NUREG/CR-0110

LICENSEE PERFORMANCE EVALUATION

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

TEKNEKRON, Inc.

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U.S. Nuclear Regulatory Commission

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TEKNEKRON, Inc.
4701 Sangamore Rd.
Washington, D. C. 20016

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ABSTRACT

A model was developed for the analysis of the performance of NRC's licensees. The model is based on identifying the distinctions between the licensee's facility, personnel, and management and the interrelationships between them. The application of this model and related methodology to available NRC licensee data permits the display of licensee performance in terms of temporal patterns that provide an understanding of performance quality and furnish an insight into the causal factors underlying this quality. In principle, the analytic methodology derived from the model can be applied to any licensee class; at present, except for operating power reactors, available data are relatively sparse. On the basis of the LER and 766 files, three nuclear power licensees in Region 3 were analyzed with the result that previously suspected differences in performance quality became evident through the displays generated by the analysis. Management attitude and capability were found to play major roles in determining performance.

EXECUTIVE SUMMARY

In order to assist NRC's Office of Inspection and Enforcement in ensuring the safety of licensee operations, we developed a methodology to analyze licensee performance. This methodology utilizes an initial conceptual "model" of a licensee, in which the physical facility, the operating personnel, and the management are clearly identified as distinct entities. The model also explicitly defines the interrelationships among these elements by characterizing flows of information and control signals among the elements. Applying the model produces profiles of licensee performance. These performance patterns, which are displayed as a function of time, not only reflect the character of performance (relatively good or relatively poor), but also provide insight into the causal factors that underlie performance quality.

The model is applicable to all licensee classes. However, feasible application is limited by the data available for each licensee category. Currently, the data that exist in NRC files are most complete for operating power reactors. Because power reactors are the most complex of all licensees and because substantial data describing their operation are available, we initially tested the methodology on this category of licensees.

In the case studies, we analyzed three operating power reactors from NRC Region 3, including one considered to be a "good" performer and one a "poor" performer. All three were alike in terms of age and type of equipment. The analysis showed substantial differences between the performance patterns of the "good" and "poor" performers, especially in the clustering of causally related events. In both cases, it was clear that the willingness and ability of management to institute prompt and generic remedial measures was a major factor in performance quality.

A major finding of this study was that the <u>content</u> (not the quantity) of Licensee Event Reports (LERs) proved to be of considerable value as a performance indicator in the context of our licensee model. Testing the noncompliance data produced by NRC's inspection process against the model provided insight into how the content of the noncompliance data could be improved to enhance its value to licensee performance evaluation.

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1.0 INTRODUCTION

In approaching this project, 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.

Two types of data - licensee event reports and inspector-reported non-compliances - give two views of how a licensee conducts his operations. By using the structure of our licensee model to analyze the content of the data, a picture of that licensee's capability and attitude emerged. We began to see apparent causes underlying the data. Because poor behavior does not always have severe consequences, we made no attempt to weight data elements. Neither did we count data elements, nor normalize them in any way. Using the content of the data as a source of attitude and behavior information made counting and normalizing unnecessary.

The results of this methodology take a non-numeric form. The licensee model and the way we used the data to illuminate the model's interrelationships suggested graphic profiles that show behavior over a period of time. We believe these profiles show the differences between licensees while still preserving their uniqueness and that they lend themselves to NRC's setting a "threshold band" above which performance is adequate and below which it is not. The methodology makes it possible to examine specific areas of a licensee's operation to pinpoint problem areas; it also enables a more comprehensive picture to be seen. Further, using licensee event reports and inspector-reported noncompliances to create separate profiles makes it possible to see the interaction between NRC and the licensee.

We believe that this report presents a valid and insightful performance analysis method. NRC needs a tool to analyze the performance of its licensees so that it can determine where to place its inspection emphasis to improve that performance. For this reason, we have used the term "licensee performance analysis." We think this name accurately reflects NRC's need for and use of such a tool.

Section 2.0 sets the stage for licensee performance analysis by linking it to NRC's mission and goals. Section 3.0 presents the FPM model and our methodology for using available data to analyze licensee performance. The fourth section shows that the methodology meets the requirements of the NRC Request for Proposal.

Section 5.0 sets out our proposed plan of action for Phase II of this program. The final section identifies a number of work areas addressing needs that became evident during the course of this study. Appendix A presents three case studies in their entirety. Reading the details of these case studies will give a full appreciation of the meaning of the performance profiles and the use of our methodology.

2.0 RATIONALE FOR LICENSEE PERFORMANCE ANALYSIS

This section discusses the factors involved in NRC's decision to develop a tool to analyze the performance of its licensees. We define "performance" and then discuss NRC's objectives in analyzing performance. NRC staff perceptions are closely interrelated with NRC objectives, and those perceptions will influence the ways in which NRC will use a performance analysis tool. Finally, we discuss prior performance measurement efforts.

