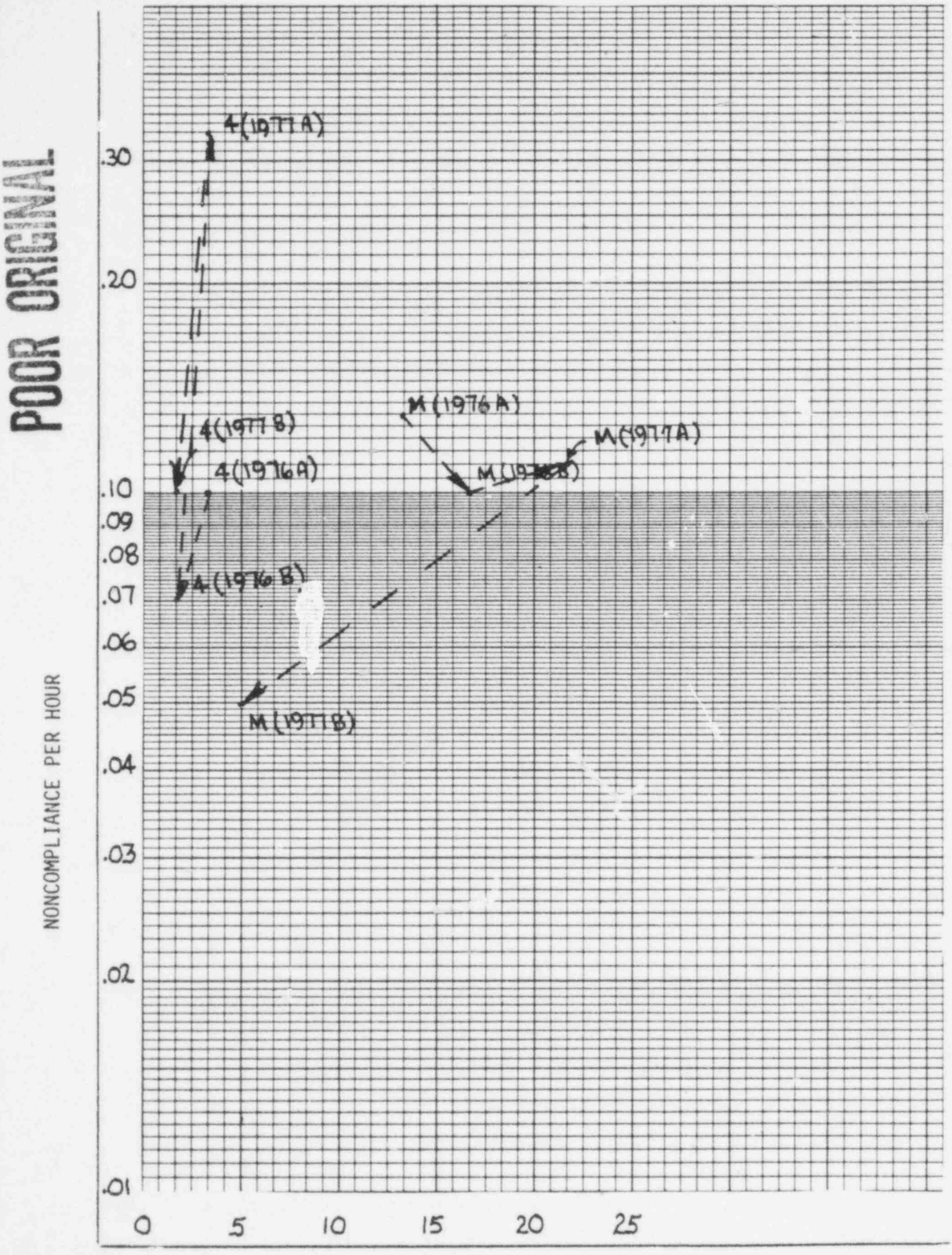
1079 232

4(1976A) indicate the inspector detected problems due to management ability and attitude. An increase in inspector effort in areas of management ability for 4(1976B) appeared to produce a positive improvement in licensee performance in this area. Increased attention by the inspector in areas affected by management attitude have the quality of the inspector artifically "running up the noncompliance count" for M(1976B) because while the number of noncompliances increased, the time spent finding them increased even faster, producing a lower rate; however, the movement shown by M(1977A) tends to indicate that while the inspector may have been running up the score in the previous period, the licensee's reaction (more noncompliances at a higher rate) confirms that the inspector had correctly identified and focused on the licensee management attitude problem.

During this same period, as shown by 4(1977A), the inspector appeared to focus less effort on management ability but this area was relatively much worse than in previous periods. In the latter half of 1977, M(1977B) showed marked overall improvement in management attitude and a lessened impact on those areas affected by it, but the position of 4(1977B), very close to 4(1976A), indicates that there was no real improvement in management ability during the two year period. The inspector's concern with matters that affected licensee management attitude tended to obscure his detection of problems with management ability.

Figure 9 shows the DEP for FPM elements "P" and "1," the elements that respectively characterize personnel attitude and ability. P(1976A) indicates that the inspector did not perceive any real problem with areas affected by personnel attitude, and there appeared to be reduced inspection effort in this area as denoted by P(1976B). 1(1976A) shows that the inspector detected a problem in the areas affected by personnel ability and devoted more attention to inspection in these areas, shown by the movement to 1(1976B). P(1977A and B) indicate marked improvement in areas affected by personnel attitude; during this same period of improvement in attitude, inspection effort in areas of personnel ability were reduced as shown by 1(1977A). Along with this reduction in inspection effort, there was an increased negative impact of licensee personnel ability on several program areas. The inspector

Figure 9



ITEMS OF NONCOMPLIANCE

1079 234

apparently realized this, since 1(1977B) indicates increased inspector attention to areas affected by personnel ability, and the licensee appeared to respond to this increased attention with somewhat improved performance. However, this ability improvement did not parallel at all the improvement shown in areas of personnel attitude.

In summary, the inspection process applied to Zion Unit 1 focused on areas affected by management and personnel attitude. This focus resulted in reduced attention to areas impacted by personnel and management ability. This reduced attention by the inspection process was paralleled by licensee reaction, since there appeared to be no real improvement in licensee organizational ability during this period.

Conclusion

The revised cause codes offer a new insight into both the performance of the licensee and the licensee's response to the inspection program. The benefits offered by this approach are:

- the development of enforcement strategies keyed to licensee organizational elements and functions responsible for deficient performance.
- the development of inspection strategies that will focus on the high risk program areas resulting from deficient licensee performance.
- the assessment of the effectiveness of implementation of the I&E inspection program applied to licensees; distinctions can be drawn between licensee performance and inspection process performance.

Additional case studies and analysis effort are required to determine the feasibility of identifying "inspection process thresholds" for determining the degree of improvement of a licensee relative to the inspection process. This could possibly result in the development of empirical and statistically meaningful thresholds similar to those identified for the LERs.

Summary

- NRC's Primary Noncompliance Cause Codes were refined in order to (a) free them of existing ambiguities and (b) correlate them directly with the FPM model.

- From reviews of the written inspection reports, it was possible in virtually all instances to assign appropriate revised cause codes on the basis of the information currently provided by the inspectors.

- Only minimal modification of the current 766 file system would be required to present the revised cause codes This presentation would enormously enhance the usefulness to I&E of the 766 file.

- The revised cause codes do not increase the usefulness of noncomliance data (with respect to LER derived measures) as a direct indicator of licensee performance. They do, however, have the effect of converting noncompliance data into a powerful diagnostic tool that provides vivid insights into <u>why</u> performance quality is what it is.

- The noncompliance data for two case example licensees - Zion and Duane Arnold - were reviewed and analyzed, using the revised cause code structure. We found it quite feasible to distinguish, in the cases of both management and personnel, between noncompliances that were the consequences of poor attitude or inadequate motivation and those that were attributable to inadequate ability. This distinction can easily be made both in terms of total noncompliances and in terms of specific program areas (maintenance, provision of safety devices, etc.).

- By tracking the analysis of noncompliances over successive time periods (a six month period is the minimum recommended), it is possible to detect changes in the licensee attitude/capability pattern in the various program areas.

- Presentations of noncompliance yields for successive time periods for the different FPM elements, both as totals and by program area, provide considerable insight into the interaction between the I&E process and the licensee, showing his responsiveness to that process.

5. AN APPROACH TO PERFORMANCE EVALUATION

This concluding section has two main purposes: to bring together the elements discussed in the previous sections to form a workable method for identifying licensees whose performance should be improved, and to touch on two topics related to performance evaluation.

5.1 A General Evaluation Approach

To be of maximum value to NRC, a performance evaluation method should attempt to take advantage of the strengths that available data present. We found that the LERs can reveal levels of performance in a way that the noncompliance data cannot; the noncompliance data, when used in conjunction with the revised cause codes, can provide real insight into why performance is what it is. This part briefly reviews the roles of each type of data we used in performance evaluation and then sets out a methodology for using that data to identify those licensees requiring more attention from NRC.

The Roles of LER and Noncompliance Data

Preceding sections of this report discussed the analytic principles involved in using LER and noncompliance data in analyzing licensee performance. This discussion adopts a more general orientation to provide a bridge between those principles and their practical application.

NRC's original Request for Proposal used the term "insight" in the discussion of the overall objective of licensee performance evaluation. From the beginning of this project, we have consistently interpreted "insight" to mean an understanding of the <u>reasons for licensee behavior</u> as distinguished from a methodology for <u>appraising that behavior</u>. A major factor in developing the FPM model as a basis for analyzing licensee behavior was our conviction that this model would, in the long run, be a highly useful tool for identifying and understanding the factors that cause a licensee to perform in a "better" or "poorer" fashion. For reasons that were detailed in our Phase I report and are summarized in this report, we found LERs to be more useful than noncompliance information in furnishing a basis for appraising and measuring licensee behavior. The LER material, as presented in the computer printouts, is of only marginal value in that form. Appropriate content analysis, organization of events by system and date, and cause code modification as required (transformation to the FPM domain) are needed before the full evaluative capability inherent in the raw data can be identified and applied. This capability is most fully expressed in the causally linked events permitted to occur by the licensee as described by total number of linked events, extreme numbers in individual series, and the mean times between these events.

In general, when a licensee's performance is considered to be "poorer" on the basis of his pattern of causally linked events, we have interpreted this as reflecting a deficiency on the part of management*, because management has, at least potentially, the authority to require that personnel identify generic causes of linked events and take appropriate corrective measures. As a rule, the LER information in the printouts is highly circumstantial and concise, virtually never providing any clue to the character of management/personnel relationships or other human factors that would help to identify the character of the managerial deficiency. When there has been a relatively long series of causally linked events, it is usually impossible to be certain from the LER file data whether management failed to take effective action because (a) it wasn't sufficiently concerned or motivated (attitude), or (b) it didn't know or couldn't decide what action to take (ability).

In summary, we think that:

- Of all available NRC data, LER-derived indicators provide the best and most reliable measure of licensee performance.
- This measure is essentially objective, offering only limited insight into the causes of the assessed performance. This limitation is due to the nature of LER content, rather than to methodology.

Noncompliance data, as transformed to the FPM domain via the revised Primary Cause Codes, complements the LER-derived performance indicators almost ideally. While the LER indicators are a powerful tool for evaluating the

*As defined in Section 1 of this report.

1079 238

quality of licensee performance, their contribution to an understanding of that performance is relatively weak. On the other hand, the transformed noncompliance data, while of limited effectiveness as an objective indicator of performance quality, provides deep and revealing insights into the "why's" of that quality.*

In applying the revised cause codes to Zion Unit 1 and Duane Arnold, we derived all of the information required for the analysis from the I&E inspection reports, not the 766 File entires. As pointed out earlier, however, the modifications to the 766 data system that are required to incorporate the revised cause codes are relatively minor.

The diagnostic value of the noncompliance data, as developed through the revised Primary Cause Codes, was discussed in considerable detail in Section 4, and does not require more than summary mention here:

- Of all available NRC data, the noncompliance data presented in the I&E reports, when used with the revised cause codes, provides the best and most complete insight into the "why" of licensee performance.
- This insight is primarily diagnostic in character, it is of limited use as a measurement tool.
- The limitation on the value of noncompliance data as a measurement tool is due primarily to the design of the inspection process.

The next subsection discusses how to use the LER-derived indicators and cause code analysis in the evaluation and diagnosis of licensee performance. From a practical viewpoint, it would appear to be in NRC's interests to use the LER indicators to make a comprehensive evaluation of licensees in order to identify the "better" and "poorer" performers. But it is questionable whether there is a real, practical advantage in performing a

*We should repeat, at this point, that we do not believe that the refinement of the noncompliance cause codes in terms of the FPM model has increased the value of noncompliance data in measuring performance. This is because the modular organization of the inspection program and the timing of these modules remain unaffected by the cause code revision.

noncompliance-based diagnostic analysis on all licensees. It seems to us that while this analysis certainly should be applied to all of the poorer performers, there is little to be gained by diagnosing the behavior of the better licensees. The better performers tend to have fewer noncompliances in a given time period, and these are generally incidental lapses rather than the consequences of persistent, deficient behavioral patterns within the licensee organization.

Independent of the value of performance evaluation as a basis for resource allocation, this assessment could also contribute to establishing thresholds for certain classes of enforcement actions. For example, an advisory letter might be sent if more than a certain number of causally linked events occurred within one year. Diagnostic analysis, on the other hand, can be of general benefit to I&E by providing an understanding of the reasons for observed deficient performance, and it can directly benefit on-site inspectors by alerting them to the particular forms of licensee organizational behavior that could have safety related implications of which they should be aware. In addition, diagnostic analysis could help the licensee by identifying the kind of actions he must take to improve his performance.

Evaluating Performance

This subsection summarizes how to use the LER-derived indicators and cause code analysis in the evaluation and diagnosis of licensee performance. Better and poorer performers are identified through the LER indicators;* the specific performance deficiencies of the poorer performers are diagnosed by applying the revised cause codes to the licensees noncompliance data and analyzing the results.

---

*Though the three licensees identified in this report as poorer performers also had serious regulatory events, these serious occurrences cannot be used as a sole indicator of poorer performance: we cannot assume that all poorer performers in the licensee population have such events. Their absence is fortunate, but it does not indicate reduced risk.

Identifying Better and Poorer Performers

Two types of assessment are required to definitely identify all the licensees that require increased attention from NRC:

- Integrated Assessment, in which the overall performance of each licensee over a substantial period is evaluated. This is to some extent a "historical" evaluation, though the end of the period will be as near to the present as possible. On the basis of this evaluation the licensee is categorized as a better or poorer performer by comparison with other licensees in the same class.
- Dynamic Assessment, which tracks performance as a function of time to identify those licensees that may be shifting from one category to the other.

Both integrated and dynamic assessment depend on determining the relationship between the performance status of the licensee and a performance threshold that separates the better from the poorer performers.

1. Integrated Assessment

This is the basic tool for identifying poorer performers, and uses the total number of causally-linked events (TNE) over the review period (we used two years). We saw in Section 2 that TNE was a valid performance indicator at a very high level of confidence, and it is also an indicator that showed no "overlap" between the better and poorer performance groups.

To determine TNE for a licensee, his LER file for the chosen period must be translated into the FPM domain, and causally linked sets of events extracted. This process is discussed in our Phase I report, but briefly, it includes organizing events by plant system, and examining the events in each system for similarity of involved components, similarity of and relationship to subsystems, and similarity of human response and involvement. If any of these cues are present, the events are causally linked. Each event in a set after the first event is counted toward the TNE.

For easy discussion, the TNE for each of the 12 case study licensees is shown here:

TOTAL NUMBER OF CAUSALLY LINKED EVENTS

Poorer Performers	Number of Causally Linked Events
Duane Arnold Unit 1	74
Zion Unit 1	54
Millstone Unit 1	32
Better Performers	
Quad Cities Unit 1	15
Arkansas Unit 1	12
Surry Unit 1	11
Trojan Unit 1	9
Prairie Island Unit 1	7
Fort Calhoun Unit 1	6
Robinson Unit 2	4
Point Beach Unit 1	2
San Onofre Unit 1	0

The mean of the poorer performers is 53.3, with a standard deviation of 21. This places the lower bound of clearly poorer performance at about 32 events, and any licensee at or above this threshold must be categorized as a poorer performer.

The table showing the TNEs reveals a "gap" of 17 events between the performance groups.* What if a licensee's TNE falls within this gap?

*The numbers shown here were, as previously stated, developed from the 12 licensees studied in Phases I and II. While expansion of the data base may alter the mean and standard deviation of each group, we cannot predict this. But conversely, we have no reason to believe that the TNEs of other poorer performers will fall much outside the range shown; we cannot estimate the number of these poorer performers in the licensee population. We discuss how NRC could develop and use an expanded data base at the close of this subsection.

NRC may choose to establish a threshold at some point in the gap (for example, the halfway point or the mean of the poorer performers -2σ) and consider a licensee falling above the threshold as a poorer performer. Or, NRC can conservatively treat all those licensees as poorer performers and proceed to diagnose their specific problems areas using the noncompliance data and revised cause codes. While this latter approach may be used initially, experience will undoubtedly show that a reasonable threshold can be established.

A graphic approach can also be taken. Figure 2 plots the elements of TNE (length of event set, and related frequency of occurrence). Plotting the TNE for a particular licensee can reveal whether any particular component of his TNE falls into the space inhabited by the poorer performers. If it does, he should probably be handled as a poorer performer.

2. Dynamic Assessment

TNE can indicate clearly the poorer performers, but it is a static, somewhat historic observation. What of a licensee whose TNE count is not alarmingly high, either in the upper end of the better performance group or the lower end of the "gap" between the two groups? He may be in the process of transition to the poorer performance group, particularly if many of the causally linked events had occurred near the end of the review period.

The indicators TNE per month, LNE (largest number of events in a causal set), and ATBE (average time between events in a maximal causal set) can be used to assess the meaning of changes in performance.

TNE per Month

We saw in Section 3 that the TNE per month, expressed in terms of mean and standard deviation, for the better and poorer performers, was:

better performers: 0.3 ± 0.2

poorer performers: 2.2 ± 0.875

These figures can be used "as is" to establish a dynamic monthly performance threshold, or they can be used to set thresholds for longer periods, say three or six months. For a better performer, the three-month threshold is three times the quantity mean plus sigma, or 3(0.5)= 1.5 events. This means that, over successive quarterly periods, the number of causally linked events experienced by a better performer should not average more than 1.5. In a similar fashion, the three-month lower bound for the poorer performers is 3(1.325) = 4.325. A licensee that has 5 or more causally linked events in a given quarter must be assessed as a poorer performer, at least for that quarter. It seems reasonable to use a three-month threshold with a licensee whose performance appears variable, but a longer period - six months - for a more stable licensee.

The easiest way to track a licensee whose performance is in question is to construct a profile of his causally linked events over all systems.* This profile is convenient to use because (1) causally linked events have already been separated from all other licensee reported events to determine the TNE, and 2) the profile displays the causally linked events in relation to their times of occurrence, thus providing an immediate visual cue that events are "packing up." The aggregate number of causally linked events for each successive quarter can easily be determined from the profile and compared with the established threshold to provide a dynamic assessment of the licensee's performance as a function of time. This process can, of course, be continued past the end of any historical review period as additional LER data accumulates. The ongoing performance of a licensee can thus be "tracked" and compared with his past record to determine whether his current performance trend is changing for the better or for the worse.

---

*The Phase I report discusses the concept of profiles, and causally linked event profiles are included in each case study in the appendix to this volume. We suggest drawing this profile only if a licensee's performance is questionable or seems to be changing.

1079 244

Some caution should be observed in interpreting the results of the TNE per month dynamic assessment, since poorer performance in one or even two quarters does not necessarily mean that a licensee has actually transited from the better to the poorer performance category.

At this point Figure 3 is a useful tool, since it employs the other two LER-based performance indicators, ATBE and LNE. Figure 3 shows the extremes of performance as a function of individual sets of causally linked events and the threshold line represents the locus of the poorest cases of performance. Any facility having four causally linked events in a would have an ATBE of .75 months/event and would clearly fall into the poorer performance space. Hence any better performer that may be on the way to becoming a poorer performer, as shown by the TNE per month analysis, should be subjected to an analysis using Figure 3. This analysis should be performed by selecting several "worst" case event sets for the facility in question (those events sets that have occurred over relatively short periods of time), and calculating the ATBE for each of those event sets. Plotting the ATBE against the related number of causally linked events will determine the licensee's location in the performance space. This technique is a useful empirical tool for evaluating performance "peaks" caused by an increase in the number of causally linked events for a better performer. A licensee that falls into the poorer performance category in both the TNE per month analysis and the ATBE/LNE analysis should be treated, at least temporarily, as a poorer performer.

Summary

Several steps are involved in identifying poorer performers:

1) Analyze the licensee's LER file to identify the sets of causally linked events over a relatively long period, say, two years.

2) Total the causally linked events in each set, excluding the first in each set, to obtain the TNE.

3) Compare the TNE to the established TNE threshold for poorer performers. If the licensee's TNE equals or exceeds the threshold TNE, he is a

1079 245

poorer performer. Figure 2 can be used to see if any element of his TNE falls into the poorer performance space.

4) If there is some question about the quality of performance, construct a profile of causally linked events over the study period, and test the TNE per month (or for a longer period) toward the end of the period against the threshold established for poorer performance. If the licensee exceeds the threshold limit for several periods, he should be treated as a poorer performer, at least temporarily.

5) If the TNE per month test is inconclusive, use Figure 3 to locate the licensee's extremes of performance (ATBE and LNE) on that performance space. A location in the poorer region means that the licensee should be handled as a poorer performer.

A Note on Expanding the Data Base

As stated earlier, the numbers - mean and standard deviations of TNE, TNE per month, ATBE, and LNE - used in this report, as well as Figures 2 and 3, are based on the 12 case studies we performed. We also stated that we used non-parametric statistics to test whether the LER performance indicators were valid and sensitive, because we could not assume that the performance groups we identified (by serious events) were representative of a normally-distributed population.

In the light of these statements, is it fair to assume that the numeric and graphic thresholds we have discussed can be used to analyze the performance of other licensees? Obviously, the best and most convincing way to answer that question is to perform further case studies and see how much the indicators shift from the values based on the 12 case examples. We would suggest that at least eight more licensees be studied to bring the total sample up to 33 percent of the power reactor population. (Ideally, all power reactors should be analyzed, since this is the goal of performance evaluation.)

But even without performing more case studies, it is safe to say that there is no reason to conclude that the performance thresholds are not applicable over the population. TNE, for example, was shown to be so different for the better and poorer performers that the "gap" between the mean ± one sigma for the two groups represented 20 events. If any licensee had 33 causally linked events in two years, he would have to be considered a poorer performer.

A realistic approach would be to recalculate the numeric indicators and add new points to Figures 2 and 3 as each licensee is analyzed. This method tracks potential shifts in the indicators without great expenditure of resources, and will result in a growing and more complete data base.

Diagnosing the Poorer Performers' Problems

Once a poorer performer has been identified, his problem areas can be pinpointed by applying the revised cause codes to his noncompliance information as presented in the inspection reports. At least at first, this will require reanalysis of each noncompliance over the same study period used to develop the licensee's TNE (we used two years), using the written, not computerized, reports.*

Once the noncompliance data has been recoded, a matrix similar to those shown in Tables 14 and 15 in Section 4 should be developed. This matrix will pinpoint the areas in which the licensee has had difficulty over the study period, and reveal trends of improvement or its lack. The inspectors can then focus their attention on the root causes of the licensee's behavior. By continuing to make entries in the matrix, the progress of the licensee can be tracked.

We also suggest that NRC develop figures similar to Figures 4 through 9 since these show the interaction between the licensee and the inspection process. By pinpointing more closely the time required to identify the noncompliances linked to a particular element (M, P, 1, or 4), these figures complement the matrices by confirming the licensee's response and assuring appropriate inspector attention.

*After the revised cause codes are in use by the inspectors in the field, the 766 file will contain all the needed information.

5.2 Two Topics Related to Performance Evaluation

Both Sections 4 and 5 have suggested that the noncompliance data, when recoded using the revised cause codes, is a powerful diagnostic tool. In fact, this tool can work both on the licensees and on the inspection process itself, and this is the first topic discussed below. The second topic is somewhat related, since it deals with the qualitative judgments that regional personnel form about licensees.

The Value of Noncompliance Data in Managing the I&E Program

The use of the revised cause codes presented in Section 4 provides diagnostic insight into licensee performance by:

1) identifying the element or relationship within the licensee's organization most often responsible for identified deficiencies,
2) identifying the licensee activity areas and programs affected by that deficient performance, and
3) displaying the interaction of the inspection process (which both detects and identifies deficient performance) with the licensee's response to citation of deficient performance.

The first two items permit I&E management to develop enforcement and inspection strategies specifically tailored to each licensee. This approach offers the potential for streamlining the process required to "turn around" a poorly performing licensee as well as a mechanism for monitoring the results of the effort. The third item has a wholly different character: the third item permits I&E management to review and evaluate the effectiveness with which these strategies are being implemented through the inspection process.

We saw in Section 2 that the LER performance indicators, at least for the 12 case study facilities, are reliable measures of performance. Using these LER indicators, it is now possible for I&E management to set relative standards for the allocation of inspection resources. It is also possible for I&E management to evaluate the effectiveness with which the various regions are implementing the inspection program. The DEP indicator (detection efficiency/deficiency prevalence) that was developed in Chapter 4, when plotted as a function of time for each FPM element, indicates whether the inspector is on the verge of identifying a problem area or whether he is "running up the score." This type of information is essential to the management of the inspection process and the efficient allocation of resources.

Unfortunately the contract resources only allowed the revised cause codes to be tested on two of the twelve case studies. Additional case studies are needed to provide a data base that can be analyzed at a level of detail equivalent to that used on the LER data. We believe I&E should seriously consider additional exploration of the concepts and methods developed in Phase II for the noncompliance data. This effort should include at the very least an expansion of the case study data base.

The Value of Qualitative Regional Judgments

Introduction

Although the NRC has never formally categorized power reactor licensees on the basis of performance, I&E regional field personnel have inevitably developed their own impressions of those licensees over whom they have cognizance. During the past few years, NRC's interest in licensee performance evaluation has grown, and I&E staff impressions have come to be regarded as a possibly important (although somewhat imponderable) factor in licensee assessment.

In order to acquire a clearer image of I&E personnel viewpoints and opinions, the NRC Office of Inspection and Enforcement sponsored a survey by Hay Associates of both regional and headquarters personnel who were involved in or associated with power reactor inspection. This survey, conducted in the fall of 1977, used a written questionnaire and included provisions to protect the respondents' anonymity. The survey focused heavily on safety related aspects of licensee operations. The respondents were asked to estimate the safety of each site with which they were familiar in terms of 10 specific areas, such as radiation protection and control, emergency planning, quality assurance, etc., and also to estimate "overall site safety." Each area was to be rated by drawing a line extending from "acceptable" toward "exceptional," with the length of the line indicating a semiquantitative subjective assessment. The questionnaire also solicited I&E staff opinion on a number of general (not site specific) safety related factors including the importance of various licensee attributes to facility safety, the importance of different areas of licensee responsibility to safety, and the importance, as a safety indicator, of compliance with NRC requirements.

The part of the survey that dealt with I&E staff perceptions of specific licensees is particularly germane to the work described in this report. Before analyzing the responses in relation to our study, a brief discussion of how the data were handled and presented will be useful. The line-length ratings of the 11 safety areas for each site were converted by Hay Associates to digital scores using a zero to one hundred linear scale. In order to compensate for possible regional differences in orientation among the I&E personnel that might influence their assessment, all respondents rated a fictitious "average" site. Each person's ratings of a real site were then raised or lowered depending on how his rating of the "average" site compared to the mean of all the respondents ratings of the "average" site. The means of the ratings for the real sites were then calculated and reconverted to a graphical display.

We assume that the appraisals of site safety in terms of the 11 areas identified in the questionnaire are identical to the assessments that would have been made had the respondents been asked to rate the same areas in terms of licensee performance quality. For example, if a respondent felt that a given site was quite safe in terms of emergency planning, this would necessarily mean that he thought well of the licensee's emergency planning operation as such. Obviously, if he had not, he would not have assigned a high site safety rating for this area. Thus we have considered that ratings assigned by the respondents to the different site performance areas represent evaluations of licensee performance in these areas.

The site ratings were presented by Hay Associates both in graphical form and as tabular data. The tabular data include individual and mean ratings for all respondents and for organizational respondent groups (inspectors, branch chiefs, HQ staff, etc). In the graphical presentations, the mean rating for each performance area is indicated by its position on a linear scale ranging from "acceptable" to "exceptional." The highest and lowest assigned ratings are also positioned on the same scale, so that each mean rating is shown in relation to the range of the perceptions from which it was derived. In a quite large percentage of the cases, this range is considerable, indicating a general absence of uniform opinion among the respondents. For example, Point Beach is one licensee whose performance we had carefully reviewed and judged to be "good." The Hay Associates survey show that the average ratings of most of the 11 areas for this site were appreciably higher than fifty, on a numerical scale of zero to one hundred. Choosing one operational area at random - quality control - the mean rating, based on ten responses, was 54.6. Of these ten, five assigned ratings of 50 or higher, and five rated quality control at lower than 50. These numbers do not, however, indicate the extent of the spread, which was considerable. Two respondents assigned ratings of 98 (this was the highest rating) and two rated the Point Beach quality control operation at 5 (this was the lowest rating). Thus this range of opinion can be numerically equated to 93 out of a possible 100. Although this is far from an isolated case, in many instances the opinion ranges were considerably smaller.

These variables ranges of opinion, together with the fact that any given range is frequently quite large, suggests two questions that must be considered in assessing the usefulness of semiquantitative subjective judgments in the evaluation of licensee performance:

- Why do the ranges of opinion vary so widely and why are these ranges often large?
- How do these variations affect the significance of the mean ratings?

These considerations are discussed below.

The Range of Opinion

At first, we thought it possible that range might be influenced, on a case by case basis, by the number of respondents assessing a particular facility, or by the average level of the raters' familiarity with the licensee. (For each rated site, the mean familiarity of the raters, as perceived by themselves, is numerically expressed on a seven point scale.) We did not perform a comprehensive analysis of these possibilities, but we did make a considerable number of spot checks for the twelve licensees whose performance we had studied. We found no evidence of systematic correlation, although in the case of Fort Calhoun, which was rated by only three respondents (the smallest number of raters for any site), the range of opinion was markedly less than for most of the other licensees.

Even though there was no demonstrable correlation of the range of the ratings with either the number of raters or their level of familiarity with the site, there are factors in the character of the survey that can readily account for the range and variability of opinion. The two most important factors, which are related in terms of their influence on the survey results, are (a) differences among indviduals in the ways in which they perceive and evaluate a given situation and (b) the lack of assessment criteria in the questionnaire that would constrict the range of these differences.

Recall that the rating population consisted of regional personnel (at all levels, from inspectors to the Regional Directors) as well as HQ staff members. It is obvious that a rater's perception of a particular site cannot be wholly independent of the rater's organizational position within NRC because he perceives each licensee within the context of his agency role. As a case in point, one of the rated areas was "cooperation with NRC." For Point Beach, the mean rating for all respondents was 30.6, with a range of 1 to 88. The HQ rating (one respondent) accounted for the 88. On the other hand, the mean for five general and technical inspectors (regional) for the same rated area was 28.2, which is substantially lower. The range for this group of five inspectors was 1 to 60.

These and other data indicate that ratings can vary significantly not only as a function of the rater's organizational role, but also among members of the same organizational group. This is understandable, because in the absence of defined rating criteria, each member of any group is free to use his own criteria, which may be quite different from those of his peers. For example, suppose that a licensee with an otherwise excellent performance record has been cited for one serious violation. One inspector might take the view that excellent performance is to be expected and that the occurrence of a major violation is a sufficient reason for assigning a low score; another might consider that high quality performance is an offsetting factor, so that he might assign a higher rating to the same licensee. This suggests that some individuals tend to be more "severe" in their assessments than others, but the matter is probably not quite that simple because differences in "severity" between two inspectors may not necessarily apply equally to all factors being evaluated. Instead, these differences may influence which factors are selected as the basis for evaluating a particular performance area. As suggested earlier, one inspector may select compliance as the <u>sole</u> parameter. Another may take into account any effort made by the licensee, beyond that required to satisfy NRC, to upgrade his performance and to reduce the risk posed by facility operation. The situation is further complicated by the fact that a given inspector, considered to be "severe," may not necessarily be <u>uniformly</u> severe with respect to all parameters he assesses because he may assign them different values as performance indicators.

Differences of this kind, among raters within the same organizational group, cannot be qualitatively identified from the survey data, but their existence can be inferred. For example, in the case of Point Beach, the inspector who assigned a rating of 1 to the licensee's attitude toward "cooperation with NRC" might, on the basis of this alone, be regarded as quite "severe." But if we examine the ratings assigned by the same inspector (identified by respondent number only) to the other operational areas, it is immediately clear that there is no reason to consider this individual generally "severe" in his evaluations. The reverse appears to be the case, because he assigned the highest ratings in his group to seven of the eleven operational areas. In the case of his quality assurance area rating, his assignment of a minimal score (1) clearly indicates that he may have focused on some particular parameter in this area that he considered important and that he assessed the licensee's performance as poor with respect to this parameter. The fact that the group ratings of quality assurance ranged from 98 to 5 strongly suggests that (a) all inspectors were not assessing the same aspects of the QA operation, or (b) they were assigning quite different levels of importance to each parameter. There is a strong implication that the members of the inspector group, in rating the areas of licensee performance, were sometimes rating them from quite different perspectives, so that the meaningfulness of the data is questionable.

Another way of examining the range of opinion associated with each of the 11 areas is to consider the ratios of the highest to lowest ratings for the same inspector group. A ratio of four, for example, would indicate that the inspector assigning the highest rating believed that licensee performance in that area was four times as "good" as the inspector assigning the lowest rating considered it to be. For Point Beach, these ratios, together with the ranges from which they were derived, are listed here

Rated Area	Opinion Ratio	Opinion Range
Overall Safety	2.7	95-35
Plant Personnel Attitude to: Maintenance of Safety	2.8	99-35
Cooperation with NRC	60.0	60-1
Technical Competence of Plant Personnel	9.0	90-10
Facility Quality (design, etc.)	14.0	99-7
Administrative Controls	8.0	80-10
Operations	1.9	99-52
Emergency Planning	1.8	95-52
Radiation Protection	1.8	99-56
Safeguards	2.5	64-26
Quality Assurance	19.6	98-5

The opinion ranges, when viewed in ratio form, appear to support the impression that the inspectors' evaluations of the different performance areas were not always based on common criteria. A group of NRC inspectors is not a random sample population: the group is characterized by several important homogeneous elements, including essentially common training, experiential background, and organizational perspective. But in spite of this commonality, it is inevitable that there will be honest differences of subjective opinion about a given area of licensee performance even when evaluated in the context of a common orientation. These differences, at their extremes, are quantified as opinion ratios. We are now faced with this question: how large can an opinion ratio become before it can no longer be explained wholly on the basis of normal divergency within a common viewpoint? While any answer might be considered speculative, it would appear from the Point Beach data that a ratio of five might err on the generous side. Six of the eleven opinion ratios in the table are below five; in fact, they are less than three. The others range from 8/1 to 60/1. The inference is nearly unavoidable that these two sets of ratios have quite different meanings. We believe that the low ratios reflect ranges of judgments of essentially similar parameters, as viewed from <u>comparable perspectives</u>.

The high ratios suggest that even _if_ similar parameters were appraised, the raters used quite different criteria in reaching their conclusions.

The implications for the general reliability of the data are obvious. As judged by the opinion ratios, the overall survey data are nonuniform in quality. For many licensees, these ratios are consistently low enough to suggest divergences of viewpoint within common perspectives. Surry is a case in point. On the other hand, the high ratios associated with Point Beach are by no means unique. As an illustration, the opinion ratios for Peach Bottom (a licensee not reviewed in our study) for the same performance areas previously tabulated for Point Beach, are, respectively, 7.6, 86, 94, 91, 3.6, 14.8, 12.3, 4.4, 16.8, 18.8 and 11.5. If a ratio of above five is accepted as indicating a lack of common perception in the assessment process, commonality is absent in nine of these eleven ratings.

The Significance of the Mean Ratings

The factors that affect the quality of the individual ratings obviously affect the significance of the mean ratings. The problem with interpreting the mean ratings as reliable subjective assessments of licensee performance depends largely on which of two hypothesis about data quality one accepts:

- If our inference that low opinion ratios reflect judgments based on comparable perspectives throughout the rating group, and that high ratios imply the converse is valid, it follows that some mean ratings may be useful indications of I&E staff perceptions of licensee performance, while others, derived from inconsistent data, are not. The mean ratings, considered by themselves, obviously provide no clue to their inherent reliability. This can be estimated only by examining the raw data. Thus, the use of a set of mean ratings as a subjective assessment of a given licensee's performance could, in a large number of instances, lead to quite erroneous conclusions about the real views of the raters.

- If the above inference is incorrect, then all sets of individual ratings must be assumed to reflect differences of opinion about comparable parameters within approximately similar perceptual contexts. In this case the opinion ratio associated with a given rating must reflect the degree of consensus about that area.

1079 256

For example, a mean of 90 with an opinion ratio of 1.8 would suggest that the raters were in general agreement that the licensee was performing well in the rated area and that the favorable assessment was, on the whole, probably reliable. On the other hand, a mean of 55 with an opinion ratio of 70 would automatically raise the question of "Who is right?" In this instance, the mean rating is not really informative. Thus, even if the individual ratings are assumed to be essentially homogeneous, the mean ratings cannot be realistically interpreted as performance assessments except within the context of the data from which they were derived.

The foregoing discussion is not intended to be critical of the basic concept of subjective licensee assessment by the I&E staff, although we believe that more consistently meaningful responses to future surveys could be obtained if the survey instruments include criteria to be used when rating specific performance areas. We suggest that both the reliability and informational value of future surveys can be enhanced by basing the survey instruments on the FPM model, including the revised cause codes and other mechanisms developed for the systematic processing of LER and inspection data and for the analysis of the findings. We also suggest that respondents be permitted to offer judgments of "unacceptable" with respect to specific performance areas they believe are operating submarginally. Such judgments could serve to alert both the NRC and the licensee to areas where prompt corrective action was most urgently required.

Using the FPM model and its related methodology as the base for any future survey is recommended for these reasons:

- Using the model provides a reliable assessment of licensee performance quality and also identifies the organizational elements responsible for performance deficiencies.
- Since the FPM methodology defines both the categories of data to be used in the assessment process and the way in which this data is to be analyzed, its use in the survey process will reduce differences among respondents that are attributable to varying orientations, regional and organizational affiliations, and other factors that might impair the quality of the survey data by introducing heterogeneity. The net effect should be to enhance the reliability of mean ratings as indicators of licensee performance quality.

It is probably evident that the more closely a survey instrument design reflects the FPM model methodology, the more it will tend to restrict the latitude offered the respondent for purely "subjective" judgment. But we do not feel that the use of the FPM methodology would or should exclude all contributions to licensee assessment based on inspectors' observations. The following is an example of one such kind of observation, identified through the careful study of a large number of I&E reports. An inspector may call the licensee's attention to minor shortcomings in performance which may not lie clearly within the scope of NRC's regulatory requirements. Subsequent inspection reports may indicate the nature of the licensee's response, showing that he either ignored the inspector's comments, or else took appropriate action to correct whatever shortcomings were identified. Information of this kind is extremely useful because it can aid NRC in distinguishing the licensee who does only what is necessary in order to meet the Agency's requirements from the licensee who will do anything that is reasonable in order to enhance the safety and overall quality of his operation, whether or not his action is formally required. This categorization of licensees can indicate facility management attitude, particularly with respect to motivation. Such indications can also be derived from application of the FPM methodology, but there is real value in having these confirmed through independent observation.

In general, we have found that I&E reports contain considerable amounts of information (beyond identifying noncompliances and other specifically regulatory matters) that could be quite valuable in supplementing conclusions based on applying the FPM methodology. But there is currently a real difficulty in using this information in a comprehensive and systematic manner because of the considerable variation among inspectors in the ways in which they discuss different topical areas and, to some extent, in the type of nonregulatory data they acquire during their site inspections. These variations appear, in part, to reflect differences among inspectors with respect to the relative importance they may assign to different nonregulatory matters. (There is a much higher degree of uniformity among inspectors in their treatment of noncompliance items.) If nonregulatory matters discussed in I&E reports are to supplement licensee performance analysis, report preparation, including the identification of appropriate topical areas, must be made more uniform to minimize individual and/or regional differences in perspective.

APPENDIX

TWELVE CASE STUDIES

The nine case studies performed in Phase II are represented here together with the three case studies completed in Phase I. In each case study, the LER analysis precedes the discussion of the noncompliances.

For each licensee, we have included three profiles, all based on LER data: profiles of events due to human error, of events attributable to component failure, and of total causally linked events over the study period.* We have deleted the system profiles and the noncompliance profiles that were used in Phase I. The reader is urged to compare the profiles.

---

*Profiles of causally linked events are not included for San Onofre or Point Beach, because they had few if any causally linked events. Also, profiles do not include events in Ultimate Heat Sink or Circulating Water Systems.

1079 260

ARKANSAS UNIT I CASE STUDY

Review of the LER File for Arkansas Unit 1

In 1976 and 1977, 61 events occurred in 26 systems, as shown in Tables A-1 on page A-10. The licensee attributed 29 of these events to personnel or management error All of the other events, with three exceptions, were ascribed to component failure we upgraded 20 of these to human error. The reported events were distributed among the 26 systems so that no single system was the origin of a large number of events. The Reactor Coolant Cleanup and the Spent Fuel Pool Cooling Systems each had five reported events. The other systems generated one to four events each, with an average of 2.1 per system. In the case of the Spent Fuel Pool Cooling System, all five events were attributed, either by the licensee or by Teknekron, to management error (ERC-M). The events associated with the Reactor Coolant Cleanup System were ultimately coded as ERC-M in three instances and ERC-F in the other two.

Spent Fuel Pool Cooling System

The five events reported for this system occurred between 9-26-76 and 11-25-77. all were due to leaks. Furthermore, in three of the cases, the leaks were attributed to defective welds and were coded by the licensee as "design fabrication error" (ERC-M). The third, curiously, was coded by the licensee as "other." In analyzing the LERs associated with this system, it became evident that the leak events began prior to the time period studied (1976-77). The first LER submitted during this period (9-26-76) stated that "During load changes, leaks in spent fuel pool cooling system were discovered. Leak on outlet nozzle of cooler E27B was caused by 3 cracks." Significantly, it also states "Event similar to 75-7 and it appears that cause may also be similar." In the event that took place on 5-5-77 (a leak in a pipe-to-pipe weld in a discharge line to the spent fuel pool), the LER stated that "This is a repetitive occurrence." It is clear that management was aware of the recurrent nature of the problem, but the LERs do not indicate any generic approach to a solution. Rather, each leak was repaired on a case-by-case basis with no evidence of an evaluation of all welds in the system. On this basis, we assigned ERC-M in those instances in which the licensee assigned a lower code.

Reactor Coolant Cleanup System

Four of the five reported events associated with the reactor coolant cleanup system were caused by leaks. These occurred during a period of somewhat over a year (6-22-76 through 8-24-77). In the description of the first event in this series, the LER stated that "A leak was discovered in a socket weld, pipe to 90 degree elbow weld, in primary makeup pump P36C suction relief line." It also stated "Cause not determined at this time. New section of piping and elbow were installed." The licensee cause coded this event as "component failure." Since it was the first reported event associated with this system and the LER did not indicate a past history of similar occurrences, we did not upgrade the licensee's cause code. The second reported leak (9-2-76) was also caused by a defective weld and was cause coded "design/fabrication error" by the licensee (ERC-M).

On 10-3-76 two unrelated events occurred. One of these was the failure of a primary makeup pump due to bearing wear. This was cause coded by the licensee as "component failure" and the LER text did not indicate any justification for upgrading it. The other event of 10-3-76 is an exact repetition of the one that occurred 6-22-76, involving makeup pump P36C. In both cases the defect was located in the suction relief line. In the LER describing the recurrence of the event, the licensee stated that "Failure may be due to the fact that the 3/4" relief line is rigidly supported while the 6" suction line is not and is subjected to vibration. An engineering evaluation is being performed." This event was cause coded "design/fabrication error." However, the same conditions (vibration of suction line) probably prevailed at the time of the 6-22-76 event. The fourth leak (8-24-77) occurred in the casing drain line of "B" primary makeup pump. This was attibuted by the licensee to "component failure." However, the LER stated that "This is a repetitive occurrence" and, on this basis, the cause code was upgraded to ERC-M. As in the case of the spent fuel pool cooling system, there was no evidence of any generic approach to the leak problem.

Leak events were also reported for other systems which are discussed immediately below.

Residual Heat Removal System

Three events were reported for this system during the period 5-26-76 through 12-03-77. All were caused by leaks. The first event was a leak at a pipe to valve weld and was attributed by the licensee to ". . . excessive vibration or improper fitup." It was coded in the LER as "design/fabrication error." The second LER reported that "During cold shut down, minor leaks were found in welds on valve DH-1401A and vent line to valve DH-1012." The cause was attributed to "Excessive vibration or improper fitup." However, the licensee cause coded this event as "component failure" rather that "design/fabrication error" as had been done in similar instances. In the third event, leaks occurred in a valve vent line (neither of the valves involved in the second event). Again, the licensee attributed this to vibration and also, again, cause coded the event as "component failure." We upgraded these latter two event codes to ERC-M.

Feedwater System

Two events occurred in this system, one on 6-24-76 and the other on 9-14-76. The first event, which involved a leak in an emergency feedwater line, was attributed to electrolysis or corrosion. The licensee cause coded this event "design/fabrication error," probably correct because of the electrolysis between the pipe and rebar in the concrete floor. The second event was wholly unrelated and involved a three minute operation at a power level above the cutoff point. This was attributed by the licensee to "personnel error."

Liquid Radioactive Waste Management System

Three events, of which two were leaks, were associated with this system. All occurred during July-August 1976. The first reported leak (7-7-76) occurred in the resin sluice line and was attributed to "improper welding" and cause coded "design/fabrication error." The second reported leak (8-10-76) was detected in the welding zone at the outlet of the Y strainer. It was stated that "This is similar to [the 7-7-76 leak]," although the texts suggest that the second leak was considerably smaller than the first. The licensee did not identify a physical cause for the second leak, and coded it as "component failure." We upgraded this code to ERC-M. The third event (8-14-76) was a cumulative release of 5.2 curies in liquid effluents to the environment; the ETS limit is 2.5 curies). The licensee coded this event as "other," but it would appear that with proper management the event could have been avoided. The LER states that "Liquid releases to the environment were terminated on 8-16," which is obviously inconsistent with the report date of 8-14. In any case, the licensee said that "For the remainder of the quarter it (the liquid radwaste) will be shipped off-site by truck." We upgraded this event to ERC-M.

Reactor Containment System

Only one event was reported for this system, which occurred 7-12-76. The contents of sodium thiosulfate tank T-9 were found to be below the 37,500 pound limit by somewhat less that 1,000 pounds. Makeup sodium thiosulfate was added. The licensee stated that "A leak from T-9 into reactor building spray system is suspected." The event was cause coded as "component failure." In view of the fact that this event occurred only once during the period covered by the analysis (1976-1977), the licensee's cause code was not upgraded.

Coolant Recirculation System

Three leakage events occurred in this system, two due to seal failures and one due to a weld failure. The first seal failure (8-16-76) was serious in that the reactor had to be brought to cold shutdown. The LER stated that "Previous seal failures have occurred but none of this magnitude." The second seal failure occurred on 12-3-77. The LER stated that "This is a recurring problem." Both events were cause coded "component failure" by the licensee. The causes codes were upgraded in each case to ERC-M because management was apparently quite familiar with the problem but had not attempted to deal with it generically. The third event was a small leak caused by a defective pipe-to-flange weld. This was cause coded "other;" in our judgment, "design/fabrication error" would have been more appropriate. We upgraded the cause code to ERC-M.

Containment Isolation System

Three events were reported for this system between 3-31-77 and 11-25-77. The last of these involved a pipe leak that was validly cause coded "component failure" by the licensee. The second event (7-26-77) involved isolation valve leakage. The licensee stated "It appears that foreign matter may have caused the isolation valves not to perform properly." The event cause was upgraded from "component failure" to ERC-P.

Containment Heat Removal System

Four events were reported for this system of which all had originally been cause coded "component failure" by the licensee. All but the first were upgraded to ERC-P or ERC-M. The second event involved improper operation of the reactor building chilled water inlet isolation valve (CV-6202). The LER stated that "inspection of the solenoid valve revealed foreign material which prevented positive actuation." This suggests lack of proper maintenance, rather than component failure in the usual sense. The last two events

1079 265

were cooling fan failures caused by "lack of bearing lubrication." For the first fan failure event, the LER stated that ". . all four fans will have the bearings lubricated on a frequent schedule." Apparently there had been no preventive maintenance program of this kind in effect. The LER describing the second fan event (11-22-77) states that "RB cooling fans were placed on lubrication schedule since VSF-1A failed 6-2-77." The first fan failure was assigned an upgraded cause code of ERC-M. The second was upgraded to ERC-P because of the apparent failure of personnel to implement the lubrication program.

Hangers, Supports, Shock Suppressors, Snubbers

Three events were reported, each of which related to hydraulic shock suppressors whose reservoirs were found empty. The LER describing the second event is somewhat contradictory: it first states that "Leaks will be repaired and suppressors will be inspected at the next shutdown." However, in the identification of cause which follows the event description, the exact words are: "Reservoirs were not filled by manufacturer, ITT Grinnell." If the latter statement is correct, how could there have been a leak? In the first and third events, in which the empty reservoirs were obviously due to leakage, it was stated that various parts (O rings, gaskets, etc.) would be replaced with polyethylene components. Original material, at least that of which the gaskets were made, was polyurethane. The date of the first event, which triggered the idea of material change, was 4-8-76. The date of the third event, in which the same change was proposed, was 12-29-77. It cannot be determined from the LERs whether polyethylene actually proved more durable and why, if it did so prove, the replacement was not immediately performed on a generic basis to avoid future problems. The first two events were coded by the licensee as "design/fabrication error." The third was attributed to "component failure." This code was upgraded to ERC-M.

Reactor Auxiliary Cooling System

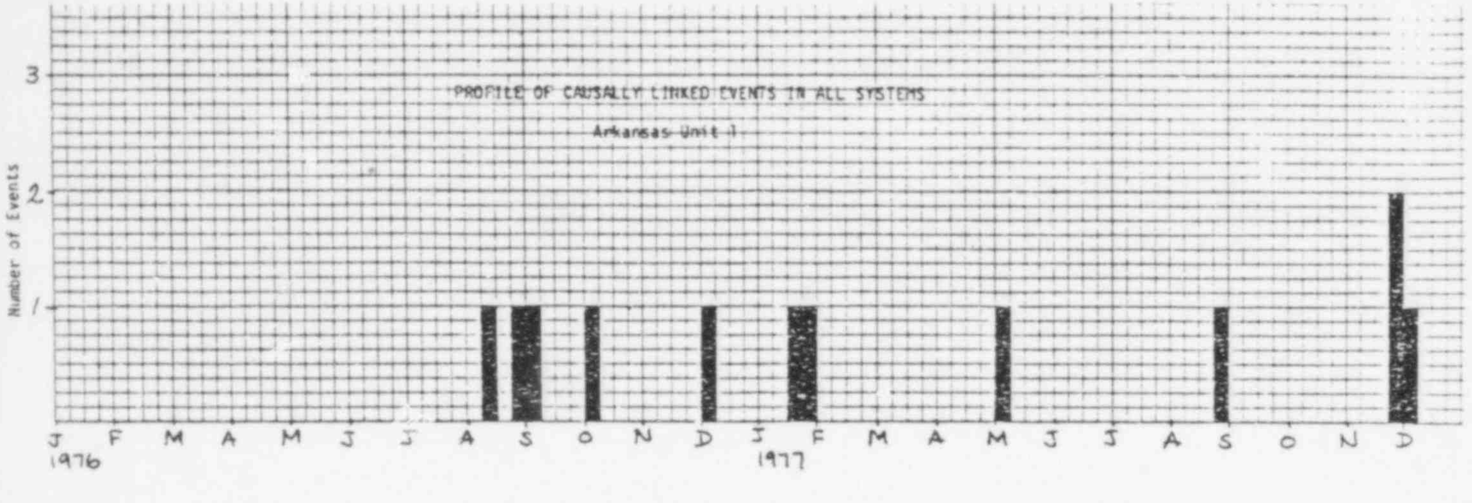
One event occurred in this system, involving improper operation of a chilled water inlet isolation valve. The air solenoid was found to be dirty. However, after cleaning, the valve still did not operate correctly and was replaced. This event is striking similarity to the second event associated with the containment heat removal system cited earlier. Th LER stated that "This event was a repetitive occurrence," and the two events are probably causally linked. The cause code was upgraded from "component failure" to ERC-M in view of management's awareness of the repetitive character of the problem.

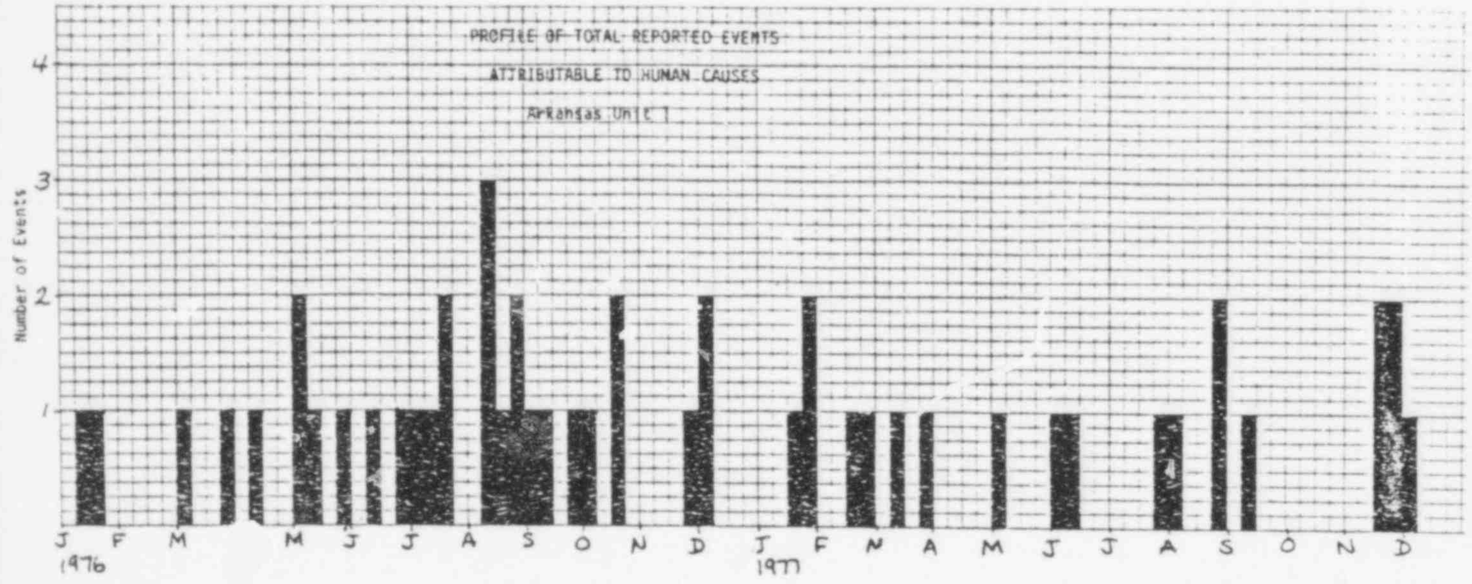
Overview

In contrast with some of the other licensees reviewed, in no case was a large number (such as ten or more) of events reported for any single system, and in 13 of the 26 systems, no more than two events were reported for the period covered by the analysis.

However, the percentage of leak-related events was unusally high (about 31%). Further, about 53% of these events were attributable to defective welds. Therefore, the historical origin of many of these leaks is associated with the construction, not the operation of the facility. This raises some question about the thoroughness and effectiveness of the licensee's QA performance during plant construction.

POOR ORIGINAL





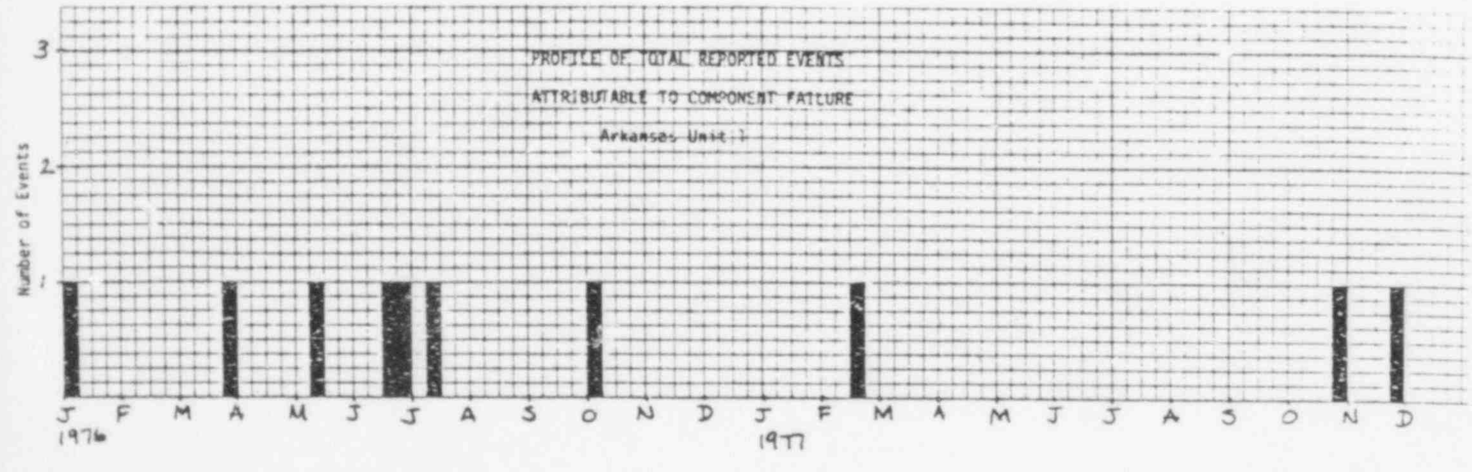


FIGURE A-1

Arkansas Unit 1 Performance Profiles

TABLE A-1

ARKANSAS UNIT 1 LERs

Reactivity Control System	Safety Injection System	D.C. On-Site Power	Reactor Trip	Reactor Vessel	Engineered Safety Feature	Other Systems
01/05/76(F)	1/20/76(P)	3/01/76(M)	3/28/76(F)	3/25/76(M)	5/12/76(F/M)[1]	5/5/76(M)
7/14/76(P)					7/16/76(P)	
11/23/77(O/P)					6/12/77(M/P)	

TABLE A-1 (Continued)

Control Room Habitability System	Emergency Generator System	Residual Heat Removal System	Chemical Volume Control and Liquid Poison System	Reactor Cooling Cleanup System	Feedwater System
5/6/76(M)	5/11/76(F)	5/26/76(M),(L/W)	6/12/76(F/P)	6/22/76(F)(L/W)	6/24/76(M),(L)
7/22/76(M)	11/22/76(0/P)	8/28/76(F/M)[4](L/W)	2/19/77(F)	9/2/76(M)	9/14/76(P)
1/24/77(M)	8/5/77(M)	12/03/77(F/M)[12](L/W)		10/3/76(F)	
	10/23/77(F)			10/3/76(M)(L)	
				8/24/77(F/M)[8](L)	

Containment Heat Removal	Liquid Radioactive Waste Management System	Reactor Containment	Hangers, Supports, Shocks Suppressors, Snubbers	Coolant Recirculation	Miscellaneous (Surveillance Test Schedules)
6/28/76(F)	7/7/76(M)(L/W)	7/12/76([illegible],(L)	4/8/76(M)	8/16/76(F/M)[3](L)	8/23/76(M)
10/21/76(F/M)[6]	8/10/76(F/M)[2](L/W)		8/10/76(P/M)	1/28/77(0/M)[8](L/W)	10/20/76(M)
6/2/77(F/M)	8/14/76(0/M)		11/29/77(F/M)	12/3/77(F/M)[8](L)	10/1/77(0)
11/22/77(F/P)[10]					

TABLE A-1 (Continued)

Spent Fuel Pool Cooling System	Mainstream Isolation System	Reactor Auxiliary Cooling System	Reactor Core Fuel Elements	Air Conditioning and Heating and Ventilating System
9/26/76(M)[5],(L)	1/10/77(O)	2/18/77(F/M)[9]	2/24/77(M/P)	3/10/77(M)
12/1/76(M)[2],(L,W)				9/6/77(M)
1/20/77(M)[7],(L,W)				
5/5/77(O/M)[7],(L,W)				
11/25/77(F/M)[11] (L)				

Containment Isolation System	Containment Combustible Gas Control System
3/31/77(P)	8/26/77(P)
7/26/77(F/P),(L)	
11/25/77(F/L)	

TABLE A-1

ARKANSAS UNIT 1

NOTES:

1. Valve failure due to inadequate maintenance.
2. Repeat of leak occurrence.
3. These seals were known to have failed previously. No generic approach.
4. Recurrence of cracked welds.
5. Recurrence of similar event in 1975 (leak).
6. Failure of maintenance procedures to ensure cleanliness of air supply lines.
7. Another defective weld in this system.
8. Repetitive occurrence.
9. See #6.
10. Second fan failure due to lack of bearing lube even though items were placed on lube schedule on 6/2.
11. Another leak - see # 5.
12. Design/fabrication error.

1079 272

Review of Inspection Reports and 766 System Data File for Arkansas Unit 1

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found a total of 43 inspection reports detailing the results of NRC I&E inspector findings. Twenty-one of these reports identify a total of 32 items of noncompliance, not including inspections relating to physical protection.

Matrix A-1 summarizes the findings of each inspection report and associated 766 system data file entries that identify noncompliances, as well as reports in which LERs were reviewed. Not including those noncompliances due to physical protection, 20 noncompliances were assignable to ERC-M and 12 were assignable to ERC-P.

There was total agreement between the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details" section of the inspection report. The inspector's perception of the underlying cause of the noncompliance and his ability to communicate that perception in terms of the available cause codes (Primary Cause of Violation) listed in enclosure D of MC 0535 is readily apparent. In general, there was good agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report, and there was total agreement between the noncompliance cause code in the 766 system and the 766 enforcement text.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In no case did a noncompliance result from inspector followup on an LER. Only two noncompliances resulted from licensee identification of new or modified procedures to the inspector. In this case study, only about 6 percent of the noncompliances resulted from possible inspector cues; cues did not play a substantial role in identifying noncompliance items.

For 16 percent of the noncompliance items, licensee remedies to prevent recurrence of the event were specified in the inspection report, while 53 percent of the noncompliance items were addressed in a subsequent letter. Generally, those items for which an immediate remedy was identified were those for which the licensee was in strong agreement with the inspector's findings.

The licensee's action on previously identified enforcement items was deficient 50 percent of the time at each inspector visit in which these items were reviewed. In reviewing LERs, the inspector never disagreed with the licensee's reporting. There were no events due to human failure that were serious from the regulatory point of view.

MATRIX A-1

NAME ARKANSAS UNIT 1

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7601	FJD2	M	Yes	Yes	Yes	No	No	No		
7602									1 item - closed	
7605	FJJ3	M	Yes	Yes	Yes	No	No	In a followup letter		
	FPE2	P	Yes	Yes	Yes	No	No	In a followup letter		
	FJF2	N	Yes	Yes	Yes	No	No	In a followup letter		
	DDD3	M	Yes	Yes	Yes	No	No	No		
7606			TWO ITEMS OF NON-COMPLIANCE ARE IDENIIFIED IN INSPECTIUN REPORT BUT NOT IN 766 SYSTEM DATA FILE			No	No	In a followup letter		2 items-agree
	FPF2	P	Yes	Yes	Yes	No	No	In a followup letter		
	ECG3	P	Yes	Yes	Yes	No	No	No		
7607	FPF2	P	Yes	Yes	Yes	No	No	In a followup letter		
7608										2 items-agree
7610	ALC2	H	Yes	Yes	No	No	No	In a followup letter		

1079 275

POOR ORIGINAL

MATRIX A-1 (Continued)
NAME ARKANSAS UNIT 1

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7610	ALB2	M	Yes	Yes	Yes	No	No	In a followup letter		
7611		NOT AVAILABLE IN DOCKET FILE								
7614	FJE2	M	Yes	Yes	Yes	No	Yes	No		
	FDL3	M	Yes	Yes	No	No	No	No		
7615	EEB2	P	Yes	Yes	Yes	No	No	Yes	1 item-open 3 items-closed	
	EEA2	H	Yes	Yes	Yes	No	No	In a followup letter		
7616									5 items-closed 1 item-open	
7617	EEB2	P	Yes	Yes	Yes	No	No	In a followup letter	3 items-open 3 items-closed	
7701										
7702	EEB2	P	Yes	Yes	Yes	No	No	In a followup letter	3 items-closed	
7703	ETB3	M	Yes	Yes	No	No	No	Yes		
7704	EEC2	P	Yes	Yes	Yes	No	No	No		

1079 276

MATRIX A-1 (Continued)

NAME ARKANSAS UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7705	EEB2	P	Yes	Yes	Yes	No	No	In a followup letter	2 items-closed	
7708	FEH2	P	Yes	Yes	Yes	No	No	In a followup letter	1 item-closed	
	FEL2	M	Yes	Yes	Yes	No	No	No		
7709	EEB2	M	Yes	Yes	Yes	No	No	Yes	1 item-open	
	FPF2	M	Yes	Yes	Yes	No	No	Yes		
7710	FJN2	M	Yes	Yes	No	No	No	In a followup letter	5 items-agree	
	EEB2	M	Yes	Yes	Yes	No	No	Yes		
7711									3 items-clo[illegible]	
7712	FPF2	M	Yes	Yes	Yes	No	No	In a followup letter		
7713	EEB2	P	Yes	Yes	Yes	No	No	In a followup letter	2 items-open	6 items-agree
	FPE2	M	Yes	Yes	Yes	No	No	No		
7714	FJD2	M	Yes	Yes	No	No	No	No	1 item-open	

1079 277

MATRIX A-1 (Continued)

NAME ARKANSAS UNIT 1

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7721	FJE2	P	Yes	Yes	Yes	No	No	In a followup letter		
7722	FPG2	M	Yes	Yes	Yes	No	Yes	In a followup letter		
7724									2 items-closed	4 items-agree
7725	FPE2	M	Yes	Yes	Yes	No	No	No		

1079 278

DUANE ARNOLD UNIT 1 CASE STUDY

Review of the LER File for Duane Arnold Unit 1

During 1976 and 1977*, 186 vents occurred in 30 systems, as shown in Table A-2 on page A-31. Ninety-five of these events occurred in 1976, and 91 in 1977. The Engineered Safety Features Instrument System, the Main Steam Isolation System, and the Emergency Core Cooling System each had 17 or more events. Three other systems each had between 11 and 14 events and six more systems each sustained between six and nine events. Thus these 12 systems accounted for more than 75% of the events at Duane Arnold; the first three systems alone accounted for more than 30% of the events.

Furthermore, every system with six or more events displayed causally linked events; in some cases, substantial numbers of linked events extending over long periods. Seven of the 18 systems with 5 or fewer events also had events that were causally linked.

Emergency Core Cooling System

This system had 20 events in 24 months. The licensee attributed six events to human failure and the rest to component failure or external causes. We identified three groups of causally linked events. The first group is:

Date (licensee code/ERC)
02-16-76 (F)
09-14-76 (F/P)
11-01-76 (F/P)
12-07-76 (F/M)
02-13-77 (M)
03-09-77 (F/M)
03-14-77 (F/M)
11-08-77 (F/M)

*Duane Arnold Unit 1 began operation on 02-75, and hence did not have two years' operating experience before 01-76. However, I&E requested that we study Duane Arnold for the full two-year period. The reader should keep in mind that this is a relatively new plant.

The licensee stated the cause of the 02-16-76 event as "instrument drift" of a Barton pressure differential indicating switch. On 09-14-76, a Barton PDIS failed in the tripped condition after drifting grossly when the fill fluid leaked out of the seal between the bellows unit and the switch frame. On 11-01-76, another Barton PDIS had drifted, and the licensee stated that future test results would be monitored to see if further action were needed. The event of 12-07-76 was identical; the licensee submitted a tech spec change to eliminate testing the negative side of the switch because the "incorrect [negative] setpoint had no effect on system operation as the high flow condition will always present a positive value."

On 02-13-77, the needle of a Barton PDIS was sticking on a protruding lock-screw. On 03-09-77, the licensee mentioned that the drift problem was repetitive and that the PDIS internals were to be replaced. The event of 03-14-77 was caused by a sticking microswitch in the PDIS; again, a new switch was to be installed. On 11-08-77, an identical event occurred, when the microswitch was "out of adjustment slightly."

The second group of causally linked events is:

Date (licensee code/ERC)
09-21-77 (M)
12-20-77 (O/M)
12-27-77 (O/M)

During surveillance testing on 09-21-77, the HPCI turbine would not develop sufficient RPM to produce the required flow and pressure. The operating instructions required the turbine and pump bearing oil supply throttling valves to be fully open, which produced insufficient oil pressure. The other events were identical. On 12-20-77, the licensee made minor adjustments to the throttling valve and other instrument settings; the HPCI system operated satisfactorily following these adjustments. On 12-27-77, the licensee stated that they could not positively identify the cause, but that the most probable cause was wear in the turbine shaft-driven oil pump. They raised the setpoint on the auxiliary oil pump cutoff pressure switch to extend the oil pump run time.

The third group of two causally linked events occured on 06-14-76 (P) and 02-19-77 (P/M). In both cases, personnel left blocks in relays after surveillance testing. In the second event, the licensee stated that "the technician has been counseled and advised disciplinary action may be taken next time."

Two other events, though not causally linked, deserve comment. On 12-20-76, the HPCI turbine tripped on fast start with a high flow indication. "High flow PDIS setpoints were corrected and HPCI system tested satisfactory. Plant personnel to be reinstructed on requirements for post-modification testing. Surveillance test performed three days earlier inserted new PDIS setpoints. Setpoints reversed due to procedure error. Procedure corrected. Contributing cause was lack of post-modification test."

The event of 02-11-77 also involved several factors. "During surveillance testing, 'A' core spray system inadvertently initiated. Due to discharge piping not being completely filled, a water hammer caused stress which resulted in the clutch housing of MOV2115 fracturing. 'B' core spray system operable. More ductile clutch housing installed. System integrity analyzed to be unaffected. [Cause:] Unknown. Subsequent testing did not duplicate occurrence. Probable cause of initiation was shorted contacts when jumpers were removed. Discharge piping not full due to leaking bypass test valve which was repaired."

Engineered Safety Features Instrument System

This system revealed five groups of causally linked events.

The first group consisted of two events a little more than one week apart. On 06-08-76, the low level switch in the condensate storage tank failed due to condensation collecting in the junction box. The condensation apparently entered the box through an unsealed penetration where the sensor wires enter the storage tank. The switch was dried and tested. On 06-16-76, an identical event occurred; this time an algae-like growth was discovered on the probe, which lowered the resistance sufficiently to give an erroneous indication of water.

The second group of events occurred on 07-14-77 and 07-15-77. On each occasion, the "A" emergency service water pump became inoperable when the river water temperature exceeded 89.9°F. The pump design is inadequate for high water temperature conditions, and the licensee stated that a design review was in progress.

The third and fourth groups of events involve instrument drift. On 02-17-77 and 07-22-77, a GE timer drifted out of tolerance. The licensee linked the occurrences to a similar event on 08-18-76 in the Emergency Core Cooling System, and on 07-22-77, replaced the timer. On 01-05-76 and 01-05-77, a Yarway switch was out of tolerance. While these occurrences are a year apart and may in fact represent genuine instances of component failure, the reports submitted by this licensee show a pervasive pattern of setpoint drift and maladjusted instruments. This will be discussed at length below.

The fifth group of events is linked by the common thread of lack of attention to detail. These events occurred on:

Date (licensee code/ERC)
08-09-76 (P/M)
08-16-76 (P/M)
10-24-76 (P/M)

On 08-09-76, leads to an annunciator were found unconnected. The leads were previously installed as part of a design change and provided an alarm function. The change was not properly completed, because "these leads were in an unconspicuous location and [were] not noticed by the man making the

1079 282

terminations." On 08-16-76, an alarm card for a core spray sparger differential pressure instrument was found pulled. The alarm card had been pulled to stop an intermittent annunciation during shutdown. It had not been logged as pulled and had not been reinserted before plant startup. On 10-24-76, a high voltage cable was found disconnected; test jacks had been installed 10 months earlier to eliminate the need to disconnect this cable during tests.

Main Steam Isolation System

Twenty events occurred in this system in 24 months. We identified five groups of causally linked events that included 18 of the 20 events. The first group of causally linked events is:

Date (licensee code/ERC)
01-28-76 (F)
06-22-76 (P)
07-26-77 (F/P)

These events involve Rosemont Engineering Co. temperature indicating switches. In the first event, two subchannels of the main steam line area high temperature switches tripped out of calibration. On 06-22-76, four channels tripped and were out of calibration by approximately the same amount. The licensee concluded they were miscalibrated at the previous testing. On 07-26-77, one channel tripped out of calibration.

The second group of two events involved problems with Rockwell Manufacturing Co. main steam isolation valves. On 03-09-76, six MSIV's were leaking above the tech spec limit due to surface irregularities on the main and pilot seats. On 06-14-76, one of these valves was found to be out of adjustment when it failed to close within the specified time.

A third pair of linked events involved Barton Model 288 pressure differential indicating switches--the same equipment that was drifting in the first group of eight events described above in the Emergency Core Cooling System. On

11-09-76, a main steam line high flow PDIS tripped out of adjustment. The licensee remarked that "this was the first instance of drift with this switch." That statement is true for <u>this</u> system, but three events involving the switch in the ECCS had already occurred. On 01-12-77, 12 of 16 main steam line high flow instruments were out of calibration. The licensee stated that functional surveillance test requirements for these switches would be modified, and setpoint lock screws would be installed.

The fourth group of linked events occurred on 10-21-76 and 10-22-76. On 10-21, while attempting to cycle a motor operated valve, the thermal overload relay tripped. There was no accuracy tolerance for the setpoint, which was at normal operating current. The licensee increased the setpoint slightly, and remarked that the problem had occurred several times with other relays during initial startup. On the same day, an identical valve would not indicate closed and a second valve would not operate. Their control relays were drooping from their sockets because they were mounted horizontally. Spring clips were added to the relays. On 10-22-76, it was discovered that the mountings for these relays did not meet seismic requirements. Spring clips were added; the licensee stated that "mixup in drawing and documentation control at NSSS vendor [resulted] in the spring clips not being specified or supplied." They also planned to institute a nonconformance review due to "this and other problems experienced with this system."

The final groups of causally linked events, involving Limitorque valve operators, is:

<u>Date (licensee code/ERC)</u>

05-20-76 (O/P) 4 events
10-15-76 (M)
10-29-76 (F/M)
11-04-76 (F/M)
11-12-76 (F/M)

1079 284

The four events that occurred on 05-20-76 all involved Limitorque valve operators for the main steam leakage control inlet valves. Four valves did not open fully because limit and torque switches on the valve operators were out of adjustment. Then two valves cycled inadvertently when the adjacent valve was being tested: the logic relay was not firmly seated in its socket. Another valve failed to cycle open for the same reason. Finally, the breaker for the valves tripped and the associated starter coil was damaged due to "binding of the mechanical interlock." Two months of weekly surveillance testing indicated that these "were not recurring problems," but on 10-15-76, MSIV-LC subsystems A, B, and D were found inoperable. The LCS MOVs were disassembled, reworked and tested during the 1977 refueling outage; the licensee stated "motor operated valves were not adequately adjusted following initial installation of system. No previous experience available on valve operators to determine optimum settings."

On 10-29-76, MSIV-LCS again failed to open and the limit switch contact pressure was adjusted. The licensee commented that this problem occurred on other switches during initial startup. On 11-04-76, a subsystem A valve would not give a fully open indication when the torque switch failed. A design change appears to have eliminated this switch on MSIV-LCS bypass and bleed valves. On 11-12-76, an identical event occurred in subsystem B; two subsystems were then inoperable and the reactor was shut down.

Reactor Core

There were 12 events in this system in 24 months; and all of them were causally linked. Their dates are given in Table A-2 on page A-31 roughly five months between clusters of events. We will not attempt to summarize each event, since the majority are similar, but we will point out specific events that illustrate the pattern.

In the first two events, the maximum critical power ratio was exceeded after rod adjustments. Tech specs were not in the control room and were not current. Events in June of 1976 also involved MCPR violations; the licensee attributed the cause to nonequilibrium xenon conditions, and stated that reactor engineering would "investigate" optimum startup conditions. In early October, the NSSS vendor informed the licensee of new operating limits; the old limits were incorrect due to vendor error. But MCPR violations continued through the end of the study period; the licensee stated that the "vendor-supplied rod pattern was not condusive to transient operation" (10-24-76) and that "MCPR violations will continue to be minimized" (05-17-77, 11-27-77).

Summary of Other Systems

A substantial number of other systems exhibited causally linked events. Rather than detail them all, they are summarized in the following table:

System	Number of Events	Causally Linked Events	Type of Linkage
Containment Isolation	11	1 group of 4 events	Failure of Rosemont temperature elements
		1 group of 2 events	MOV failure (Anchor valve)
System Code Not Applicable	14	1 group of 5 events	Failure to inspect or test
		1 group of 2 events	Shock suppressors failed because of low oil.
Reactor Core Isolation Cooling	7	1 group of 3 events	Barton PDIS switches drifting
Reactor Trip	7	1 group of 2 events	GE APRM instrument drift
		1 group of 2 events (these groups may be crosslinked)	GE voltage regulator failures
Coolant Recirculating	8	1 group of 3 events	Stat-o-ring pressure switch drift
		1 group of 2 events	GE voltage regulator failures

System	Number of Events	Causally Linked Events	Type of Linkage
Emergency Generator	8	1 group of 3 events	Diesel fire
		1 group of 2 events	Incomplete inspections
Residual Heat Removal	9	1 group of 2 events	Microswitch failures (Barksdale)
		1 group of 4 events	Pipe stress; shock suppressor failures; improper venting
Process and Effluent Radiological Monitoring	6	1 group of 4 events	Failure to assure that personnel follow procedures
Containment Combustion Gas Control	5	1 group of 2 events	Oxygen leaks
		1 group of 3 events	Cad cell leaks
AC Onsite Power	5	1 group of 2 events	Westinghouse relay drift
		1 group of 2 events	Failure to adjust setpoints
Safety Related Display Instruments	4	1 group of 3 events	Drift and failure (Honeywell)
Reactor Containment	4	1 group of 2 events	Torve level off
Station Service Water	2	1 group of 2 events	Mud and silt in ESW pit
Reactor Coolant Pressure Boundary Leak Detection	2	1 group of 2 events	Design errors
Control Room Habitability	4	1 group of 2 events	Fan blower inoperable

The foregoing table lists a substantial number of causal linkages involving instrument drift and lack of adjustments. We mentioned this situation above in the discussion of the Engineered Safety Features Instrument System. Of the 186 total events, more than 31% were attributed by the licensee to instrument drift or lack of adjustment. Given the repetitive drift of identical components, both within and across systems, the picture that emerges is oen of inadequate maintenance, apparently tolerated by or unknown to management. This is supported by the series of events (System Code Not Applicable, Process and Effluent Radiological Monitoring) revealing failure to carry out inspections on time or at all. Events in several other systems (such as 10-06-77 in the Reactor Coolant Cleanup System; 11-28-77 in the Control Room Habitability System; 11-20-77 in the Liquid Radioactive Waste Management System) carry out this pattern.

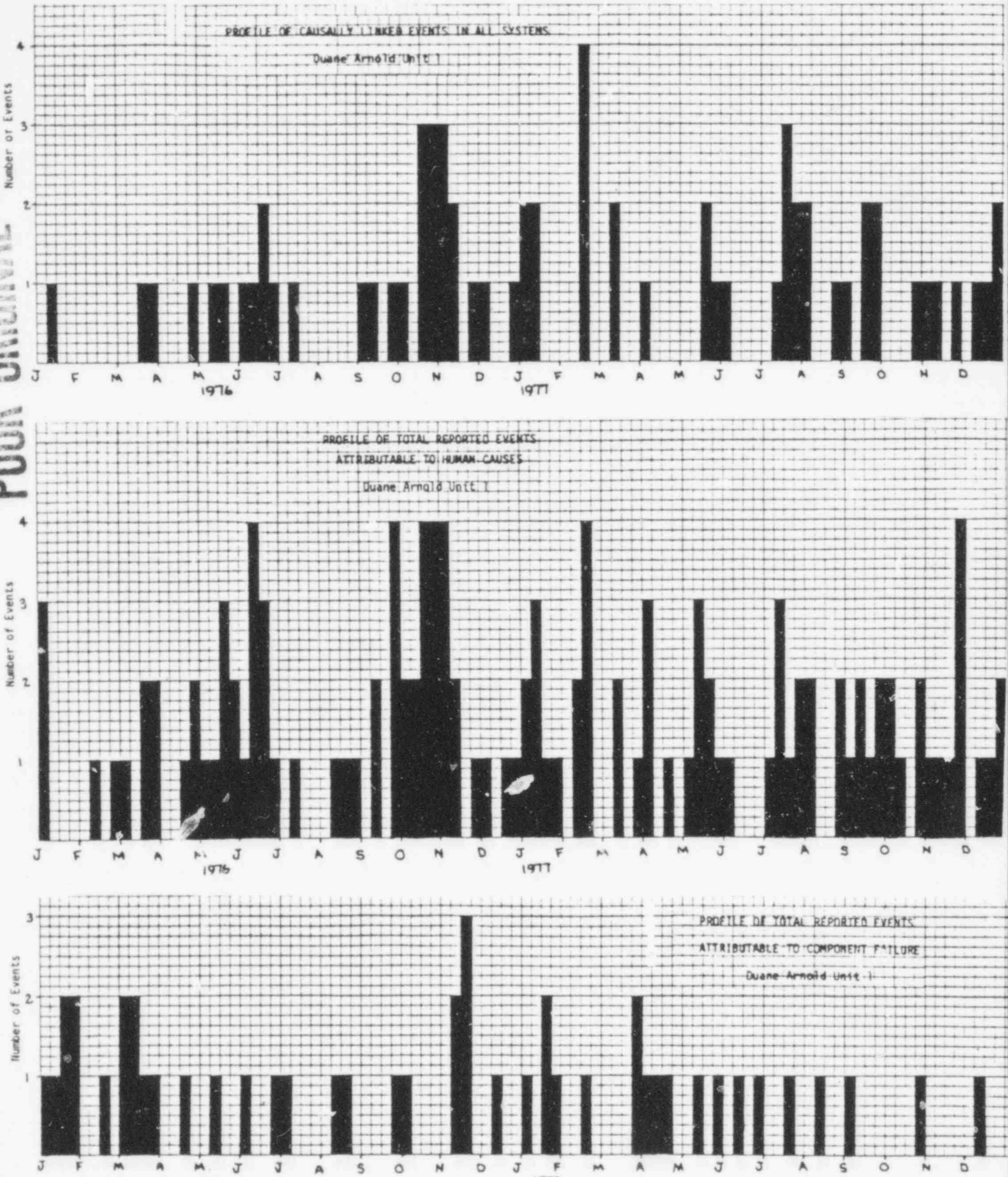


FIGURE A-2

Duane Arnold Unit 1 Performance Profiles

TABLE A-2

DUANE ARNOLD LER's

1976-77

Engineered Safety Features Instrument System	Main Steam Isolation System	Coolant Recirculating System	Emergency Core Cooling System	Emergency Generator System	System Code Not Applicable
01-05-76 (F)	01-28-76 (F)	02-14-76 (M)	02-16-76 (F)	02-27-76 (F/P)	03-02-76 (O)
01-12-76 (F)	03-09-76 (F)	10-07-76 (F)	06-14-76 (P)	03-17-76 (F/P)[1]	05-27-76 (M)
06-08-76 (M)	04-19-76 (F/P)	02-18-77 (F/M)[33]	08-18-76 (F)	10-07-76 (F/M)	06-10-76 (P)
06-16-76 (M)[7]	05-20-76 (O/P)[5]	03-22-77 (O)	09-14-76 (F/P)	11-02-76 (P/M)[18]	06-10-76 (O)
08-09-76 (P/M)	06-14-76 (F/P)[6]	03-27-77 (F)	09-28-76 (O/F)	11-04-76 (M)[20]	10-12-76 (O)
08-16-76 (P/M)	06-22-76 (P)[8]	08-04-77 (F/M)[42]	11-01-76 (F/P)	05-10-77 (F/P)	01-04-77 (P/M)
10-24-76 (P/M)	08-27-76 (M)	10-27-77 (F)	12-07-76 (F/M)[24]	05-12-77 (M)	03-27-77 (F)
11-08-76 (F)	10-15-76 (M)[13]	10-28-77 (F/P)[1]	12-20-76 (M)[25]	10-06-77 (M)	05-22-77 (O)
01-05-77 (F)[27]	10-21-76 (O/M)		01-18-77 (F)		05-27-77 (O)
02-17-77 (F)[32]	10-21-76 (M)[14]		02-11-77 (O/P)		05-31-77 (P/M)[38]
02-19-77 (P)	10-22-76 (M)[15]		02-13-77 (M)		09-04-77 (F/P)[43]
04-05-77 (F)	10-29-76 (F/M)[17]		02-19-77 (P/M)[34]		09-15-77 (P/M)[44]
04-08-77 (F)	11-04-76 (F/M)[19]		03-09-77 (F/M)[35]		10-01-77 (O)
05-12-77 (F)	11-09-76 (F)		03-14-77 (F/M)[36]		
07-14-77 (M)	11-12-76 (F/M)[21]		03-28-77 (M)		
07-15-77 (M)[1]	01-12-77 (F/M)[30]		09-21-77 (M)		
07-22-77 (F/P)[40]	07-26-77 (F/P)[41]		11-08-77 (F/M)[46]		
08-15-77 (F)			11-23-77 (O/M)		
11-28-77 (P/M)			12-20-77 (O/M)[47]		
			12-27-77 (O/M)[1]		

TABLE A-2 (Continued)

Reactor Containment System	DC Onsite Power System	Reactor Core System	Reactor Core Isolation Cooling System	Containment Isolation System	Reactor Trip System
03-03-76 (P)	03-07-76 (F)	01-10-76 (M)	01-14-76 (P)	01-16-76 (F)	01-19-76 (F)
05-28-76 (P)	01-24-77 (F)	01-11-76 (M)[1]	07-04-76 (O/F)	03-24-76 (F/P)	04-17-76 (F)
09-09-76 (P)[1]	05-26-77 (F)	06-01-76 (M)[1]	11-17-76 (F)	04-27-76 (P)	05-12-76 (F/P)[9]
06-28-77 (F)		06-28-76 (M)[1]	11-21-76 (F)	04-30-76 (P)[3]	04-18-77 (F)
		10-05-76 (P/M)[1]	06-13-77 (F)	05-03-76 (P)[3]	07-26-77 (O/M)
		10-07-76 (O/M)[12]	07-11-77 (F/P)[1]	11-22-76 (F)	09-02-77 (F)
		10-19-76 (F/M)[1]	12-12-77 (F/M)[1]	12-27-76 (F/M)[26]	09-15-77 (F/P)[45]
		10-24-76 (M)[16,1]		03-11-77 (O)	
		05-17-77 (O/M)[16,1]		04-16-77 (F/P)	
		06-05-77 (O/M)[16,1]		07-18-77 (F)[39]	
		11-27-77 (O/M)[16,1]		12-29-77 (F/P)[3]	

Containment Combustion Gas Control System	AC Onsite Power System	Safety-Related Display Instruments	Reactivity Control Systems	Feedwater System and Controls	Main Steam System
01-23-76 (F)	03-07-76 (F)	03-14-76 (F)	03-17-76 (O)	03-23-76 (P)	03-31-76 (F)
06-08-76 (F)	03-17-76 (F)	12-15-76 (F)	08-12-76 (F)		
09-03-76 (P/M)[10]	03-30-76 (O/P)[2]	08-24-77 (F/P)[1]	04-05-77 (O)		
11-12-76 (M)[22]	05-07-77 (M)	11-03-77 (F/M)[1]	05-15-77 (P)[4]		
08-06-77 (O/M)[1]	07-16-77 (P/M)[1]				

1079 291

TABLE A-2 (Continued)

Gaseous Radioactive Waste Management System	Station Service Water System	Emergency Lighting System & Controls	Control Room Habitability System	Reactor Coolant Cleanup System	Liquid Radioactive Waste Management System
05-14-76 (F)[4]	06-22-76 (F/P)	04-13-77 (O)	08-28-77 (F/P)	10-06-77 (F)	11-20-77 (P/M)
	07-13-76 (O/P)[1]		09-30-77 (F/P)[1]	10-31-77 (P/M)	
			10-11-77 (F/P)	12-27-77 (O)	
			11-28-77 (P/M)		

Residual Heat Removal System	Airborne Radioactive Monitoring System	Process and Effluent Radiological Monitoring System	Reactor Coolant Pressure Boundary Leak Detection	Turbine-Generator and Controls	Containment Air Purification and Cleanup System
6/23/76(F)	9/08/76(O)	9/30/76(P)	1/07/77(M)[28]	1/12/77(M)	4/05/77(P)
9/23/76(F)	9/17/77(O)	10/24/76(P/M)[1]	1/09/77(M)[29]		
9/30/76(F/P)[11]		11/27/76(P/M)[23]			
1/31/77(F/M)		1/17/77(O/M)			
2/20/77(M)[1]		1/22/77(F)			
3/29/77(O)		4/04/77(M)			
4/06/77(M)[37]					
9/27/77(O/M)[1]					
12/15/77(F)					

1079 292

TABLE A-2

NOTES:

1. Causally linked to previous event in system.
2. Linked to event of 03-07-76. Involve closely related Westinghouse relays, lack of adjustment.
3. Linked to event of 04-27-76.
4. Improperly classified under "System Code Not Applicable."
5. Series of four interrelated events on same day.
6. Linked to event of 03-09-76. Both involve Rockwell valves. Also linked to 05-20-76 event, in which limitorque valves out of adjustment.
7. Linked to event of 06-08-76. Indicates the treatment of 06-07 event was not thorough.
8. Linked to 01-28-76 event.
9. Linked to 04-17-76 event.
10. Linked to event of 01-23-76.
11. Linked to event of 09-23-76. Both microswitch failures.
12. Related to event of 10-05-76; vendor had miscalculated fuel element data.
13. Linked to events of 05-20-76 and 06-22-76.
14. Linked to event of same date.
15. Linked to event of 10-21. Indicates a review of entire system.
16. Improperly classified under "Reactivity Control Systems."
17. Linked to events of 10-15-76, 05-20-76.
18. Linked to event of 10-07-76.
19. Linked to events of 10-29-76, 10-15-76, 05-20-76.
20. Linked to previous events in system.
21. Linked to events of 11-04-76; see Note 19.
22. Linked to event of 06-08-76.
23. Linked to previous events in system.
24. Linked to event of 11-01-76.
25. New set points inserted, then reversed due to procedural error. No post-modification test.
26. Identical to previous event.
27. Linked to event of 01-05-76. Same switch involved.