2.1 DEFINITION OF PERFORMANCE

In this study, "licensee performance" is specifically related to elements that affect the level of risk presented by the licensee's operation. One assumption, basic to any program that regulates hazardous activities, is that compliance with regulations will maintain the risk at or lower than a level "acceptable" to NRC. Because of this assumption, one of our early definitions of performance included "...demonstrated compliance... with the regulations and the conditions of the license."

That early definition also included "the ability of the licensee to comply" as well as the "attitude of the licensee toward compliance." These two factors influence performance rather than being essential components thereof, but their inclusion recognized that unless attention were given to motivation and ability to perform, NRC could not fully understand the reasons for inadequate performance. NRC's Request for Proposal made it clear that the methodology developed must be able to distinguish between "good" and "poor" performers as well as provide insights into the "whys" of performance. NRC must have a tool with both these dimensions if it is to successfully remedy poor performance.

While "good" and "poor" performance are relative terms, we can say that a "poor performer" is a licensee who has more noncompliances or safety-related events than NRC feels he should have. This must be a subjective definition, since there can be no fixed threshold of noncompliances or events above which performance threatens public health and safety. But excessive noncompliances or LERs can indicate a lack of management controls, which, if widespread, could eventually threaten public health and safety.

Therefore, although the concept of performance remains closely linked to regulatory compliance, we did not restrict it to that criterion. In fact, we found that safety-related performance is more accurately analyzed and more meaningfully interpreted when seen as a multidimensional behavioral pattern rather than a numerical record of lapses from regulatory grace.

Thus, over the first phase of this study, Teknekron's working definition of performance has been:

> PERFORMANCE: Those patterns of behavior that show the ability and willingness of the licensee to conduct his operation to minimize the risk to public health and safety and to the environment.

2.2 OBJECTIVES OF LICENSEE PERFORMANCE ANALYSIS

During the early part of this study, the tentative objective of performance analysis was to identify "those licensees whose level of performance (as measured principally, but not solely, by compliance) may require improvement." As the study evolved, no findings of the case studies contradicted or were inconsistent with this objective. But the objective appeared incomplete: it did not include understanding the behavioral differences among licensees nor did it include identifying their levels of performance.

The methodology Teknekron developed makes it possible to compare behavior patterns of one licensee against those of another. A comparison might be expressed as: "Licensee A has been more effective than licensee B in eliminating facility conditions that can induce recurrent and causally connected events. It is clear that A's management is the more alert and responsive of the two, and that, on the whole, the potential risk presented by A is substantially less than that associated with B's operations."

We must emphasize that our methodology does not attempt or intend to rank licensees (within a given class) on any sequential or numerical basis. The method does, however, allow the relatively good and the relatively poor performers to be identified in a way that gives NRC insight into the reasons why these licensees are different.

2.3 PERCEPTIONS OF LICENSEE PERFORMANCE ANALYSIS

As part of Phase I, Teknekron met with a variety of people who will be affected in some way by licensee performance analysis. The perceptions and feelings of these people should be recognized and accounted for as much as possible if this program is to be most useful.

The perceptions of NRC personnel are critical. We met with headquarters staff and each of the regional directors; we sifted through several documents that expressed NRC viewpoints and concerns. Several of these concerns were related to earlier NRC attempts at performance evaluation; Section 2.5.1 briefly discusses one of these earlier attempts. The view of headquarters and regional personnel toward licensee performance analysis are discussed separately below.

NRC's licensees will obviously be affected. To obtain the licensees' views, and what they perceive such an assessment might mean, we met with the secretary of the Atomic Industrial Forum (AIF) and also with the AIF's Ad Hoc Committee on Inspection Practices, where representatives of four power companies and two NSSS suppliers were present.

Finally, to complete the spectrum of perceptions, we obtained the intervenors' viewpoint in discussions with the Natural Resources Defense

Council. While intervenors are not directly affected by licensee performance analysis, they may be interested in its potential use in their representation of one public viewpoint, a factor that may affect the form taken by public release of performance analysis results.

2.3.1 Headquarters Staff

As is natural in any group of people, the aims and inclinations of individuals vary. But there was more agreement than disagreement on a number of major points. First, some analysis of performance will be conducted, because it is basic to focusing the resources of the inspection program efficiently and effectively, and it may also provide a way to link enforcement action to the weak spots in the licensees' behavior. If it is properly structured, performance analysis may also help to improve relations between NRC and the licensees, so that the goal of adequately protecting public health and safety can be more easily attained. These basic feelings about the purposes of the program influence its form, and a majority of the headquarters staff lean toward the idea of NRC-established "thresholds" of acceptable performance rather than classifying licensees into groups. The "threshold" concept is consistent with the NRC's regulatory mandate to require levels of safety that adequately protect the public.

Nearly everyone agreed that licensee capability and attitude are important indicators of performance - if data can be obtained that reflect those qualities. "Management inspections" are to be reinstated, and they may help provide this data. The actions a licensee takes to investigate his own problems, the actions he takes to correct them, and the effectiveness of those actions are indicators that reflect both attitude and capability. Some of the staff felt that the perceptions of the regional personnel should be a potential indicator, and others felt that occupational exposure and effluent release data should be included.