28. Note this is a repetitive occurrence.
29. Identical to previous event.
30. Identical to event of 11-09-76. Management indicates event was repetitive and states set point lock screws to be installed.
31. Linked to events of 12-07-76 and 11-01-76.
32. Related closely to event of 08-18-76 in ECCS. Licensee made the connection.
33. Identical to previous event. Licensee states repetitive; test done as part of nonconformance review in progress.
34. Linked to event of 06-14-76.
35. Linked to events of 12-07-76, 11-01-76.
36. Linked to events of 02-13-77, 12-07-76, 11-01-76, 02-16-76.
37. Linked to events of 02-20-77 and 01-31-77.
38. Linked to event of 01-04-77.
39. See events of 05-20-76, 10-15-76, 10-29-76, 11-04-76, 11-12-76 in "Main Steam Isolation System."
40. Linked to event of 02-01-77. Licensee made the connection.
41. Linked to events of 06-22-76 and 01-28-76.
42. Linked to events of 02-18-77, 10-07-76.
43. Linked to event of 03-27-77. Licensee classified this under "Other System."
44. Linked to events of 05-31-77, 01-04-77.
45. Linked to previous event; see event of 09-15-77 in "System Code Not Applicable."
46. Linked to event of 03-14-77.
47. Linked to event of 09-21-77.

Review of 766 System Data File and Inspection Reports for Duane Arnold Unit 1

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found a total of 48 inspection reports detailing the results of NRC I&E inspector findings. Twenty-three of these reports identify 59 items of noncompliance, not including physical protection.

Matrix A-2 summarizes the findings of each of the 23 inspection reports and associated 766 system data file entries that identify noncompliances. Not including those noncompliances due to physical protection, 27 noncompliances were assignable to ERC-M, and 32 to ERC-P.

In general, the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details" section of the inspection report agreed reasonably well. About 19 percent of the noncompliance cause codes either were ambiguous or did not agree with the associated inspection report details. In three cases, the enforcement text provided for each item of noncompliance identified in the 766 system did not agree with the "Enforcement Actions" section of the associated inspection report.* There was less agreement between the noncompliance cause code in the 766 system and the 766 enforcement text: approximately 39 percent of the items bore either an ambiguous or irrelevant relationship to each other. The ambiguity was partly due to a lack of supporting detail in the 766 enforcement text, and also reflects the 19 percent ambiguity found in the relationship of the 766 system cause codes to the inspection report. This substantial ambiguity between the noncompliance cause code and the 766 enforcement text for Duane Arnold Unit 1 means that a review of the 766 enforcement text and the noncompliance cause code <u>without</u> the supporting inspection would <u>not</u> provide a sufficiently comprehensive understanding of a noncompliance and the circumstances of its origin.

*In another case, the 766 text was wholly at variance with the description of the noncompliance in the I&E report. In these analyses, the 766 and I&E report texts are considered to "disagree" when important details (exact nature of the noncompliance, technical specification citations, etc.) do not correlate precisely, even though the 766 file may reflect the report text in an overall sense. Total disagreement between the two is relatively rare.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In approximately 12 percent of the cases a noncompliance resulted from inspector followup of an LER. In another nine percent of the cases, a noncompliance resulted from a licensee-identified matter. For this case study, about 21 percent of the noncompliances resulted from possible inspector cues. While these percentages are not insignificant, the majority of noncompliances did not result from possible cues to the inspector.

For 11 percent of the noncompliance items, licensee remedies to prevent recurrence of the event were specified in the inspection report, while 80 percent of the items were addressed in a subsequent letter. In two instances, no response was required; the licensee failed to respond four times.

The licensee's action on previously identified enforcement items was incomplete or inadequate at 64 percent of the inspector visits in which these items were reviewed. On six occasions, the licensee had not resolved several items. In reviewing LERs, the inspector disagreed with the licensee's reporting of the event three times during 11 reviews (4 of 92 LERs).

There were two events due to human failure that were serious from a regulatory viewpoint:

Emergency Diesel Generator Exhaust Manifold Fires

This noncompliance resulted from the licensee's failure to take timely and adequate corrective action to stop a series of diesel fires. A portion of Inspection Report 76-05 is reproduced here:

> (Item h) On March 2, 1976, upon arrival at the site, the inspector was notified that the 1G21 (B) Diesel Generator had experienced another ignition of the exhaust manifold insulation during surveillance testing. The previous event had occurred in December 1975. The cause of the ignition was a result of oil leaking onto the insulation and eventually penetrating to the potentially hot exhaust pipe. The

1079 296

inspectors examined the diesel and noted that the new insulation that had been installed subsequent to the most recent fire was already becoming soaked with leaking oil (east side of engine). An examination of the west side exhaust manifold also revealed evidence of oil leaks and oil on the insulation. Further examination of the 1G31 (A) Diesel revealed essentially the same condition. The Licensee Event Report 50-331/75-70 corrective action included a committment to install insulation shielding to prevent oil absorbtion. No evidence of shielding was noted. When questioned, the licensee stated that the shielding had not yet been installed.

Since the diesel generators were being maintained in an operable condition and could be called upon to operate automatically, the potential for fire still existed. The inspector requested that immediate action be taken to reduce the potential of further ignitions. The licensee responded by initiating inspections every two hours by the roving operator to wipe off the leaking oil. The licensee also stated that the affected insulation on both diesels would be replaced, and adequate protection provided until the problem of the oil leaks could be alleviated.

The inspector informed the licensee that the problem of oil soaked insulation had been pointed out during an inspection in May 1975. The condition apparently was allowed to continue without adequate corrective action and resulted in an insulation fire in December 1975. The RO report specified the corrective actions that would be taken to prevent recurrence, however a second fire occurred in February 1976 apparently as a result of failure to take adequate corrective actions. Failure to take adequate corrective action regarding this matter is considered contrary to 10-CFR 50, Appendix B, Criterion XVI and the DAEC QAD 1316.1 and is included as an item of noncompliance.

The LER file indicates that a subsequent fire took place in November 1976, caused by fuel spraying on the exhaust header through a crack in the fuel line fitting.

Personnel Contamination Incidents

This noncompliance resulted from a failure to adhere to radiation work permit requirements. The inspector's review of the radiation protection logs and the radiation work permits covering the 1977 refueling outage revealed two instances of contamination. Inspection Report 77-21 states:

1079 297

(Paragraph 4.a) On April 4, 1977, operations supervisors decided that they would not follow the clothing requirements designated on the radiation work permit. Work continued in this fashion despite the objection of the Radiation Protection Engineer. Several persons received significant amounts of skin contamination during this time. On April 7, 1977, operations personnel were scheduled to start work on LPRMs. Radiation protection representatives instructed the operations personnel to obtain a radiation work permit specific for the job. The operations personnel started the job without a specific radiation work permit for LPRM work and were subsequently found to have portions of their skin highly contaminated. These persons expended a significant effort to effect decontamination, and were whole body counted several times over about a one week period to determine if internal contamination had also occurred. Analysis of the counting results indicated no significant internal contamination. This matter constitutes an item of noncompliance with Technical Specification 6.8.1.2, refueling procedure No. 16, and Plant Radiation Protection Manual, Section 6.9., because radiation work permit requirements were not adhered to.

Summary

The overall impression of this licensee, as developed from through reviews of the I&E report texts, is one of high motivation at the top management level that does not appear to be matched at intermediate management levels. A common theme, not restricted to noncompliance items, is a failure to take required actions that are clearly indicated. There also appears to be some basis for questioning the quality of personnel capability in the performance of routine operations. Several examples are presented here:

- The vice-president in charge of generation was ill and was unable to meet with the inspector. At this point, Duane Arnold (Board Chairman) assumed responsibility and personally committed the utility to correcting the problems identified by the appropriate inspector. This indicates top management willingness to take appropriate action. However, it does not necessarily imply effective followthrough in actual performance (Report 70-12).

- The most recent revisions of controlled Piping and Instrument Drawings (P&IDs) did not match the actual plan configuration existing at the time they were prepared. (This and following items are from Report 76-22.)

- One infraction cited four failures to adhere to QA Directives and Administrative Control Procedures. In two instances, management was remiss in documentation and documentation review. In the other two, personnel failed to follow procedures correctly.

- A reportable event was neither properly reviewed nor reported in the required time period.

- Three infractions were failures of personnel to adhere to procedures: a control block was not removed from a relay after test; four subchannels were miscalibrated in the Main Steam Line Area High Temperature trip logic; the HPCI Turbine Steam High Flow Trip was grossly miscalibrated.

- Management assigned certain significant responsibilities to an unqualified engineer.

- Corrective actions promised to resolve LERs and noncompliances, as well as commitments to NRC, were not audited or verified as completed. "Lack of a follow-up or verification of completion has resulted in commitments to NRC not being met" (Report 76-15).

MATRIX A-2

NAME DUANE ARNOLD

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7601	FJC2	P	Yes	Can't Tell	Yes	No	No	In followup letter	6 items-closed 3 items-open	-----
	EKB2	M	Yes	Yes	Yes	No	No	In followup letter		
	FCC2	M	No	Can't Tell	Yes	No	Yes	Not required		
7605	FCG2	M	Yes	Can't Tell	Yes	No	No	In followup letter	2 items-closed	9 items-agree
	ESB2	P	Yes	Yes	Yes	No	Yes	In followup letter		
7607	FDR3	P	No	Yes	Yes	No	No	In followup letter	5 items-closed 4 items-open	-----
	FJP3	P	Yes	Yes	Yes	No	No	In followup letter		
	FDR3	P	Yes	Yes	Yes	No	No	In followup letter		
	FDR3	P	Yes	Yes	Yes	No	No	In followup letter		
7609	----	---	---	---	---	---	---	---	1 item-closed	-----
7612	FJN2	M	Yes	Yes	Yes	No	No	Yes	3 items-closed 4 items-open	-----
7613	FPF2	P	766 Text does not agree with I&E Report.						-----	-----

1079 300

MATRIX A-2 (Continued)

NAME DUANE ARNOLD

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7613	ELE2	M	Yes	Yes	Yes	No	No	In followup letter		
	EEB2	M	No Cause Code Provided		Yes	No	No	In followup letter		
7615	FDA2	M	Yes	Yes	Yes	No	No	In followup letter	---	5 items - agree
	FJF2	P	Yes	Yes	Yes	No	No	In followup letter		
	EEB2	P	Yes	Yes	Yes	Yes	No	Yes		
	VWB3	M	No	No	Yes	No	No	In followup letter		
7617	Special	Inspection								
7621	FPF2	P	Yes	Yes	No	No	No	In followup letter	2 items-closed	-----
	FDH2	M	Yes	Yes	Yes	No	No	In followup letter		
	EEB2	P	Yes	Yes	Yes	No	No	In followup letter		
	ELA2	M	Yes	Yes	Yes	No	No	In followup letter		
	EFA2	P	Can't tell	Can't tell	Yes	No	No	In followup letter		

1079 301

MATRIX A-2 (Continued)

NAME DUANE ARNOLD

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7621	ERB2	P	Yes	No	Yes	No	No	In followup letter		
	FJJ2	M	No	No	No	No	No	In followup letter		
7622	EFA2	M	No	Can't tell	No	No	No	In followup letter	2 items-closed	5 items-agree 1 item-disagree
	EEB2	P	Yes	Yes	Yes	No	No	In followup letter		
	FJM2	P	Yes	Yes	Yes	Yes	No	In followup letter		
	FPF2	P	Yes	Yes	Yes	Yes	No	In followup letter		
	FCG2	P	Yes	Yes	Yes	Yes	No	In followup letter		
	FCE2	M	Yes	Can't tell	Yes	No	Yes	In followup letter		
	FJB2	M	Yes	Yes	Yes	No	No	In followup letter		
7626	FJG2	P	Yes	Yes	Yes	Yes	No	In followup letter	----	14 items-agree
	FPF2	P	Yes	Yes	Yes	Yes	No	In followup letter		
	EFA2	M	Yes	Yes	Yes	No	No	Yes		

1079 302

MATRIX A-2 (Continued)

NAME DUANE ARNOLD

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7626	EMA2	P	Yes	Yes	Yes	No	No	Yes		
7701	FPG2	M	Yes	Can't tell	Yes	No	No	---	---	---
7702	EEB3	P	Yes	Yes	Yes	No	No	In followup letter	19 items-closed 6 items-open	1 item-agree
	ETA3	P	Yes	Yes	Yes	No	No	In followup letter		
7703	FEM2	P	Yes	Yes	Yes	No	No	In followup letter	---	---
7705	EEB3	P	Yes	Yes	Yes	No	No	Yes	---	7 items-agree
7706	EBB2	M	Yes	Yes	Yes	No	No	No	---	---
7707	EEB2	P	NOT IN FILE							
7710	FDG2	M	No	Can't tell	Yes	No	No	In followup letter	---	8 items-agree
	FDF2	M	Yes	Yes	Yes	No	No	In followup letter		
7713	EEB3	P	No	Yes	Yes	No	No	In followup letter	---	---
	FPF2	M	Yes	No	Yes	No	No	In followup letter		

1079 303

MATRIX A-2 (Continued)

NAME DUANE ARNOLD

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7713	ELG2	P	Yes	Can't tell	Yes	No	No	In followup letter		
	EEB3	P	Yes	Yes	Yes	No	No	In followup letter		
	FDJ2	M	Yes	Can't tell	Yes	No	No	No		
	FCL2	M	Yes	Can't tell	Yes	No	No	No		
7714	FJP3	P	No	Can't tell	Yes	Yes	No	In followup letter	----	----
	EEB2	P	Yes	Yes	Yes	No	No	In followup letter		
	FDF2	M	Yes	Can't tell	Yes	No	No	In followup letter		
7715	EJA2	M	Yes	Yes	Yes	No	No	In followup letter	10 items-closed 4 items-open	16 items-agree
7716	EDA3	P	Yes	Can't tell	Yes	No	No	Yes	----	10 items-agree
7719	FCG2	M	No	Can't tell	Yes	No	No	No	3 items-closed	6 items-agree 2 items-disagree
	FJP3	P	Yes	Yes	Yes	No	Yes	Not Required		
7721	FJF2	M	Yes	Can't tell	Yes	No	Yes	In followup letter	2 items-closed	----

1079 304

MATRIX A-2 (Continued)

NAME DUANE ARNOLD

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7722	EMA2*	M	Yes	Can't tell	Yes	No	No	In followup letter	----	4 items-agree 1 item-disagree

* - Repeat Noncompliance

1079 305

FORT CALHOUN UNIT 1 CASE STUDY

Review of the LER File for Fort Calhoun Unit 1

During 1976-1977, 83 events orginated in 24 systems as listed in Table A-3. Twenty-seven of these events were attributed by the licensee to either personnel or management error. Of the 56 events the licensee attributed to component failure or external cause, we upgraded 19 to personnel or management error, and one was assigned ERC-O. The largest numbers of events were associated with the Emergency Core Cooling System (11 events) and the Reactor Trip System (12 events). The average number of events per system for the other 22 systems was 2.7. Three systems had five events each: A.C. Onsite Power System, Emergency Generator & Controls, and Engineered Safety Features System. Causally related events clearly occurred in both the Emergency Core Cooling System and the Reactor Trip System.

Emergency Core Cooling System

Eleven events occurred in this system between 2-2-76 and 10-24-77. Nine of these had originally been coded as component failure (ERC-F), one as management error and one as "other." We recoded three of these as ERC-M and four as ERC-P. For most part, these failures were attributable to such causes as dirty switch contacts, binding and misaligned relay contacts and sticking timer drive mechanisms. Four events were causally linked in that they all involved Bliss Eagle Signal timers. The dates and descriptions are:

6/29/76 "The Bliss Eagle Signal Timer relays Model No. HA-41A6-L-08 was binding which retarded the timer relay after it received its initiating signal."

3/28/77 "The Bliss Eagle timer operating mechanism was found to be sticking. The timer was exercised and returned to service."

5/02/77 "The Bliss Eagle timer operating mechanism was found to be sticking. The failed timer was replaced." [This LER is a supplement to the one above dated 3/28/77.]

8/29/77 "The Bliss Eagle Timer mechanism was found to be sticking." The timer was replaced.

Most of these events occurred during surveillance testing of the sequence timer relays in the ECCS. After the second replacement of the timer mechanism on 8/29/77, no further events associated with this component were reported.

Reactor Trip System

Twelve events were reported for this system in two years. Of these, 10 were originally attributed to component failure, one to design error and one to "other." Eight of these events were, on analysis, recoded to ERC-M. As in the case of the ECCS, most of the failures involved electronic or electrical components and the record shows no evidence that the facility management made any systematic effort to overhaul the entire reactor trip system in order to improve its operating reliability. Instead, failures were corrected on a case-by-case basis as identified. This is well illustrated by one group of causally related events, all of which involved Bell & Howell 19-301A adder/subtractor modules:

3/26/76 "The two Bell & Howell 19-301A adder/subtractor modules which are used to generate the positive and negative (limits) were found to have gone into oscillation and saturated. The positive limit module was replaced.."

3/27/76 "The Bell & Howell 19-301A adder/subtractor module which is used to generate the upper limit was found to have gone into oscillation and saturated causing the positive limit to go out of specification."

4/05/76 "The Bell & Howell 19-301A adder/subtractor module which is used to generate the upper limit was found to have gone into oscillation and saturated, causing the positive limit to go out of specification."

4/13/76 "Random noise signals caused the Bell & Howell 19-301A module to oscillate. A minor circuit modification has been implemented to prevent this oscillation from reoccurring."

In this LER the statement is made that "This event was similar to 75-12 (LER) and 74-14 (LER).

Subsequent to the "minor circuit modification" to the 19-301A module on 4/13/76, no further events were reported for this component. Apparently, the difficulty was permanently corrected.

Events reported for the remaining systems appeared to be essentially random in character, although this does not imply that personnel or management error were not causative factors in many instances, as the following examples show.

Main Condenser System

1/5/76 "Condenser evacuation pump discharge directed to hogging vent instead of stack." This was necessary because of excessive pressure drop across the hydrogen purge filter caused by moisture in condenser off gas and motive air. A design error was cited as the cause, as the system did not provide for rerouting past the filter to the stack "in event of a similar emergency." The LER stated that the system was to be appropriately modified.

7/10/76 The delta T of the river (limit of 20° F) was exceeded for ten minutes because of a failure of a condenser backwash valve. (The excess delta T (4°F) was a violation of technical specifications). The LER stated that the valve was repaired.

In both of these events, the licensee's response indicates a willingness to institute corrective action without the need for direction by NRC.

Circulating Water System

Two events were reported for this system (1-9-76 and 12-20-76), both of which were attributable to icing conditions and were validly cause coded as "external" by the licensee.

Reactor Auxiliary Cooling System

This system was the origin of two reported events (3-20-76 and 3-15-77). The first involved raw water corrosion of a pump due to "EMF series potential difference in pump materials." The licensee had cause coded this as "component failure," but in our analysis we assigned the event an ERC-M reflecting a design error. The second event also related to a raw water pump. In this case, total failure occurred due to a sheared shaft coupling. The LER stated that "erosion of pump internals increased running clearances to such a point that vibration increased, wear increased and eventual shaft coupling failure under a high torque start occurred." The "component failure" cause code assigned by the licensee was left unchanged becuase it could not be established from the LER information whether the "erosion" was galvanic in character.

Emergency Generator System

Five events were reported for this system, four of which the licensee attributed to human failure. The fifth event, a drifted airgap setting in a magnetic pickup tachometer, was coded as "component failure." A previous LER stated that this airgap had been incorrectly set. A causal linkage is possible in this case, but not firmly established.

Process & Effluent Radiation Monitor Systems

Three events were reported, all of which were cause coded as due to human error. We upgraded one of these in terms of cause code from personnel to management error because faulty test instructions were responsible for incorrect monitor set point adjustments.

Gas Radwaste Management System

Two events were reported by the licensee, both attributed to human error. One was upgraded from ERC-P to ERC-M. The licensee thought that a calculated release rate was in violation when, in fact, it later proved not to be so. The error was attributable to the assumption of "conservative alternates" by the mathematical model used.

Other Systems

Of four miscellaneous events, three were attributed by the licensee to human error. The remaining event, assigned by the licensee to "external," was upgraded to ERC-M because of an identified computer program error.

Liquid Radwaste System

One event was reported. The operator of a monitor failed to return the instrument from "calibrate" to "operate" position. The licensee correctly attributed this event to personal error.

Spent Fuel Storage System

Only one event was reported for this system during the two year period covered by the analysis. The circumstances were that "A spent fuel pool rack was transferred from the cask area to a new location to provide additional room for rack disposal. Contrary to technical specification, a portion of the rack passed over the spent fuel." The LER stated that the "Supervisor in charge of operation misinterpreted the intent of the technical specification." This event was originally cause coded "personnel error," but was upgraded to ERC-M.

1079 310

Control Room Habitability System

One event was reported. This related to the partial collapse of an air duct due to the improper placement of a flexible section. The licensee correctly attributed this to design error (ERC-M).

Engineered Safety Features

Five events were reported. The licensee attributed all of these to component failure. Two were upgraded to ERC-M. In one case the switch installed for a given operation was found to be incorrect for its purpose. This is a design error. In the other, the problem involved a sticking Bliss Eagle timer which, from experience with the ECCS, was known to be a source of difficulty. The unit was exercised, but not replaced.

Summary

The overall performance of this licensee (as based on reported events) during the period covered by the analysis (1976-1977) is characterized by:

- Two series of causally related events (in two systems) taking the form, in both cases, of repetitive failures of particular components, as opposed to chains of successive or interdependent events involving different components within a single system.
- A scattering of random, unrelated events occurring in about 20 systems.

With respect to the causally related events, the fact that these occurred in only two systems suggests a fairly well managed and effective maintenance program. For example, in the case of the ECCS, the defective Eagle timer was replaced after (5-2-77) sticking was detected on two occasions (6-29-76 and 3-28-77). This action was appropriate. The subsequent failure of this timer, requiring a second replacement, was obviously not due to a fault on the part of the licensee. The time distribution density of the events occurring in both the Reactor Trip System and ECCS - four over two years in each case - is considered satisfactorily low.

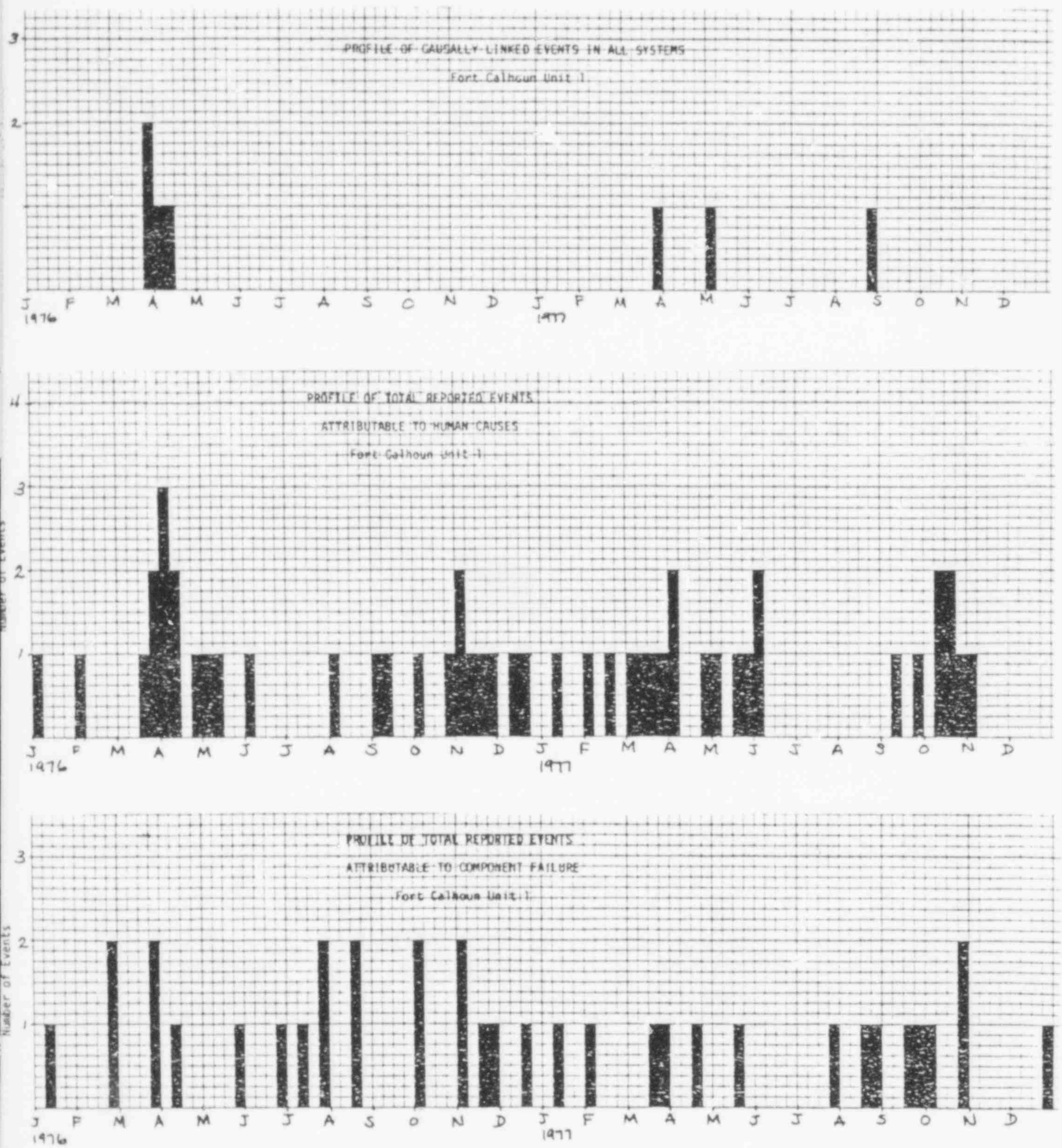


FIGURE A-3

Fort Calhoun Unit 1 Performance Profiles

TABLE A-3

FORT CALHOUN LERs

Main Condenser System	Circulating Water System	Emergency Core Cooling System	Reactor Trip System	Cooling System Reactor Auxiliary Pumps
1/5/76(M)	1/9/76(O)	2/2/76(F/P)	2/27/76(F)	3/20/76(F/M)
7/10/76(F)	12/20/76(O)	4/14/76(F/P)	2/27/76(F)	3/15/77(F)
		6/29/76(F)	3/26/76(F/M)	
		7/26/76(F)	3/27/76(F/M)[2]	
		11/19/76(M)	4/01/76(F/M)	
		3/28/77(F/P)[8]	4/05/76(F/M)[4]	
		4/29/77(O/P)	4/13/76(F/M)[4]	
		5/02/77(F/M)[8]	12/14/76(M)	
		8/29/77(F)[8]	2/16/77(O/M)	
		9/08/77(F/M)	5/16/77(F/M)	
		10/24/77(F/M)	10/20/77(F/M)	
			10/31/77(F)	

TABLE A-3 (Continued)

Offsite Power System	Emergency Generator System	Chemical Volume Control and Liquid Poison System	Process & Effluent Radiation Monitor System	Gas Radwaste Management System
3/29/76(O)	4/7/76(M)	4/8/76(F)	5/6/76(P)	5/14/76(P/M)
3/29/76(O)[3]	4/27/76(P)	4/25/77(F)	9/1/76(P/M)	10/11/77(M)
2/10/77(F)	8/15/76(F)[6]		5/4/77(M)	
8/22/77(F/O)	4/6/77(M)			
	4/7/77(P)			

Main Steam Supply System	Other Systems	Liquid Radwaste System	A.C. On-Site Power System	Coolant Recirculation System	Spent Fuel Storage
5/28/76(F)	6/4/76(O/M)[5]	8/1/76(P)	8/15/76(F)	8/31/76(O)	9/8/76(M)
10/1/76(F)[7]	10/24/76(P)		4/17/77(F)	10/1/76(F)	
9/30/77(F)[7]	3/7/77(M)		5/17/77(F)		
10/20/77(M)	3/21/77(P)		7/31/77(F)		
			12/25/77(F)		

TABLE A-3 (Continued)

Containment Air Purification & Cleanup System	Hangers, Supports Shock Suppressors	Control Room Habitability System	Engineered Safety Features	Reactor Core System
10/4/76(F/P)	11/1/76(P)	11/3/76(M)	11/5/76(F)	11/06/76(F)
2/4/77(F)	6/3/77(M)		11/20/76(F)	11/24/76(F)
	6/3/77(M)		9/26/77([illegible])[3]	12/22/76(M)
	11/1/77(M)		10/2/77(F)	1/16/77(M)
			10/11/77(F/M)	

Reactor Vessel System	Containment Heat Removal System	Residual Heat Removal System
11/16/76(M)	1/11/77(F&P)	10/19/77(F)
10/26/77(F)	3/13/77(P)	

TABLE A-3

NOTES:

1. Two events in reactor trip system in one day, however, not necessarily causally related.
2. Second event in two days involving Bell and Howell equipment. Deficient causal linkage to 3126/76 event.
3. Unclear. If only problem was extent pressure loss, why is transformer called "defective" rather than unenergized. The two 3/29/76 events are obviously causally related, but outside of the licensee's control.
4. Note that this is the third citation of the same Bell and Howell unit - #19-301A Adder-subtractor.
5. No applicable NRC system code.
6. Linked to 4/29/76 - same component.
7. Could be personnel error.
8. Multiple occurrences of sticky timer - should have been checked.
9. Problem - timer in ECCS should have alerted.

1079 316

Review of Inspection Reports and 766 System Data File for Fort Calhoun Unit 1

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found a total of 38 inspection reports detailing the results of NRC I&E inspector findings. Nineteen of these reports identify a total of 32 items of noncompliance, not including those related to physical protection.

Matrix A-3 summarizes the findings of each inspection report and associated 766 system data file entries that identify noncompliances, as well as one report in which LERs were reviewed. Not including those noncompliances due to physical protection, 16 noncompliances were assignable to ERC-M, 15 were assignable to ERC-P, and one was assignable to ERC-F.

In general, there was strong agreement between the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details" section of the inspection report. Only 10 percent of the non-compliance cause codes either were ambiguous or did not agree with the associated inspection report details. The inspector's perception of the underlying cause of the noncompliance and his ability to communicate that perception in terms of the available cause codes (Primary Cause of Violation) listed in enclosure D of MC 0535 is readily apparent. In general, there was strong agreement between the enforcement text provided for each item of non-compliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. There was excellent agreement between the noncompliance cause code in the 766 system and the 766 enforcement text: only seven percent of the items bore either an ambiguous or irrelevant relationship to each other.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In no case did a noncompliance result from inspector followup on an LER, or from licensee identification of new or

1079 317

modified procedures to the inspector. In this case study, none of the noncompliances resulted from possible inspector cues.

At no time did this licensee specify remedies to prevent recurrence of the event in the inspection report; 81 percent of the noncompliance items were addressed in a subsequent letter.

The licensee's action on previously identified enforcement items was incomplete 50 percent of the time at each inspector visit in which these items were reviewed. In reviewing LERs, the inspector disagreed with the licensee's reporting of two of 43 visits. There were no events due to human failure that were serious from the regulatory point of view.

MATRIX A-3

NAME FORT CALHOUN

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7602	[illegible]2	P	Yes	Yes	Yes	No	No	In a followup letter		
7603	FPE2	P	Yes	Yes	Yes	No	No	In a followup letter		2 items-agree
	FJL3	P	Yes	Yes	Yes	No	No	In a followup letter		
7605	FJG2	M	No	Yes	No	No	No	In a followup letter	2 items-closed	2 items-agree
7610	FPE2	M	Yes	Yes	Yes	No	No	In a followup letter		1 item-disagree
	EWC3	M	No	No	Yes	No	No	In a followup letter		
	EKA2	M	Cause code missing	Cause code missing	Yes	No	No	In a followup letter		
	ESA2	M	Can't tell	Yes	Yes	No	No	In a followup letter		
	FJ[illegible]2	H	Cause code missing	Cause code missing	Yes	No	No	In a followup letter		
	EEB3	P	Yes	Yes	No	No	No	In a followup letter		
7611	ALC2	F	Yes	Can't tell	Yes	No	No	In a followup letter	1 item-closed	6 items-agree
7613	ETA3	M	Yes	Yes	Yes	No	No	In a followup letter		5 items-agree

1079 319

MATRIX A-3 (Continued

NAME FORT CALHOUN

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identi-fied Action	Has Licensee Specified Remedies to Preclude Recur-rance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7613	FPG2	P	Yes	Yes	Yes	No	No	In a followup letter		
7615	FPG2	P	Yes	Yes	Yes	No	No	In a followup letter		
7617	EEB2	M	Cause code missing	Cause code missing	Yes	No	No	No		
	FDB	M	Yes	Yes	Yes	No	No	In a followup letter		
7701	HAD3	M	Yes	Yes	Yes	No	No	No	1 item-closed 2 items-open	3 items-agree
	EEB2	P	Yes	Yes	Yes	No	No	No		
7702	FJM2	M	Yes	Yes	Yes	No	No	No	1 item-open 1 item-closed	
7705	EEB2	P	Yes	Yes	Yes	No	No	In a followup letter	2 items-open 1 item-closed	1 item-agree 1 item-disagree
7707	FEP2	M	Yes	Yes	Yes	No	No	In a followup letter		
	FEP2	M	Yes	Yes	Yes	No	No	In a followup letter		
7708	EEB3	P	Yes	Yes	Yes	No	No	In a followup letter		
7710	EEB2	M	Yes	Yes	Yes	No	No	In a followup letter	3 items-closed 1 item-open	12 items-agree

1079 320

MATRIX A-3 (Continued)

NAME FORT CALHOUN

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identi-fied Action	Has Licensee Specified Remedies to Preclude Recur-rance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	IERs Reviewed Adequacy of Response (Disagree?)
7713	EEB2	P	Yes	Yes	Yes	No	No	In a followup letter	3 items-closed	
7714	KRL3	P	Yes	Yes	Yes	No	No	No		
7717	EEB2	P	Yes	Yes	Yes	No	No	No		
7719	FPG2	H	Yes	Yes	Yes	No	No	In a followup letter	1 item-closed	
	FPG2	H	Yes	Yes	Yes	No	No	In a followup letter		
7720	EEB2	P	Yes	Yes	No	No	No	In a followup letter		
	JAY2	P	Yes	Yes	Yes	No	No	In a followup letter		
	NED2	P	Yes	Yes	Yes	No	No	In a followup letter		

1079 321

MILLSTONE UNIT 1 CASE STUDY

Review of the LER File for Millstone Unit 1

During 1976 and 1977, 106 events were reported in 29 systems, as shown in Table A-4. On analysis, it was determined that several of these system classifications were incorrect. As a result of reorganizing the data, the original 29 systems were reduced to 25.

Seventeen of the 106 events involved the circulating water system and all of them consisted of excessive inpingements on the water intake screens of various aquatic species (usually, but not exclusively, fish). The water inflow rate was not affected to any great degree, so that these events did not pose even a potential risk and are, therefore, excluded from the analysis.

Thirty-six of the remaining 89 events were associated with 4 systems, leaving an average distribution of about 2.8 events per system for the balance of 19 systems. This small number does not imply, however, that all of these events were random. In some instances, well defined causal linkages could be identified.

Residual Heat Removal System

Twelve events were associated with this system, none of which was attributed by the licensee to human lapse or error. On analysis, the cause codes of three were left unchanged (ERC-F), and we upgraded the rest to ERC-M. Several of the reported events were causally linked.

On 2-12-76, an isolation condenser tube failed and was replaced; on 5-28-76 the conductivity of the reactor coolant water was above the technical specification limit. The licensee's explanation was that "(It) appears that materials and/or processes used in the recent isolation condenser retubing

1079 322

are causing increases in the water conductivity and chloride ion concentration in the return leg."

On 7-14-76 the inboard inlet isolation valve could not be opened. The licensee attributed this to "Failure of yoke nut adapter and bevel gear housing of motor operator [which] allowed motor operator to separate from the valve." This means, in effect, that the motor drive/valve assembly came apart. The ERC-F cause code was left unchanged. On 9-25-76 the same valve experienced a packing leak, requiring plant shutdown until it was repaired. The cause code was upgraded from F to M. On 11-21-76, a weld joint failure in the head spray system was causally linked to the reactor coolant water chemistry degradation following retubing (2-12-86). On 12-17-76 the same inlet isolation valve that was involved in the 7-14-76 event failed to close on signal; the torque switch actuator was incorrectly set. On 12-18-76 the auxiliary cleanup bypass valve failed to open. The operator motor was burned out. We upgraded these last two events from F to M.

The three valve failures following the initial one on 7-14-76 are all regarded as causally linked. The 12-18-76 event, even though it involved a different valve, is included in this series because management failed to order a checkout of all condenser valves. Ten months later, on 10-31-77, the inlet valve that first failed on 7-14-76 failed again. It was inoperable. The licensee stated that "(The) cause of this occurrence has not been determined." Thus there were four causally linked valve events, not including the first event.

The residual heat removal system experienced one other chain of causally related events. On 6-15-77, the set points of a Meltron pressure switch was found to have drifted and was reset. This was one of four redundant switches. About three months later, on 9-12-77, the same thing happened, except that this time two of the four switch set points had drifted.

1079 323

Emergency Generator System

Nine events were reported for this system, and they fell into two sets of causally linked events. On 2-29-76 the gas turbine governor was found to be out of adjustment with the result that the starting time was somewhat long. The governor was readjusted and the turbine was returned to service. Nine days later (3-8-76) exactly the same event recurred. On 3-15-76 the turbine "failed to achieve rated speed." This time an electronic component board in the governor electrical circuit was found defective and replaced. The last two events were upgraded from ERC-F to ERC-M. On 8-10-76 the gas turbine tripped during a loss of normal AC plant power due to a hurricane. The licensee stated that "Incorrect alternate AC feed to gas turbine auxiliaries caused the gas turbine to trip during loss of normal power and caused low DC control power and unit trip after restart." This event was cause coded "defective procedures" in the LER. This could have meant either that the procedures were correct but improperly implemented, or that the procedures were incorrect as set forth. Later tnat month (8-30-76) the gas turbine generator "became inoperable due to an overspeed condition," according to the licensee, who also stated that "the cause was traced to a faulty electronic control." The control was replaced. Although the component was manufactured by a different firm from that which fabricated the faulty circuit component board (3-15-76 event), the 8-30-76 event is regarded as causally linked to the governor events because management should have required an examination of the entire turbine speed control system.

On 2-1-77 the diesel generator "was declared inoperable (in order) to repair a small fuel oil leak adjacent to the injector for the number 12 cylinder." The LER also states that "the cause of the fuel oil leak was attributable to a small crack in the threaded nipple connected to the number 12 injector." Exactly the same event, due to a crack in the nipple, occurred again on 10-12-77. The cause code for the latter event was upgraded from ERC-F to ERC-M.

1079 324

The final event in these two series took place on 12-10-77. Both the gas turbine and the diesel generator failed, leaving no source of emergency power. The gas turbine failure was due to a burned-out transformer in the governor circuit and was causally linked to the preceding speed control events. The diesel generator was inoperable "because of a governor shutdown solenoid malfunction." This event was upgraded from ERC-F to ERC-M. There were four causally linked events associated with the gas turbine.

Emergency Core Cooling System

Teknekron identified six events a validly classified under this system. All of these had originally been attributed by the licensee to "component failure," but three were upgraded to ERC-M. All events were instances of valve failures or pressure switch set point drifts. The first event (2-12-76) was caused by a diaphragm failure in a Fischer Porter pressure sensor. This was an isolated case. The second event (6-23-76) was due to set point drift in a Meltron pressure switch. On 12-28-76 the Meltron switch set point was observed to have drifted again. About five months later, on 5-3-77, a third Meltron pressure switch set point drift was noted. The lincensee stated that "The failure of the pressure switch to trip at its desired set point was attibutable to set point drift." The switch was replaced. The last event classified under this system occurred on 8-18-77 when a core spray pump discharge relief valve leaked during an operability demonstration. According to the licensee's LER, "(The) cause of the occurrence was attributable to particles in clearance between the valve disc and guide which did not allow valve to completely reseat." This event was cause coded "component failure" by the licensee and this code was not upgraded. However, it is possible that the particles entered the valve from coolant water whose quality was not properly maintained, so that the cause code assignment is not wholly above question.

Engineered Safety Features

The six events in this system occurred in a period of less than one year. (12-7-76 through 11-10-77). Five of these events involved instrument set point drift:

12-7-76 During surveillance testing, two of four Barton Instrument pressure switches were found to be tripping at pressures in excess of those identified in the technical specifications. The licensee's cause code of "component failure" was not upgraded.

12-8-76 A Meltron pressure switch was found to be tripping "at a value outside of the range specified in the technical specifications." This was attributed to set point drift and was coded as component failure. However, in view of the fact that an ECCS Meltron switch had also drifted, the cause code was upgraded to ERC-M.

12-17-76 Two of four Barton Instrument pressure switches "were tripping at values higher than that allowed by the technical specifications." The licensee stated that "The failure of these switches to trip at the desired end point is attributable to setpoint drift." The LER cause code of "component failure" was upgraded to ERC-M.

1-12-77 This was virtually a repeat of the 12-7-76 and 12-17-76 events, except that only one Barton Instrument switch was involved. The cause code was upgraded to ERC-M.

2-14-77 This event was a repeat of the 1-12-77 event. One Barton Instrument pressure switch setpoint drifted. The reported cause code of "component failure" was upgraded to ERC-M.

The last three pressure switch setpoint drift events are linked to the 12-7-76 event because management did not order a complete checkout of all containment pressure switches.

Main Steam Systems

The LER file listed three events under this heading. On analysis, it appeared that five other events were more appropriately classified under this system than as orignally categorized. Each of these eight events had been cause coded "component failure" by the licensee; we upgraded five to ERC-M:

11-9-76 Surveillance of the steam tunnel temperature switches (manufactured by Fenwal Electronics Co.) indicated that four of sixteen switches exhibited setpoint drift. These were readjusted. Because there had been no previous reported drift events associated with Fenwal switches, the licensee's cause code of "component failure" was left unchanged.

6-17-77 A Target Rock relief valve opened at a pressure below the proper setpoint, causing a reactor scram. The problem was attributed to "excessive pilot seat leakage." The licensee's cause code "component failure" was not upgraded. However, the LER referenced similar events that had occurred in 1971 and 1975.

6-18-77 One day later a second Target Rock valve in the same system malfunctioned. The cause was a "collapsed main section filter and steam cutting of the pilot and second stage seats and disks." The cause code was upgraded to ERC-M.

7-21-77 The bellows of a Target Rock safety relief valve failed, requiring a plant shutdown. The fault was attributed to a faulty cable connected to the bellows sensor (a pressure switch). The code "component failure" was not upgraded.

8-7-77 A second malfunction of a safety relief valve bellows occurred. On this occasion the fault was caused by a defective pressure switch. The cause code was upgraded to ERC-M.

10-28-77 This event was a third malfunction of a safety relief valve bellows and appeared to be identical in cause with that of the 7-21-77 event (short circuit in pressure switch bellows sensor cable). The cause code was upgraded to ERC-M.

11-18-77 The reactor cool down rate exceed the specified rate. It was found that a Target Rock valve "lifted at pressure below desired setpoint pressure." The cause of this malfunction was found to be excessive pilot seat leakage. The cause code was upgraded to ERC-M.

11-29-77 A Target Rock safety valve was actuated during a check of the 125 volt DC bus, when the valve solenoid was actuated because of a cable fault. The cause code was upgraded to ERC-M.

The 6-18-77 event is linked to that of 6-17-77, because the same component type (Target Rock valve) was involved, even though the details were different. The bellows events of 8-7-77 and 10-28-77 are linked to the first bellows

1079 327

malfunction that occurred 7-21-77. It is evident that the facility management had not instituted a complete review of the problems with the bellows sensors and the associated cables. The last two events, on 11-18-77 and 11-29-77, both involved Target Rock valves, directly in the first case and indirectly in the second, and are linked to the 6-17-77 event. The 6-17-77 and 11-18-77 events are identical instances of valve pilot seat leakage.

Process and Effluent Radiological Monitoring System

Three events were reported for this system, all of which occurred during the relatively brief period of 8-8-76 to 9-17-76. They were all causally linked. In each case, the stack flow recorder either provided erroneous indication or failed to operate. Without exception, the cause of these events was rain water that had reached the primary flow sensor, which is in the shape of a U-tube. The licensee cause coded these events as "component failure" in the first instance and "external cause" (ERC-O) in the other two. The cause code for the first event in the series was not changed. The code for the second and third events was upgraded from ERC-O to ERC-M on the grounds that management should have taken measures to redesign the sensor.

Reactor Trip System

Five events were classified under this system, each of which was caused by switch setpoint or other instrument drift. All were coded as component failure, and we upgraded the last event to ERC-M.

1-20-76 GE radiation monitor output was low due to internal amplifier drift. The unit was stable after recalibration.

2-10-76 Condenser reactor protection system trip threshold was outside of specification limits. This was attributed to a drift in the setpoint of a Barksdale pressure switch.

2-19-76 Turbine control valve acceleration relay pressure switch tripped at 167 PSIG instead of 170 PSIG. This was attributed to setpoint drift. The instrument was manufactured by Penn Controls.

1079 328

8-13-76 Intermediate range monitor setpoints less conservative than required by technical specifications. Attributed to setpoint drift.

2-15-77 During test of condenser low vacuum scram, two of four Barksdale pressure switches tripped at values outside of technical specification range. Attributed to setpoint drift. These switches were of the type implicated in the 2-10-76 event, and we upgraded the cause case to ERC-M.

Containment Isolation System

Five events occurred in this system between 4-22-76 and 11-7-77. The first event was the failure of a Dezurik primary containment isolation valve to close fully, apparently due to internal binding. The licensee's cause code "component failure" was not upgraded. The second event (1-25-77) was also a failure of the same valve to close completely. On this occasion, the difficulty was traced to dirt in the air line actuating the valve. The licensee's component failure cause code was not upgraded, although it was considered that there were some grounds for recoding this event ERC-M. The next event (2-11-77) was setpoint drift in a Yarway water level switch. The licensee's component failure cause code was not upgraded. The fourth event, which occurred on 2-14-77, was due to setpoint drift in a Barksdale pressure switch. This switch was not, however, the same model that was implicated twice in the reactor trip system, and the cause code (component failure) was not upgraded. In the last event of this series (11-7-77), a Yarway water level switch failed to trip because ". . . foreign particles, that appeared to be metallic in nature, causing a binding of (the) magnet shaft assembly." This time, the "component failure" cause code was upgraded to ERC-M on the grounds that management should have reviewed the switch malfunction problems in this system and instituted a generic corrective program.

Most of the events classified under the other systems were random. There was, however, one important linked series associated with the gaseous radwaste management system. On 12-13-77, two hydrogen explosions occurred in the off gas system and the stack base. The LER states that "(The) initial

1079 329

hydrogen detonation was caused by welder causing an arc to strike on instrument tubing associated with the off gas system." This event was serious: there was "momentary radioactive release and injury to one employee." The LER also states that "As a result of the detonations, a site emergency was declared"; it does not, however, indicate the cause of the second explosion at the stack base. In a subsequent LER, classified under the failed fuel detection system, it was stated that "an inspection of the stack gas monitor sample probes and mounting beam revealed damage caused by the 12-13-77 stack base hydrogen detonation." The reference damage was detected on 12-19-77, or six days after the hydrogen explosions. The second event, though classified under a different system from the initial event, is, nevertheless, directly linked to it.

Overview

Probably the most striking feature of the LER record of this licensee is the frequency of occurrence of the instrument drift problem. Of 89 events (excluding impingement events), 18, or somewhat over 20%, were attributable to drift. In comparison with several other licensees whose performances have been analyzed, this is a relatively large fraction. However, it should be noted that Millstone-1 is not a young facility (commercial operation was initiated March 1971) and aging of components may account for setpoint drifts and other instabilities. A review of the earlier LER record of this licensee would be useful in determining whether, in fact, the incidence of instrument drift showed an increase with time. In any case, during the 1976-1977 period which was analyzed, the problem was severe. Major findings were:

- Instruments made by several manufacturers were implicated.
- Instruments made by a given manufacturer were implicated in more than one system, so that there were cross-system causal linkages.

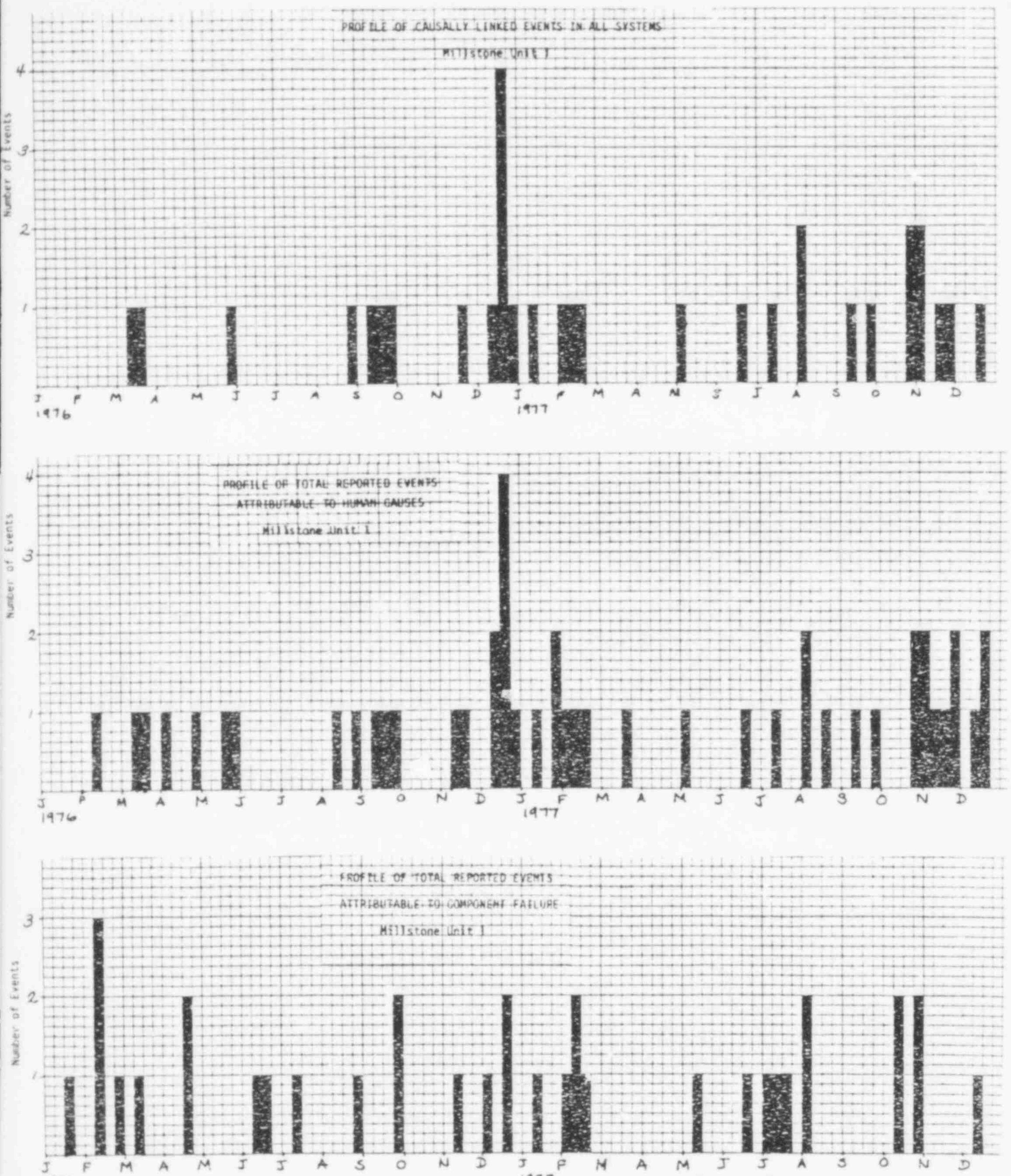


FIGURE A-4

Millstone Unit 1 Performance Profiles

TABLE A-4

MILLSTONE UNIT 1 LERs

Circulating Water System	Reactor Trip System	Reactor Containment Systems	System Code Not Applicable	Residual Heat Removal System	Emergency Core Cooling System	Emergency Generator System
1/17/76(0)	1/20/76(F)	1/26/76(F)	2/02/76(0)	2/12/76(F)	2/12/76(F)	2/29/76(F)
2/21/76(0)	2/10/76(F)	8/05/77(F/M)[22]	2/10/76(M)	5/28/76(0/M)[3,4]	6/23/76(F)	3/08/76(F/M)[1]
3/15/76(0)[2]	2/19/76(F)		4/23/76(0)	7/14/76(F)[6]	12/28/76(F/M)	3/15/76(F/M)[1]
4/10/76(0)	8/13/76(F)		6/08/76(0)[5]	9/25/76(F/M)[9,10]	5/03/77(F/M)[15]	8/10/76(M)
5/08/76(0)[2]	2/15/77(F/M)[19]		10/05/76(0)	11/21/76(F/M)[4]	7/13/77(F/M)[21]	8/30/76(F/M)
5/13/76(0)[2]			10/05/76(0)	12/17/76(F/M)[10]	8/18/77(F)	2/01/77(F)
5/23/76(0)[2]				12/18/76(F/M)[13,10]		9/09/77(0)
5/28/76(0)[2]				1/28/77(0/M)		9/27/77(F/M)[25]
6/05/76(0)[2]				2/01/77(0/M)[17]		12/10/77(F/M)[1]
6/17/76(0)[2]				6/15/77(F)[6]		
7/27/76(0)[2]				9/12/77(F/M)[6,24]		
12/08/76(0)				10/31/77(0/M)[10]		
12/15/76(0)						
12/22/76(0)						
1/15/77(0)						
1/28/77(0)						
2/23/77(0)						

TABLE A-4 (Continued)

Hangers, Supports and Shock Suppressors	Offsite Power Systems	Containment Isolation System	Gaseous Radioactive Waste Management Systems	Coolant Recirculation System	Reactor Core	Main Steam Systems
3/09/76(F)	4/07/76(P)	4/22/76(F)	4/26/76(P)	5/23/76(P)	10/28/76(F)	11/09/76(F)
11/30/77(O/P)		1/25/77(F)	12/21/76(F)	12/20/76(M)[16]	11/12/76(P)[11]	6/17/77(F)
		2/11/77(F)	12/13/77(P)	6/14/77(F)		6/18/77(F/M)[20]
		2/14/77(F)	12/31/77(O)			7/21/77(F)
		11/10/77(F/M)[27]				8/07/77(F/M)[23]
						10/28/77(F/M)[23]
						11/18/77(F/M)[20,9]
						11/29/77(F/M)[20,9]

1079 333

TABLE A-4 (Continued)

Airconditioning, Heating & Ventilating Systems	Engineered Safety Feature Systems	Area Monitoring Systems	Reactor Coolant Cleanup Systems	Failed Fuel Detection System	Feedwater System
11/18/76(F)	12/07/76(F)	12/31/76(F/M)	12/18/76(F)	1/08/77(F)	1/26/77(M)
	12/08/76(F/M)[12]			7/14/77(F)	11/22/77(F)
	12/17/76(F/M)[12]			11/01/77(F/M)[26]	
	1/12/77(F/M)[12]			12/19/77(P)	
	2/14/77(F/M)[12,18]				
	11/10/77(P)				

TABLE A-4 (Continued)

Reactivity Control Systems	Containment Air Purification Systems	Compressed Air Systems	Containment Heat Systems	Process and Effluent Radiological Monitoring Systems
3/18/77(O/M)	5/14/77(O/F)	8/06/77(F)	10/12/77(O)	8/8/76(F)
	10/12/77(F)			9/11/76(O/M)[8]
				9/17/76(O/M)[8]

TABLE A-4

NOTES:

1. Causally linked to 2/29/76 event in that governor adjustment problem not resolved.
2. Improperly classified event under "System Code Not Applicable."
3. Improperly classified event under "Other Coolant Subsystems."
4. Causally linked to 2/12/76 event in that the retubing caused a water chemistry problem.
5. Improperly classified event under "Liquid Radioactive Waste Management Systems."
6. Event classified under "RCIC System."
7. Event classified under "Process & Effluent Radiological Monitoring Systems."
8. Causally linked to 8/08/76 event in that management did not install a "fix" for the primary sensor.
9. Event classified under "Emergency Core Cooling System."
10. Causally linked to 7/14/76 event on same valve.
11. Resulted in civil penalty.
12. Linked to 12/07/76 event in that management did not check all containment pressure switches.
13. Linked to 7/14/76 event in that management did not check all valves associated with isolation condenser.
14. Event classified under "Reactivity Control Systems."
15. Linked to previous event of 6/23/76.
16. Linked to previous event in that both appear to be due to lack of attention to technical specifications.
17. Linked to 1/28/77 event which is similar.
18. Event classified under "Reactor Trip System."
19. Linked to 2/1/76 event in that failure to resolve drift problem is resulting in increased system degradation - when failure is detected.
20. Linked to 6/17/77 event.
21. Appears linked to 2/12/76 event.
22. Linked to 1/26/76 event (identical)

1079 336

23. Linked to 7/21/77 event - incomplete review of problems with bellows monitoring.
24. Linked to 6/15/77 event (identical).
25. Linked to 2/01/77 event.
26. Linked to 7/14/77 event.
27. Linked to 2/11/77 event.

- The licensee did not conduct an effective program designed to solve the drift problem throughout the facility. The failure to initiate such a program was evident with respect to other categories of events, such as the repetitive disablement of the effluent gas sensor by rain water and the various component malfunctions that were traced to dirt in valves, in actuating airlines, etc.

Review of Inspection Reports and 766 System Data File for Millstone Unit 1

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found 67 inspection reports detailing NRC I&E inspector findings. Twenty-two of these reports identify a total of 44 items of noncompliance, not including those related to physical protection. Three noncompliances were described in two I&E reports that were withheld from public disclosure in accordance with 10CFR2.790. One of these reports resulted in civil action against the licensee.

Matrix A-4 summarizes the findings of each inspection report and associated 766 system data file entries that resulted in noncompliances. A selection of reports in which LERs and previous enforcement actions were reviewed and two reports covering management meetings are also included. Not including noncompliances due to physical protection and those for which reports were not available, 20 items were assignable to ERC-M, 19 were assignable to ERC-P, one was assignable to ERC-F, and one to ERC-O.

There was substantial disagreement between the noncompliance cause code as listed in the 766 system and the detailed discussions in the "Report Details" section of the available inspection reports. Approximately 34 percent of the noncompliance cause codes either were ambiguous or did not agree with the inspection report details. There was good agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. However, there was less agreement between the noncompliance cause code and the 766 enforcement test. Approximately 48 percent of the items bore either an ambiguous or irrelevant relationship to each other. There

1079 338

is not enough detail in the 766 enforcement text and the associated noncompliance cause code (without analyzing the supporting inspection report) to provide a sufficiently comprehensive understanding of the noncompliance and the circumstances of its origin.

We reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In approximately 17 percent of the cases, a noncompliance resulted from inspector followup of an LER. Only 7 percent of the noncompliances resulted from inspector followup on a licensee-identified matter. Thus for Millstone Unit 1, 24 percent of the noncompliance items resulted from inspector cues.

For 24 percent of the noncompliance items, remedies specified by the licensee to prevent recurrence of the event were identified in the inspection report. Fifty-six percent of the items were addressed in a subsequent followup letter. The licensee's action on previously identified enforcment items was complete with one exception. The inspector found the licensee's reporting of LERs acceptable in all but one of the 11 events reviewed in the inspection reports.

Our review of the inspection reports revealed one event due to human failure that was serious from the regulatory point of view. This event is summarized below, followed by two other examples of noncompliance, one of which had the potential to result in a serious occurrence.

<u>Criticality Incident - November 12, 1976 (as described in I&E Inspection Report No. 50-245/76-32)</u>

From the regulatory viewpoint, this was a serious incident. It was categorized as a violation and the NRC, on 1-21-77, transmitted a letter to the licensee imposing a fine of $15,000. Associated with the violation were two other

1079 339

noncompliance items, each categorized as an infraction. The licensee's LER file shows that the criticality event was reported to NRC on November 24, 1976. The following descriptions of these noncompliances are quoted directly from the Summary of Findings accompanying the inspection report.

"Violation

Item 76-32-01

Technical Specification Section 6.8.1 requires that written procedures shall be established, implemented and maintained covering refueling operations.

Operating Procedure OP 1408, Revision 0, Change 2, dated September 17, 1976, "Administrative Controls for Fuel Loading and Unloading," states that shutdown margin testing shall be performed at times specified by the Reactor Engineer, and in accordance with the general procedures specified in Section 3.2.6. Section 3.2.6.2 requires that after the control rod with the most worth has been positioned (as specified in Section 3.2.6.1) that a second rod shall be withdrawn to a specified position.

Procedure 631.10, Revision 0, dated March 8, 1976, "Reactivity Margin--Core Loading Shutdown Margin Test," requires that the control rods used for shutdown margin testing be specified to the operators by the Reactor Engineer. Reactor Engineering instructions dated November 6, 1976 specified that Shutdown Margin Testing be performed after the cell containing control rod 46-23 was loaded, and that control rod 46-23 was the control rod with the most worth. It further specified that after positioning control rod 46-23, that control rod 42-19 be withdrawn to a specified position, and that control rod 46-23 would then be additionally withdrawn to demonstrate the shutdown margin.

Contrary to the above, on November 12, 1976, while performing the specified shutdown margin test, control rod 46-19 was erroneously selected and withdrawn to a predetermined position following the proper positioning of control rod 46-23. An unplanned criticality and automatic reactor trip from high flux on four (4) IRM channels occurred at 4:49 a.m. following withdrawal of control rod 46-23. Between 4:50 and 4:58 a.m., on the same date, further shutdown margin testing was performed without recognition of the previous rod selection error. Control rod 46-23 was positioned as specified. Again, control rod 46-19 was erroneously selected and withdrawn to a predetermined position and control rod 46-23 was then withdrawn. The second withdrawal, while terminated prior to a second automatic reactor trip, did result in a reactivity increase requiring immediate insertion of control rod 46-23 in order to prevent a second reactor trip.

1079 340

"Infractions

1. Item 76-32-02

Technical Specification 3.3.B.3.b requires that whenever the reactor is in the startup or run mode below 10 percent rated thermal power, no control rods shall be moved unless the rod worth minimizer is operable or a second independent operator or or engineer verifies that the operator at the reactor console is following the control rod progr.m.

Contrary to the above, on November 12, 1976, with the reactor mode switch in the startup mode and the rod worth minimizer bypassed, control rods were moved for shutdown margin testing without an independent operator or engineer verifying that the operator at the reactor console was following the control rod program.

2. Item 76-32-03

Technical Specification Section 6.8.1 requires that written procedures shall be established, implemented and maintained covering Appendix A of Regulatory Guide 1.33, November 1972.

a. Pursuant to the above requirement, Operating Procedure 106, Revision 0, dated September 30, 1975, "Control Room Procedure," requires that operators shall believe installed instrumentation to be correct unless proven faulty by direct comparison with other instruments involving the same variable or proven faulty by instrument functional testing or calibration.

   Contrary to the above, on November 12, 1976, nuclear instrumentation indicating that an unplanned criticality had occurred was not believed and was not proven faulty by direct comparison with other instruments or by functional testing or calibration in that the Shift Supervisor dismissed the automatic reactor trip as being the result of a spurious signal, and continued with additional control rod withdrawals.

b. Pursuant to the above requirement, Operating Procedure 502, Revision 4, dated August 26, 1975, "Emergency Shutdown," and Station Order SO-6.01, Revision 4, "Nuclear Power Facility Communications Control" require that the Shift Supervisor promptly notify higher management of events which include automatic action of the reactor proctection system and unplanned criticalities.

   Contrary to the above, on November 12, 1976, the Shift Supervisor did not promptly inform higher management of the unplanned criticality and automatic reactor trip which occurred at 4:49 a.m. The notification was not made until approximately 7:30 a.m. when higher management reported for the start of the day's work."

Trucking Incident - October 4-5, 1976 (as described in I&E Inspection Report No. 50-245/76-29)

This incident involved an improperly banded container of radioactive waste. The noncompliance was categorized as a deficiency, apparently since contamination was minor. The following details are presented as they appeared (verbatim) in the inspection report.

Licensee's Statement:

"The inspector inquired into those events surrounding the above referenced radioactive shipment. The following is an overall summary of licensee statements:

"On September 27, 1976, the container in question was loaded with various pieces of reactor hardware resulting from the refueling outage which was in progress for Millstone Unit No. 1. The container, a reinforced wooden crate measuring approximately 14 feet long by 4 feet wide by 5 feet high was loaded at the 108 foot level of the reactor building. The hardware itself was loaded into a plastic liner within the crate and a wooden lid was nailed into place. The closed container was then transferred to a shipment area to await pickup and transfer from the site.

"On September 30, 1976, health physics surveys were performed and the container in question was loaded on a flatbed trailer operated by McCormick Trucking. The trailer was loaded by two men assigned to the Maintenance Staff, one man an employee of the licensee and the other from a service organization who was supplying extra manpower during the refueling outage. A licensee representative stated that the licensee individual who routinely supervised loading operations of this type was not available at the time this shipment was loaded.

"According to the licensee, the driver of the truck recommended that this container, which was placed above five other containers, be laid on its side due to clearance limitations. The Maintenance people went along with the driver's recommendation and loaded the uppermost crate on its side. This crate was then secured to the trailer with a chain and two heavy duty ropes. Remaining health physics surveys were completed, along with associated paperwork and State Notifications. The truck was released from the site at approximately 2000 hours on September 30, 1976 bound for Barnwell, South Carolina and final disposal.

"On October 4, 1976 near Roanoke Rapids, North Carolina, the driver of the aforementioned truck noticed that the lid of the crate in question was ajar and some of the crate's contents were exposed. North Carolina radiological health officials responded to the scene. Since the top of the crate was restrained by ropes and chains, the contents of the box were not in danger of falling off the truck. Due to the lateness of the hour and lighting conditions, North Carolina officials deferred recovery operations until the following day. On October 5, 1976 some minor contamination was received by the individuals repacking the crate in order that it could be removed from the truck and banded. The contamination was minor and resulted from a small amount of liquid (approximately 2-3 tablespoons) which fell on the individual's clothing. The contamination was easily removed by washing and no other contamination was found either on the crate, the truck or other location where the truck had been parked. The truck was released by North Carolina officials at about 1700 hours on October 5, 1976 with the shipment arriving at Barnwell, South Carolina on October 8, 1976."

The Inspector's Comments:

"The inspector noted that two actions by the licensee contributed to the above referenced incident, namely (a) failure to band the shipment before loading and (b) loading a container of this size and weight on its side. The inspector stated that while the later action showed, at minimum, a lack of proper judgement, the initial action (failure to band the container) was in noncompliance with Millstone Station Standing Order No. 1-6.10, "Radwaste Shipments," Section 6.1, Part F, which states in part that once loaded, LSA boxes will have a cover installed and be banded prior to shipment."

"The licensee stated that in order to prevent this occurrence from happening again, a new procedure entitled "Procedure for Ensuring Proper Loading of Radioactive Shipments," had been prepared and approved. This procedure was designated Station Order SO-3.05 and approved for immediate implementation on October 28, 1976. The inspector reviewed this procedure and noted that it did speak to the two areas involved (banding and loading) and included other guidance and a check list to prevent recurrence of the aforementioned incident.

"The inspector reviewed all axilliary [sic] procedures and paperwork related to the shipment of radwaste in general and the aforementioned incident. These items included health physics surveys, State notifications prior to shipment, and the notification of State representatives on October 6, 1976, the date upon which plant personnel became aware of the incident. The inspector noted that with the exceptions noted in Paragraph 4 above, all licensee actions were in full compliance with appropriate NRC regulations and Millstone procedures.

"During the course of this inspection, the inspector observed the packaging, storage and loading of two radwaste shipments. No abnormalities or problem areas were noted."

Deficiencies in the Performance of the Operator Requalification Program - March 29-31, 1976 (as described in I&E Inspection Report No. 50-245/76-06).

Nineteen individuals who were required to attend lectures conducted under the operator requalification program as a prerequisite to license renewal had failed to do so. Two noncompliance citations were made in this case, each categorized as a deficiency. Details are provided in the following portion of a letter dated May 18, 1976 from the NRC Division of Project Management (HQ) to the licensee.

"Gentlemen:

This letter concerns the activities of the licens . operators and senior operators at Millstone Point, Unit No. 1.

We have received a copy of IE Inspection Report 76-06, dated April 8, 1976. The report indicates serious deficiences in the Millstone Point, Unit No. 1, Operator Requalification Program. The report indicates that nineteen (19) licensed individuals did not participate in the lecture series portion, as required by Sections III and V.A. of your program.

The current operator and senior operator licenses held by members of the Unit 1 staff are based, in part, on our determination that they have satisfactorily participated in the approved operator requalification program. We are required to make this determination pursuant to Section 55.33(c)(2)(ii) of 10 CFR Part 55.

Based on the information contained in the Inspection Report, we have determined that we would have been unable to make the finding required by Section 55.33(c)(2)(ii), at the time the individuals involved submitted applications for renewal of their licenses.

In view of the substantial deficiencies in the implementation of your program and the total lack of participation in the lecture series by the individuals involved, we would have required the applicants to successfully complete a written examination, in accordance with Section 55.33(c)(2)(iii), as one condition for license renewal. Therefore, in accordance with Section 55.40(b) the licenses of the nine (9) operators and senior operators that have been renewed recently are modified by imposing the condition requiring satisfactory performance on a written examination to be administered by this office.

In addition to the nine (9) licenses mentioned above, ten (10) additional licensees have failed to participate in the program. All are due for license renewal during 1975. We will require these individuals to be administered a written examination prior to renewing their license. Their licenses are also conditioned as indicated above."

MATRIX A-4

NAME MILLSTONE UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7602	FJF2	P	Yes	Yes	Yes	No	No	Yes	1 item-closed	6 items-agree
"	FCN2	F	Yes	No	Yes	No	No	In a followup letter		
7604	ABC2	M	No	Can't tell	Yes	Yes	No	In a followup letter		
"	ASA2	M	Yes	Can't tell	Yes	Yes	No	In a followup letter		
7605	FPF2	P	Yes	Yes	Yes	Yes	No	In a followup letter		
7606	FPE3	P	Yes	Yes	Yes	No	No	Not applicable		
"	DAM3	M	Yes	Yes	Yes	No	No	In a followup letter		
7608	KRA3		I&E REPORT WITHHELD FROM PUBLIC DISCLOSURE IN ACCORDANCE WITH 10CFR 2.790							
"	KRB3		I&E REPORT WITHHELD FROM PUBLIC DISCLOSURE IN ACCORDANCE WITH 10CFR 2.790							
7609	FPE2	P	Yes	Yes	Yes	No	Yes	Yes		1 item-agree
7612									5 items-closed	
7615	EEA3	P	Yes	Yes	Yes	No	No	In a followup letter	3 items-closed	1 item-agree

1079 345

MATRIX A-4 (Continued)

NAME MILLSTONE UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7615	EFA2	P	Yes	No	Yes	No	No	In a followup letter		
"	FJN2	M	Can't tell	Can't tell	Yes	No	No	In a followup letter		
"	EWE2*	P	Yes	Yes	Yes	No	No	In a followup letter		
7616	FEM2	M	Yes	Yes	Yes	No	No	In a followup letter		
"	FEP2	M	Yes	No	Yes	No	No	In a followup letter		
7619										
7621	FJE2	M	No	Yes	Yes	No	No	Yes		
7622	DDA2	M	No	No	Yes	No	No	In a followup letter		
7623	EFA2*	M	Yes	Yes	Yes	No	No	In a followup letter	1 item-open	2 items-agree 1 item- disagree
7625	FPE2	P	Yes	Yes	Yes	No	No	In a followup letter		
7628			I&E REPORT WITHHELD FROM PUBLIC DISCLOSURE ACCORDING TO 10CFR 2.790							
7629	FJH3	M	No	No	Yes	No	Yes	Yes		

1079 346

MATRIX A-4 (Continued)

NAME MILLSTONE UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7630	FDF3	M	Can't tell	Can't tell	Yes	No	No	In a followup letter	1 item-closed	
7632 Incident	FJF1	P	Yes	Yes	Yes	Yes	No	Yes		
	FCC2	P	Yes	Yes	Yes	Yes	No	Yes		
	FJE2	P	Yes	Yes	Yes	Yes	No	Yes		
	ALC2	P	Can't tell	Can't tell	Yes	Yes	No	Yes		
7633	FDF2 (1)	P	No	No	Yes	No	No	In a followup letter		
7635									2 items-closed	
7636										1 item-agree
7638	DFL3	M	Can't tell	Can't tell	Yes	No	No	In a followup letter	1 item-closed	
7701										
7703	EWD2	M	No	Yes	Yes	No	No	No	2 items-closed	
	FJD2	M	No	Can't tell	No	No	No	No		

Note: (1) Noted in 766 system as an infraction and in IE report as a deficiency.

MATRIX A-4 (Continued)

NAME MILLSTONE UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7703	ETC3	P	Yes	Can't tell	Yes	No	No	No		
	FJE3	P	Can't tell	Can't tell	Yes	No	No	No		
	ERB3	P	Yes	Can't tell	Yes	No	No	No		
	EFB3	P	Yes	Can't tell	Yes	No	No	No		
	EBN2	M	Yes	Yes	Yes	No	No	No		
7705										
7707	FPG2	O	No	Can't tell	Yes	No	No	Yes		
7709										
7711										
7713										
7715									2 items-closed	
7717 (Mgt Visit)			TO DISCUSS IMPLEMENTATION OF RESIDENT INSPECTION PROGRAM AT MILESTONE SITE							

1079 348

MATRIX A-4 (Continued)

NAME MILLSTONE UNIT 1

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identi-fied Action	Has Licensee Specified Remedies to Preclude Recur-rance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7721			INTRODUCE NEW I&E REGIONAL DIRECTOR							
7722	FPG2	P	Yes	Yes	No	No	No	In a followup letter		
7725	FDD3	M	Yes	Yes	Yes	No	No	In a followup letter		
7726	FPG3	M	Yes	Yes	Yes	No	Yes	Yes		
7728										
7730	FPE2*	M	Yes	Yes	Yes	No	No	In a followup letter		
	FPE2	M	Can't tell	Can't tell	Yes	No	No	In a followup letter		
	FPE2	P	Yes	Yes	Yes	No	No	In a followup letter		
	ALA2	M	Yes	Can't tell	Yes	No	No	In a followup letter		
7732										
7734										
7735										

POINT BEACH UNIT 1 CASE STUDY

Review of the LER File for Point Beach Unit 1

During 1976 and 1977, 26 events occurred in 16 systems at this unit, as shown in Table A-5 on page A-93. Nineteen of these were reported as component failures; we reclassified one to Teknekron ERC-M. Two events were reported as "other" and we reclassified one as ERC-M. The remaining events were reported as human error (personnel error or defective procedures), which we converted to ERC-M or ERC-P. However, none of these conversions required reclassification on the basis of our review.

Five of the systems had more than one event; these systems averaged three events each over the 24-month period. A detailed review of the events in each system indicated only two causally linked groups of events.

The first group of causally linked events was in the Engineered Safety Features Instrumentation System. On 12-29-76 a differential reading was noted between the "B" steam generator steam line pressure instrument 1PT-478 and the redundant instruments 1PT-479 and 1PT-483. Investigation revealed a frozen point in the sensing line where the tubing exits the facade to enter the main building. The licensee stated "insulation on sensing line had a gap which allowed the line to freeze. Gap repaired and heat lamp installed." On 12-11-77 an identical event occurred.

The second group of causally related events occurred in the Air Conditioning, Heating, Cooling, and Ventilation System. On 4-30-77 an air damper did not operate properly. The licensee stated: "foreign matter in Johnson Service Company Model R-130-1 air regulator which obstructed orificed exhaust line.

1079 350

TABLE A-5

LERs BY SYSTEM AT POINT BEACH UNIT 1 - 1976 and 1977

Feedwater System	Containment Isolation System	Engineered Safety Features Instrumentation System	Chemical, Volume Control & Liquid Poison System	Control Room Habitability System	Station Service Water System
1-08-76(F)	1-08-76(F)	1-10-76(F)	3-08-76(F)	3-10-76(F)[1]	6-16-76(F)
		11-30-76(F)	12-30-76(F)		6-15-77(F)
		12-29-76(M)[4]			10-31-77(P)
		10-10-77(M)[5]			12-21-77(F)
		12-11-77(O/M)[7]			

TABLE A-5 (Continued)

LERs BY SYSTEM AT POINT BEACH UNIT 1 - 1976 and 1977

Circulating Water System	System Code Not Applicable	Reactor Trip Systems Instrumentation	Reactor Core Fuel Elements	On Site Power System	Main Steam Supply System	Air Conditioning, Heating, Cooling, & Ventilating System
7-06-76(F)	8-06-76(O)[2]	11-30-76(F)[3]	12-22-76(F)	2-09-77(F)[5]	2-26-77(F)[5]	4-30-77(F)[5]
						5-28-77(F/M)[5,6]

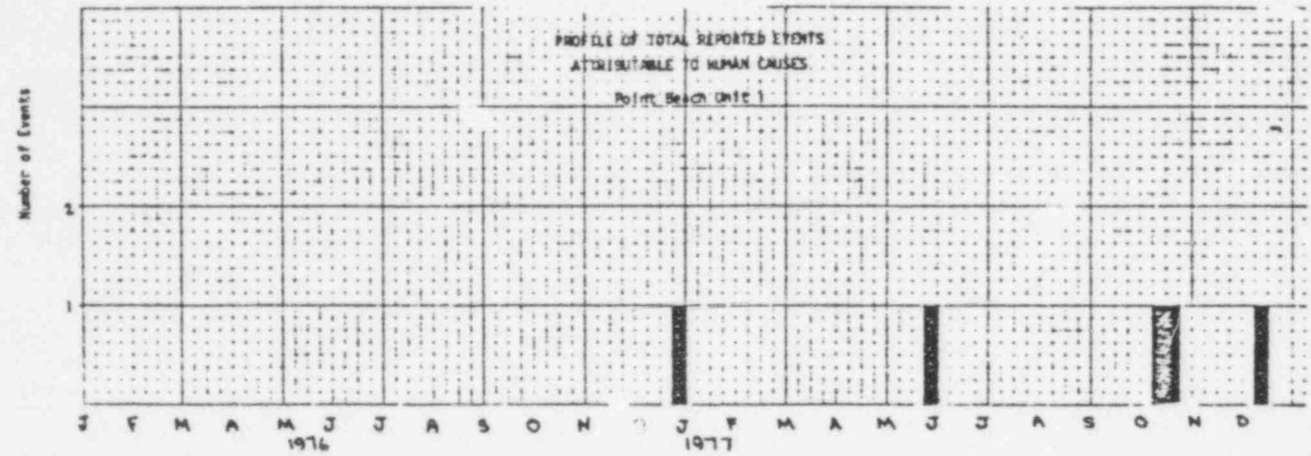
Coolant Recirculation System	Emergency Generator System	Hangers, Supports Shock Suppressors
6-20-77(F)	6-29-77(F)	10-21-77(P)[5]
6-23-77(F)		

POINT BEACH UNIT I

NOTES:

1. Component failure to meet technical specification requirement during a test.
2. Error in vendor safety analysis - licensee evaluated impact and determined that continued operation is acceptable.
3. Appears similar to power supply failure in event 1/10/76(c) under Engineered Safety Features Instrumentation Systems.
4. Appears to be a design error. Clearly causally linked to previous events in this category.
5. Discovered during routine test.
6. Appear to be causally related to 4/30/77(c) event in that the cause is generic.
7. Identical to 12/29/76 event as to component and cause.

1079 353



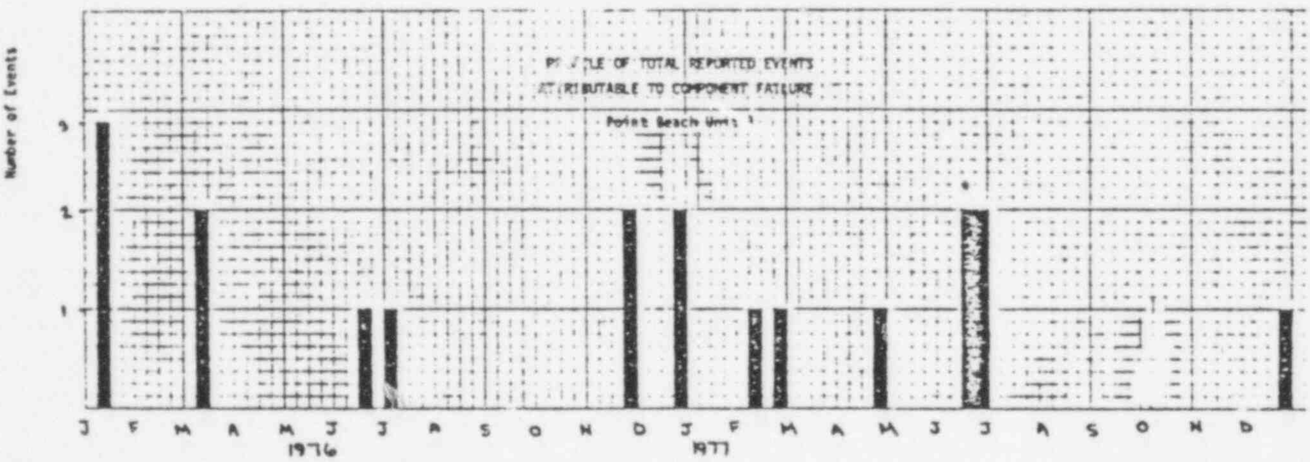


FIGURE A-5

Point Beach Unit 1 Performance Profiles

Regulator was cleaned and adjusted." On 4-28-77 an identical event occurred. The licensee identified the same cause but ordered a new regulator to replace the repaired regulator.

In summary, the reported events that appear to be causally linked are too few to suggest a pattern of deficient licensee performance. The limited total number of events both isolated and causally linked in the LER file suggests a pattern of facility operation virtually unimparied by management or personnel error. The patterns of management and personnel performance at Point Beach Unit 1 contrast sharply with those identified in other case studies.

Review of Inspection Reports and 766 System Data File for Point Beach Unit 1

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found a total of 38 inspection reports detailing the results of NRC I&E inspector findings. Thirteen of these reports identify a total of 25 items of noncompliance. Nine of these 25 items involve physical protection and are identified in three separate inspection reports.

Matrix A-5 summarizes the findings of each inspection report and associated 766 system data file entries that identify noncompliances, as well as one report in which LERs were reviewed. Not including those noncompliances due to physical protection, ten noncompliances were assignable to ERC-M and six were assignable to ERC-P.

In general, there was strong agreement between the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details"

MATRIX A-5

Review of 766 File and Inspection Reports for Point Beach Unit 1

NAME POINT BEACH UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
76-06	FDP3	P	NO	NO	YES	NO	YES	NO		
	FDP3	M	YES	YES	YES	NO	NO	YES		
76-07 (Phys. Prot.)	RMA2	P	YES	YES	YES	NO	NO	YES	YES	
	RME2	P	YES	YES	YES	NO	NO	YES	YES	
76-08	NONE	-	-	-	-	-	-	-		2 EVENTS/AGREE
76-09	ASA2	M	YES	CAN'T TELL	YES	NO	NO	YES		
76-11	DAW3	M	YES	YES	YES	NO	NO	YES		2 EVENTS/AGREE
76-13 (Phys. Prot.)	RMC3	M	YES	YES	YES	NO	NO	CAN'T TELL	YES (2 ITEMS)	

1079 356

NAME POINT BEACH UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
76-13	RLL2	P	YES	YES	YES	NO	NO	CAN'T TELL	YES (2 ITEMS)	
	RRA3	P	YES	YES	YES	NO	NO	CAN'T TELL	YES (2 ITEMS)	
76-15	FPE	P	YES	YES	YES	NO	NO	YES	YES (3 ITEMS)	
76-18	F?F	P	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER	NOT REVIEWED	
77-03	FCS2	P	YES	CAN'T TELL	YES	NO	YES	YES	YES	2 EVENTS/AGREE
77-09	FPG3	M	YES	YES	YES	NO	YES	IN SUBSEQUENT LETTER		2 EVENTS/AGREE
	FMY2	M	YES	CAN'T TELL	YES	NO	NO	IN SUBSEQUENT LETTER		
	FMY2	M	YES	YES	YES	NO	NO	NO		

1079 358

NAME POINT BEACH UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed, Adequacy of Response (Disagree?)
77-09	ASB2	M	YES	YES	YES	NO	NO	YES		
77-13 (Phys. Prot.)	NED2	M	NO	NO	YES	NO	NO	IN SUBSEQUENT LETTER	YES (2 ITEMS)	
	NED2	P	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
	NEB3	P	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
	NDE3	M	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
77-16	EMA2	P	NO	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
	EEB2	M	YES	CAN'T TELL	YES	NO	NO	IN SUBSEQUENT LETTER		
	EJF2	M	YES	CAN'T TELL	YES	NO	NO	IN SUBSEQUENT LETTER		

1079 358

NAME POINT BEACH UNIT 1

Insp. Rpt.	Non-Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
77-17	FPG2	P	YES	CAN'T TELL	YES	NO	NO	YES	YES (1 ITEM)	2 EVENTS/AGREE
77-19	FDJ2	M	YES	NO	YES	NO	NO	IN SUBSEQUENT LETTER		

1079 359

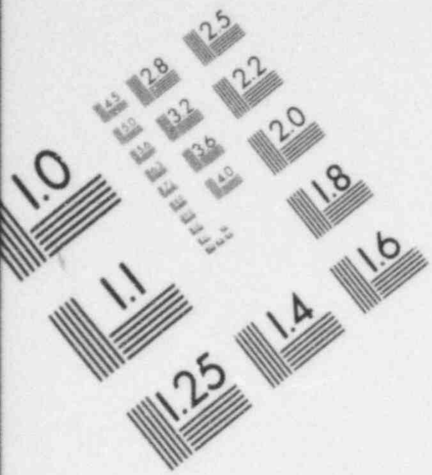
section of the inspection report. Less than 12 percent of the noncompliance cause codes either were ambiguous or did not agree with the associated inspection report details. The inspector's perception of the underlying cause of the noncompliance and his ability to communicate that perception in terms of the available cause codes (Primary Cause of Violation) listed in enclosure D of MC 0535 is readily apparent. In general, there was strong agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. There was less agreement between the noncompliance cause code in the 766 system and the 766 enforcement text: approximately 44 percent of the items bore either an ambiguous or irrelevant relationship to each other. This lower level of agreement was due largely to a lack of supporting detail in the 766 enforcement text. This lack of agreement between the noncompliance cause code and the 766 enforcement text means that a review of the 766 enforcement text and the noncompliance cause code <u>without</u> the supporting I&E report would not provide a sufficiently comprehensive understanding of the noncompliance and the circumstances of its origin.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In no case did a noncompliance result from inspector followup on an LER. Only three noncompliances resulted from licensee identification of new or modified procedures to the inspector. In this case study, only about 12 percent of the noncompliances resulted from possible inspector cues; cues did not play a substantial role in identifying noncompliance items.

For 36 percent of the noncompliance items, licensee remedies to prevent recurrence of the event were specified in the inspection report, while forty-four percent of the noncompliance items were addressed in a subsequent letter. Generally, those items for which an immediate remedy was identified were those for which the licensee was in strong agreement with the inspector's findings.