A few other views were less widely held, but they indicate that the staff feels a need to move ahead in devising a workable analysis tool. Nearly all agreed that numerical counts of noncompliances and reported licensee events are not valid performance indicators, because counting implies the need for a weighting factor related to severity levels. There has been no agreement that any weighting scheme devised so far is completely satisfactory. Similarly, most Headquarters staff believe that the issue of normalization (by inspection hours, modules completed, or inspectable requirements) is difficult; that issue may well dissipate with the advent of the resident inspector program. Since normalization was an attempt to handle regional differences and variations in time spent with different licensees, the need for normalization may disappear if the analyses for each region are kept separate.

2.3.2 Regional Staff

Teknekron held separate discussions with each regional director and his staff. Despite our attempts to follow a similar format, each conversation took a slightly different turn, and not all topics were covered in all discussions. But the perceptions on a core of topics that were covered in all the discussions show some views that are quite similar to those of the headquarters staff as well as a few that are quite different.

All the regions stated that some sort of performance analysis should be performed. But a number of regions felt that they "know" which licensees are "good" performers and which are not. They also agreed that regional differences are substantial, including style of management. The regional personnel feel that they are closest to the day-to-day operation of the licensees, and that any method that is developed must accomodate regional differences and not be simply a tool for use by headquarters.

Regional feelings on performance indicators varied, but they centered around the idea of management responsibility. All but one of the regions mentioned that counting LERs and noncompliances was inappropriate. Uneasiness about counting stemmed from the feeling that human errors and adequate management response in correcting those errors are more important factors. Most of the regions stressed that ability and attitude of the plant manager was a major force in shaping the plant's performance. More than half the regions said that some form of subjective evaluation should be included; more than half also felt that repeated noncompliance was a good indicator because it revealed poor management response.

A majority of regions supported the concept of performance thresholds, but the idea of ranking licensees produced several negative reactions. We could find no agreement on normalization of noncompliances. Some felt inspection hours should be used, and other regions had no fixed opinion. Three regions stated that normalization may be unnecessary, particularly in light of the resident inspection program.

2.3.3 Licensees

It is safe to say that the nuclear industry is nervous and suspicious about NRC's reasons for wanting an analysis tool. Their feelings have two bases. First, the industry feels beleaguered by a negative attitude toward nuclear power as expressed in public reaction, legal intervention, and in press coverage. They feel that this negative public attitude will almost certainly result in the possible misuse and misrepresentation of <u>any</u> assessment method, and because of this, no method can receive a fair trial. Second, they assume that an ability to determine where emphasis is needed implies ranking or comparatively rating licensees. The strong feeling against ranking, even in such terms as "A, B, and C" or in quadrants as used in the TRW* report - not to mention a 1-60 list with attached scores - is intimately linked with industry's fear of public reaction and public (mis)use.

*Discussed in Section 2.5.1.

On the more positive side, licensees enthusiastically welcome the concept of NRC-established thresholds for acceptable performance. The threshold concept clarifies the relationship between the NRC and the licensee and potentially offers a clear goal to be achieved. If the thresholds are mutually acceptable, the licensees realize that they should perform at an acceptable level both for their own good and for the good public perception of the industry.

A few other comments illuminate the current relationship between NRC and licensees. The licensees perceive strong differences in management approach among the NRC regions, and in some cases they feel that the inspection process results in little if any increase in safety. But they also feel that reduced inspection effort by NRC would have little or no effect on safety although it could function as an incentive.

Licensees also feel that in many cases the inspection program does not help them find particular areas of weakness because it seldom helps locate the causes of noncompliance.

Finally, the licensees are concerned about the possible impact of licensee performance analysis on the licensing process. If the analysis process were applied to a reactor under construction, licensees feel that a poor level of performance in the construction stage could make it difficult for that reactor to be licensed to operate. Increased difficulty in obtaining an operating license places in jeopardy the time and money already spent in construction.

2.3.4 Intervenors

The Natural Resources Defense Council's (NRDC's) feelings about licensee performance analysis must be placed in the context of its position on nuclear power.* Broadly stated, its position is that nuclear power plants should not be built or operated, first because licensees cannot be trusted to build and operate plants safely by themselves, and second, because the regulatory system does not adequately oversee the licensees to assure that they meet specifications and license conditions. Since NRDC can deal more directly with NRC's regulatory role than it can with a multiplicity of licensees, the thrust of many of its comments was directed at evaluating the effectiveness of the inspection program. NRDC feels that measurement of I&E effectiveness is basic to encouraging adequate licensee behavior.

In NRDC's view, a fundamental question is not whether performance analysis is feasible, or what method should be used, but whether the public will believe the results if they show that licensee X is good. This stems from its perception that no licensee is performing adequately, at least in part because the regulatory program cannot make him do so. On the other side of the coin, NRDC will not attack an analysis methodology because it feels that adequate regulatory control is lacking.

2.4 USES OF LICENSEE PERFORMANCE ANALYSIS

The primary user of a performance analysis tool will of course be the NRC. Based on the perceptions of NRC personnel and on the objectives of identifying those licensees whose performance must be improved and analyzing why one licensee differs from another, we believe that licensee performance analysis can be effectively used to:

- Allocate I&E Resources

  The case studies we have performed (all in Region 3) demonstrate an extremely wide range of licensee

*We contacted two intervenor groups but held discussions with only one. We felt that the intervenor's viewpoint should not be ignored, because public perception is a factor of concern to the licensees; we also feel that the intervenor's view should not be a major factor in shaping the final product. But a *caveat* is necessary: NRDC's views may not be those of other intervening groups.

performance quality. The managerial quality of the best performer strongly suggests that this licensee is highly motivated to maintain an excellent operation (responsible and highly compliant) and would do so even if the NRC inspection program did not exist. Poorer performers obviously require more of NRC's attention.

By analyzing the relative quality of operation of licensees in a given class, I&E can then allocate its inspection and other resources to focus on upgrading the poorer performers, while possibly devoting less inspection effort to those licensees who are more self-motivated. Further, in the case of the poorer performers, licensee performance analysis will permit NRC to identify those facility systems that have experienced repeated causally related events and to concentrate on those systems that have the greatest safety implications. Using this method of analysis, NRC can identify major organizational causes of system breakdown, and the onsite inspector can concentrate his efforts on the cause rather than the effect.

- Assess the Likelihood of Future Events

  A sustained sequence of causally linked events in a single system suggests a higher probability of future events occurring in the same system (within a given period) than does the absence of such a sequence. The reason for this rests primarily in the quality of facility management that a sequence of events implies. In well-managed operations, repetitive events occur in smaller numbers because the cycle is truncated by generic correction of the problem. (For example, if seal leaks have occurred in similar equipment on two or three occasions, management will order all such equipment to be inspected and all questionable seals replaced.) Thus, a low incidence of causally linked events suggests good management; good management, in turn, characteristically designs and carries out effective inspection and maintenance programs that reduce the likelihood of event occurrence. In less well managed facilities, where the probability of future events is relatively greater, it does not necessarily follow that the event, if it indeed occurs, is causally linked to the sequence of past events in the same system. It may be causally linked to a sequence of past events or it may be unrelated. Causal linkage supports the earlier remarks about management quality.

- Support Enforcement Action

  The imposition of sanctions against a licensee can legally take place only if the licensee is not in compliance with legitimate requirements. Therefore, his performance patterns, as developed through the FPM methodology, cannot themselves be used as the basis for enforcement action. But once NRC has decided to bring an enforcement action on regulatory grounds, licensee performance analysis can be used as a guide for determining the severity of this action. For example, a large number of causally related events occurring within a given time period might suggest a more severe penalty than would the occurrence of a small number of random events within the same period.

- Identify I&E Regional Differences

  Some aspects of our analysis are particularly sensitive to the ways in which I&E inspection actions are implemented and to the ways in which reactive inspections are triggered. We believe that further case studies will identify and define significant regional differences in the inspection process.

2.5 BRIEF ANALYSIS OF RELATED WORK

As part of Phase I, Teknekron examined other NRC efforts dealing directly or indirectly with analysis of licensee performance. Three documents are particularly pertinent to this project, since they have helped to focus the views and attitudes of I&E personnel on the acceptability and usefulness of various methods of analyzing licensee performance and, to some degree, on the role of the inspection process itself. These three documents are:

- "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.

This discussion briefly summarizes Teknekron's views on these efforts and shows how they influenced our work.

"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 LER's submitted, and other measures that are ultimately combined into a single index (Z score). Its intent is to arrive at a numerical rating that realistically reflects licensee performance, since the better performer is assumed to incur fewer noncompliances and issue fewer LERs. This statistical methodology defines one view of "licensee performance." This report has stimulated considerable comment within NRC, much of which has focused on certain specific issues, including:

- The problem of developing a broadly acceptable relative weighting system for the various noncompliance categories: violations, infractions and deficiencies.
- 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 the methodology.
- Licensee performance evaluations expressed as single numbers (as aggregates of 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.

Overall, NRC's development of a statistical methodology has proven valuable in illuminating factors specific to this approach, as well as others that are largely independent of the particular 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.

Review of both the NRC statistical approach and the commentary generated by it within the agency influenced the direction we took in developing our own licensee assessment methodology. It appeared that even if the statistical method could be refined to the point at which most of the specific issues were resolved, it was not designed to provide the insight into licensee performance (an understanding of the reasons for performance quality, as well as performance assessment) required by the RFP. This led us to a different approach.

"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. But the concept of the TRW report of great value to our study 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 - relates to licensee motivation; the second - capability - relates to his capacity to translate his motivation into action.

The TRW report presents a graphic display classifying licensees who (at least 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 is of considerable interest to us because our methodology analyzes performance through its controlling causal factors. We were able to build on TRW's "performance space" concept by attempting to use performance indicators to discover causes, not only as measures of performance.