1079 360

**IMAGE EVALUATION
TEST TARGET (MT-3)**



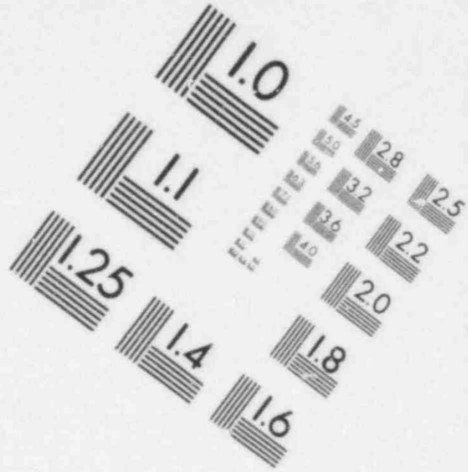
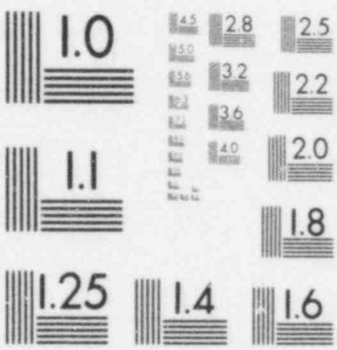
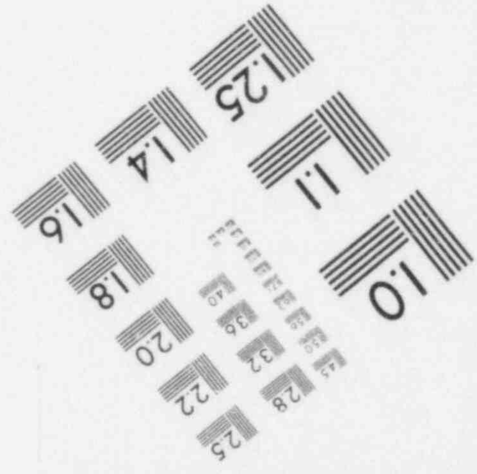
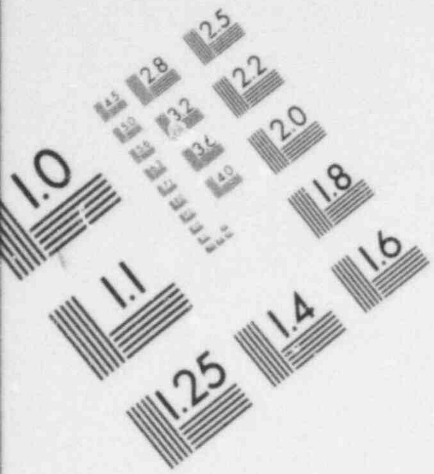


IMAGE EVALUATION TEST TARGET (MT-3)



6″





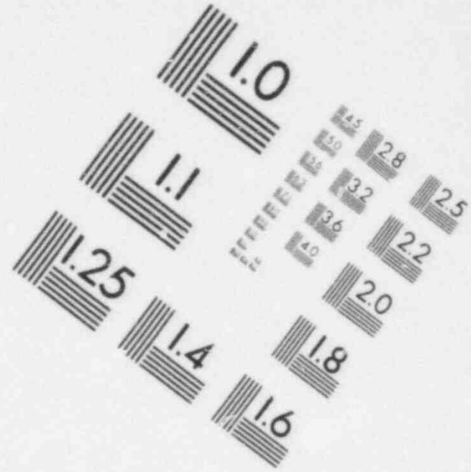
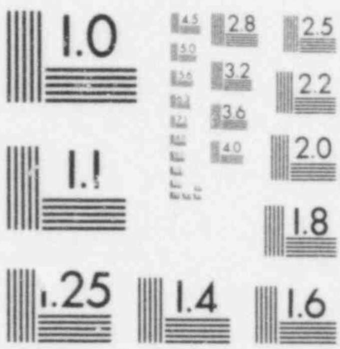
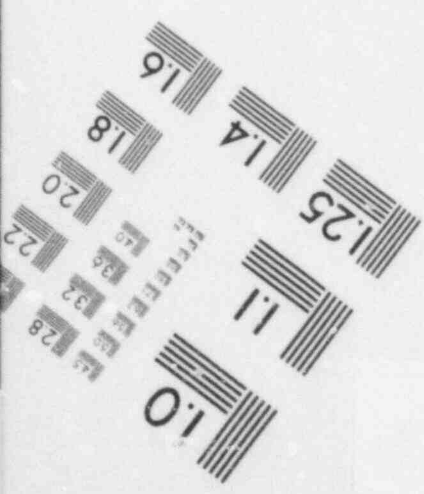


IMAGE EVALUATION
TEST TARGET (MT-3)



6″



The licensee's action on previously identified enforcement items was always timely and complete at each inspector visit in which these items were reviewed. In reviewing LERs, the inspector never disagreed with the licensee's reporting. There were no events due to human failure that were serious from the regulatory point of view.

PRAIRIE ISLAND UNIT 1 CASE STUDY

Review of the LER File for Prairie Island Unit 1

During 1976 and 1977, events occurred in 22 systems as shown in Table A-6 on page A-110. The Circulating Water System sustained an extraodinarily large number of events in comparison to the other 21 systems. These 21 systems averaged 3.0 events over the 24-month period. Four of these 21 systems had an average of 7.25 events per system; removing these systems from the group of 21 resulted in an average of 2.0 events in 24 months for the remaining 17 systems. A detailed review of these 17 systems revealed two systems (one with three events; the other with four events) in which causally linked events were related to failures in human performance.

Circulating Water System

In 24 months, 41 events occurred in this system. The licensee attributed three of these events to component failure and the remainder to cause code "other." We upgraded two of the events designated by the licensee as component failure to Teknekron Event Responsiblity Code M (ERC-M); we upgraded 26 of the 38 events classified as "other" to ERC-M.

For 20 months, this system was unable to meet the environmental technical specifications for tower blowdown. A large number of our reclassifications were prompted by equipment design temperature requirements that could be met only by increased blowdown rates, a factor we considered due to faulty design. Our remaining reclassifications were made on the basis of apparently high velocities in the intake structure, which result in fish impingement outside of technical specifications, which we also consider faulty design. We consider virtually all of these 26 events to be causally linked. However, the number and frequency of the events, as well as the way they were reported in the LERs, indicates that management was aware of the basic cause. By 8/04/76 plant engineers were studying alternative designs. It was also evident that a conscious decision had been made by the facility management to continue to operate the facility while redesigning the circulating water system because the system does not affect operating safety.

Ultimate Heat Sink Facilities

Eight event reports were associated with the operation of this system. The results of our review produced a reclassification of five events from a licensee-identified cause code of "other" to ERC-M. Four of these were causally linked because flow rates in excess of the environmental technical specifications were required to maintain system design temperature conditions for a period of two months. This points to system design inadequacy, in which case the plant management should have redesigned the system or changed the technical specifications. But these causally linked events occurred only for a two month period of 1976 and did not occur thereafter, probably indicating corrective management action.

Containment Heat Removal System

This system had nine events in 24 months, and we noted two groups of cuasally linked events. The first groups involved three events spanning a 19-month period. The date on which they occured, together with the Event Responsibility codes assigned by the licensee and by Teknekron, are:

Date (licensee code/ERC)
1-21-76(F)*
7-01-77(F/M)
7-26-77(F/M)

During a containment inspection on 1-21-76, the dome discharge damper for the No. 14 fan coil unit was found to be improperly positioned. The licensee stated the cause and its response as "binding of the actuator shaft in its bushing. All actuators will be disassembled and inspected at the upcoming refueling

*If no change in code occurs, only the licensee cause code is given.

1080 003

outage. Airline lubricators will also be installed at that time." On 7-01-77 the No. 12 fan coil unit dome damper failed to operate. The licensee stated cause and response was "sheared pins in the damper-to-actuator shaft couplings. Pins were replaced. Pacific Air Products damper with Ramcon No. R-260 actuators." On 7-26-77, during containment inspection, the No. 12 fan coil unit dome damper was found partially closed. The damper was immediately clamped in full open position. The licensee stated that "actuator failure" was the cause of the event. Both actuators were replaced. The equipment involved was a Pacific Air Product damper with Ramcon No. R-260 actuators.

In summary, there appears to be a causal link existing between the 1-21-76 and the 7-26-77 events, since the two failures occurred in similar equipment in redundant systems. This may indicate an incomplete identification of the cause of the 1-21-76 event, an incomplete application of the prescribed remedies to the 1-21-76 event, or possibly just a random subsequent failure. The failure of the actuator-to-damper pins in the 7-01-77 event indicates that the identified causes and/or the remedies prescribed for the 1-21-76 event may not have been adequate. However, the lack of subsequent events in the LER file for the period of record very likely indicates that management and personnel had identified and implemented generic remedies to prevent this type of event.

The second group of causally linked events occurred on 7-27-77 (F) and 9-14-77 (F/M). These events were identical in that the cause of both events was a failure of control fuses and both events occurred in redundant systems (No. 13 and No. 14 fan coil units). The lack of subsequent events in the LER file indicates that management and personnel had probably identified and implemented generic remedies to prevent recurrence.

Reactor Containment System

Events on 5-04-76 and 10-23-76(P) clearly are the result of isolated personnel error. But the event of 8-25-76(P/M) and 9-29-77 (P/M) appear to be linked through apparent management failure to development and implementation administrative controls for the auxiliary building special ventialation zone. In the report of the 8-25-76 event, the licensee identified lack of administrative control as being partly responsible for the event. The 9-29-77 event seems to have resulted from a less-than-complete implementation of the administrative controls. This event group demonstrated that the facility management was aware of the need for generic event cause identification and remedy application. It is also a positive demonstration of how the facility management performs its role in responding to events.

Station Service Water System

The licensee coded the event on 2-25-77 as component failure; the event of 5-20-77 was coded as sluggishness of the diesel water cooling pump governor. The 5-20-77 event also was associated with a sluggish governor. At this point, management began surveillance testing of governor response. There were no subsequent events, indicating effective management response.

On Site Power System

All three events in this system are causally linked. In the events of 6-15-76(F) and 11-21-76(F), the cause and specific system point of occurrence are identical. The cause of the event on 3-14-77 is identical to the previous two, but it occurred in a redundant system. The fact that another event with the same cause has not occurred in the period of record indicates effective management action.

System Code Not Applicable

Point Beach Unit 1 used this "catch all" category to collect occurrences related to technical specification violations by personnel and to record management oversights and communication breakdowns among personnel. The six events in this

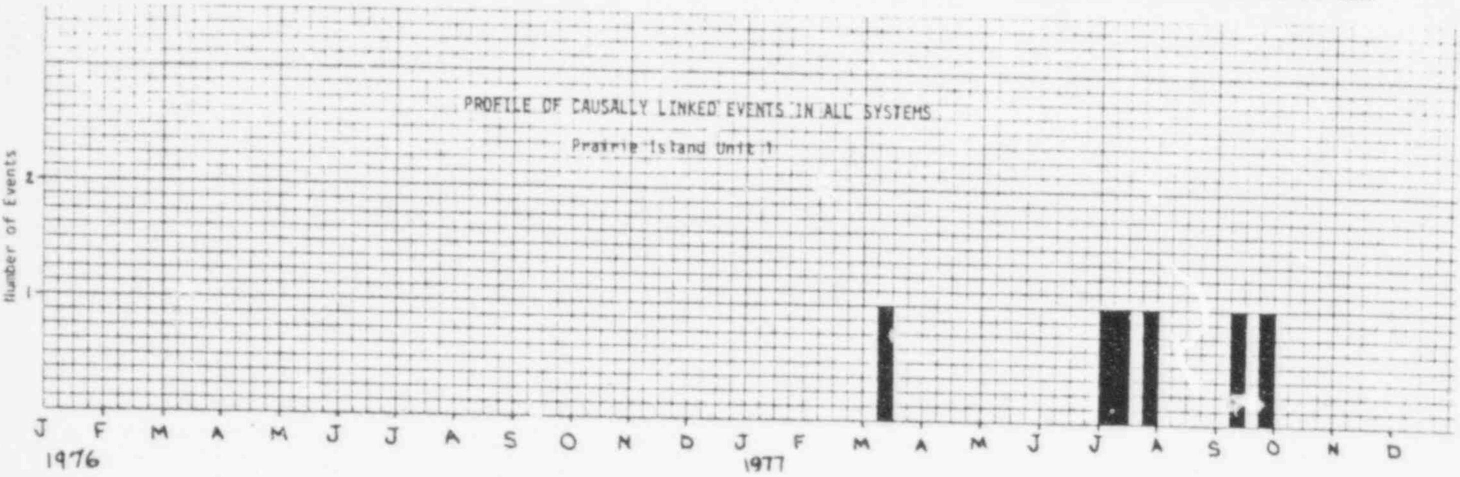
1080 005

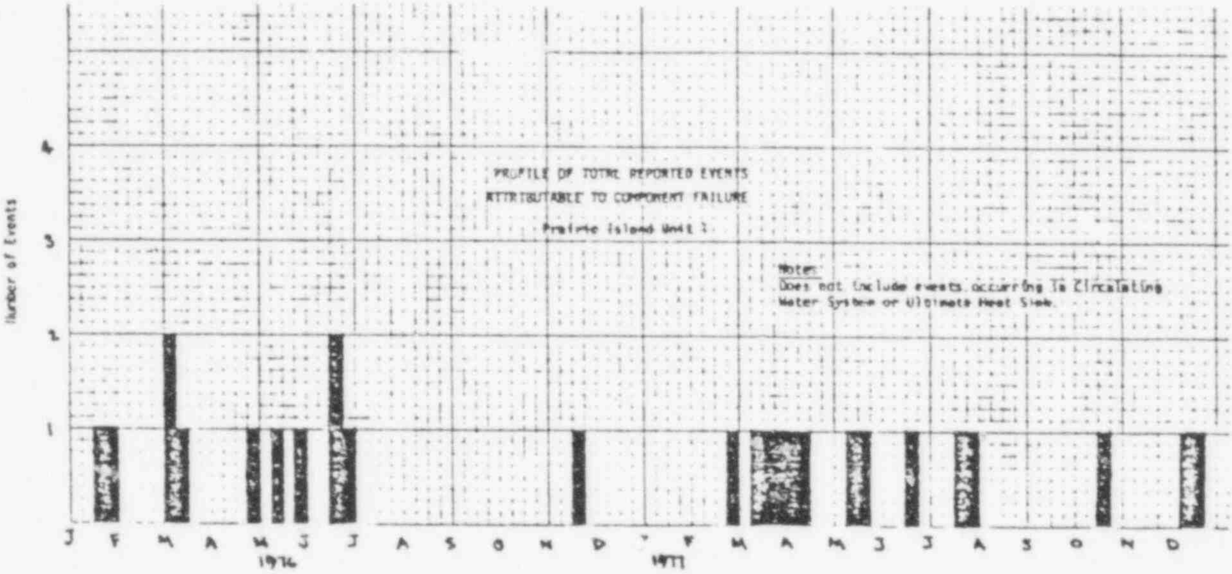
system ranged from a licensed operator's misunderstanding of the requirements for reactor core axial offset control to a failure to perform a required test because personnel were absent

Summary

The analysis of the LER event reports for this licensee indicated design problems in the Ultimate Heat Sink Facility and the Circulating Water System. It appears that design changes in the Ultimate Heat Sink Facility must have been made around 10-76, since there are no event reports on file for this system after this date. It is also possible but we do not think likely that the licensee ceased to report events resulting from the operation of this system after 10-76. A review of other system files of which patterns could be identified (Containment Heat Removal system, Reactor Containment Systems, Station Service Water System, On Site Power System, and System Code Not Applicable) indicated management attention to repeated component failures and personnel errors. In the systems where causal relationships did appear, the facility management's responsiveness was such that no more than three events occurred before an apparent resolution was found and event reports ceased to appear. On the basis of the LER "Event Description" and "Cause Description" provided by the licensee, the facility management approach to resolution of events was to analyze each event for its generic impact on the plant and resolve the event accordingly. This undoubtedly resulted in the low repeatability of events and demonstrates ongoing management awareness of and attention to unscheduled occurrences, particularly in those areas which can be identified as safety-related.

1080 006





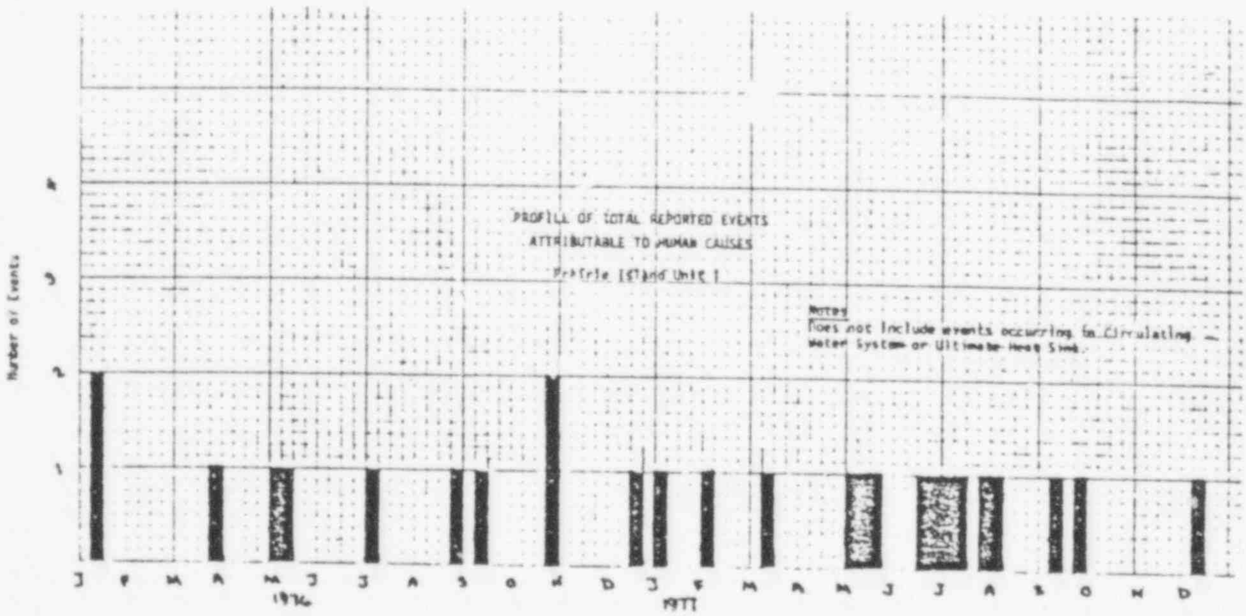


FIGURE A-6

Prairie Island Unit 1 Performance Profiles

TABLE A-6

LERs BY SYSTEM AT PRAIRIE ISLAND UNIT 1 - 1976 and 1977

Emergency Generating System	Containment Combustion Gas Control System	Containment Heat Removal System	Circulating Water System	Ultimate Heat Sink Facilities	Reactor Trip System	Emergency Core Cooling System
1-09-76(0)	1-13-76(P)	1-15-76(F)	1-21-76(0)	1-28-76(F)	2-08-76(0)	3-01-76(F)
12-09-77(P/M)		1-21-76(F)	2-11-76(0)	2-03-76(0)	6-17-76(F)	5-13-76(F)
		9-10-76(P)	3-04-76(F)	5-13-76(0/F)	1-07-77(M)	4-11-77(F)
		5-13-77(0/F)	6-16-76(0)	6-01-76(0/M)	10-15-77(F)	
		7-01-77(F/M)(6)	6-30-76(0)	6-06-76(0/M)		
		7-21-77(F/M)	7-07-76(0)	7-01-76(0/M)		
		7-26-77(F/M)(8)	7-14-76(0)	8-01-76(0/M)		
		7-27-77(F)	7-21-76(0/M)	10-01-76(0/M)		
		9-14-77(F/M)(10)	7-28-76(0/M)			
			8-04-76(0/M)			
			8-11-76(0/M)			
			8-18-76(0/M)			
			8-25-76(0/M)			
			9-01-76(0/M)			
			9-01-76(0/M)			
			9-08-76(0/M)			
			9-15-76(0/M)			
			9-22-76(0/M)			
			9-29-76(0/M)			
			10-06-76(0/M)			
			10-13-76(0/M)			
			10-20-76(0)			
			10-27-76(0)			
			11-03-76(0)			
			11-10-76(0)			
			11-17-76(0)			
			11-24-76(0)			
			12-01-76(0/M)			
			12-08-76(0/M)			
			12-15-76(0/M)			
			12-22-76(0/M)			
			1-03-77(0/M)			
			1-26-77(0/M)			
			2-14-77(F/M)			
			2-23-77(0/M)			
			3-08-77(F/M)			
			4-18-77(0/M)			
			5-12-77(0/M)			
			6-30-77(0/M)			
			7-31-77(0/M)			
			8-31-77(0/M)			

TABLE A-6 (Continued)

LERs BY SYSTEM AT PRAIRIE ISLAND UNIT 1 - 1976 and 1977

Other Engineered Safety Feature Systems Instrumentation	Engineered Safety Feature System Instrumentation	Airborne Radioactive Monitoring System Instrumentation	Reactor Containment System	Station Service Water System
3-01-76(F)	3-03-76(O/F)	4-24-76(F)	9-04-76(P)	5-11-76(P)
3-28-76(M)	4-07-77(F)	5-24-76(F)	8-25-76(P/M)	6-29-76(F)
3-08-77(F)			10-23-76(P)	2-25-77(F)
			3-16-77(F)	5-20-77(O/F)(2)
			9-29-77(P/M)(9,4,11)	
			12-09-77(F)	

Air Conditioning, Heating Cooling, Ventilation System	On Site Power System	Chemical Volume Control System (Chlorine Addition to Cir. Water System)	Spent Fuel Storage Facilities	Containment Isolation System
5-18-76(M)	6-15-76(F)	7-01-76(M)	10-24-76(P)	3-24-77(F)
	11-21-76(F)(2)	2-03-77(P/M)		
	3-14-77(F/M)(3)			

TABLE A-6 (Continued)

LERs BY SYSTEM AT PRAIRIE ISLAND UNIT 1 - 1976 and 1977

Feedwater System	Systems Code Not Applicable	AC Onsite Power System	Chemical, Volume Control, & Liquid Poision System	Reactor Coolant System
3-01-77(M)	1-11-76(P)[4]	6-17-77(F/P)	6-28-77(F/P)	12-20-77(O/F)
6-18-77(F)	8-05-76(O)[5]			
	12-21-76(P/M)			
	5-08-77(P/M)[4]			
	7-14-77(P/M)[7]			
	8-05-77(P/M)[9]			

PRAIRIE ISLAND UNIT 1

NOTES:

1. This event was not assigned to a system in the LER. The category selected for this event by Teknekron was due to the continued necessity for high blowdown rates which identified it as the circulating water system.
2. This event is an identical repeat of the previous event in terms of equipment type and cause of failure - suggests a possible design deficiency.
3. This event appears to be a repeat of the previous event in terms of equipment type and cause of failure - management should be reviewing this as a design deficiency.
4. Violation of technical specifications.
5. Vendor error in accident analysis assumptions.
6. Appears to be identical to previous event 1-21-76 which required equipment to be disassembled and lubricated - now the pins are sheared (perhaps lack of lubrication?).
7. Similar to 12-21-76 event - appears to be failure of management oversite in scheduling of personnel.
8. Similar to previous event 7-01-77 and 1-21-76.
9. Communications breakdown among personnel and management.
10. Similar to previous event on 7-27-77 in a redundant system.
11. Similar to previous event on 8-25-76.

1080 011

Review of 766 System Data File and Inspection Reports for Prairie Island Unit 1

When reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found a total of 48 inspection reports detailing the results of NRC I&E inspector findings. Sixteen of these report identify a total of 29 items of noncompliance. Eleven of these 29 items involve physical protection and are identified in three separate inspection reports.

Matrix A-6 summarizes the findings of each of the 16 inspection reports and associated 766 system data file entries that identify noncompliances. Not including those noncompliances due to physical protection, nine noncompliances were assignable to ERC-M, and nine to ERC-P.

In general, the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details" section of the inspection report agree reasonably well. Less than 20 percent of the noncompliance cause codes either were ambiguous or did not agree with the associated inspection report details. There was generally strong agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. There was less agreement between the noncompliance cause code in the 766 system and the 766 enforcement text: approximately 37 percent of the items bore either an ambiguous or irrelevant relationship to each other. The ambiguity was partly due to a lack of supporting detail in the 766 enforcement text, and also reflects the nearly 20 percent ambiguity found in the relationship of the 766 system cause codes to the inspection report. This substantial ambiguity between the noncompliance cause code and the 766 enforcement text for

MATRIX A-6

Review of 766 File and Inspection Reports for Prairie Island

NAME PRAIRIE ISLAND UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed. Adequacy of Response (Disagree?)
76-02	FJP3	M	YES	YES	YES	YES	NO	YES	NONE	1 EVENT/AGREE
	ASE2	M	NO	CAN'T TELL	YES	NO	NO	NO	NONE	
76-03	FPG2	P	YES	YES	YES	NO	NO	YES	NOT INSPECTED	
76-08 (Phy. Prot.)	RLC2	P	NO	CAN'T TELL	YES	NO	NO	IN SUBSEQUENT LETTER		
	RMC2	P	YES	YES	YES	NO	NO	YES		
	RLC2	P	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
76-09	FJL3	M	YES	YES	YES	YES	YES	IN SUBSEQUENT LETTER	NONE	2 EVENTS/AGREE
	FDB2	M	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		

1080 013

NAME PRAIRIE ISLAND UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
76-11	FJE3	M	YES	YES	YES	NO	NO	NO	YES (3 ITEMS)	9 EVENTS/AGREE
76-13	FJG2	M	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER	YES (1 ITEM)	5 EVENTS/AGREE
76-15	JAY3	P	YES	YES	NO	NO	NO	IN SUBSEQUENT LETTER	NOT INSPECTED	
76-16	FCG2	P	YES	CAN'T TELL	YES	NO	NO	YES	YES (1 ITEM)	2 EVENTS/AGREE
76-18 (Phys. Prot.)	RMB2	M	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER	YES (3 ITEMS)	
76-19	FCG2	P	YES	NO	YES	YES	NO	YES	YES (3 ITEMS)	2 EVENTS/AGREE
77-02	FCS2	P	CAN'T TELL	CAN'T TELL	YES	NO	YES	NO	YES (2 ITEMS)	

1080 014

NAME PRAIRIE ISLAND UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
77-02	FEP3	P	YES	YES	YES	NO	NO	YES		
77-07	FPF2	P	YES	YES	YES	NO	NO	NO		
77-11	FJF2	P	YES	CAN'T TELL	YES	NO	YES	YES		3 ITEMS/AGREE
77-18	FDP3	M	YES	YES	YES	NO	NO	YES	2 ITEMS	9 EVENTS/LICENSEE FAILED TO REPORT AS REQUIRED
										3 EVENTS/AGREE
	FDP3	P	CAN'T TELL	CAN'T TELL	YES	NO	NO	IN SUBSEQUENT LETTER		
	FJP3	M	CANT'T TELL	CAN'T TELL	YES	YES	NO	IN SUBSEQUENT LETTER		
77-23 (PHY. PROT.)	NDE3	M	YES	YES	YES	NO	NO	YES	YES (2 ITEMS)	

1080 015

NAME PRAIRIE ISLAND UNIT 1

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
77-23 (PHYS. PROT.)	NEG2	M	YES	NO	YES	NO	NO	NO		
	NED2	M	YES	NO	YES	NO	NO	YES		
	NED2	P	YES	YES	YES	NO	NO	YES		
	NED2	P	YES	YES	YES	NO	NO	YES		
	NED2	M	YES	CAN'T TELL	YES	NO	NO	NO		
	NED2	P	YES	YES	YES	NO	NO	NO		
77-26	FJE2	M	YES	YES	YES	YES	NO	YES		6 EVENTS/AGREE

1080 016

Prairie Island Unit 1 means that a review of the 766 enforcement text and the noncompliance cause code <u>without</u> the supporting inspection report would <u>not</u> provide a sufficiently comprehensive understanding of a noncompliance and the circumstances of its origin.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In approximately 17 percent of the cases a noncompliance resulted from inspector followup of an LER. In only three cases did a noncompliance result from a licensee-identified matter. For this case study, about 28 pecent of the noncompliances resulted from possible inspector cues. While these percentages are not insignificant, the majority of noncompliances did not result from possible cues to the inspector.

For 45 percent of the noncompliance items, licensee remedies to prevent recurrence of the event were specified in the inspection report, while 31 percent of the items were addressed in a subsequent letter.

The licensee's action on previously identified enforcement items was always timely and generally complete at each inspector visit in which these items were reviewed. On one occasion, the licensee had not resolved several items; this appears to be an isolated instance. In reviewing LERs, the inspector never disagreed with the licensee's reporting of the event. However, there was one occasion on which the inspector identified a group of items that the licensee failed to report. There were no events due to human failure that were serious from the regulatory point of view.

QUAD CITIES UNIT 2 CASE STUDY

Review f the LER File for Quad Cities Unit 2

During 1976 and 1977, events at this unit occurred in 17 systems, as shown in Table A-7 on page A-127. These 17 systems averaged 2.9 events over the 24-month period. Three of these systems had half of the total events reported by the facility for the 24 month period, and averaged 8.3 events per system; removing these systems from the group of 17 resulted in an average of 1.8 events in 24 months for the remaining 14 systems. A detailed review of these 17 systems revealed six systems (two with five events; one with four events; one with three events; two with two events) in which causally linked events were related to failures in human performance.

Reactor Containment System

In 24 months, nine events occurred in this system. The licensee attributed eight events to component failure and one to personnel error. We upgraded four of the events designated by the licensee as component failure to Teknekron Event Responsibility Code M (ERC-M). The system contained one group of causally linked events spanning a 17 month period. The date on which they occurred, together with the Event Responsibility Codes Assigned by the licensee and by Teknekron, are:

Date (Licensee Code/ERC)

6/27/76(F)
2/06/77(F/M)
4/15/77(F/M)
6/18/77(F/M)
11/08/77(F/M)

During a surveillance test of the drywell/torus vacuum breaker AO 2-1601-33A on 6-27-76, a dual indication (we assume position indication) was obtained. The licensee stated, "Problem lies with limit switch. Limit switch will be repaired next outage." On 2-06-77 a drywell/torus vacuum breaker failed to give a full open indication in one channel of the dual indication system.

1080 018

The failure was corrected by realigning the position indication limit switches. The licensee stated the cause as, "Limit switch alignment problem on two valves." On 4-15-77, during the monthly drywell/torus vacuum breaker surveillance testing, vacuum breaker AO 2-1601-33C would not clear dual indication in open position. The licensee stated. "Closed position of valve deduced by green light indication and by integrity of drywell/torus differential pressure. During required 15 day decay test performed the dual indication was cleared." On 6-13-77, during monthly surveillance testing, a drywell/torus vacuum breaker showed dual indication in the open position. The licensee stated that "When suppression chamber becomes available for access, the breakers will be repaired as necessary... postulate(d) that both vacuum breakers have malfunctioned due to limit switch problems due to misalignment or mispositioning." During montly surveillance testing on 11-08-77, vacuum breaker AO-2-1601-33A failed to give a close indication and AS-2-1601-32B gave a dual indication. The licensee stated, "The position switches on valve 33A and 32B were out of alignment....the switches on 32B were readjusted and tested....the switches on 33A were repaired." The licensee indicated that the switches on 32D were redesigned. However, it is not clear if the redesign was performed for all the vacuum breaker switches. Since the last occurrence in this group of causally linked events happened close to the end of the period of record, it is not clear that the management had successfully identified the generic event cause or had successfully implemented a generic solution for the limit switch problem.

Reactor Trip System

This system contained a total of seven events reported by the licensee as component failure (ERC-F). We reclassified one of these events to ERC-P and five to ERC-M. Five of the events were determined to be causally linked and occurred in a 13 month period. The dates on which these events occurred, together with the Event Responsibility Codes assigned by the licensee and by Teknekron, are:

Date (Licensee Code/ERC)

7-24-76(F/P)
1-18-77(F/M)
4-22-77(F/M)
7-22-77(F/M)
8-22-77(F/M)

The first event in the causally linked group occurred on 7-24-76. During routine surveillance it was determined that the turbine first stage pressure switches PS-2-504A and PS-2-504B exceeded allowable technical specification setpoint limits. The licensee re-calibrated the pressure switches to prevent recurrence.

The event was reported by the licensee as "component failure, due to instrumen setpoint drift. The licensee stated in the cause description, "Instrument setpoint set at same value as limiting condition for operation which made no allowance for instrument drift." Since the setpoint being improperly set was the stated cause of the event, we reclassified it from component failure to a failure by "hands-on" personnel, i.e., ERC-F to ERC-P. On 1-8-77, during normal surveillance testing, the turbine first stage pressure switch exceeded allowable technical specification setpoint limits. Again the event was reported by the licensee as setpoint drift. The licensee stated in the cause description, "Instrument setpoint set at same value as limiting condition for operation which made no allowance for instrument drift." On 4-22-77 during normal surveillance testing an event similar to the 1-18-77 event occurred with an identical cause description. On 7-22-77 during normal surveillance testing, an event similar to the 1-18-77 event occurred again. However, the cause description stated only, "Instrument setpoint drift." On 8-22-77 during normal surveillance testing another event similar to the 1-18-77 occurred. In the event description the licensee stated, "Due to persistent drift of switch, switch replaced. New switch calibrated and functionally tested satisfactorily after installation." The lack of subsequent events in the LER file indicates that management and personnel had probably identified and implemented the correct remedy to prevent event recurrence.

The event of 11-14-76 (F/M) occurred while the licensee was performing a monthly functional test of the Reactor Protection System (RPS) Channel B Main Steam Isolation Valve Scram Sensor. The licensee stated that "One of the RPS limit switches failed due to the harsh environment inside the drywell created by high temperatures in the vicinity of the main steam lines." This was upgraded to ERC-M since the event appeared to be attributable to a design defect rather than a random component failure. There were no other events of this type reported for the period of record. This may indicate that the licensee replaced all similar sensors with more durable ones - or the failure may have been random.

Emergency Core Cooling System

This system had nine events in 24 months. The licensee attributed one event to human failure and all the remaining eight events to component failure. We reclassified three of these events as ERC-M and identified one group of causally linked events encompassing four of the nine events.

These four causally linked events occurred over a period of 12 months. The dates on which they occurred, together with the Event Responsibility Codes assigned by the licensee and by Teknekron, are:

Date (Licensee Code/ERC)

11-01-76(F)
3-23-77(F/M)
9-23-77(F/M)
11-06-77(F/M)

On 11-01-76, during startup, the electromatic relief valves (manufactured by Dresser Industries) were tested for operability. Two of the relief valves failed to open when actuated from the control room. The cause was described by the licensee as "Valve disk guide corrosion leading to possible piston ring binding or leakage. Also thread damage on disc retaining plate connection." During a test on 3-23-77, a main steam electromatic relief

1080 021

valve (Dresser Industries) failed to open. The licensee stated that ". . . system vibration (may have) caused loosening of disc retainer plug locking arm on valve. After locking arm came loose, additional vibration caused retainer plug threads to wear and allowed an excessive amount of steam to leak in area below valve disc causing valve not to open when actuated."

On 9-23-77, the main steam electromatic relief valve (Dresser Industries) failed to open during testing - the licensee stated that the valve was replaced. The cause description stated by the licensee was, "Rings on main valve disc had worn grooves in disc guide inhibiting valve disc from moving. Pilot valve seating surface found cut by steam indicating a leakage through the pilot." The licensee identified modifications to the relief valve to preclude further events. However, it is not clear from the LER file whether the "fix" was implemented for the replacement valve in this event.

Following a reactor scram on 11-06-77, a relief valve (Dresser Industries) was opened and failed to properly reseat upon closing. The licensee stated that "Failure to reseat was caused by steam cutting and erosion of pilot valve seat. Cutting provided leakage path which would not allow pressure to equalize in valve assembly to fully close main valve. Faulty relief valve was replaced and relief valve discharge temperatures are being monitored to identify faulty pilot valves."

Since the last event occurred close to the end of the period of record, it is not possible to observe the effectiveness of the licensee's identification and implementation of the required remedies. However, on the basis of the 11-06-77 event, it does not appear that the modifications described in the 9-23-77 event were applied to all the relief valves.

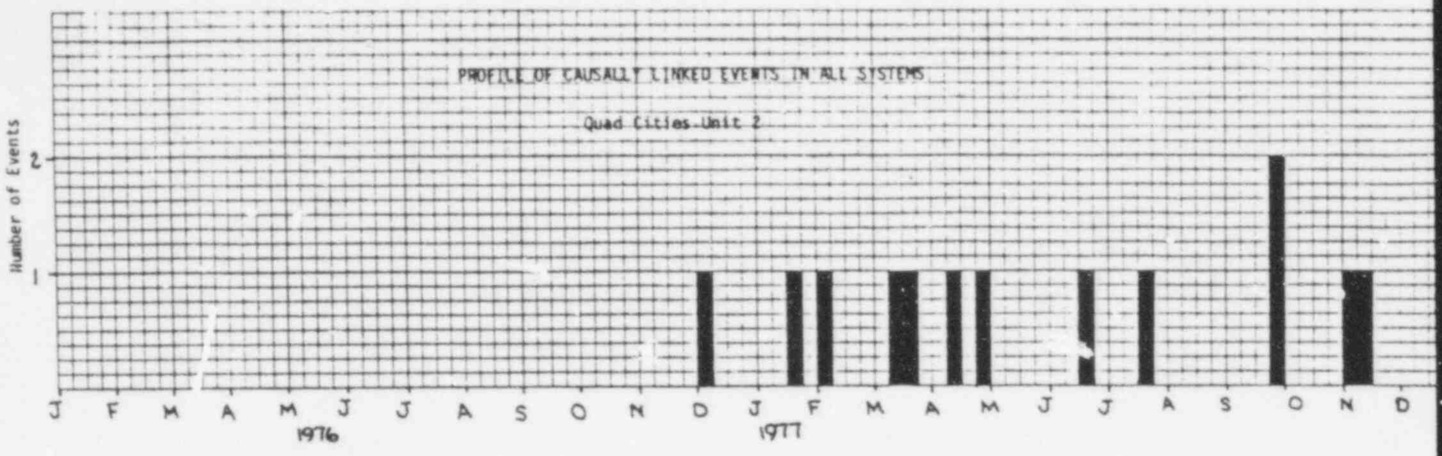
Hangers, Supports, and Shock Suppressors

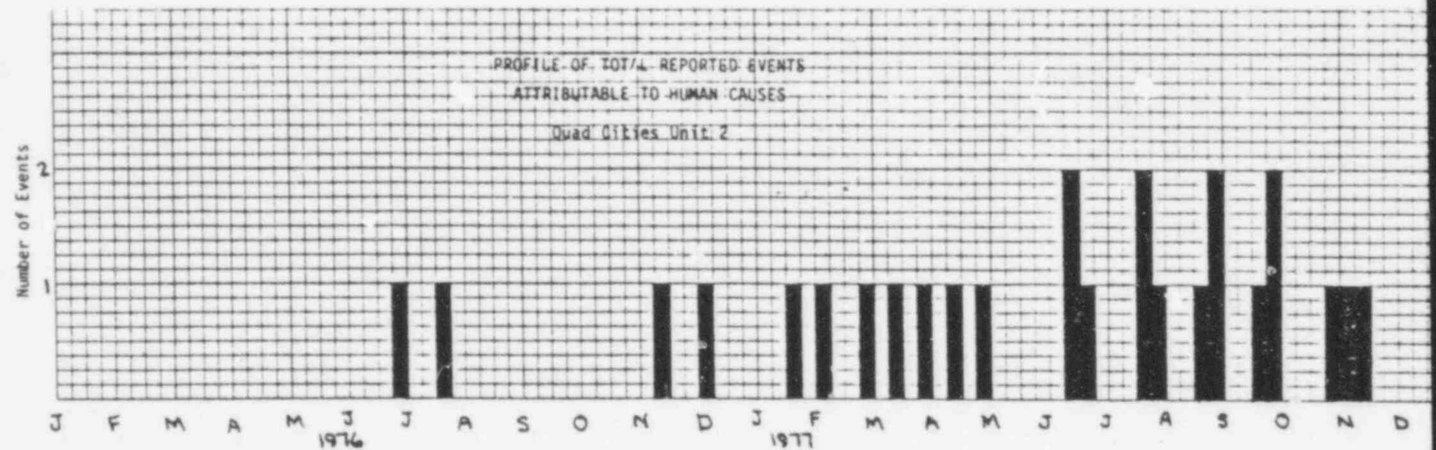
This "system" is unique in that it is not classified as a system in the LER file codes but as a component. However, it is a component that is present in most, if not all, facility systems; and its absence from the system list may indicate a weakness in that data system. For the purpose of this analysis, the events identified as "Hangers, Supports, and Shock Suppressors" under various systems were collected and reviewed as we would a system.

The licensee identified a total of three events due to failure of hydraulic snubbers. On 9-22-76, during a routine inspection of hydraulic snubbers, three Grinnell and one Bergen-Patterson snubber were found to have empty oil reservoirs. The licensee stated that, "All other snubbers that were inspected had satisfactory fluid levels. All four snubbers were found to have oil leakage around the shafts through the 'O' rings. The rings were observed to be dried out and cracked in several places." There was no indication in the event report that the licensee attempted to examine all other Grinnell and Bergen-Patterson snubbers. On 12-03-76, during normal surveillance inspection, another Grinnell snubber was found to have an empty oil reservoir. All other hydraulic snubbers that were inspected were in satisfactory condition. The licensee stated that, "The empty snubber oil reservoir was caused by leakage through the reservoir end cap gaskets, no fittings or tubing were found to be defective, and the snubber appeared to be fully intact." On 3-08-77, during routine surveillance, five snubbers were found inoperable. The licensee stated, "Oil reservoirs found empty. Snubbers repaired. ITT Grinnell snubber oil reservoir leakage through reservoir end caps due to loose tie rod. Empty Bergen-Patterson oil accumulators appeared to be caused by hardening of seals and 'O' rings."

The first two events were apparently due to failures of separate elements - 'O' rings and end cap gaskets - in the same component. The third event was due to a combination of 'O' ring and end cap gasket failures. It would appear that a comprehensive surveillance and maintenance program based on the findings of the first and second events could have prevented the occurrence of the third event. However, the fact that no further events were identified for the nine month period after the event of 3-08-77 probably indicates that management had successfully implemented a generic remedy for all the hydraulic snubbers.