"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 Section 3.4.2, we consider statistical sampling as a possible means of analyzing the performance of classes of licensee for which the existing data are too sparse to permit individual analysis (materials licensees). For this reason, this report is of interest to us.

The Statistical Sampling 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.

The authors of the report argue against further development of the SSIP on several grounds:

- 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 are 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.

3.0 METHODOLOGY OF LICENSEE PERFORMANCE ANALYSIS

This section is central to our report. It presents a model of licensee structure and operation and describes how we use that model to analyze the patterns of a licensee's performance. We discuss in detail the types of data available, and how our methodology uses the data. There is a brief discussion of how performance analysis may be related to the performance appraisal team program. The section concludes with a determination of the licensee classes for which performance analysis is feasible.

3.1 GENERAL CRITERIA

When this study was first planned, before any analysis method had been developed, we felt that any approach to analyzing licensee performance must satisfy certain key criteria in order to be both practical - meaning that it can be readily implemented and that the results can be easily interpreted - and useful - meaning that the results will support NRC's safety-related mission. These criteria are:

Practicality

- The methodology should use available data where possible and should permit other data to be readily obtained.
- The methodology should be easy to apply.
- The methodology should be free from ambiguity, both in using data and in interpreting results.
- The methodology should use data that are related to or reflect safety factors.
- The methodology should not strain NRC's resources.

Usefulness

- The methodology should produce results that permit both absolute and relative analysis.

* The methodology should permit improvement - for both the licensee and NRC - to be assessed from one analysis to the next.

* The methodology should reveal patterns of compliance and non-compliance.

The criteria for practicality generally concern whether a method is feasible to use. But as this study proceeded, it became clear that the results of the analyses will be released in some form to the public; feasibility must also consider whether the analysis method is acceptable to the nuclear industry and to intervenors. A licensee analysis methodology may be highly useful to the NRC, but if it is inherently unacceptable to major interest groups, NRC's credibility as an objective agency will be impaired and any benefit of applying the methodology might well be outweighed by adverse public reaction. Potential public reaction was one of several factors that led us to adopt an approach geared to licensee structure and operation. This method permits licensees in a given class to be compared on the basis of "better" or "worse," but it is not designed to provide relative numerical ratings.

3.2 THE FPM MODEL

Performance is fundamentally grounded in the structure and operation of the licensee. We developed a licensee model to distinguish between "good" and "poor" performers and to gain insight into why one licensee differs from another. The structure of this licensee performance analysis model - the FPM model - is comprehensive and applies to the most complex category of NRC licensees, the operating power reactors. It can be modified to apply to other licensee classes as discussed in Section 3.4.1.

The conceptual design of the FPM model meets the general criteria for practicality and usefulness outlined in Section 3.1. The FPM model offers a reliable presentation of the licensee's performance pattern and an understanding of why this pattern has assumed its particular form. Understanding why provides insight into the causal factors underlying the performance of a given licensee and, when used on a comparative basis, identifies the reasons for performance differences among licensees in the same category. In addition, the FPM model shows licensee performance over time for two reasons: (1) the temporal relationships among events, inspection findings, and licensee responses provide significant insights into the nature and quality of licensee performance,* and (2) licensee performance is a potentially dynamic function that may improve or deteriorate with time.

FPM Model Structure

The model explicitly differentiates between two sets of parameters:

- Intrafacility relationships and interactions, such as those between management** and personnel.** These are critical determinants of licensee performance.

- External indicators of performance quality, such as inspector-reported noncompliances, other inspection findings, and LERs.

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*In many instances, the meaning of certain patterns in these relationships may become clear only when viewed over an appreciable interval, such as year or two. We use a two year period in this analysis. But the model must also be sensitive to abrupt changes in the licensee's operation that may have significant implications.

**These terms, as employed in the model, have been assigned specific meanings that are defined later.

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, we recognize that 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.

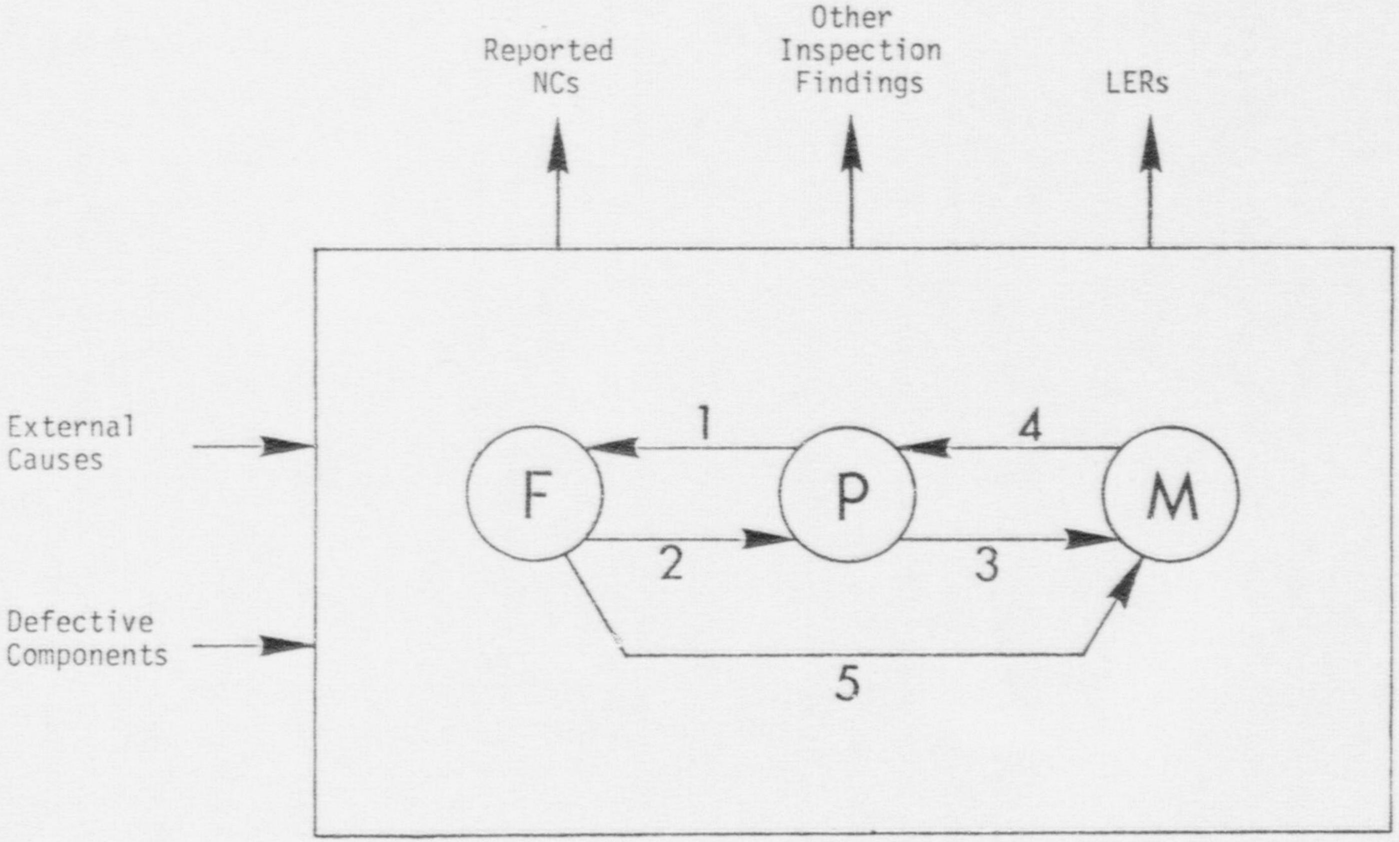

FIGURE 1
The FPM Model

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.

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 represent 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. Our structural model is essentially simple; but a great deal of information about licensee performance is represented by the arrows themselves. A more detailed discussion of the interrelationships will help to understand the detail they can contribute to the analysis of performance.

Arrow 1

This arrow represents all the "hands on" activities that personnel perform in their operation of the facility. It includes both routine and nonroutine actions. These actions may be triggered by information and data that come from the facility via Arrow 2 or by directives to personnel from management via Arrow 4.

Arrow 2

Because it represents all information that the facility transmits to personnel, this arrow symbolizes routine data and also unscheduled or undesirable events or conditions. These non-routine events may reflect spontaneous failure within the facility, but they may also result from improper personnel action or the absence of appropriate action transmitted via Arrow 1. These two types of events directly represent the NRC LER Proximate Cause Code Categories of "component failure" and "personnel error."

Arrow 3

Arrow 3 represents the flow of information from personnel to management. Much of this information relates to the state of the facility as originally transmitted via Arrow 2. In addition to providing an information transfer route to management, Arrow 3 is also the channel through which personnel seek information from management.

Arrow 4

This information flow channel from management to personnel carries several types of communication, including written and verbal expressions of policy, intangible expressions of management attitudes, descriptions of administrative practice and procedure, and facility operating and other instructions. Arrow 4 also permits management to question personnel about the facility.

Arrow 5

This arrow carries facility information and data directly to management. In general, the information transmitted via Arrow 5 is included in the information carried by Arrows 2 and 3; Arrow 5 represents the independent check that management should have on the operation of the facility. It also reflects the awareness that good management should have. For example, management will sometimes observe significant facility operating indications that personnel has overlooked. Conversely, management may overlook those indications in some cases.

Using the FPM Model

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.

In most instances, the primary cause of a performance defect or deficiency can be assigned to one of the FPM circles, although it may first appear as an incorrect or missing component of the information flow along one of the arrows. Suppose, for example, that management had developed an incomplete or erroneous procedural plan for some operation and that this plan was transmitted to personnel via Arrow 4. Examining the plan as a component of the total information flow proceeding along Arrow 4 would immediately identify management error as the primary cause of whatever consequences stemmed from the use of the defective procedure. As another example, assume that personnel has transmitted to management (via Arrow 3) some significant information about facility operation that requires immediate management decision and response. The delay time, as measured by the interval between the transmittal via Arrow 3 and the management response via Arrow 4, as well as the appropriateness and adequacy of the response, provide an indication of management performance in this particular situation.