1080 023





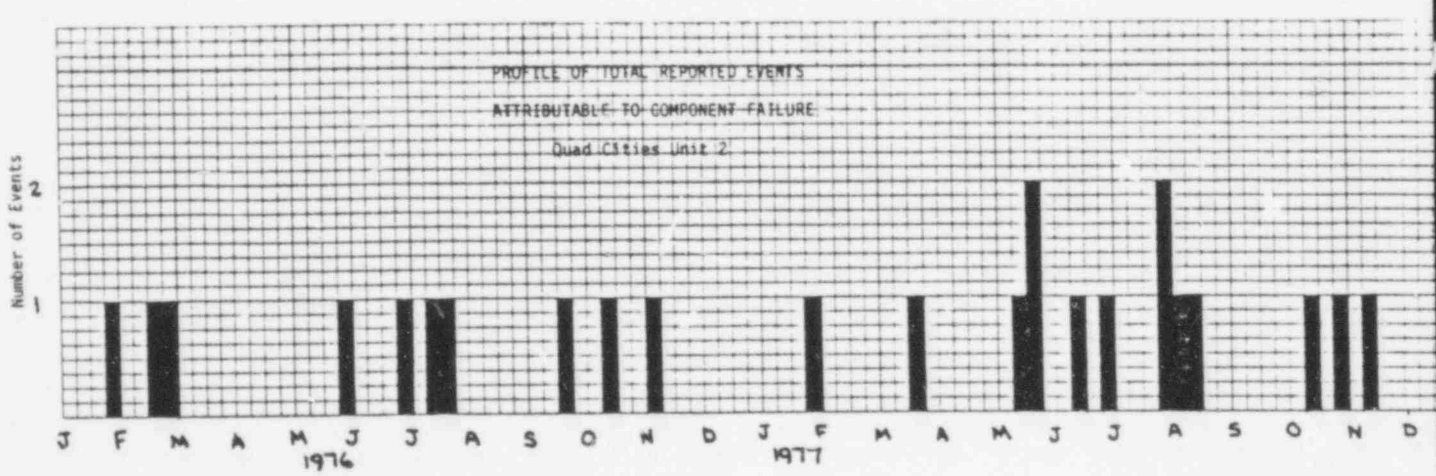


FIGURE A-7

Quad Cities Unit 2 Performance Profiles

1080 024

TABLE A-7

QUAD CITIES UNIT 2 LERs

Other Instrument Systems Required for Safety	Main Steam Isolation System	Reactor Containment System	Area Monitoring Systems	Containment Isolation System
1/29/76(F)[1]	3/19/76(F)	3/30/76(F)[1]	6/28/76(M)	7/12/76(F)
	5/27/76(F)[1]	6/27/76(F)	2/28/77(P)	
	9/22/77(F/M)[8]	2/06/77(F/M)[5]		
		4/15/77(F/M)[5]		
		6/18/77(F/M)[5]		
		7/28/77(F)[1]		
		9/29/77(P)		
		10/31/77(F)		
		11/08/77(F/M)[5]		

TABLE A-7 (Continued)

Residual Heat Removal System	Reactor Trip Systems	Hangers, Supports, and Shock Suppressors	Reactor Core Isolation Cooling System	Emergency Core Cooling System
7/22/76(F)	7/24/76(F/P)[1]	9/22/76(F)	10/12/76(F)[1]	11/01/76(F)
5/30/77(F)	11/14/76(F/M)	12/03/76(F/M)[2,3]	5/19/77(F)	1/28/77(F)
8/18/77(F/M)	1/18/77(F/M)[1,4]	3/08/77(F/M)[2]	7/27/77(P)	3/23/77(F/M)[6]
8/24/77(F/P)	4/22/77(F/M)[1,4]			5/17/77(F)
	7/22/77(F/M)[1,4]			6/20/77(F)
	7/25/77(F)[1]			7/19/77(P)
	8/22/77(F/M)[1,4]			9/23/77(F/M)[9]
				11/05/77(F/M)[10,11]
				11/14/77(F)

TABLE A-7 (Continued)

D.C. Onsite Power Systems	Containment Air Purification & Cleanup System	Feedwater Systems	Turbine Generator Control System	Emergency Generator System
3/17/77(F)	5/14/77(F)	6/13/77(F/P)	8/05/77(F)	8/10/77(F)
6/09/77(F/P)[7]				

Coolant Recirculation System	Reactivity Control Systems
10/13/77(F)	10/26/77(M)

TABLE A-7

NOTES:

1. Instrument setpoint drift discovered during routine surveillance.
2. Causally linked to 9/22/76 event in that apparently a generic evaluation of the 9/22/76 event was not performed and a generic resolution was not implemented, i.e., Grinnell Corp. snubbers.
3. Classifed in LER file under "Reactor Core Isolation Cooling System."
4. Causally linked to 7/24/76 event - identical - apparently management did not change procedures or reinstruct personnel on adjustment of instrument setpoints.
5. Causally linked to 6/27/76 event - management failure to implement a generic evaluation and fix to the first event, i.e., 6/27/76.
6. Causally linked to 11/01/76 event - management failure to follow up on cause of "thread damage on disc retaining plate connection" identified for the 11/01/76 event, i.e., Dresser Industries valve.
7. Causally linked to 3/17/77 event - when the D.C. power supply system was returned to service after replacement of faulty current control circuit - apparently adjustment and testing of new circuitry was incomplete.
8. Causally linked to 3/19/76 event - in that this event (9/22/77) was due to a faulty pilot valve assembly due to a damaged "O" ring. The 3/19/76 event identified small pieces of foreign material in pilot assembly.
9. Causally linked to 3/23/77 event - in that this event, i.e., 9/23/77, was due to failure to generically resolve design defects in the Dresser Industries electromatic relief valve.
10. Causally linked to 9/23/77 event in that the failure of the pilot valve seat occurred in the 9/23/77 event. Failure by management to identify generic cause and resolve resulted in this event.
11. Event improperly classified under "Main Steam System."

Review of 766 System Data File and Inspection Reports for Quad Cities Unit 2

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found a total of 61 inspection reports detailing the results of NRC I&E inspector findings. Twenty six of these reports identify a total of 45 items of noncompliance. Three of these 45 items involve physical protection and are identified in two separate inspection reports.

Matrix A-7 summarizes our review of 30 inspection reports. It includes the findings of the 26 reports which discuss noncompliances as well as four additional reports. These four additional reports were selected to determine the character of the inspection when no items of noncompliance were identified and to gather additional data on a licensee action on previously identified enforcement items. Not including those noncompliances due to physical protection, 16 noncompliances were assignable to ERC-M and 20 to ERC-P.

In general, the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details" section of the inspection report agreed reasonably well. Less than 17 percent of the noncompliance cause codes either were ambiguous or did not agree with the associated inspection report details. There was generally strong agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. There was less agreement between the noncompliance cause code in the 766 system and the 766 enforcement text: approximately 33 percent of the items bore either an ambiguous or irrelevant relationship to each other. The ambiguity was partly due to a lack of supporting detail in the 766 enforcement text, and also reflects the 17 percent ambiguity found in the relationship of the 766 system cause codes to the inspection report. This substantial ambiguity between the noncompliance cause code and the 766 enforcement text for Quad Cities Unit 2 means that a review of the 766 enforcment text and the noncompliance cause code without the supporting inspection report would not provide a sufficiently comprehensive understanding of a noncompliance and the circumstances of its origin.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In approximately 15 percent of the cases a noncompliance resulted from an inspector followup of an LER. In only five cases did a noncompliance result from a licensee-identified matter. For this case study, about 27 percent of the noncompliances resulted from possible inspector cues. While these percentages are not insignificant, the majority of noncompliances did not result from possible cues to the inspector.

For 51 percent of the noncompliance items, licensee remedies to prevent recurrence of the event were specified in the inspection report, while 49 percent of the items were addressed in a subsequent letter. The licensee's action on previously identified enforcement items was always timely and generally complete at each inspector visit in which these items were reviewed. On one occasion, the licensee had not resolved one item; this appears to be an isolated instance.

In reviewing LERs, on one occasion (Report No. 7/18) the inspector disagreed with the licensee's reporting of two events. In general there appear to be no problems with the licensee's LER reporting. There were no events due to human failure that were serious from the regulatory point of view.

MATRIX A-7

NAME QUAD CITIES UNIT 2

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7603 (Phys. Prot.)	RME2		(REPORT NOT	AVAILABLE)						
	RMC2									
7605	ART3	M	No	Yes	Yes	Ko	No	Yes	1 item-closed	
	FCJ2	P	Yes	Yes	Yes	No	Yes	Yes		
	ASB2	M	Yes	Yes	Yes	No	Yes	Yes		
7607	FCG2	F	Yes	Yes	Yes	No	No	In a followup letter		
7608	ABC2	M	Yes	Can't tell	Yes	No	Yes	Yes		4 items-agree
	FCJ2	P	Yes	Yes	Yes	Yes	No	Yes		
7610										
7613										
7615	FDP3	0	Yes	Yes	Yes	No	No	In a followup letter	2 items-closed	
7618										

1080 031

MATRIX A-7

NAME QUAD CITIES UNIT 2

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7620	EEA2	M	Yes	Yes	Yes	No	No	In a letter		
7621	FES2	P	Yes	Yes	Yes	No	No	Yes		
	FPD2	M	Yes	No	Yes	No	No	Yes		
7625 Phys. Prot.	RMA2	M	REPORT NOT PURSUED							
7626	FDB2	M	Yes	Can't tell	Yes	No	No	In a followup letter	3 items-closed	
	ABC2	M	Yes	Can't tell	Yes	Can't tell	Yes	In a followup letter		
7627	ETA3	P	Yes	Can't tell	No	No	No	Yes	1 item-open	
7628	EEC3	P	Yes	Yes	Yes	No	No	Yes		
	ELG3	P	Yes	Yes	Yes	No	No	In a followup letter		
7629	EEB2	P	Yes	Yes	Yes	No	No	In a followup letter		5 items-agree
	FJG2	M	Yes	Yes	Yes	No	No	Yes		
	FJG3	M	Yes	Yes	Yes	No	No	In a followup letter		

1080 032

MATRIX A-7

NAME QUAD CITIES UNIT 2

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated in IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7629	EEB3	P	No	Yes	Yes	No	No	In a followup letter		
7702*	FCJ2	P	Yes	Yes	Yes	Yes	No	Yes		
	FCJ	P	Yes	Yes	Yes	Yes	No	Yes		
7705	FJJ	P	Yes	Yes	Yes	Yes	No	In a followup letter		
	ASE	M	Can't tell	Can't tell	Yes	No	Yes (1)	In a followup letter		
7706	EDG	M	No	Can't tell	Yes	No	No	Yes		3 items-agree
	EEB3	P	Yes	Yes	Yes	Yes	No	In a followup letter		
7709	FJP3	P	Yes	Yes	Yes	No	No	In a followup letter		
7710	EGB2	P	(REPORT NOT AVAILABLE)							
7711	FCG2	P	Yes	Yes	Yes	Yes	No	Yes		
	ASA2	P	Yes	Yes	Yes	No	No	In a followup letter		
	FPG2	P	No	No	Yes	No	No	Yes		

*Report 7702 shows two noncompliances which result from inspector followup on LER for Unit 1. 766 file for same report shows two noncompliances against Un Unit 2.

(1) Due to allegation

1080 033

MATRIX A-7

NAME QUAD CITIES UNIT 2

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7711	HAI2	M	No	Can't tell	Yes	No	No	In a followup letter		
7713	FDE3	M	Yes	Can't tell	Yes	No	No	Yes		
7715	FCS2	O	Yes	Can't tell	Yes	No	No	Yes	1 item closed	
	FDP3	P	Yes	Yes	Yes	No	No	In a followup letter		
	FCS2	O	Yes	Can't tell	Yes	No	No	Yes		
7718	FCE2	P	Yes	Yes	Yes	No	No	Yes	2 items-closed	2 items-disagree 5 items-agree
7722	FCG3	F	Yes	Yes	Yes	No	No	Yes	2 items-closed	3 items-agree
7723	FPF3	P	Yes	Yes	Yes	No	No	In a followup letter		
7724	LAA2	M	Yes	No	Yes	No	No	In a followup letter	1 item-closed	1 item-agree
7725	EEC2	M	Yes	Yes	Yes	No	No	In a followup letter		1 item-agree
	FJP3	M	No	Can't tell	Yes	No	No	Yes		
7731	ECH2	P	Yes	Yes	Yes	No	No	In a followup letter		7 items-agree

1080 034

ROBINSON UNIT 2 CASE STUDY

Review of the LER File for Robinson Unit 2

In 1976 and 1977, forty-seven events occurred in 22 systems, as shown in Table A-8 on page A-142. The Reactor Core System sustained eight events; eight were associated with the Chemical Volume and Liquid Poison Control System and six with the Reactivity Control System. The remaining nineteen systems averaged 1.4 events each. On analysis of the events as described in the LER file, two cause codes were upgraded from ERC-F to ERC-M, one from ERC-P to ERC-M, and three from ERC-F to ERC-P. Two were downgraded from ERC-M to ERC-F and one was downgraded from ERC-P to ERC-F. This low number of upgrades indicates that the responsibility for the events reported was, in our view, usually correctly identified. Four groups of causally linked events were noted. One of these was of particular interest because, unlike most event relationships of this kind, it did not reflect adversely on management.

Reactivity Control System

None of the six events in this system was attributable to human error: four were coded ERC-F and two ERC-O. One of the ERC-F events was of special importance because it triggered the linked series considered to be of unusual interest. On April 4, 1976, during a periodic reactivity control system test, a rod dropped. The cause was a failed electrical connector (later replaced), which resulted in a radial tilt. The reactor then operated in a degraded mode, but within applicable technical specification limits. The related events that were subsequently reported are categorized under the Reactor Core System.

Reactor Core System

Eight events were associated with this system, including one which the licensee categorized as "System Code Not Applicable." Of these eight events, two were coded ERC-O, one as ERC-P, and three as ERC-M; two others, originally categorized by the licensee as the responsibility of management, were downgraded to ERC-F. On April 4, 1976, following the rod drop event described above, a second occurrence of radial tilt was observed during recovery from the outage made necessary by the dropped rod. While this led to operation in a degraded mode it was not a violation of technical specifications. The tilt was attributed to "residual effects of the xenon poisoning" that followed the first event. Later on the same day, the licensee noted that "As a result of the various forced power maneuvers due to the dropped rod, radial tilts and low RCP seal flow, the total cumulative time outside CAOC (constant axial offset controls) limits exceeded 1 hour." This degraded mode operation was allowable under the technical specifications. The three reports describing these events were prepared on May 3, 1976. The second two events were cause coded by the licensee as "design/fabrication error" (Teknekron equivalent is ERC-M), presumably because of the failed connector which precipitated the situation. The first event in the series was coded (by the licensee) as "component failure" (ERC-F). We believe that in this case component failure is in fact the appropriate code for all three events; for this reason, we downgraded the second two events from ERC-M to ERC-F. The second two occurrences were changes of operating state rather than events in the strict sense and in no case was there a violation of technical specifications. On the basis of a discussion with the NRC Division of Operating Reactors Project Manager for this facility, it appeared that the licensee was not obligated to report the second two changes of state (that is, these were not "reportable events" as viewed by the agency). The fact that they were reported reflects a conscientious attitude on the part of licensee management in discharging its obligations to NRC.

Chemical Volume and Liquid Poison Control System

Eight events were reported for this system between 04-12-76 and 06-22-77. Of these, five related to the "B" boric acid transfer pump. The first event (04-12-76) had originally been associated with "Other Coolant Subsystems" ar. was reclassified in our analysis. In this event, a pump tripped due to too high settings of the heater circuits. The licensee validly cause coded this as "personnel error," or ERC-P. On 10-18-76 the pump tripped again. It was found that the bearings were worn, the stator was defective and the pressure indicator read low. These components were replaced. The licensee's cause code of "component failure" (ERC-F) was not altered. The next pump trip event occurred on 10-29-76. This was essentially a repeat of the initial trip event in that the thermal setting was found to be too high. Whether the resetting made on 04-12-76 had been altered when the pump was repaired on 10-18 of the same year is not known. The licensee attributed the 10-29 event to personnel error, and we upgraded the coded to ERC-M. The first and third events are causally linked, but the second appears to be independent. On 01-24-77 the pump tripped again, this time because the line that conducts the lubricating and cooling medium (boric acid solution) to the bearings became clogged with solid boric acid. The line was cleansed and the pump restarted. The licensee attributed this event to "component failure" (ERC-F), which was not upgraded. The root cause of the clogging, obviously due to precipitation of boric acid from solution, is not given in the LER file, but it may have been due to the fact that the last known thermal setting, on 10-29-76, was made before the onset on winter weather that reduced the ambient temperature. Thus, a setting appropriate for October could be too low for January, thus permitting cooling of the lube line with consequent precipitation of the boric acid. This speculation is supported by the fact that on 01-31-77 the pump tripped again, but this time because the temperature setting was found to be too low. The licensee cause coded this event "personnel error" (ERC-P). This cause code was not upgraded.

A second series of causally linked events occurred in this system. On 06-07-77 two charging pumps (Union Pump Type TX-150) exhibited low pressurizer levels; these pumps were found to be airbound "due to accumulation of air at the suction of the pumps." The pumps were vented to correct this condition. Somewhat over two weeks later, on 06-22-77, one of the two pumps involved in

1080 037

the first became airbound again. Both events were cause coded "component failure" by the licensee. We upgraded the second event to ERC-M.

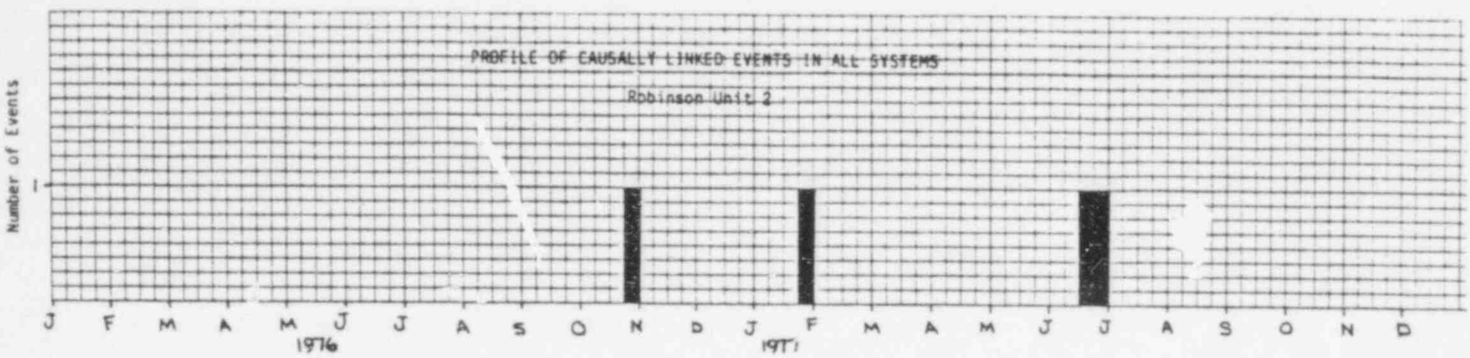
Reactor Containment System

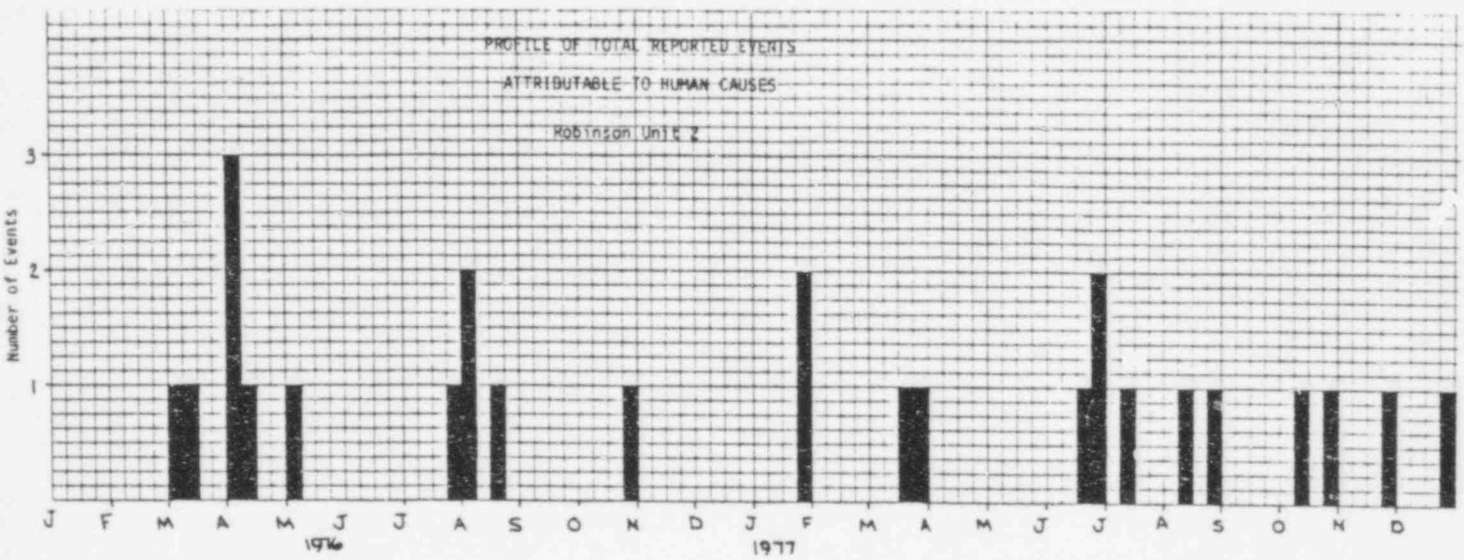
Only two events were reported for this system, but they were causally linked. On 06-10-77 "CV purge outlet inner valve (was) declared inoperable." This was due to leakage past the inner valve rubber seat resulting from "normal wear." The LER states that "Adjustments in reducing this leakage to seat ring were successful." The licensee coded this event as component failure. On 06-19-77, the same valve leaked again for the same reason. This time the seat was replaced. The licensee's cause code of "component failure" was upgraded to ERC-M.

Other Systems

Twenty-three events were reported in the remaining 16 systems, and none appeared to be causally linked. We upgraded three of the licensee's cause codes from ERC-F to ERC-P. In the Station Service Water System, a pump breaker tripped open because the thermal overload device had been improperly set. In the Containment Heat Removal System, during routine testing of the fan cooler unit, both the normal and emergency damper failed to operate. The problem was traced to a lack of alignment and lubrication. In the Feedwater System, the auxiliary feedwater pump tripped during testing when a valve failed to close completely because of inadequate stem lubrication.

POOR ORIGINAL





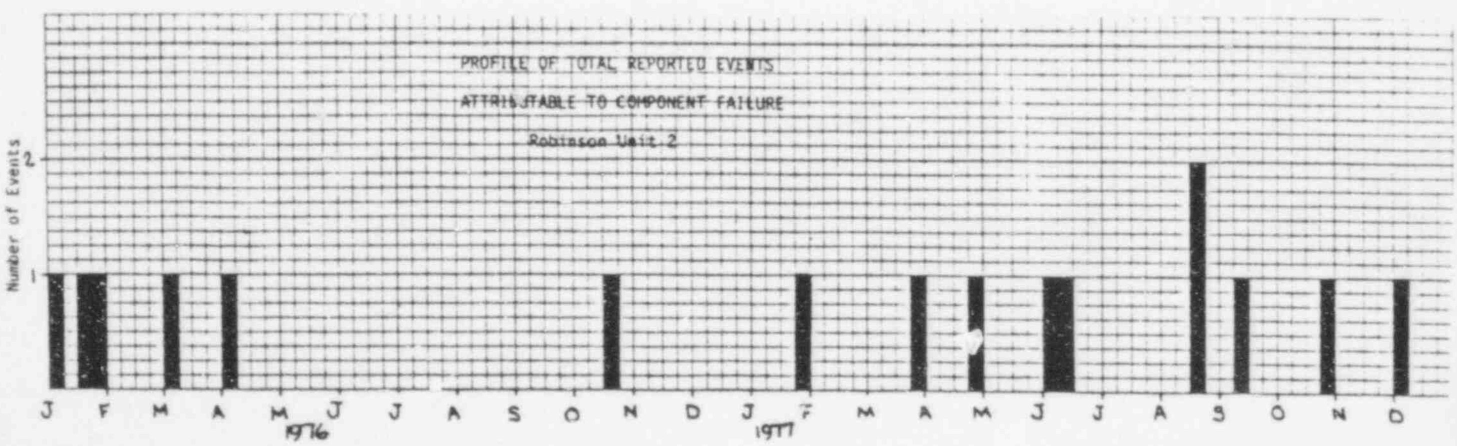


FIGURE A-8

Robinson Unit 2 Performance Profiles

1030 039

TABLE A-8

ROBINSON UNIT 2 LERs
1976-77

Reactivity Control System	Reactor Trip System	Emergency Generator System	Containment Heat Removal System	Reactor Core System
01-02-76 (F)	01-21-76 (F)	03-01-76 (F)	03-03-76 (F/P)	03-12-76 (M)
01-28-76 (F)		09-13-77 (F)		04-04-76 (M/F)
04-04-76 (F)				04-04-76 (M)
04-24-77 (F)				05-01-76 (P)
10-07-77 (0)				08-05-76 (M)
11-26-77 (0)				08-07-76 (M)
				10-05-77 (0)
				12-19-77 (0)

Aircond., Heating & Ventilating System	Miscellaneous	D.C. Onsite Power System	Feedwater System	Chemical, Volume Control & Liquid Poison System	Safety Related Display System
04-02-76 (P)	06-27-77 (P)	07-26-76 (P)	8-17-76 (M)	04-12-76 (P)	03-17-77 (P)
			12-22-77 (F/P)	10-18-76 (F)	
				10-29-76 (P/M)(1)	
				01-24-77 (F)	
				01-25-77 (P)	
				01-31-77 (P)(1)	
				06-07-77 (F)	
				06-22-77 (F/M)(2)	

1080 040

TABLE A-8 (Continued)

Containment Heat Removal System	Condensate and Feedwater System	Reactor Containment System	Station Service Water System	Coolant Recirculating System
03-24-77 (P)	03-26-77 (F)	06-10-77 (F)	06-26-77 (O)	08-13-77 (M)
	08-16-77 (F)	06-15-77 (F/M)[3]	07-10-77 (F/P)	
	08-17-77 (F)			

Containment Air Purification Cleanup System	Liquid Radwaste System	Systems Required for Safe Shutdown	Residual Heat Removal System	Emergency [illegible]re Cooling [illegible]em
[illegible]25-77 (M)	10-08-77 (P)	[illegible]-26-77 (M)	10-26-77 (F)	11-23-77 (P/M)
			12-03-77 (F)	

1080 041

TABLE A-8

NOTES:

1. Linked to 4/12/76 event due to improper resetting of heater circuits

2. Linked to 6/22/77 event in that the venting of the pump section was probably incomplete.

3. Linked to 6/10/77 event.

Review of Inspection Reports and 766 Sytem Data File for Robinson Unit 2

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found a total of 29 inspection reports detailing the results of NRC I&E inspector findings. Sixteen of these reports identify a total of 29 items of noncompliance, not including those relating to physical protection.

Matrix A-8 summarizes the findings of each inspection report and associated 766 system data file entries that identify noncompliances, as well as one report in which LERs were reviewed. Not including those noncompliances due to physical protection, 17 noncompliances were assignable to ERC-M and 12 were assignable to ERC-P.

There was reasonable agreement between the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details" section of the inspection report. About 21 percent of the noncompliance cause codes either were ambiguous or did not agree with the associated inspection report details. In general, there was strong agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. There was also reasonable agreement between the noncompliance cause code in the 766 system and the 766 enforcement text: approximately 28 percent of the items bore either an ambiguous or irrelevant relationship to each other. This level of agreement largely reflects the 21 percent disagreement between the 766 cause code and the report details and some lack of detail in the 766 enforcement text. These figures suggest that the cause codes may not have been chosen with sufficient care, or that they cannot express the root cause of events for this licensee. In either case, the supporting I&E report must be consulted to understand the noncompliance and its origin.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. Only 3 percent of noncompliances resulted from inspector followup on an LER, and only 10 percent of noncompliances resulted from licensee identification of new or modified procedures to the inspector. In this case study, only about 10 percent of the noncompliances resulted from possible inspector cues; cues did not play a substantial role in identifying noncompliance items.

For only 3 percent of the noncompliance items, licensee remedies to prevent recurrence of the event were specified in the inspection report; 97 percent of the noncompliance items were addressed in a subsequent letter.

The licensee's action on previously identified enforcement items was timely and complete, with one exception, at each inspector visit in which items were reviewed. In reviewing LERs, the inspector never disagreed with the licensee's reporting. There were no events due to human failure that were serious from the regulatory point of view.

MATRIX A-8

NAME ROBINSON UNIT 2

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7602	----	----	Special inspection to review erratic operation of RPS relays--licensee appeared to be satisfactorily resolving the problem						--	----
7604	FJH2	M	No	No	Yes	No	No	In a followup letter	1 item - open 1 item - closed	4 items agree
	FJG2	M	No	No	Yes	No	No	In a followup letter		
7606	FJH2	M	Yes	Yes	Yes	No	No	In a followup letter	----	----
7608	FDL3	P	Yes	Yes	Yes	No	No	Yes	2 items-closed	4 items agree
7609	FPG3	M	Yes	Yes	Yes	No	No	In a followup letter	----	----
	FPG3	P	Yes	Yes	Yes	No	No	In a followup letter	----	----
7612	EGD3	M	Yes	can't tell	Yes	No	No	In a followup letter	1 item - closed	----
7613	EJC2	M	Yes	Yes	No	No	No	In a followup letter	----	----
	ESA2	M	Yes	Yes	Yes	No	No	In a followup letter		
	FJH2	P	Yes	Yes	Yes	No	No	In a followup letter		
7614	AEB3	M	No	Yes	Yes	No	No	In a followup letter	2 items - closed	----

1080 045

MATRIX A-8

NAME ROBINSON UNIT 2

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7703	ETA3	M	Yes	can't tell	Yes	No	No	In a followup letter	----	1 item - agree
7705	----	---	---	---	---	---	---	---	----	1 item - agree
7707	FEP3	M	No	Yes	Yes	No	No	In a followup letter	---	---
	FPD3	P	Yes	Yes	Yes	No	No	In a followup letter		
	FEM3	P	Yes	Yes	Yes	No	No	In a followup letter		
	FEP3	P	Yes	Yes	Yes	No	No	In a followup letter		
7709	HAI2	M	Yes	Yes	Yes	No	No	In a followup letter	1 item - closed	---
	ALD2	M	Yes	Yes	Yes	No	No	In a followup letter		
	ART3	M	Yes	can't tell	Yes	No	No	In a followup letter		
	FPG2	P	Yes	Yes	Yes	No	No	In a followup letter		
7710	FJP3	M	can't tell	Yes	Yes	Yes	No	In a followup letter	---	---
7716	ALA3	P	can't tell	can't tell	Yes	No	No	In a followup letter	---	---

1080 046

MATRIX A-8

NAME ROBINSON UNIT 2

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7716	ALA3	P	can't tell	can't tell	Yes	No	No	In a followup letter	---	---
	AEA3	M	Yes	can't tell	Yes	No	No	In a followup letter		
7717	FJE2	P	Yes	Yes	Yes	No	No	In a fo. letter	---	4 items - agree
	FJE2	P	No report details	Yes	Yes	No	No	In a followup letter		
7718	FPF3	M	Yes	Yes	No	No	No	In a followup letter	---	---
7720	FJE2	P	Yes	Yes	Yes	No	Yes	In a followup letter	---	6 items - agree
	FCE2	P	Yes	Yes	Yes	No	Yes	In a followup letter		
7721	FCJ2	M	Yes	can't tell	Yes	No	No	In a followup letter	2 items - closed	---

SAN ONOFRE UNIT 1 CASE STUDY

Review of the LER File for San Onofre Unit 1

During 1976 and 1977, 26 events occurred in 14 systems, as shown in Table A-9 on page A-154. Eleven events were reported as component failure, and we reclassified one as ERC-P. Three events were reported as "other"; we reclassified one as ERC-P. The remaining events were reported as human error; we upgraded one event classed as personnel error to ERC-M.

The description of the single event in the Emergency Core Cooling System mentions a related event (number 77-02) that is missing from the LER file. Our conversations with NRC staff make it clear that the event was never entered into the computer file. The date of the event was 01-17-77, but since we could not verify the system or the content of the event, it is not included in our analysis.

Six of the systems had more than one event, averaging 3 events each over the 24-month study period. Only two systems had causally linked groups of events.

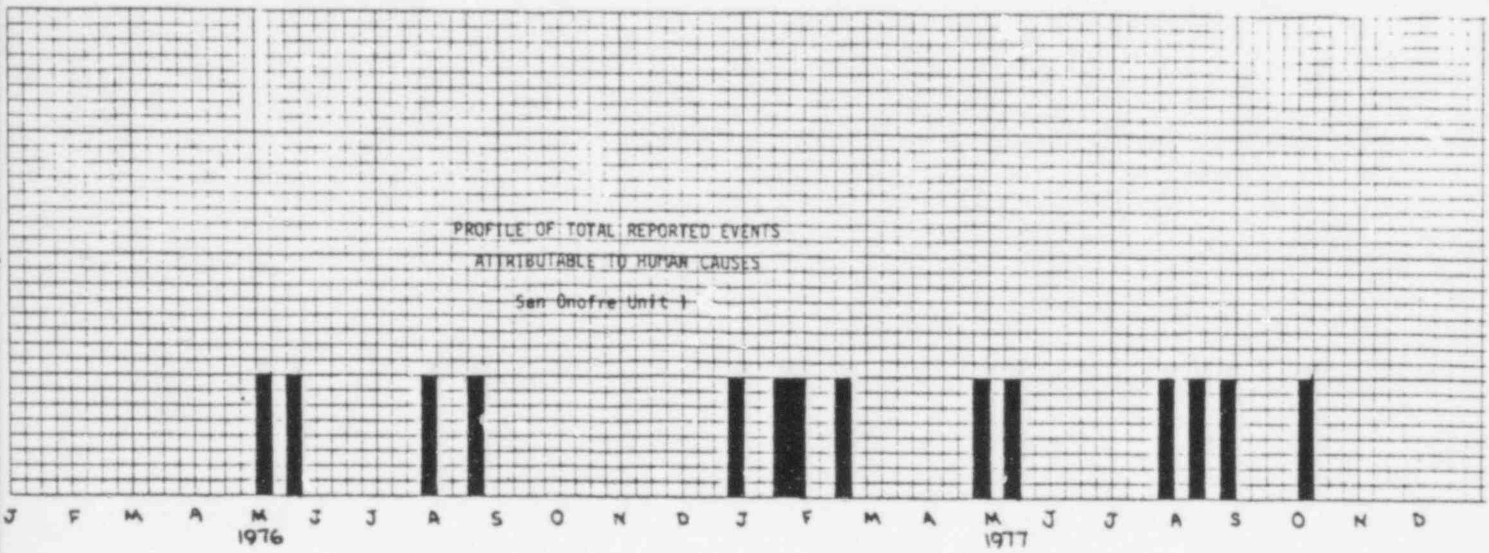
The first group of causally linked events was designated as "System Code Not Applicable." Four events involved ocean water temperature sensors. On 01-05-76 and 02-02-76, scheduled biweekly verification checks revealed that some of the sensors had not been operating, a violation of environmental tech specs. At the second event, new sensors were installed. On 06-24-76, buoy anchor cables were found severed during the biweekly check, apparently due to heavy wave action. On 04-21-77, one temperature sensor was found missing. The cause description indicates a thorough search of the area; the licensee concluded that since the sensor was not in the vicinity of the buoy and no heavy surf action had occurred, the sensor may have been stolen.

The second group of events occurred in the Main Steam System and Controls. On 07-30-76, the licensee observed a primary to secondary leak in steam generator C. They located the leak and plugged the tube after searching for other leaks. On 11-01-76, eddy current examinations revealed greater than 50% tube wall thinning in 64 steam generator tubes; the thinning occurred at the anti-vibration bars and two inches above the tube sheet. The thinned tubes were plugged. On 09-19-77, similar testing showed that 25 more tubes were thinned and one was leaking. These tubes were also plugged. One further event in the Coolant Recirculating System (10-01-77) is related to these tube pluggings.

The licensee had little control over either of these groups of causally-linked events. The events in the Main Steam System are not surprising in an older plant. There is little in the LER file to suggest deficient performance; in fact there is much to suggest that the licensee is well able to search out the root cause of events and correct them promptly. For example, on 06-14-77, a fuse opened in the Onsite Power System forcing transfer of power to the backup supply. The cause description states:

> "A General Electric 28F5108FC capacitor in capacitor bank C-6 failed, resulting in the failure of an additional capacitor in capicator bank C-4. All capacitors in banks C-6 and C-4 were replaced."(emphasis ours)

A second example reveals that the licensee audits his own performance. On 07-30-76, a blockage was found in the boric acid transfer pump discharge line. Investigation revealed that a three-foot section of line was not heat traced or insulated. On 04-26-77, nine months later, a boric acid transfer pump failed to start, due to an accumulation of boric acid crystals. The licensee apparently submitted two LERs on this occurrence, both on the same day; the second updates the first by including a statement "the heat tracing components were checked and found to be operating properly." The licensee appears to have reviewed previous events related to the pumping equipment in his investigation of the cause of the second event.



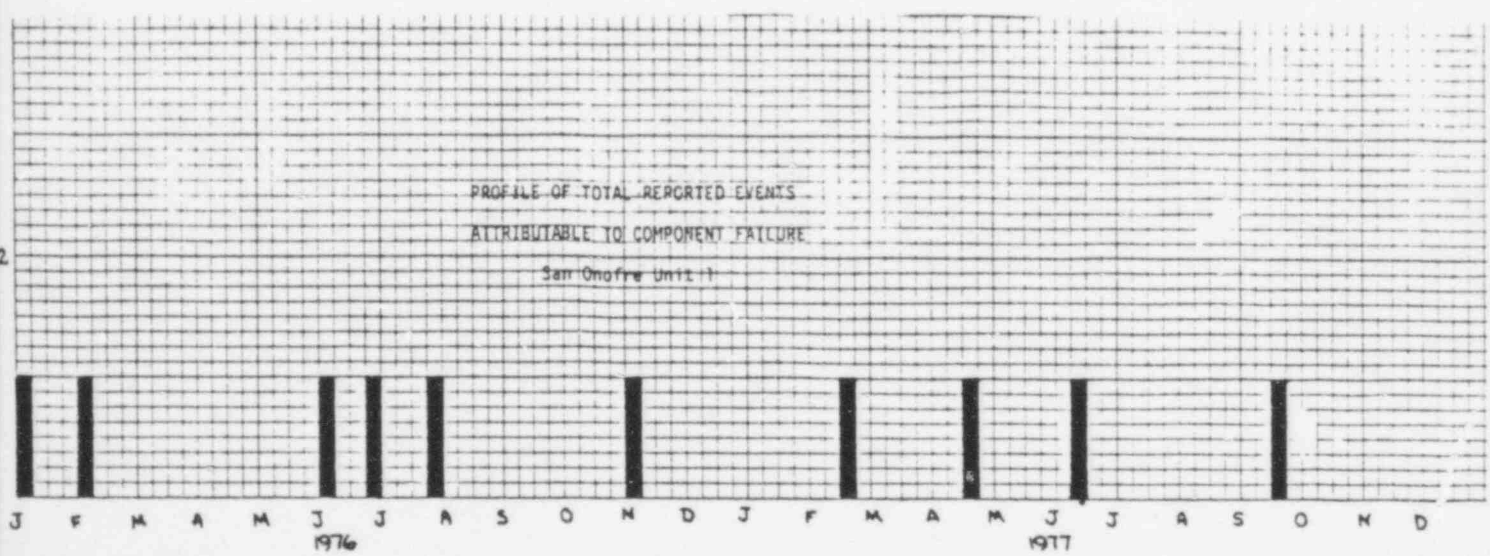


FIGURE A-9

San Onofre Unit 1 Performance Profiles

1080 050

TABLE A-9

SAN ONOFRE UNIT I LERs

1976-77

System Code Not Applicable	Fuel Handling System	Other Systems	Other Instrument Systems Not Required for Safety	Reactor Trip System	Main Steam System and Controls	D.C. Onsite Power Systems
01-05-76 (F)	05-03-76 (P/M)	05-21-76 (M)	06-01-76 (F)	06-28-76 (F)	07-30-76 (F)	06-14-77 (F)
02-02-76 (F)[1]				08-23-76 (F/P)	11-01-76 (F)[2]	
06-24-76 (O)					09-19-77 (F)[2]	
12-31-76 (P)						
01-17-77 (P)						
04-21-77 (O)[4]						

Reactor Vessel and Appurtenances	Chemical, Volume Control, & Liquid Poison System	Residual Heat Removal System	Emergency Core Cooling System	Reactor Containment System	Coolant Recirculating System	Emergency Generator Systems
07-30-76 (M)	07-30-76 (M)	[illegible]-24-77 (P)	02-15-77 (F)[3]	[illegible]-20-77 (M)	04-17-77 (F)	05-10-77 (M)
07-29-77 (M)	04-26-77 (O/P)			08-09-77 (M)	10-01-77 (P)[5]	
	08-24-77 (M)					

1080 051

TABLE A-9

NOTES:

1. Linked to previous event.
2. Linked to previous event. Poor design by vendor.
3. See event of 05-03-76 in "Fuel Handling System." Also indicates a related event missing from this file.
4. Wrongly classified under "Other Systems."
5. Related to steam generator tube pluggings in "Main Steam System and Controls."

Review of Inspection Reports and 766 System Data File for San Onofre Unit 1

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we fcund a total of 34 inspection reports detailing the results of NRC I&E inspector findings, including one management meeting. Ten of these reports identify a total of 20 items of noncompliance. Ten of these 20 items involve physical protection and are identified in a single inspection report. This small number of noncompliances indicates an excellent record. This view was also held by I&E which, in the management meeting (Report #7713), indicated that no adverse trends had been noted and that noncompliances were low for facility operation and administration as well as for radiation and environmental protection.

Matrix A-9 summarizes the findings of each inspection report and associated 766 system data file entries that identify noncompliances as well as one report in which LERs were reviewed. Not including those noncompliances due to physical protection, six noncompliances were assignable to ERC-M, three were assignable to ERC-P, and one was assignable to ERC-O.

Of the ten cited noncompliances, records of eight only could be found in the 766 file. There was universal agreement between the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details" section of the inspection report. The inspector's perception of the underlying cause of the noncompliance and his ability to communicate that perception in terms of the available cause codes (Primary Cause of Violation) listed in enclosure D of MC 0535 is readily apparent. There was also total agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. But there was only 50% agreement between the noncompliance cause code in the 766 system and the 766 enforcement text due largely to a lack of supporting detail in the 766 enforcement text. This lack of agreement between the noncompliance cause code and the 766 enforcement text means that a review of the 766 enforcement text and the noncompliance cause code <u>without</u> the supporting I&E report would not provide a sufficiently comprehensive understanding of the noncompliance and the circumstances of its origin.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In no case did a noncompliance result from inspector followup on an LER. Only two noncompliances resulted from licensee identified items. Thus only 20 percent of the noncompliances resulted from possible inspector cues. For nine out of 10 noncompliances, the licensee specified remedies to preclude recurrence in a follow-up letter.

The licensee's action on previously identified enforcement items was timely and complete at each inspector visit in which these items were reviewed, with one exception. In one other case, the inspector stated that insufficient time had elapsed to have completed remedial action. In reviewing LERs, the inspector never disagreed with the licensee's reporting. There were no events due to human failure that were serious from the regulatory point of view.

MATRIX A-9

NAME SAN ONOFRE UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7601										1 item - agree
7602	ESA3	M	Yes	Yes	Yes	No	Yes	In followup letter	Not applicable	---
7606	LPS3	M	Yes	Yes	Yes	No	No	In followup letter	Not applicable	2 items - agree
7609	----	---	---	---	---	---	---	---	Not applicable	5 items - agree
7611	ETA3	P	Yes	Yes	Yes	No	No	No	1 item--open (IE report stated) ~~that interval~~ between inspections was two short to ~~permit action to~~ be completed	
7614	----	---	---	---	---	---	---	---	1 item - closed	4 items - agree
7701		M	766 System contained no record of this report or the infraction contained in the report			No	No	In followup letter	1 item - open	----
7702	----	---	---	---	---	---	---	---	---	1 item - agree
7704	FJF2	P	Yes	can't tell	Yes	No	No	In followup letter	1 item - closed	---
	HAG3	M	Yes	No	Yes	No	No	In followup letter		

MATRIX A-9 (Continued)

NAME SAN ONOFRE UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7705	----	---	---	---	---	---	---	---	Not applicable	2 items - agree
7707									---	4 items - agree
7709	ABC2	O	Yes	can't tell	Yes	No	Yes	In followup letter	2 items-closed	---
7710	----		---	---	---	---	---	---	---	3 items - agree
7711	EDA2	P	Yes	Yes	Yes	No	No	In followup letter	---	1 item - agree
7713	--------	--------	IE indicates no adverse trends and low level of NC's in facility operation and administ. and in radiation & environmental protection			--------	--------	--------	--------	--------
7714	FDH2	M	Yes	can't tell	Yes	No	No	In followup letter	1 item - closed	4 items - agree
7719	----	---	---	---	---	---	---	---	---	2 items - agree

1080 056

SURRY UNIT 1 CASE STUDY

Review of the LER File for Surry Unit 1

During 1976 and 1977, 52 events occurred in 25 systems as shown in Table A-10 on page A-164. Three systems--the Circulating Water System with seven events, the Chemical Volume Control and Liquid Poison System with eight events, and the Emergency Generator System with four events--had substantial numbers of causally linked events. The other 22 systems had an average of 1.5 events each; four of these systems displayed causally linked events.

Circulating Water System

Seven events occurred in this system in the last ten months of 1976. One group of three events occurred on 03-22 (and 23), 03-26, and 04-12. In each case, the delta-T across the station exceeded the technical specification limit of 15°F, due to a rapid drop in river temperature caused by tidal action and weather conditions. Events due to this legitimate external cause did not recur in the study period, because on June 25, 1976, the license conditions were amended to raise the condenser cooling water discharge temperature from 98° to 103°F.

Two other events were causally linked and due to human performance. On 06-25-76, the delta-T across the C waterbox was exceeded while the D waterbox was out of service for maintenance. The licensee stated: "The immediate corrective action was to put the 'D' waterbox back in service. Upon inspection of the 'C' waterbox, an excessive amount of trash was found on the tubes." The event of 12-19-76 also involved the waterboxes. The rate of change of water temperature at the discharge point exceeded the allowable rise, because three (of a minimum of 4) waterboxes were open for maintenance at a time when power was being increased. There is no indication of action taken by the licensee to correct the situation, nor any indication of why the boxes were undergoing maintenance at that time.

Chemical, Volume Control, and Liquid Poison System

This system had eight events during the study period. Five events over 11 months involve similar equipment; the other events are peripherally related. The five strongly linked events are:

Date (licensee code/ERC)
03-26-76 (F)
08-23-76 (F/M)
09-16-76 (F/M)
01-26-77 (F/M)
02-20-77 (F/M)

All but the third event involved failure of Grinnell two-inch diaphragm check valves, resulting in leakage of borated water. The licensee attributed all these diaphragm ruptures to component failure due to normal wear, and in reporting the event of 01-26-77, stated that the "diaphragm failures which have been experienced were most probably related to valve overtightening when shutting." The description of the 02-20-77 event repeats this statement, and no further events of exactly this type were reported in the study period, though there is no indication of what action was taken.