Unfortunately, complete and detailed internal information and data are generally not available to those outside the rectangle in the FPM model diagram (to NRC, for example); a reliable assessment of licensee performance cannot currently be made on the basis of these alone.* Because of this, performance analysis must depend, at least at present, on indicators that are external to the rectangle in the FPM model diagram, such as LERs, reported noncompliances and other accessible data. Other approaches to licensee performance analysis have stressed numerical counts of these indicators

*During the inspection process, some degree of awareness and understanding of this type of information may be acquired by observation. When the resident inspection program is established and operating, it is very likely that the inspectors will gain more insight into licensee performance in terms of the internal structure of the FPM model through more continuous exposure to the facility and its staff.

over defined periods of time. The FPM methodology emphasizes analyzing the <u>content</u> of LERs and noncompliance reports. When keyed to the integral 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. We have presented the analytic results in a graphic form that permits immediate visual comparison of licensee performance patterns. The differences between the profiles of "good" performers and "poor" performers are clearly evident.

How we use the available data and analyze licensee performance are discussed in the next section. But we should note here that we have not used the severity of reported events and noncompliances in this evaluation. The discussion (in Section 2.5) of the statistical methodology developed within NRC pointed out the difficulty of finding a widely-acceptable weighting scheme, and we have chosen to weight violations, infractions, and deficiencies equally for the sake of simplicity in devising and initially testing the FPM methodology. This equal weighting is consistent with the fact that numbers of events or noncompliances are not central to the FPM approach.

While the numbers and magnitudes of events and noncompliances play no role in this analysis, we place considerable emphasis on the <u>patterns</u> 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 the limited number of case studies we have performed, 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.

The design concept of the FPM model guided the analysis of the external data; this analysis preceded the construction of the graphic performance patterns. The FPM model also aids in understanding the implications of the performance patterns, once these patterns have been developed. The next section of this report details the procedures we used to analyze the external data (LERs and noncompliances), to construct the graphic performance patterns, and to interpret those patterns.

The decision to portray the results of licensee performance analysis through graphic patterns, rather than to attempt statistical manipulations of these results, was made soon after the model concept was first developed. We referred the question of graphic or statistical display to our consultant statistician before making a final decision. His view was 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. He felt that statistical treatment would tend to blur causal relationships that could be readily inferred from graphic displays. Furhter, the perceptions of NRC, licensees, and intervenors, discussed in Section 2.3, made it clear that ranking of licensees, made easier by numerical results, could threaten the acceptability of licensee performance analysis.

3.3 AVAILABLE DATA AND ITS USE

This section describes the data available for performance evaluation and how two kinds of data are used in the FPM methodology. First, we summarize the major types of data, the extent to which they are potentially available for each class of licensees, and the reasons for choosing LER and noncompliance data for use with the FPM model. Then, the type and extent of data contained in the LER file is discussed, followed by a thorough description of how we use LER data in licensee performance analysis. Noncompliance data is treated in a similar fashion. Potential problems in using each type of data are discussed where appropriate.

The three case studies on which we tested the FPM performance analysis methodology are contained in Appendix A, but the introduction and conclusions drawn from the case studies are presented in this section to show the type of performance analysis produced by the FPM methodology. The section concludes with a brief discussion of the potential relationship of licensee performance analysis and NRC's Performance Appraisal Team.

3.3.1 Why Licensee Event Reports (LERs) and Noncompliances were Selected for Use in the FPM Model

Data describing the information that flows along the arrows of the FPM model are not readily available. But the NRC collects and makes available a variety of external data on its licensees. Occupational exposures, effluent releases, inspection findings, and events falling outside technical specifications are reported to NRC; Table 1 summarizes the type of data collected for each class of licensee.

Data on licensee events and on inspection findings in the form of noncompliances* are available in either written or computerized form for all classes of licensees. Effluent release and occupational exposure data are less widely available and in most cases are dupliacted in licensee event information. Thus, we believe that the information on noncompliances and licensee events is most useful in analyzing the performance of NRC's licensees, especially since this information covers a broad spectrum of licensee activities. Even more importnat, these data are computerized for three of the four major classes of licensees, an essential aid when analyzing substantial amounts of information for a sizable number of licensees. Computerization also places the data in a standard format, an advantage for ready comparison, and an evaluation methodology that can to some extent be computerized provides an element of uniformity in an evaluation process that must be sensitive to individual differences.

*As discussed in Section 3.2, we have weighted violations, infractions, and deficiencies equally. The term "noncompliance" covers all three categories.