Other events in this system also indicate problems with valves and valve operators. On 04-29-76, a seal water return line valve failed to close when the control switch was used. The torque switch close circuit movable contact was out of adjustment and did not make proper contact. The switch was adjusted and tested satisfactorily. On 07-02-76, the "B" safety injection accumulator was below the allowable boron concentration when routinely sampled during normal operation. The cause was leaking check valves, diluting the accumulator boron concentration from the "B" primary loop. Action stated was "the accumulator was recirculated with the RWST to increase the boron concentration above 1950 ppm.....The sample frequency of the accumulator was increased to weekly." No comment was made on valve repair or replacement.

On 09-16-76, line 1"-CH-56-152 was found blocked, so that the volume control tank could not receive boric acid makeup. The cause of obstruction was "unknown."

The problems in this system appear to stem from a lack of care in maintenance or from improper maintenance procedures.

Emergency Generator System

Four events in this system are causally linked:

Date (licensee code/ERC)

04-16-76 (P)
05-08-76 (F/M)
07-02-76 (F/M)
07-23-76 (F/M)

The event of 04-16-76 is representative, and is reproduced in full:

> During a routine starting test of the emergency diesel generators from the control room, the #1 diesel generator was damaged. The engine was started with #17 piston cylinder flooded with water. The damage was a bent connecting rod, ruptured cylinder wall and broken piston. The backup emergency DG was tested immediately and periodically thereafter. The backup emergency diesel generator was demonstrated to be operable. Therefore, the safety systems would have functioned if they had been needed. EMD-GM Turbo VEE 20,3,810 BHP diesel engine was found to have a crack in #17 cylinder head which extended between two exhaust valve seats and into water jacket. Area of high heat stress probably caused crack.

The event of 5-08 involved the same diesel generator but a similar crack in the #1 cylinder head, which was discovered during preparations for a test. On 07-02, a crack was observed in the #19 cylinder head; the #7 cylinder head was cracked on 07-23. The last two events state that the engine was repaired by replacing the cylinder head and head gasket.

It would seem the licensee should have closely examined all the cylinder heads after the second, if not the first, event.

Summary

While only three systems had four or more causally linked events, a substantial number of these events seem to be related to inattentive maintenance and a tendency to fix only the immediate problem. This impression is borne out by events in other systems, as illustrated by a few examples:

02-19-77 A torque switch would not de-energize because it was wired incorrectly during maintenance.

03-28-77 The high steam flow relay would not close. The cause was "foreign material (that) forcefully opposed closing the contacts."

11-03-76 The manipulator crane area monitor failed due to corrosion of the 12 volt and 22 volt power cables.

In three systems in less than one month (09-17-77 to 10-14-77), several snubbers were inoperable.

A number of other events involve loose screws, corroded contacts, and leaks.

While the events involving snubbers described action the licensee took or intended to take to prevent recurrence, about 40% of the LERs mentioned only a solution to the immediate event, while 26% mentioned a generic fix; 33% failed to mention any action. Further, many of the "cause descriptions" of the LERs essentially duplicated the event descriptions, indicating a failure to percieve generic causes.

TABLE A-10

SURRY UNIT I LERs

1976-77

Circulating Water System	Process and Effluent Radiological Monitoring System	Coolant Recirculating System	Feedwater Systems Controls	Chemical, Volume Control & Liquid Poison System	Emergency Generator System
02-28-76 (F)	03-02-76 (P)	03-13-76 (M)	03-18-76 (F)	03-26-76 (F)	04-16-76 (P)[5]
03-22-76 (O)[2]		06-16-77 (O/M)[12]		04-29-76 (F/P)	05-08-76 (F/M)[6]
03-26-76 (O)[3]		08-23-77 (F)		07-02-76 (F)	07-02-76 (F/M)[6,5]
04-12-76 (O)[4]				08-23-76 (F/M)[7]	07-23-76 (F/M)[6]
06-25-76 (O/P)				09-16-76 (F/M)[7]	
10-18-76 (F/P)				01-26-77 (F/M)[7]	
12-19-76 (M)[10]				02-20-77 (F/M)[7]	
				12-09-77 (O/M)	

Reactor Trip Systems	Area Monitoring System	Other Coolant Subsystems	Main Steam System	Process Sampling Systems	Cooling System for Reactor Auxiliary & Containment Pumps
11-01-76 (F)	11-03-76 (F/P)	11-13-76 (F)	01-20-77 (F)	01-25-77 (F)	02-08-77 (F)
03-28-77 (F/P)[11]			02-15-77 (F/P)[17,18]		
12-16-77 (F)			10-11-77 (P/M)[15]		

1080 061

TABLE A-10 (Continued)

1976-77

Reactor Containment System	Containment Heat Removal System	Containment Air Purification and Cleanup System	Reactor Core System	Emergency Core Cooling System	Gas Radioactive Waste Management System	System Code Not Applicable
02-19-77 (P)	08-16-77 (M)[13]	07-21-76 (P/M)	07-23-76 (P/M)	09-09-76 (F/P)	09-13-76 (P)	11-08-76 (O)
	08-29-77 (M)[14]	10-05-76 (M)[9]	08-05-76 (M)			01-26-77 (P)
			08-05-76 (O/M)[8,9]			

Other Engineered Safety Features System	Control Room Habitability System	Reactivity Control Systems	Station Service Water System	Other Systems	Condensate and Feedwater Systems
10-07-76 (M)	10-26-76 (F/P)	08-18-77 (F/P)	09-06-77 (O)	09-17-77 (P)	10-14-77 (O/M)[16]

1080 062

TABLE A-10

NOTES:

1. Licensee noted that a similiar event occurred in 1975 (28th LER).

2. Also an occurrence on 03-23-76.

3. Linked to event of 03-22-76.

4. Linked to two previous events. This event and the 03-22-76 event were handled by power reduction; in this event and event of 03-26-76, condenser outlet valves were opened to increase water flow through condenser.

5. Duplicate report of event.

6. Causally linked to event of 04-16-76.

7. Causally linked to event of 03-26-76.

8. Causally linked to other event of same date.

9. Improperly classified under "System Code Not Applicable."

10. Related to event of 06-25-76.

11. See also event of 10-26-76 in "Control Room Habitability System"; event of 06-25-76 in "Circulating Water System."

12. Linked to event of 03-13-76.

13. See events in the "Coolant Recirculating System."

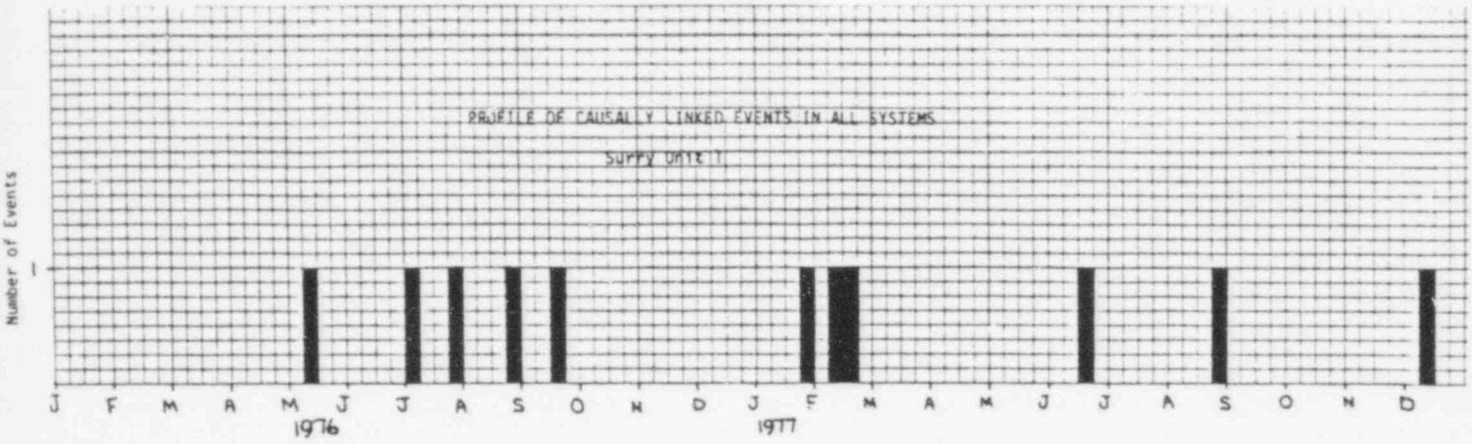
14. Linked to event of 08-16-77.

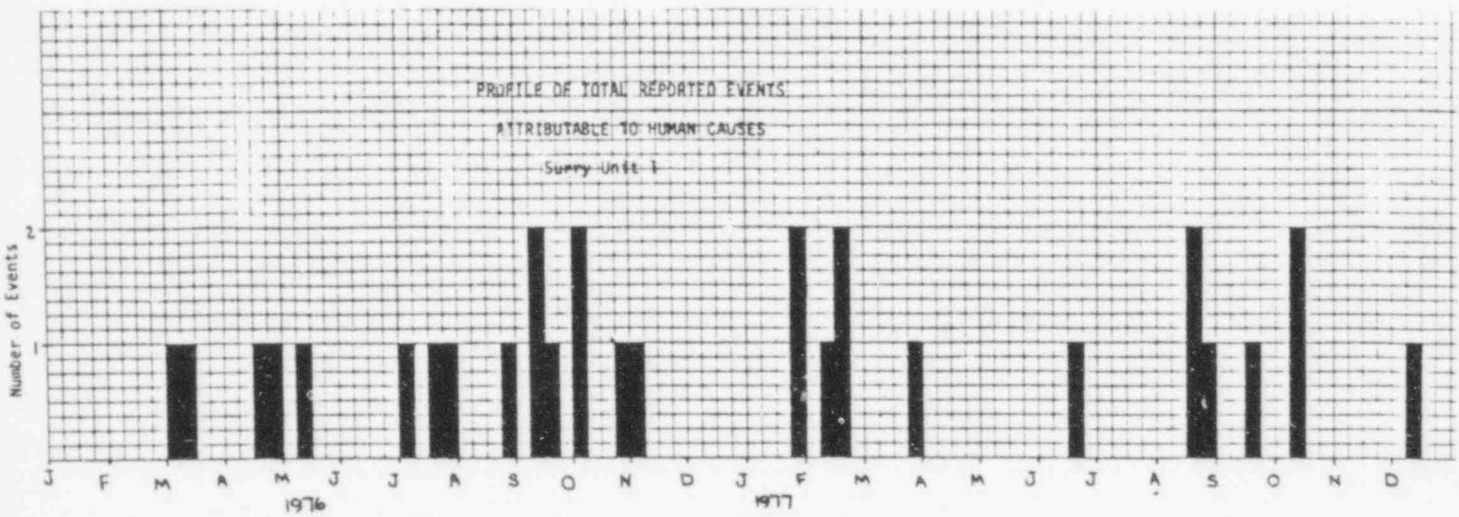
15. See event of 09-17-77 in Other Systems.

16. See Note 15, and event of 10-11-77 in "Main Steam Systems."

17. Improperly classified under "Other Engineered Safety Features System."

18. Causally linked to event of 01-20-77.





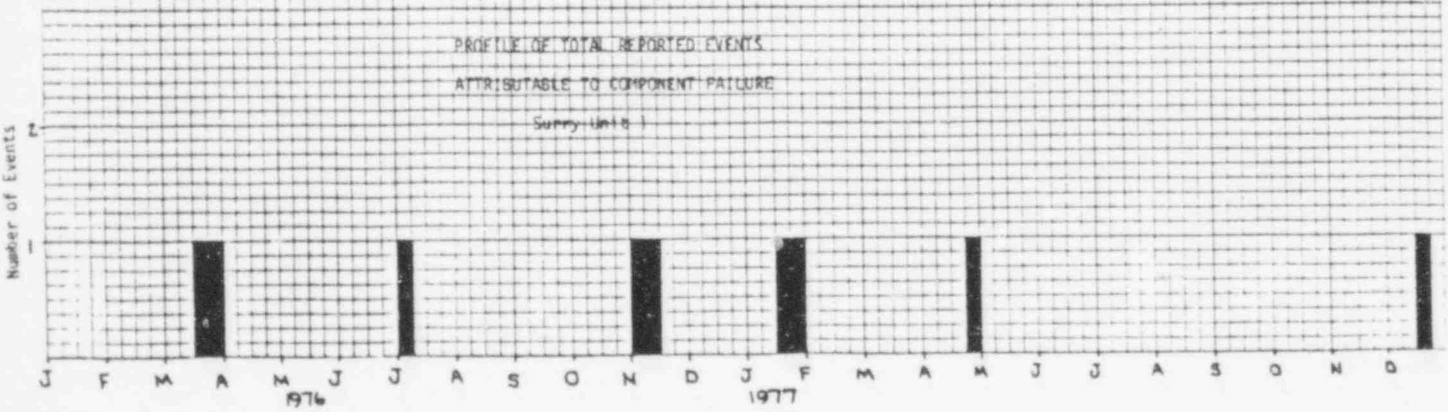


FIGURE A-10

Surry Unit 1 Performance Profiles

Review of 766 System Data File and Inspection Reports for Surry Unit 1

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found a total of 54 inspection reports detailing the results of NRC I&E inspector findings. One of these was a special investigation five dealt with physical protection. Thirty-seven noncompliance items were cited in 22 on-site visits.

Matrix A-10 summarizes the findings of each o the inspection reports and associated 766 system data file entries that identify noncompliances. Not including those noncompliances due to physical protection, 19 noncompliances were assignable to ERC-M, 16 to ERC-P, and one to ERC-F.

There was only moderate agreement between the noncompliance cause code as listed in the 766 system and the detailed discussion in the "Report Details" section of the inspection report. More than 30 percent of the noncompliance cause codes either were ambiguous or did not agree with the associated inspection report details. There was generally strong agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. There was substantially less agreement between the noncompliance cause code in the 766 system and the 766 enforcement text: approximately 43 percent of the items bore either an ambiguous or irrelevant relationship to each other. The ambiguity was partly due to a lack of supporting detail in the 766 enforcement text, and also reflects the 31 percent ambiguity found in the relationship of the 766 system cause codes to the inspection report. This substantial ambiguity between the noncompliance cause code and the 766 enforcement text for Surry Unit 1 means that a review of the 766 enforcement text and the noncompliance cause code <u>without</u> the supporting inspection report would <u>not</u> provide a sufficiently comprehensive understanding of a noncompliance and the circumstances of its origin.

We also reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In only 5 percent of the cases did a noncompliance result from inspector followup of an LER, though 16% of noncompliances resulted from licensee-identified matters. For this case study, about 21 percent of the noncompliances resulted from possible inspector cues. While these percentages are not insignificant, the majority of noncompliances did not result from possible cues to the inspector.

For 29 percent of the noncompliance items, licensee remedies to prevent recurrence of the event were specified in the inspection report, while 71 percent of the items were addressed in a subsequent letter. However, the licensee's action on previously identified enforcement items was less than complete. Nearly 29 percent of the inspection reports that specifically discuss "Licensee Action on Previously Identified Enforcement Items" indicated one or more items for which the licensee had not yet achieved compliance; NRC specifically noted (see IE report 50-280/77-1) that promised action had not been taken. In reviewing LERs, the inspector never disagreed with the licensee's reporting of the event.

MATRIX A-10

NAME SURRY UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7601	FJL3		No cause code in 766	No cause code in 766	Yes	No	No	In followup letter		
7602	FJP3	M	can't tell	Yes	No	Yes	No	Yes	1 item - closed	11 items - agree
7603	FMY2	M	can't tell	can't tell	Yes	No	No	In followup letter	1 item - open 1 item - closed	3 items - agree
	FPG2*	P	Yes	Yes	No	No	Yes	In followup letter		
	FJP3	M	Yes	Yes	Yes	No	No	In followup letter		
	ALA2*	P	can't tell	can't tell	Yes	No	No	In followup letter		
	FJP3	M	can't tell	Yes	Yes	No	No	In followup letter		
	ASB2	M	Yes	can't tell	Yes	No	Yes	In followup letter		
	FDG2	M	Yes	No	Yes	No	Yes	Yes		
7606	DDH2*	M	Yes	Yes	Yes	No	Yes	In followup letter	1 item - open	4 items - agree
	EIF2	M	Yes	can't tell	Yes	No	No	In followup letter		
7607	FJE2	M	Yes	Yes	Yes	No	No	Yes		

* REPEAT NONCOMPLIANCE

1080 067

MATRIX A-10

NAME SURRY UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated in IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7607	EBB3	M	Yes	Yes	Yes	No	No	In followup letter		
7609	FPG2	P	Yes	Yes	Yes	No	No	In followup letter	1 item - closed	1 item - agree
	HAD3	M	can't tell	can't tell	Yes	No	No	In followup letter		
7611	JAY3	M	Yes	can't tell	Yes	No	No	In followup letter		
7613	FPG2	P	Yes	Yes	Yes	No	No	Yes	2 items - closed	
	ALA2	P	Yes	Yes	Yes	No	No	Yes		
	AEB3	P	Yes	can't tell	Yes	No	No	In followup letter		
7614	FJF2	P	Yes	Yes	[illegible]	No	No	In followup letter	2 items - closed	
7616	----	---	---	---	---	---	---	---	---	3 items - agree
7618	FDN2	M	can't tell	can't tell	Yes	No	No	In followup letter	1 item - closed	
	ASE2	M	No	can't tell	Yes	No	No	In followup letter		
7701	EEB2*		Cause code not in 766 file		Yes	No	No	In followup letter	1 item - open	

* REPEAT NONCOMPLIANCE

MATRIX A-10

NAME SURRY UNIT 1

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7703	FCR2	P	No	can't tell	Yes	No	No	In followup letter	3 items-closed	
7704	ABC2	F	Yes	No	Yes	Yes	No	Yes	3 items-closed	
7705	AEA3	M	Yes	can't tell	Yes	No	No	Yes	1 item - closed	
7709	EEB2	P	Yes	Yes	Yes	No	No	In followup letter	2 items-closed	1 item - agree
7713	FPG2	M	Yes	Yes	Yes	No	No	Yes	4 items-closed	
	FPG2*	P	Yes	Yes	Yes	No	Yes	Yes		
7720	FDE3	M	can't tell	can't tell	Yes	No	No	In followup letter		
7722	EMA2	M	can't tell	Yes	Yes	No	No	In followup letter		
7727	DAM2	M	Yes	Yes	Yes	No	No	In followup letter		
7729	FDG2	P	can't tell	can't tell	Yes	No	No	In followup letter	1 item - closed 1 item - open	
	FPG2*	P	Yes	Yes	Yes	No	No	Yes		
	FPG2	P	Yes	Yes	Yes	No	Yes	In followup letter		

* REPEAT NONCOMPLIANCE

MATRIX A-10

NAME SURRY UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7729	FPG2*	P	Yes	Yes	Yes	No	No	In followup letter		
	ALC2*	P	Yes	Yes	Yes	No	No	Yes		
7733	----	---	---	---	---	---	---	---	---	5 items-agree

*Repeat noncompliance

1080 070

TROJAN UNIT 1 CASE STUDY

Review of the LER File for Trojan Unit 1

From January 1, 1977 to April 28, 1978,* 60 events occurred in 27 systems as shown in Table A-11 on page A-180. Two of these systems, the Emergency Core Cooling System and the Feedwater System and Controls, each had six events, some of which were causally linked. The remaining 25 systems averaged 1.92 events per system over the study period. Four of these 25 systems had at least four events; two of these, the Reactor Coolant Cleanup System and the Reactor Trip System, revealed causally linked events. The other 21 systems had an average of 1.5 events each, and of these 21 systems, only one, the Reactivity Control System with three events, displayed causal linkage.

Emergency Core Cooling System

In 15 months, six events occurred in this system. The licensee attributed three of these events to component failure and the other three to design/fabrication error. We upgraded one event designated as component failure to Teknekron Event Responsibility Code M (ERC-M).

Five of the six events were causally linked: the dates on which they occurred, together with the Event Responsibility Codes assigned by the licensee and by Teknekron, are:

Date (licensee code/ERC)

3-02-77 (F)
5-28-77 (M)
7-27-77 (M)
7-28-77 (F/M)
1-30-78 (M)

*Trojan's initial criticality date is 12/75. Therefore, it does not meet the requirement for two years of operation before 1/1/76. The study period for Trojan relects this.

In the event of 3-02-77, one of two redundant safety injection pumps failed to start upon receipt of an inadvertent safety injection signal. The licensee examined the DBA sequencer, and declared the cause to be "improper actuation of DBA sequencer contacts..." The sequencer had not been operated for 125 days prior to the event, and the licensee instituted increased surveillance testing requirements. On 5-28-77, during a routine surveillance, the DBA and normal shutdown sequencers failed to start all the required pumps, though all the pumps started manually. The cause was stated as "due to circuitry design, some of the sequencer contacts operated with a current lower than that which is condusive to reliable operation. Circuit modifications have been made to increase contact current."

The event of 7-27-77 involved an "A" train DBA sequencer. During a periodic test, it was found that the "mechanism had mechnically bound when it was last reset. This binding prevented the mechanism from starting its assigned loads. Sequencer was reset after this testing. Binding was due to insufficient clearance between collar and cam. Binding was caused by improper design of a clutch spring collar which had been adjusted two weeks earlier." On the next day (7-28), a pump failed to start during periodic testing of the DBA sequencers for train G, though it could be started manually. The licensee could not identify the exact cause because the failure could not be reproduced. They replaced all sequencers with new units and had them adjusted by a vendor representative; the sequencers tested satisfactorily.

The final event in this sequence occurred on 1-30-78. Again, the "A" train DBA sequencer failed to start several loads during periodic testing. The cause appeared to be a loose locking device that prevented the drive gear from engaging properly. After the locking device was tightened, the sequencers tested satisfactorily.

These events all involve DBA sequencers provided by Eagle Signal. After the fourth event, on 7-28-77, the licensee had all the sequencers replaced and adjusted by the vendor, a move obviously aimed at removing the sequencers that were causing a variety of problems. The last event, occurring six months later, was reported as design/fabrication error, but it may in fact have been a component failure or a personnel error and not connected with the previous events. However, it is not possible to determine which is the case from the event/cause description in the LER.

Feedwater Systems and Controls

There were six events in this system over the study period, five reported as component failure and one as cause code "other." We found two groups with causal linkage, each with two events.

The first two linked events occurred on 7-06-77 (O/M) and 8-21-77(F/M). In both cases, feedwater isolation signals were received following a reactor trip; the event of 8-21 involved two identifical occurrences. In the event of 7-06, a hydraulic feedwater isolation valve failed to shut, and the licensee attributed the failure to the "improper assembly of the solenoid by the manufacturer. Investigation revealed that the valve's closing solenoid was incorrectly assembled." We upgraded this event to ERC-M, since it was discovered during normal operation, not testing. Incorrect assembly of the solenoid should have been discovered during a system test following installation of the valve; the event appears to indicate that such a test was not performed. The second event, on 8-21, occurred when a hydraulic feedwater isolation bypass valve failed to shut, due to "excessive moisture accumulation in operating solenoid. The moisture accumulated as a result of a steam leak on the valve." This also seems to indicate inadequate testing or surveillance procedures.

The second "group" of linked events both occurred on 12-17-77. Both were reported as component failure; we reclassified the second event as ERC-P. In the first instance, the diesel driven auxiliary feedwater pump was started manually but immediately tripped on overspeed. Attempts to reset the trip and restart the pump from the control room were unsuccesful. The steam driven auxiliary pump was started and used. The cause was maladjustment of a microswitch in the speed sensing circuit; the overspeed condition did not actually exist, but the pump tripped out of service. The second and related event of that date involved the redundant steam driven auxiliary feedwater pump: "The steam driven auxiliary feedwater pump was inoperable due to the failure of a limit switch in the overspeed trip circuitry which prevented the overspeed trip mechanism from being reset. The cause of this occurrence was due to the failure of a limit switch..." Woodward Governor equipment serving an overspeed protection function was involved in both these occurrences in redundant feedwater pumps. It seems likely that the same personnel were responsible for both the diesel and steam feedwater pumps; improper maintenance or surveillance testing may have been involved.

Reactivity Control System, Reactor Coolant Cleanup System, and Reactor Trip System

Two of the three vents in the Reactivity Control System were causally linked. During a periodic test on 3-31-77, the control bank D rods could not be moved, and the licensee manually tripped the reactor. The immobility of the the rods was due to failure of the supervisory buffer memory and the in/out pulse shaper logic cards. The licensee replaced the cards; rod control was restored to normal. On 8-21-77, half of the control rods in banks B and D and all the rods in bank C were immobilized when the supervisory buffer memory card failed. The description of this event does not reveal what action the licensee took, but no further events occurred in this system.

Of the four events in the Reactor Coolant Cleanup System, two were causally linked; the licensee specifically mentioned the relationship and reported the second event as Revision 1 to the first event. On 3-01-77, two cracks were discovered in a weld joining a support plate to a CVCS letdown line. The cracks were attributed to stress corrosion. On 11-17-77, cracks were again discovered in the same CVCS letdown line; the licensee made the link to the previous event and stated: "In both cases, cracks occurred at an attachment weld of an inverted 'T-Bar' pipe support. . . Cracks are attributed to improper application of this support design. T-Bar supports were located

1080 074

in pipe section which experienced vibration during normal operation." No further events involving T-Bar supports occurred in the study period.

Two and possibly three events in the Reactor Trip System were causally linked. On 5/04/77, four Barton instruments (three transmitters and one pressure switch) were found to be out of calibration due to set point drift. On 4/05/78, four of 12 steam generator Barton level transmitters had again drifted out so that the reactor trip set points associated with steam generator water level were below tech spec minimum values. The licensee again attributed the cause to normal instrument drift, but added that they were calibrated when the generators were cold and depressurized. In another event on 7/08/77, a Hamilton Comparator was found to have experienced set point drift. Other instrumentation - including Barton - has been found out of calibration.

Summary

Trojan began commercial operation in December of 1975; it had only one year of operation prior to the study period. While there were some potentially serious events - for example, inoperable and redundant feedwater pumps - no system displayed more than six events, and no more than five events in any system were causally linked. Some of the event/cause descriptions show that facility management is aware of root causes and is willing to make corrections; other event/cause descriptions give no hint of management response. Management also seems reasonably willing to attribute events to human causes: 43% of events were reported in these categories, while 45% were reported as component failure. Many licensees report a substantially higher ratio of component failures.

The event file as a whole reveals some difficulties in properly implementing surveillance and maintenance procedures, but this is not unexpected in a relatively new plant. Trojan appears to still be in a "learning curve," and it is too early to see the patterns of performance that are characteristic of older plants.

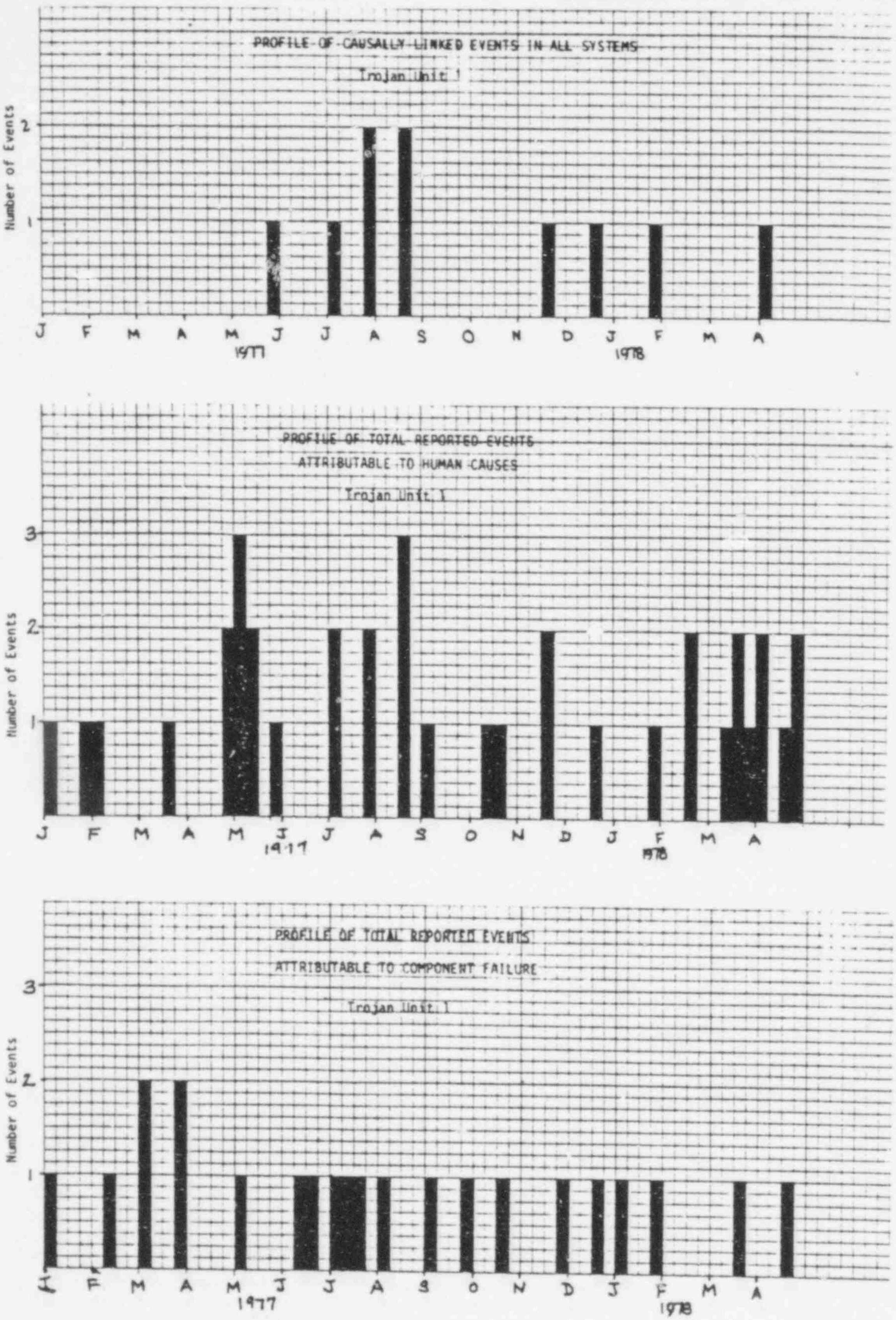


FIGURE A-11

Trojan Unit 1 Performance Profiles

TABLE A-11

TROJAN LERs

1977 and 1978 (through 4/28/78)

Reactor Control System	Reactor Trip System	Offsite Power System	Chemical, Volume Liquid Poison System Control	Liquid Radwaste System
1/01/77(O/M)	1/07/77(F)	1/23/77(M)	2/07/77(P)	2/08/77(F)
9/01/77(P/M)	5/04/77(F)	4/26/77(P)	8/04/77(O/F)	
	7/08/77(F)	4/29/77(P)		
	4/05/78(O/M)[10]	10/18/77(F)		

Reactor Coolant Cleanup System	Emergency Core Cooling System	Control Room Habitability System	Circulating Water System	Feedwater Systems and Controls
3/01/77(F)	3/02/77(F)	3/16/77(P)	3/15/77(O)[2]	3/24/77(F)
11/17/77(M)	5/28/77(M)[3]			7/06/77(O/M)
5/01/77(M)	7/27/77(M)[3]			8/21/77(F/M)[7]
9/23/77(F)	7/28/77(F/M)[3]			11/27/77(F)
	1/04/78(F)			12/17/77(F)
	1/30/78(M)[3]			12/17/77(F/P)[8]

TABLE A-11 (Continued)

Reactivity Control Systems	Containment Heat Removal System	Other Systems	Residual Heat Removal System	Ultimate Heat Sink Facilities
3/31/77(F)	5/02/77(F)	5/06/77(P/M)	5/21/77(M)	6/12/77(F)
5/16/77(P/M)	11/17/77(M)		10/16/77(P)	
8/21/77(F/M)[6]			3/20/78(M)	
			3/25/78(P)[9]	
			4/25/78(P)	

Emergency Generator System	Engineered Safety Features System	Main Steam Supply System	Process and Effluent Radiological Monitoring System	Coolant Recirculation System
6/22/77(F)	7/01/77 (F)[4]	7/06/77(O/M)[5]	7/21/77(F)	8/21/77(P)
2/17/78(M)				

1080 078

TABLE A-11 (Continued)

Other Instrument Systems Required for Safety	Spent Fuel Pool Cooling and Cleanup System	Containment Isolation System	Main Steam Isolation System	D.C. On Site Power Systems
9/03/77(O/F)	10/10/77(M)	1/28/78(F)	02/21/78(F/P)	3/17/78(P)
	3/08/78(P)	3/15/78(F)		

System Code Not Applicable	Fire Protection System
4/05/78(P/M)	4/15/78(M)
4/28/78(M)	4/19/78(F)

TABLE A-11

NOTES:

1. Causally linked to 3/01/77 event. Management made the causal linkage at the 11/17 event.
2. Improperly classified under "Other Systems."
3. Causally linked to 3/02/77 event. All involve DBA sequences, Eagle Signal equipment.
4. Improperly classified under "Other Engineered Safety Features System."
5. Indication of failure to report similar previous events in same system.
6. Causally linked to 3/31/77 event; both involved failure of supervisory buffer memory logic unit.
7. Causally linked to 7/06/77 event; both involve solenoid failure.
8. Causally linked to other 12/17/77 event; both involve Woodward Governor Company equipment serving an overspeed protection function in redundant equipment.
9. Similar to event of 5/21/77, but cause not related.
10. Causally linked to event of 5/04/77.

1030 080

Review of 766 System Data File and Inspection Reports for Trojan

When we reviewed the 766 system data file and associated inspection reports for 1977 and the first four months of 1978, we found 29 inspection reports. Eleven of these reports identify a total of 25 items of noncompliance. Seven of these noncompliances involve physical protection and are identified in one inspection report.

Matrix A-11 summarizes the findings of 10 of the 11 inspection reports and associated 766 system data file entries that identify noncompliances (one inspection report was missing from the file). Not including noncompliances due to physical protection, eight noncompliances were assignable to ERC-P, and 10 to ERC-M.

The noncompliance cause codes listed in the 766 system agreed well with the discussion in the "Report Details" section of the inspection report: less than 12% of the cause codes did not agree with the report details. In 88% of the cases, the enforcement text in the 766 system agreed with the "Enforcement Actions" section of the associated inspection report. There was somewhat less agreement between the noncompliance cause code in the 766 system and the 766 enforcement text: about 24% of the items did not agree, with only one case being ambiguous. This disagreement was mainly due to a lack of detail in the text. While 24% disagreement is considerably lower than for many of the other case studies, care must still be taken in attempting to use the 766 file cause codes and enforcement text for performance evaluation.

Cues were very often the source of noncompliances. About 6% of the noncompliances resulted from inspector following of an LER; nearly 59% resulted from following of a licensee-identified matter. Thus about 65% of noncompliances resulted from cues to the inspector. (Four of the 10 licensee identifed matters stemmed from a special investigation that was indirectly related to plant security.)

1080 081

for 47% of the noncompliance items, remedies to prevent recurrence were specified in the inspection report, while 12% were addressed in a followup letter. No remedies were specified in 41% of the cases, all of which occurred in 1977.

The licensee's action on previously identified enforcement items was variable. Half the time the inspector reviewed these items, at least one was open; all the open items occurred in 1978. In reviewing LERs, the inspector never disagreed with the licensee's reporting of the event. There were no events due to human failure that were serious from the regulatory point of view.

1080 082

MATRIX A-11

NAME TROJAN

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7701	EEB2	P	MISSING FROM FILE							
7702										1 item-agree
7703										2 items-agree
7706	NCK2	P	Yes	Yes	No	No	No	Yes	1 item-closed	5 items-agree
7708									1 item-closed	5 items-agree
7712										2 items-agree
7714	ALA2	P	Yes	AMBIGUOUS	Yes	No	No	No		2 items-agree
7715	FJP3	M	Yes	Yes	Yes	No	No	No	6 items-closed	12 items-agree
	DAM2	H	Yes	Yes	Yes	No	No	Yes		
7718	NED2	P	Yes	Yes	Yes	No	No	No		
	NED2	P	Yes	[illegible]	Yes	No	Yes	No		
	NED2	M	No	Yes	Yes	No	Yes	No		

1080 083

MATRIX A-11 (Continued)

NAME TROJAN

Insp. Rpt.	Non Comp.	Teknek-ron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7718	NED2	M	Yes	Yes	Yes	No	Yes	No		
	NED2	P	Yes	Yes	No	No	Yes	No		
7719	FPG2	P	Yes	Yes	Yes	No	Yes	Yes		1 item-agree
	FPG2	P	Yes	Yes	Yes	No	Yes	Yes		
7721 (Phys. Prot)	NED2	M	No	No	Yes	No	No	In a followup letter		
	NEG2	M	Yes	Yes	Yes	No	No	In a followup letter		
	NED2	P	Yes	Yes	Yes	No	No	In a followup letter		
	NDE3	P	Yes	Yes	Yes	No	No	In a followup letter		
	NED2	P	Yes	Yes	Yes	No	No	In a followup letter		
	NDE3	P	Yes	Yes	Yes	No	No	In a followup letter		
	NED2	M	No	No	Yes	No	No	In a followup letter		
7723	FCB1	M	Yes	No	Yes	Yes	No	Yes		

MATRIX A-11 (Continued)

NAME TROJAN

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does N[illegible] Caus[illegible]de in 76[illegible] Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow-Up on LER	Did N/C Result from Insp. Followup On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrance as Stated In IE Report	Licensee Action on Previously Identified Enforcement Items	LERs Reviewed Adequacy of Response (Disagree?)
7801	FMY2	M	Yes	No	Yes	No	Yes	Yes		
	EEC2	M	Yes	Yes	Yes	No	Yes	Yes		
[illegible]	ERB2	M	Yes	Yes	Yes	No	Yes	In a followup letter	4 items-closed 5 items-open	
	EBB2	M	No	No	Yes	No	Yes	In a followup letter		
7803	FDH2	M	Yes	Yes	Yes	No	No	Yes	1 item-open	11 items-agree
7804									4 items-closed 3 items-open	

1080 085

ZION UNIT 1 CASE STUDY

Review of the LER File for Zion Unit 1

During 1976 and 1977, events at this unit occurred in 26 systems, as shown in Table A-12 on page A- . Six systems, the Containment Isolation System, Reactor Trip System, Airborne Radioactive Monitoring System, System Code Not Applicable, Emergency Core Cooling System, and Hangers, Supports, and Shock Suppressors* had large numbers of events - two of them extraordinarily large numbers - when compared to the other 20 systems. In addition, these six systems exhibited significant numbers of causally linked events. A number of these causally linked groups occurred repeatedly over long periods of time with only brief intervals between repetitions.

In the six systems with the most events, the Containment Isolation System had 20 events, Reactor Trip Systems had 27 events, System Code Not Applicable had nine events, the Airborne Radioactive Monitoring System had 11 events, the Emergency Core Cooling System had eight events, and the Hangers, Supports, and Shock Suppressors had eight events. The remaining 20 systems averaged 2.6 events over 24 months. Three of these 20 systems had a group average of 5.6 events per system, and removing these systems from the group of 20 resulted in an average of 2.0 events in 24 months for the remaining 17 systems. A detailed review of these 17 systems indicated six systems with casually linked events that appear related to failures in human performance (Reactor Core, three events; Feedwater Systems, four events; Area Monitoring System, four events; Containment Air Purification and Cleanup System, two events; Containment Heat Removal System, one event linked to a pre-1976 event; liquid Radioactive Waste Management System, three events).

Containment Isolation System

This system had 20 events in 24 months. The licensee attributed one of these to human failure and the rest to component failure. We reclassified 15 of these 19 events as Teknekron ERC-M and identified three causally

*This is not a system code in the LER file, but as explained later in this section, Zion Unit 1 had a number of closely related and highly similar events involving these related components.

1080 086

linked groups th t included 15 of the 20 events. The dates of the first group of causally linked events, together with the cause assigned by the licensee and Teknekron's ERC Code, are:

Date (licensee code/ERC)

9-21-76(F/M)

11-04-76(F/M)

11-22-76(F/M)

1-16-77(F/M)

2-13-77(F/M)

9-01-77(F/M)

12-08-77(F/M)

The licensee stated that 9-21-76 event was similar to a previous event and identified the cause of excessive leakage of the containment purge isolation valve as a bulge on the valve's seating surface. The cause of the 11-04-76 event was identified as "cold air," so the licensee insulated and heat traced the valve and stated that no further problems were anticipated. On 11-22-76 the same event occurred; the cause was stated as overloaded circuits that cut off the heat tracing. In the 1-16-77 event, the licensee stated that the heat tracing was unable to keep the valve seats warm; they began using temporary space heaters. Extraneous material caught in the valve seats produced the 2-13-77 event. The 9-01-77 event stemmed from the valves' maladjustment. The cause of the 12-08-77 event was identified as failure to energize the heat tracing.

The second group of causally linked events is:

Date (licensee code/ERC)

4-07-76(F)

8-11-76(F/M) - 2 events

9-30-76(F/M)

1-23-77(F/M)

4-25-77(F/M)

7-23-77(F/M) - 2 events

The licensee identified the cause of the 4-07-76 event as a valve (inlet unloader valve) stuck open by "crud and rust." The valve was located in the system that provides compressed air to pressurize penetrations. On 8-11-76 two events occurred in which two identical components (solenoid valves) failed. For one event, the licensee stated the case as "...probably due to impurities in the instrument air system." The other event, involving an identical component, was listed as due to "varnish buildup." On 9-30-76, an identical event (solenoid valve failure) occurred with the same stated cause as the 8-11-76 event ("varnish buildup"). The 1-23-77 event (solenoid valve failure) identified the same component failure as the 8-11-76 event; the stated cause was impurities in the instrument air supply. The 4-25-77 event was identical to the 1-23-77 event in all respects, but the licensee stated that new equipment was being installed. On 7-23-77 two separate events occurred, each identical to the previous 4-25-77 event. In this case, the licensee stated that monthly tests would be performed and the air line blown clean.

Two occurrences make up the third group of causally linked events:

Date (licensee code/ERC)

1-07-76(F)

5-18-76(M)

In the 1-07-76 event, a valve failed to close, and the stated cause of the failure was that the valve internals were galled (due to unknown reasons), causing mechanical binding. No further action was planned. The 5-18-76 event was identical, and the licensee stated that "... procedures were revised."

In summary, it appears that proper management attention to these three groups of causally linked events would have prevented their further occurrence. In the first group, events occurred about every two months over a 15-month period. The second group of events also extended over 15 months with an occurrence frequency of about two months. The third group of two events extended over four months.

<u>Reactor Trip System</u>

This system had 27 events in 24 months. The licensee attributed four events to human failure and all but one of the remaining 23 events to component failure. We reclassified 13 of these 23 events as ERC-M and identified four groups of causally linked events encompassing 17 of the 27 total events.

The second group of causally linked events is:

Date (licensee code/ERC)
2-26-77(F)
3-19-77(F/M)
4-16-77(M)
5-12-77(F/P)
7-08-77(F/M)
7-29-77(F/M)

On 2-26-77 the licensee received a low steam flow indication from steam generator 1D electrical instrumentation. The cause of the low flow indication was determined to be a defective coil in the Fischer-Porter flow transmitter. On 3-19-77 an identical failure occurred in the 1D steam generator instrumentation, with the identical cause. On 4-16-77, a similar failure occurred in the 1D steam generator, but this time the licensee identified in the cause as "loss of fluid in the DP cell for the differential pressure transmitter." The failed transmitter was replaced with a spare and returned to service. On 5-12-77, a similar event to the 4-16-77 event occurred in steam generator 1D. The licensee identified the cause as "apparently due to an intermittent connection, since the problem disappeared when the transmitter was replaced." On 7-08-77 the licensee identified a Fischer-Porter transmitter out of calibration in a situation similar to the 5-12-77 event. On 7-29-77 the licensee again reported low steam flow indication for steam generator 1D and stated the cause to be sediment plugs in the differential pressure lines on the Fischer-Porter transmitter.

The third group of causally linked events is:

Date (licensee code/ERC)
11-17-76(F)
7-19-77(F/M)
8-06-77(F/M)
9-14-77(F/M)
12-08-77(F/M)

On 11-17-76 the licensee reported a failure in the loop D instrumentation, a defective lead/lag module made by Hagan Controls. On 7-19-77 a defective Hagan Controls lead/lag module failed in the instrumentation for the pressurizer pressure channels. On 8-06-77, the set point of a Barton Model 386 pressurizer level transmitter was found to have drifted. This event is linked to the event of 7-19-77 because both involved failure in the pressurizer instrumentation. It appears that management should have examined all the pressurizer instrumentation at that time. On 9-14-77 another instrumentation failure occurred and was identified by the licensee as a "recurring problem" involving a Hagan Corporation signal summator. On 12-08-77, the licensee reported an event identical to the 8-06-77 event.

The fourth group of causally linked events is:

Date (licensee code/ERC)
10-21-77(F)
10-28-77(F/M)
10-31-77(F/M)
12-09-77(F/M)

On 10-21-77 the licensee reported that the setpoints of the steam generator level transmitters had drifted. The licensee rezeroed and recalibrated the Fischer-Porter transmitters. On 10-28-77 setpoint drift occurred in the reactor coolant flow transmitter. The licensee rezeroed and recalibrated the Fischer-Porter transmitter, stated an intention to study and to "trend" setpoint drift and remarked that no further action was required. On 10-31-77, during testing, the licensee found that the reactor coolant flow transmitters in loop D had experienced setpoint drift. The licensee recalibrated these Fischer-Porter transmitters. On 12-09-77 the steam flow from steam generator loop A was found to be reading low, and the cause was found to be setpoint drift of the Fischer-Porter flow transmitter.

These four causally linked groups have been established on the basis of subsystem location, equipment manufacturer, and function. Groups one and three may be crosslinked since both involve Hagan Controls equipment; Group four and group two may be crosslinked since both involve loss of indication and Fischer-Porter instrumentation (though somewhat different failure modes).

The sheer number of these apparently related events and the time period over which they occur seem to indicate an inability on the part of facility management and personnel to technically identify fundamental causes of problems and to effectively manage their resolution.

Airborne Radioactive Monitoring System

Eleven events occurred in this system in 24 months. The licensee attributed two of these to human failure, two events to other causes and the remaining seven events to component failure. We reclassified all seven component failures as Teknekron code ERC-M. We reclassified one of the two events classified by the licensee as "other" as ERC-M and one as ERC-F. Eight of the 11 events appear to fall into two causally linked groups.

Before describing the two groups of events, a single event on 4-13-77(O/M) deserves special mention due to its stated cause and resolution. On that date, the air ejector radiation monitor blower tripped out of service. The licensee stated that the blower tripped because the monitor cabinet was overheated due to poor ventilation. The licensee's solution: "The monitor cabinet was opened slightly to allow better ventilation."

The first group of causally linked events is:

Date (licensee code/ERC)
7-01-76(F/M)
11-12-76(F/M)
8-28-77(F/M)

On 7-01-76 the containment purge iodine monitor was declared inoperable due to a blower failure. The licensee stated that "the failure of the blower is directly related to its continuous operation," and that "an equipment lubrication and preventive maintenance program is in operation at this time." This statement indicated an awareness of the cause and potential generic resolution of the event. On 11-12-76 the gas decay tank monitor failed. The licensee attributed the failure to "...constant operation of the monitor." On 8-28-77 the pump for the containment particulate radiation monitor failed. The licensee stated that "...cause of pump failure was approximately 10,000 hours of continuous use." The pump was replaced.

The second group of causally linked events is:

Date (licensee code/ERC)
8-16-76(O/F)
4-09-77(O/M)
4-19-77(F/M)
5-21-77(F/M)
6-14-77(F/M)

On 8-16-76 the containment radiation monitors for gas and particulates were declared inoperable due to electrical problems. The licensee stated that "inoperability of the monitors was due to blown fuses in the circuits which control input to blowers and monitors. Cause for fuse failure unknown. Fuses replaced and monitors returned to service." On 4-09-77 the containment radioactive gas monitor became inoperable. The stated cause and response were "loss of contact between instrument drawer and instrument panel. Contact was cleaned and restored, with the monitor responding correctly." The event of 4-19-77 was identical to the 4-09-77 event. The licensee-stated cause was "plug connector was worn from opening and closing drawer for monitor surveillance and other related periodic checks." On 5-21-77 the containment purge radioactive iodine monitor failed. The stated cause was identical to the 4-09-77 event. On 6-14-77 the passive gas failure monitor failed. The stated cause of the event was a capacitor failure that caused the circuit board in the instrument drawer to fail.

In summary, the first event in this system, which received special mention, was singled out because it indicates 1) a lack of management awareness of the potential generic implication of events and 2) a lack of management commitment to resolve identified causes of events with a permanent fix.

The first and second groups of causally linked events indicate that when the generic implication of events is identified, the management appears unable to implement effectively a preventive program over an extended time period.

Emergency Core Cooling System

This system had eight events in 24 months. The licensee attributed three events to human failure, four events to component failure, and one event to "other." We reclassified three of the four component failures and the event classified as "other" to human error. We found two groups of causally linked events comprising five of the eight total events.

The first group of causally linked events is:

Date (licensee code/ERC)

4-01-76(F/M)

6-23-76(O/M)

10-19-76(M)

On 4-01-76 the 1C accumulator level transmitters experienced setpoint drift. The licensee stated that "the Barton Model 384 level transmitters experienced instrument drift. There is a very tight tolerance on these transmitters due to an improper application." On 6-23-76 the 1D accumulator was found to be overfilled. The licensee identified the cause as "apparently due to momentary backleakage of reactor coolant water through check valves into the accumulator." The licensee resolved this by draining the accumulator to the proper level and resuming power operation. On 10-19-76 the accumulator level transmitters for the 1A, 1B, and 1C accumulators drifted high. The licensee stated the cause as "inadequacy of presently installed transmitters Barton Model 384 for the given measuring range. Plans are being made to replace these transmitters."

The second group of causally linked events is:

Date (licensee code/ERC)
1-26-77(F)
1-28-77(F/M)

On 1-26-77 the 1A accumulator discharge valve failed to open after closing. The licensee stated that "...a long-term solution is being investigated...." and listed the cause as, "the contacts in the motor operator control center were hung up." On 1-28-77 an identical event occurred in the 1B accumulator.

To summarize, the first group of causally linked events indicates a management willingness to tolerate identified technical deficiences in equipment design and application in safety-related systems. The first and second groups of events show a lack of management willingness to explore generic causes of events and implement immediate resolution. When aware of the technical causes of events, the frequency of event occurrence appears to guide timeliness of resolution by management.

Hangers, Supports, and Shock Suppressors

This "system" is unique in that it is not classified as a system in the LER file codes but as a component. However, it is a component that is present in most, if not all, facility systems; and its absence from the system list may indicate a weakness in that data system. For the purpose of this analysis, the events identified as "Hangers, Supports, and Shock Suppressors" under various systems were collected and reviewed as we would a system.

The licensee identified a total of nine hydraulic snubber failures due to the escape of hydraulic fluid past thread seals. The first event on 2-30-77 involved the pressurizer snubbers. Not until 8-06-77 was this type of event reported again, and eight events of this type occurred in hydraulic snubbers in eight different systems from 8-06-77 to 11-09-77. The last event on 11-09-77 was similar to the 2-03-77 event since the pressurizer snubbers were involved. The licensee stated that the hydraulic snubbers in the pressurizer

TABLE A-12

LERs BY SYSTEM AT ZION UNIT 1 - 1976 and 1977

Containment Isolation System	Engineered Safety Features Instrumentation System	System Code Not Applicable	Reactor Containment System	Chemical Volume Control & Liquid Poison System	Reactor Trip System	Process & Effluent System
1-07-76(F)	1-08-76(O/P)	1-21-76(O)[1]	1-22-76(M)	1-28-76(F)	2-09-76(O/F)	2-20-76(F)
4-07-76(F)	9-23-76(F)	3-18-76(M)	?-04-76(O)	2-03-76(F)	2-21-76(P/M)	9-22-77(F/P)
5-18-76(M)[3]	?-27-77(F)	3-19-76(M)	?-26-76(P/M)[2]	2-27-76(F)	3-05-76(F)	9-25-77(F)
8-11-76(F/M)[7]		4-13-76(O)		1-28-77(F)	6-18-76(F)	
8-11-76(F/M)[8]		6-25-76(P/M)[5]		3-22-77(F/M)[21]	9-17-76(F)	
8-11-76(F/M)[8]		8-05-76(O)		5-30-77(P)	11-17-76(F)	
9-21-76(F/M)[5]		8-11-76(O/F)			12-01-76(F)	
9-30-76(F/M)[8]		11-30-76(F)			2-26-77(F)	
11-04-76(F/M)[11]		2-24-77(O)			3-03-77(F/M)[18]	
11-22-76(F/M)[13]					3-19-77(F/M)[19,20]	
1-16-77(F/M)[13]					4-16-77(M)[24,25]	
1-23-77(F/M)[8]					5-12-77(F/P)[27]	
2-03-77(F)					5-15-77(F)	
2-10-77(F)					5-31-77(F)	
2-13-77(F/M)[13]					7-08-77(F/M)[27]	
4-25-77(F/M)[8]					7-08-77(P/M)[30]	
7-23-77(F/M)[8]					7-19-77(F/M)[31,32]	
7-23-77(F/M)[8]					7-29-77(F/M)[27]	
9-01-77(F/M)[11]					8-06-77(F/M)[33]	
12-08-77(F/M)[13]					8-23-77(P/M)[2]	
					9-14-77(F/M)[32]	
					10-07-77(F)	
					10-20-77(F/P)[36]	
					10-21-77(F)	
					10-28-77(F/M)[37]	
					10-31-77(F/M)[37]	
					12-08-77(F/M)[36]	
					12-09-77(F/M)[37]	

1080 096

TABLE A-12 (Continued)

LERs BY SYSTEM AT ZION UNIT 1 - 1976 and 1977

Failed Fuel Detection System	Reactor Core	Feedwater System	Gas Radioactive Waste Management System	Airborne Radioactive Monitoring System	Emergency Core Cooling System	Fire Protection System
2-25-76(P)	2-26-76(O/P)	3-05-76(F/M)	3-12-76(F/M)	3-24-76(M)[2]	4-01-76(F/M)	4-27-76(M)
	7-16-76(O/P)	8-08-76(F)	2-01-77(P)	7-01-76(F/M)	6-23-76(O/M)[4]	5-04-76(F/P)
	7-30-76(O/M)[6]	12-03-77(F)		7-30-76(F/M)	9-16-76(F)	
		12-08-77(F/M)[39]		8-16-76(O/F)	10-19-76(M)[10]	
				11-12-76(F/M)[12]	1-26-77(F/M)[17]	
				4-09-77(O/M)[22]	1-28-77(F/M)[17]	
				4-13-77(O/M)	2-18-77(P)	
				4-19-77(F/M)[26]	12-18-77(P)[2]	
				5-21-77(F/M)[26]		
				6-14-770F/M)[26]		
				7-27-77(P/M)		
				8-28-77(F/M)[12,34]		

1080 097

TABLE A-12 (Continued)

LERs BY SYSTEM AT ZION UNIT 1 - 1976 and 1977

Process Sampling System	Circulating Water System	Hangers, Supports Shock, Suppressors	Main Steam Isolation System	Containment Combustible Gas Control System
11-23-76(F)	12-07-76(O)	2-03-77(F)	10-07-77(F)	11-30-77(F)
	12-14-76(O)(2)	8-06-77(F)	12-03-77(F)	
	1-31-77(O/M)	9-19-77(F/M)(35)		
	1-31-77(O/M)	9-21-77(O/M)(35)		
	1-31-77(O/M)	10-04-77(F/M)(35)		
	2-09-77(O/M)	10-04-770F/M)(35)		
	3-09-77(P/M)	11-01-77(F/M)(35)		
		11-09-77(F/M)(34,38)		

1080 098

TABLE A-12 (Continued)

LERs BY SYSTEM AT ZION UNIT 1 - 1976 and 1977

Area Monitoring System	Emergency Generator System	Containment Air Purification Cleanup System	Containment Heat Removal System	Reactor Coolant System	Residual Heat Removal System	Liquid Radioactive Waste Mgt. System
5-13-76(F)	6-21-76(F)	9-14-76(O/M)[5]	9-23-76(F/M)[5]	10-04-76(P/M)[9]	10-06-76(F)[2]	10-20-76(F)
12-10-76(F)	9-24-76(F)	1-21-77(M)[16]				6-03-77(P/M)[28,29]
12-12-76(F/M)[14]						10-28-77(P/M)
12-15-76(F/M)[15]						

1080 099

TABLE A-12

NOTES:

1. Vendor error in accident analysis - no immediate action required.
2. Violation of technical specifications.
3. Identical to 1-07-76 event.
4. This event appears to be related to the 4-01-76 event. Management didn't follow up on 4-01-76 event to substantiate the cause. Had they done so, it appears this event would not have occurred.
5. Similar events occurred in a previous period of record.
6. Related to previous events 2-26-76 and 7-16-76 in that operating personnel are having difficulties handling xenon oscillations.
7. Identified by licensee as a repetitive occurrence - a check of this record period provides no indication of the repetitive event.
8. Related to previous event 4-07-76 in that this event had potential generic implications which were not identified by the licensee.
9. This event was improperly classified in LER file under "Reactor Core Isolation Cooling System."
10. Failure of management to follow up on 4-01-76 event to which this is identical.
11. This event related to event of 9-21-76 in that the 9-21-76 event cause was identified in such a way that a permanent fix was not utilized.
12. Event of 7-01-76 indicated licensee understanding that air monitoring systems which operate continuously require a preventive maintenance program - the understanding does not appear to have been applied beyond the containment purge monitoring system.
13. Similar to 11-04-76 event.
14. Similar to 12-10-76 event.
15. A result of preceeding 12-10-76 and 12-12-76 events.
16. Similar to 9-14-76 event.
17. Identical to previous event 1-26-77 in a redundant system.

18. Similar to 6-18-76 event which occurred in a redundant piece of equipment.

19. Improperly classified in LER file as "Condensate Storage Facility."

20. Similar to 2-26-77 event.

21. Appears related to 10-06-76 event filed under "Residual Heat Removal System" - the maintenance performed for previous event may have been incomplete.

22. Similar to 8-16-76 event in same component group. Had management followed up on generic cause of fuse failure in 8-16-76 event this event would probably not have occurred.

23. The type of fix implemented for this event denotes lack of management attention to detail of plant design, i.e., where else in plant would a failure of this type occur due to overheating; is the problem generic?

24. Improperly classified in LER file as "Main Steam Supply System."

25. Related to previous event 3-19-77 in that both events occurred in the same steam generator instrumentation package (ID) with the indication of failure for both events being the same, i.e. low flow for the first event, zero flow for the second. Inadequate review of first event, probable cause of second event.

26. Related to 4-09-77 event. Improper review and resolution of previous event resulted in this event.

27. Maintenance and cause identification performed to resolve previous event of 4-16-77 was apparently incomplete resulting in this event.

28. Related to 10-20-76 event - management didn't follow up on previous event.

29. Event improperly classified under "System Code Not Applicable."

30. Event improperly classified under "Feedwater Systems."

31. Event improperly classified under "Reactor Core Instrumentation."

32. Previous event 11-17-76 was due to failure of Hagan lead/lag module - the licensee stated "cause of module failure will be documented...after repairs are made." Apparently no generic follow up by management.

33. During previous maintenance to rectify 7-19-77 event not all pressurizer instrumentation was rechecked and recalibrated. Only the affected equipment received maintenance.

34. Appears that preventive maintenance program identified in 7-01-76 event has not been carried out.

35. Related to 8-06-77 event in that management did not apparently view the problem generically.

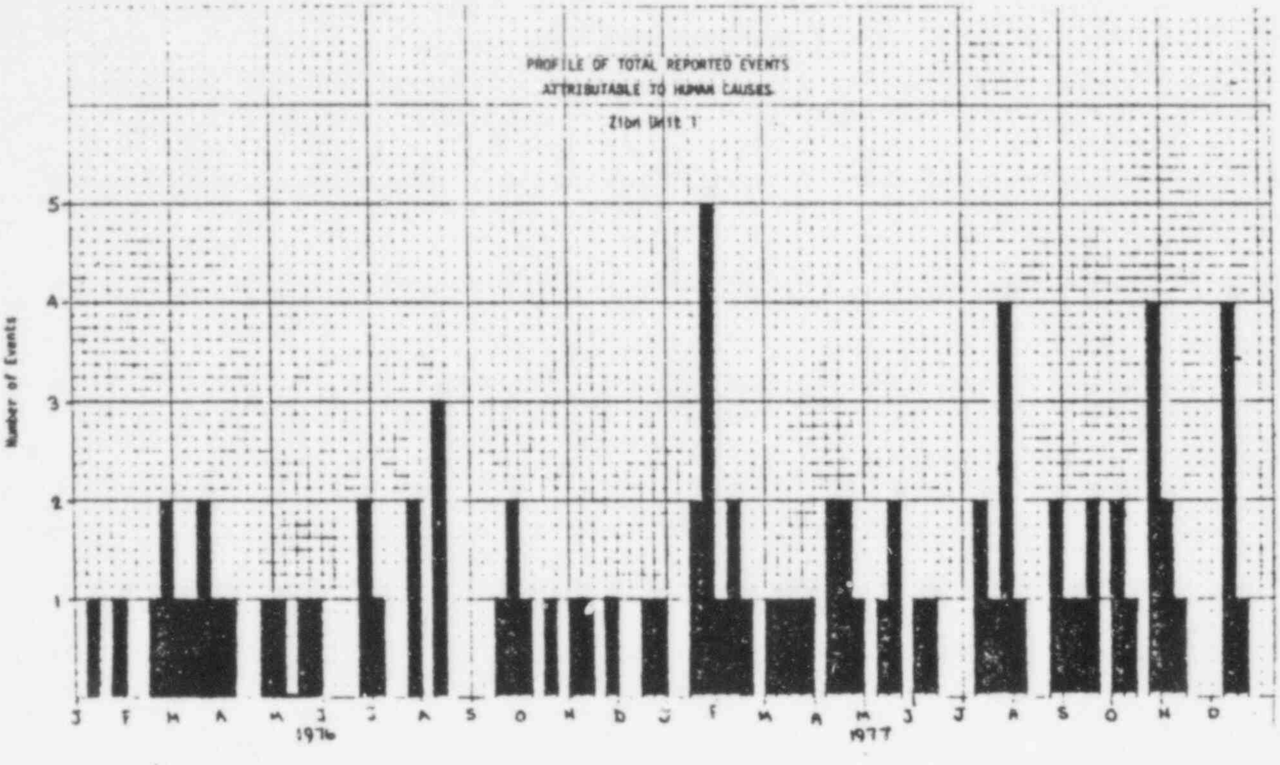
36. Management failed to view 8-06-77 as generic and repeatable.

37. Management failed to view 10-21-77 event as generic and repeatable.

38. Event in this system occurred previously 2-03-77.

39. Similar to previous event 12-03-77.

1080 102



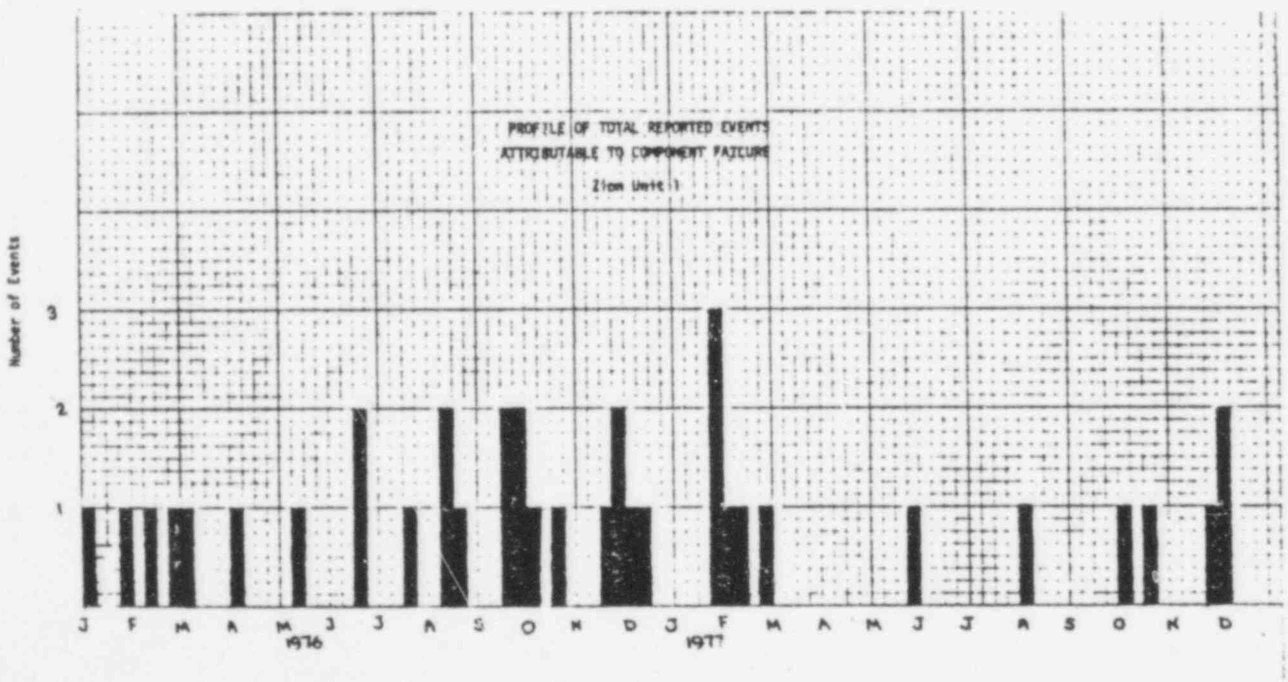


FIGURE A-12

Zion Unit 1 Performance Profiles
(Continued on next page)

POOR ORIGINAL

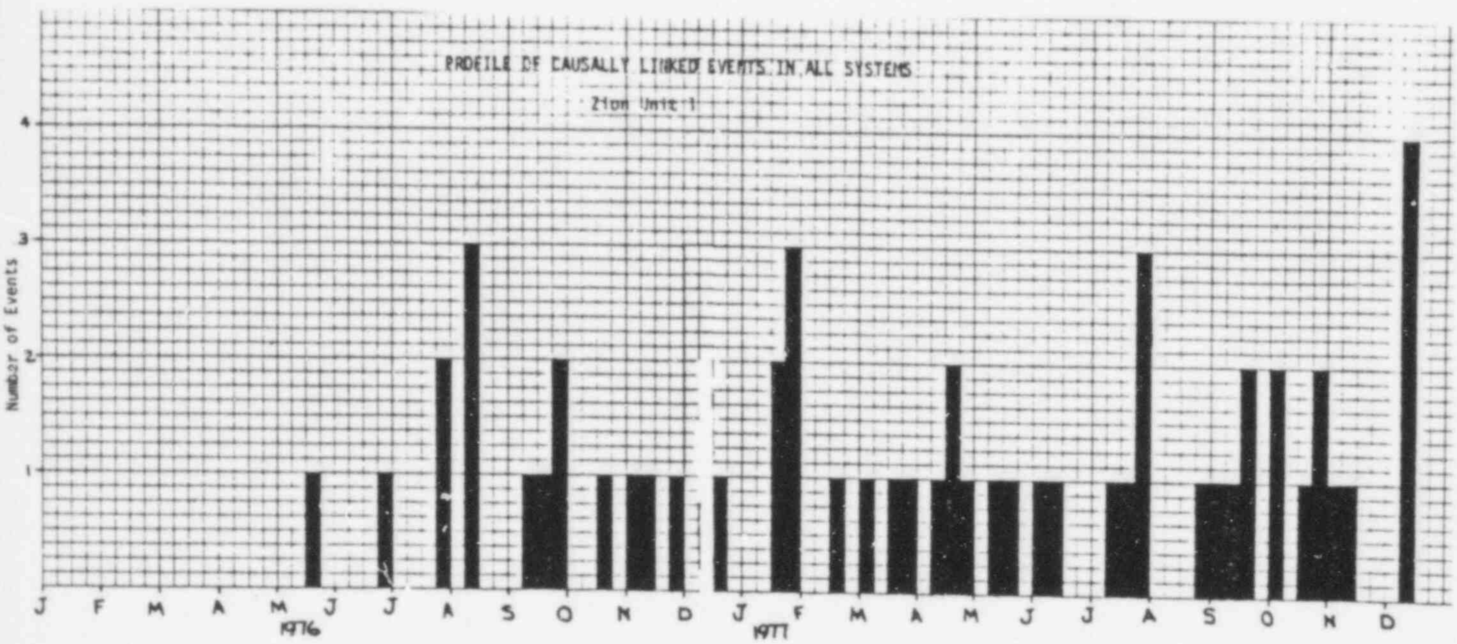


FIGURE A-12 (continued)

Zion Unit 1 Performance Profiles

1080 104

system would be replaced with mechanical ones, "since the fluid probably leaked out due to high temperature environment."

As a result of the 11-02-77 event of hydraulic snubber failure, the licensee stated that "inspections each refueling cycle identify leaking seals. No further corrective action is deemed necessary."

The 11-02-77 event and the 11-09-77 event present an interesting view of facility management perception of and response to generic event causes.*

Review of Inspection Reports and 766 System Data File for Zion Unit 1

When we reviewed the 766 system data file and associated inspection reports for 1976 and 1977, we found 60 inspection reports detailing NRC I&E inspector findings. Twenty-seven of these reports identify a total of 78 items of noncompliance. Two of these reports resulted in civil action against the licensee. Of the 78 items of noncompliance, ten involve physical protection and are identified in two separate inspection reports.

*Point Beach Unit 1 also reported an event in this "system" on 10-21-77. They stated the cause as personnel error. The event itself was described as "During...testing of safety-related shock suppressors according to T.S. 15.4.13.2...snubber did not lock up when specified load rate was applied." Their cause description and response: "Control valve...found to be imprope[r] set. Control valve was properly set, and snubber retested satisfactorily. Similar snubber control valves are being rechecked." The response of Po[int] Beach Unit 1 in checking similar snubber control valves shows that some licensees look for generic implications beyond the "conventional" system level.

1080 105

Matrix A-12 summarizes the findings of each inspection report and associated 766 system data file entries that resulted in noncompliances. Two reports in which LERs were reviewed and two reports covering management inspections are also included. Not including noncompliances due to physical protection and those for which reports were not available, 33 of 62 items were assignable to ERC-M, and 25 were assignable to ERC-P.

There was generally good agreement between the noncompliance cause code as listed in the 766 system and the detailed discussions in the "Report Details" section of the available inspection reports. Less than nine percent of the noncompliance cause codes either were ambiguous or did not agree with the inspection report details. There was also strong agreement between the enforcement text provided for each item of noncompliance identified in the 766 system and the "Enforcement Actions" section of the associated inspection report. However, there was less agreement between the noncompliance cause code and the 766 enforcement text. Approximately 47 percent of the items bore either an ambiguous or irrelevant relationship to each other. There is not enough detail in the 766 enforcement text and the associated noncompliance cause code (without analyzing the supporting inspection report) to provide a sufficiently comprehensive understanding of the noncompliance and the circumstances of its origin.

We reviewed possible sources of cues that may have aided inspectors in identifying noncompliance items. In approximately 32 percent of the cases, a noncompliance resulted from inspector followup of an LER. Almost 20 percent of the noncompliances resulted from inspector followup on a licensee-identified matter. Thus for Zion Unit 1, more than 50 percent of the noncompliance items resulted from inspector cues.

1080 106

MATRIX A-12

Review of 766 File and Inspection Reports for Zion Unit 1

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
76-02	FCS2	M	YES	CAN'T TELL	YES	NO	NO	YES	YES (4 ITEMS) NO (2 ITEMS)	
	FCS2	O	YES	CAN'T TELL	YES	NO	YES	YES		
	FMY3	M	NO	NO	YES	YES	NO	YES		
	FMY3	M	YES	CAN'T TELL	YES	NO	YES	YES		
	FDP2	M	YES	CAN'T TELL	YES	NO	NO	YES		
76-03	JAY3	M	YES	NO	YES	NO	NO	IN SUBSEQUENT LETTER	INCOMPLETE (1ITEM) YES (1 ITEM) NO (2 ITEMS)	
76-07	ESB2	M	NO	YES	YES	NO	YES	YES	YES (6 ITEMS) NO (6 ITEMS)	3 ITEMS/DISAGREE

1080 107

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
	FDG2	P	YES	YES	YES	YES	NO	IN SUBSEQUENT LETTER		
	FCA2	P	YES	CAN'T TELL	YES	YES	NO	YES		
	FJP3	P	YES	YES	YES	NO	YES	YES		
	FJR3		CAN'T TELL	CAN'T TELL	YES	YES	NO	YES		
	FJR3*	P	YES	YES	YES	YES	NO	IN SUBSEQUENT LETTER		
	FPE3*	P	YES	CAN'T TELL	YES	NO	NO	IN SUBSEQUENT LETTER		
76-10	FCL2	M	NO	NO	YES	NO	NO	IN SUBSEQUENT LETTER	NOT INSPECTED	2 IDENTIFIED IN 766, BUT NOT EVIDENT IN IE REPORT
76-11	MGT. INSP.							-DISCUSSED COMMON CAUSE FACTORS CONTRIBUTING TO OPERATING PROBLEMS. -CONTINUED LICENSEE EFFORT TO MINIMIZE FUTURE INCIDENTS CAUSED BY OPERATOR ERROR AND IMPORVE PLANT PERFORMANCE.		

NOTES

(*) Repeat noncompliance

1080 108

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
(1) 76-12	ASA1	M	YES	CAN'T TELL	YES	YES		NO	NONE REVIEWED DURING INSPECTION	
	FPG2	M	YES	YES	YES	YES		NO		
	ABC1	M	YES	CAN'T TELL	YES	YES		NO		
76-13	FPG2	P	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER	YES (1 ITEM) NO (2 ITEMS)	
	FDG2	P	YES	YES	NO	YES		YES		2 ITEMS/AGREE
	ABC2	P	NO	YES	YES	NO	YES	YES		
	FDG2	F	YES	CAN'T TELL	YES	YES		IN SUBSEQUENT LETTER		
76-17	FDN2	P	YES	NO	YES	YES		YES	YES (11 ITEMS)	10 ITEMS/AGREE 1 ITEM/OPEN

NOTES

(1) Licensee fined

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
	FPE2	P	YES	YES	YES		YES	YES		
76-20	FJG3	P	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER	NONE INSPECTED	
	FJG3	P	YES	YES	YES	NO	NO	YES		
76-21 (PHYS. PROT.)	FPH2	P	YES	YES	YES	NO	NO	IN A SUBSEQUENT LETTER	NONE INSPECTED	
76-22	FJP3	P	YES	YES	YES	YES		YES	YES (3 ITEMS) NO (2 ITEMS)	
	FCS2*	P	YES	YES	YES	NO	NO	YES		
76-25	FPE3	P	YES	YES	YES	NO	NO	YES	NONE INSPECTED	4 ITEMS/AGREE

NOTES

(*) Repeat noncompliance

1080 110

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
(2) 76-26	FJE2	P	YES	NO	YES	YES		IN SUBSEQUENT LETTER	NONE INSPECTED	
76-29 (Phys. Prot.)	RMC2	P	YES	CAN'T TELL	YES	NC	NO	YES	YES (3 ITEMS) NO (2 ITEMS)	
	RLL2	P	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
	RME2	M	YES	CAN'T TELL	YES		YES	YES		
76-30	FJP2	M	YES	CAN'T TELL	YES	NO	YES	YES	NONE INSPECTED	
76-31	ASE2	M	YES	CAN'T TELL	YES	NO	NO	YES	NONE INSPECTED	1 ITEM/DISAGREE
	FDG2*	M	YES	CAN'T TELL	YES	NO	YES	IN SUBSEQUENT LETTER		
	FDG2	M	YES	NO	YES	NO	NO	NO		

NOTES

(*) Repeat noncompliance

(2) Inspection to follow-up on an LER, unexplained boron dilution event, October 2, 1976.

1080 111

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed, Adequacy of Response (Disagree?)
	FCJ2	F	YES	YES	YES	YES		YES		
	FJP3		NO	NO	YES	YES		NO		
76-32	FCA2	M	YES	CAN'T TELL	YES	YES		YES	NO (1 ITEM) YES (1 ITEM)	13 ITEMS/AGREE 5 ITEMS/DISAGREE
(3) 77-05									YES (4 ITEMS)	7 ITEMS/AGREE
77-07	FPH2	P	YES	YES	YES	NO	NO	YES		
77-08	FJJ3	M	YES	NO	YES	NO	NO	NO	YES (1 ITEM) 1 ITEM	1 ITEM/AGREE
	FJE2	P	YES	YES	YES	NO	NO	NO		
	FJF2	P	YES	YES	YES	NO	YES	NO		

NOTES

(3) Inspector noted that LER write-ups were scant and that all facts available were not presented to make a complete evaluation.

1080 112

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enfoncement Items	LER's Reviewed Adequacy of Response (Disagree?)
	FJK3	M	YES	NC	YES	NC	NO	NO		
77-09	FJC3	M	YES	CAN'T TELL	YES	NO	NO	YES	YES (2 ITEMS) NO (1 ITEM)	
77-10		REPORT NOT AVAILABLE (4 ITEMS OF NONCOMPLIANCE)								
77-11	KRB3	M	YES	YES	YES	NO	NO	NO		
77-15	FDG3	M	YES	NO	YES	YES		YES	YES (7 ITEMS) 1 ITEM	1 ITEM/AGREE
	FJE2	M	YES	NO	YES	YES		YES		
	FCJ2	M	YES	NO	YES	YES		YES		
	FDG2	M	YES	NO	YES	YES		YES		

1080 113

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
	FPG2	M	YES	YES	YES	NO	NO	NO		
	FPG2	M	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
	DDH2	M	YES	YES	YES	YES		NO		
	ART3	M	YES	YES	YES	NO	NO	NO		
	FJP3	M	YES	YES	YES	YES		YES		
	FDF2	M	YES	YES	YES	NO	NO	NONE REQUIRED		
	FDF2	M	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
(1) (4) 77-16	FJP3	M	YES	YES	YES		YES	CAN'T TELL		

NOTES

(1) Licensee fined

(4) July 8, major event water hammer, safety injection event due to human error.

1080 114

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enforcement Items	LER's Reviewed Adequacy of Response (Disagree?)
	FPE2	P	YES	NO	YES		YES	CAN'T TELL		
	FJF2	P	YES	YES	YES	YES		NO		
	FPF2	P	YES	YES	YES		YES	NO		
	FES2	P	YES	YES	YES		YES	NO		
77-17	FJG2	P	YES	YES	YES	NO	NO	IN SUBSEQUENT LETTER		
77-18	FJM2	M	YES	YES	YES	NO	NO	NO		8 ITEMS/CAN'T TELL
77-19 (Phys. Prot.)	RLL2	M	YES	CAN'T TELL	YES	NO	NO	YES	YES (4 ITEMS) NO (2 ITEMS)	
	RLD3		CAN'T TELL	CAN'T TELL	YES	NO	NO	NO		

NAME ZION UNIT 1

Insp. Rpt.	Non Comp.	Teknekron Cause Code	Does NC Cause Code in 766 Agree With IE Report	Does NC Cause Code in 766 Agree With 766 Text	Does 766 Text Agree With IE Report	Did N/C Result from Insp. Follow Up On LER	Did N/C Result from Insp. Follow Up On a Licensee Identified Action	Has Licensee Specified Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identified enfoncement Items	LER's Reviewed Adequacy of Response (Disagree?)
	RMD2	M	YES	CAN'T TELL	YES	NO	NO	YES		
	RM[illegible]3	M	YES	CAN'T TELL	YES	NO	NO	YES		
	RLE3	P	YES	YES	YES	NO	NO	YES		
	NDE3	M	YES	YES	YES	NO	NO	YES		
	NDE3	M	YES	YES	YES	NO	NO	YES		
77-20		REPORT NOT AVAILABLE (2 ITEMS OF NONCOMPLAINCE)								
77-26										19 ITEMS/AGREE
77-27	MGT. MTG.				DISCUSSED NEED FOR IMPROVED MANAGEMENT CONTROL					

1080 116

For 50 percent of the noncompliance items, remedies specified by the licensee to prevent recurrence of the event were identified in the inspection report. Twenty-one percent of the items were addressed in a subsequent followup letter. However, the licensee's action on previously identified enforcement items was generally deficient. Nearly 70 percent of the inspection reports that specifically discuss "Licensee Action on Previously Identified Enforcement Items" indicated one or more items for which the licensee had not yet achieved compliance.

The inspector found the licensee's reporting of LERs unacceptable in 12 percent of the 74 total cases addressed in the inspection reports. This was because of the inspector's judgment that the licensee provided insufficient detail to substantiate the event. For 36 percent of the events, not enough detail was present in the inspection reports to make it clear whether the inspector had reviewed the LERs in detail.

Our review of the inspection reports revealed three events due to human failure that were serious from the regulatory point of view. The identification of these events and the subsequent determination of their seriousness was made possible by the inspection process. These events are summarized individually.

Radiation Exposure Incident - March 18, 1976 (as described in I&E Inspection Report No. 050-295/76-12)

On March 18, 1976 an employee received an 8.05 rem dose when he entered the cavity beneath the reactor vessel to determine the location of a water leak from the refueling cavity into the reactor cavity. The referenced inspection report describes the details of the event and the circumstances of its occurrence; we will not duplicate that information. However, part g of the inspection report, "Problems Revealed by this Incident," was enlightening and is reproduced here in its entirety:

g. Problems Revealed by this Incident

This incident revealed the following apparent problems related to radiation protection:

(1) The unlighted, difficult-to-reach tunnel and cavity beneath the reactor were not recognized and treated as an extremely hazardous high-radiation area.

(2) Neither station management nor Radiation Protection personnel understood the source of the high radiation levels beneath the reactor. Radiation levels were vaguely attributed to the reactor vessel, not to the incore system. No effort had been made to relate the position of the withdrawn incore thimbles to the bottom of the vessel.

(3) None of the tunnel entries, which resulted in 3.5 man-rems of dose in addition to Employee A's 8 rems, produced very meaningful exposure rate data. Employee A knew only that exposure rates greater than 10 R/hr probably existed and that doses received during the previous entries by Employees C and D had exceeded the range of their 0-200 millirem pencil dosimeters.

(4) Radiation Protection neither prohibited Employee A from making a solo entry nor provided monitoring assistance, even though high radiation levels were known to exist in the area. Nor, as required by Procedure No. RP-253, was a special work permit issued to ensure proper monitoring, protective equipment, instructions, and approvals. Procedure No. RP-253 requires preparation of a special work permit for work resulting in a daily whole body dose greater than 50 millirems, unless the work is otherwise approved in writing by the Radiation Protection Supervisor or the work is continually monitored by a Radiation Protectionman.

(5) Despite the known existence of high-radiation areas, Employee A was provided no high-range dosimetry, other than his film badge.

(6) There are indications that this incident may have been caused or at least contributed to by an ineffective working relationship between Radiation Protection and certain station management personnel.

The cause of the event was a performance deficiency assignable to the management "circle" in the FPM model. However, the manifestations of the event appear as either incorrect (paragraphs 1, 4, and 6 of the description) or missing components (paragraphs 2, 3, and 5 of the description) of the information flow along one or more of the arrows in the FPM model.

This occurrence resulted in a citation for three items of noncompliance and the institution of a civil penalty.

Boron Dilution Incident - October 3, 1976 (as described in I&E Inspection Report No. 050-295/76-26

On October 3, 1976, licensee personnel observed that pressurizer level changes and boron analysis over the previous 24 hours indicated that an unexplained dilution was in progress in Unit 1. The inspection report describes the details of the event and the circumstances of its occurrence, but the relevant section of the inspection report entitled "Management Interview" is reproduced here in its entirety:

Management Interview

An exit interview was conducted on October 15, 1976, with (Mr. X) and other members of the staff. The following items were discussed:

A. The inspector asked the licensee why valve 1IW0153 was open. The licensee stated there was no reason for the valve being open and did not know how it was opened. The inspector stated that valve 1IW0153 being open without justifiable reason was contrary to the requirements of Procedure SOI-7 and constituted an infraction against Technical Specification 6.2.A. (Paragraph 2.e, Report Details)

B. The inspector asked when the suspected leaking valve 1MOV-VC-8106 would be tested. The licensee stated the valve would be type C leak tested by October 16, 1976. The inspector requested that the

1080 119

licensee telephone in the results of the test by October 18 and the licensee agreed to do this.* (Paragraph 2.e, Report Details)

C. The inspector stated that it took six hours after a sample had revealed 864 ppm of boron in the reactor coolant system before boration was accomplished. The inspector stated that this was not considered to be a timely response and that during discussions with operating personnel regarding actions to be taken in future events that a more timely response should be emphasized. The licensee stated that from hindsight more timely boration would have been indicated but that during the event the emphasis was on finding the cause of the dilution. (Paragraph 2.3, Report Details)

D. The inspector suggested that the design of the injection seal water system be reviewed to determine if the alarm on the injection seal water tank level might be adjusted to give an earlier indication of undue flow out of the system. The licensee stated that if the level alarm was adjusted to alarm at a higher level in the tank, normal leakage out of the system would cause alarms and diminish usefulness of the level alarm. The inspector asked what the value of the normal leakage was. The licensee responded that the leakage was measured but did not recall the exact value.

The cause of the event is clearly assignable to management. However, the manifestations of the event and its aftermath appear as either <u>incorrect</u> (paragraphs B and C of the description) or <u>missing</u> components (paragraphs A and D of the description) of the information flow along one or more of the arrows in the FPM model.

The occurrence resulted in a citation for one item of noncompliance.

<u>Water Hammer and Safety Injection Event - July 8, 1977 (As described in I&E Inspection Report No. 50-295/77-16)</u>

The "Report Details" section describes this event:

1. On July 8, 1977, during performance of a periodic test by a licensed operator, a momentary distraction caused the operator to omit several steps of the procedure resulting in a reactor trip.

*The licensee notified the inspector October 21 of the results of the test. Test results revealed no significant leakage.

1080 120

2. In response to the reactor trip, all systems functioned as designed. However, the auxiliary feedwater system flow control had been incorrectly adjusted after a previous test of the system; the maladjustment resulted in flow rates approximately three times higher than required (or desired) by current operating procedures.

3. Due to a clerical error, the current operating procedures had not been distributed for use, and the flow control adjustment had been performed with outdated procedures.

4. This series of events caused a system water hammer when the auxiliary feed pumps came on automatically. The water hammer was of sufficient magnitude to shake various transmitters located in the immediate vicinity; the shaking transmitters initiated a spurious safety injection.

5. When a safety injection is initiated, the system is designed to operate for 60 seconds in that mode. After 60 seconds, the operator is to reset the safety injection in accordance with a procedure for recovery from a false or inadvertent safety injection. Contrary to these procedures, personnel manually defeated the safety injection for 30 seconds prior to resetting it. This manual defeat of the safety injection signals preclude receipt of additional safety injection signals.

This event was caused by peformance deficiencies assignable to both management and personnel. However, the manifestations of the event preceded it in time and appear as either incorrect or missing components of the information flow along one or more of the arrows in the FPM model. The occurrence resulted in a citation for two items of noncompliance.

Including the last occurrence described, three serious events occurred at Zion Units 1 and 2 between July 8 and 12, 1977, two water hammers with consequent safety injection events and a pressurizer draining event. At the exit interviews following the management meetings held to investigate these events, inspectors informed the licensee of:

- the seriousness with which NRC viewed these events;
- observations involving the breakdown of management controls.

The NRC levied a civil penalty in a subsequent enforcement action.

C FORM 335
7)

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER (Assigned by DDC)	NUREG/CR-0979
TLE AND SUBTITLE (Add Volume No., if appropriate)	icensee Performance Evaluation - Phase II
2. (Leave blank)	
3. RECIPIENT'S ACCESSION NO.	
UTHOR(S)	H. E. Chakoff, D. M. Speaker, S. R. Thompson, S. C. Cohen
5. DATE REPORT COMPLETED	MONTH March YEAR 1979
DATE REPORT ISSUED	MONTH August YEAR 1979
ERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)	Teknekron, Inc. 1483 Chain Bridge Road McLean, VA 22101
6. (Leave blank)	
8. (Leave blank)	
SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)	Office of Inspection and Enforcement U. S. Nuclear Regulatory Commission Washington, D. C. 20555
10. PROJECT/TASK/WORK UNIT NO.	
11. CONTRACT NO.	NRC-05-78-302
TYPE OF REPORT	Technical
PERIOD COVERED (Inclusive dates)	
SUPPLEMENTARY NOTES	
14. (Leave blank)	

ABSTRACT (200 words or less)

This report details work performed during the second phase of a two-phase contract to develop methodology for Licensee Performance Evaluation. The Phase I report, NUREG/CR-0110 details initial efforts on the contract. The model developed in Phase I was used to evaluate nine additional facilities for this report. Performance indicators from noncompliance data were also evaluated. Methodology was developed employing the noncompliance indicators and used for 12 case studies. It was found that licensee event report indicators could be more easily identified and utilized than noncompliance indicators based on presently available data systems. However, noncompliance data, appropriately ralated to cause, could provide real insight into why performance was what it was.

KEY WORDS AND DOCUMENT ANALYSIS

17a. DESCRIPTORS

b. IDENTIFIERS/OPEN-ENDED TERMS

AVAILABILITY STATEMENT	Unlimited
19. SECURITY CLASS (This report)	Unclassified
21. NO. OF PAGES	359
20. SECURITY CLASS (This page)	Unclassified
22. PRICE	S

C FORM 335 (7-77)

1080 123

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U.S. NUCLEAR REGULATORY
COMMISSION

U.S. MAIL

POOR ORIGINAL

1080 124