TABLE 1

DATA COLLECTED FOR EACH LICENSEE CLASS

	Non-Compliance Data	Licensee Event Data	Effluent Release Data	Occupational Exposure Data
POWER REACTORS				
Construction	766 file	region; some in LER file		
Operation	766 file	LER file	HQ (file)	REIRS file
TEST & RESEARCH REACTORS	766 file	LER file	HQ (written)	REIRS file
FUEL FACILITIES	766 file	LER file		REIRS file
MATERIALS LICENSEES				
Special Nuclear Materials	766 file	region*		
Manufacturing & Distribution	766 file	region		REIRS file
Radiography	766 file	region		REIRS file
Waste Disposal & Collection	766 file	region		
Industrial	766 file	region		
Academic	766 file	region		
Medical	766 file	region		
Environmental	766 file	region		
Source Material Operations	766 file	region		
Shipping Casks & Transportation	766 file	region		
All Other	766 file	region		

*Not required to report to the Office of Management Information and Program Control (OMIPC); may be in LER file if the region sends report to OMIPC. This note applies to all materials licensees.

3.3.2 Licensee Event Reports (LERs)

3.3.2.1 Type and Extent of LER Data

Each licensee is required by law to report actual happenings that fall outside the bounds of his applicable technical specifications and license conditions. Since the summer of 1973, information extracted from these reports has been gathered in a computerized file of information known as the Licensee Event Report (LER) file, maintained by the Office of Management Information and Program Control (OMIPC). Operating power reactors and other production and utilization facilities report events directly to OMIPC, using an LER form. Other classes of licensees (including reactors under construction) report to the regional offices, which may or may not send the reports to OMIPC for coding and entry into the computer. The file is designed to accommodate events reported by <u>all</u> licensees, but the file currently contains data primarily submitted by power reactors since the beginning of 1969: for 1976 and 1977, only 137 LERs are in the file for the 93 test and research reactors, the 38 fuel facilities, and the more than 9,600 materials licensees; 78 construction deficiency reports are included for 28 construction sites in the same time period.

Instructions for completing the LER form were updated in July 1977, mainly to improve the specificity of information provided and to add new information on the licensee's reaction to an event. The LER form is shown in Figure 2. The 1977 revision added a cause subcode (item 13) and subcodes for components and valves (items 15 and 16). Codes were added to describe action taken immediately and in the future (items 18 and 19), the effect on the plant, the method used to shut down the plant (if required), and the length of time the plant was shut down (items 20, 21, and 22). A code was provided to indicate whether the event was publicized, together with a brief description of the event (items 44 and 45).* Little of the data now in the file is in this new format, since most licensees began using the new form at the beginning of 1978. But the new cause subcodes and the codes for action taken and planned will soon make it possible to sort the file more easily for data of particular interest, since it is relatively easy to sort a data file on a coded field.

LER Data Elements Used in Licensee Performance Analysis

Three major types of data elements now in the LER file contribute to the analysis of a licensee's (or a group of licensees') performance. First, and most basic, is information that identifies a licensee. Referring to the LER form in Figure 2, a licensee can be identified by code (item 2), by license type (item 4) or by docket number (item 7). The information provided by docket number and licensee code is duplicative; either can conveniently be used as the key element when searching the LER file for events pertaining to a particular licensee. License type is potentially useful in extracting data for a group of licensees for aggregate rather than individual evaluation.

The second set of data elements describes the event, an actual occurrence that results in activity outside the bounds set by license conditions and technical specifications. The event date (item 8) places the event in its chronological order in the eventual profile of licensee activities. The system code (item 11) identifies the system in which the event

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*This revision also deleted a coded block used to identify whether an event was a "violation." The term "violation" was not specifically defined, and received varying interpretations by licensees. A licensee-reported noncompliance was not entered in the 766 file after October of 1977. Since our study period was 1976-1977, most licensee-reported noncompliances are included.

NRC FORM 366
(7-77)

U. S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT

CONTROL BLOCK: (1) 1 – 6

(PLEASE PRINT OR TYPE ALL REQUIRED INFORMATION)

0 1 | 7 8 | 9 LICENSEE CODE 14 (2) | 15 LICENSE NUMBER 25 (3) | 26 LICENSE TYPE 30 (4) | 57 CAT 58 (5)

CON'T

0 1 | 7 8 | REPORT SOURCE 60 (6) | 61 DOCKET NUMBER 68 (7) | 69 EVENT DATE 74 (8) | 75 REPORT DATE 80 (9)

EVENT DESCRIPTION AND PROBABLE CONSEQUENCES (10)

0 2

0 3

0 4

0 5

0 6

0 7

0 8

7 8 9 80

0 9 | 7 8 | SYSTEM CODE 9 10 (11) | CAUSE CODE 11 (12) | CAUSE SUBCODE 12 (13) | COMPONENT CODE 13 18 (14) | COMP. SUBCODE 19 (15) | VALVE SUBCODE 20 (16)

(17) LER/RO REPORT NUMBER | EVENT YEAR 21 22 | — 23 | SEQUENTIAL REPORT NO. 24 26 | / 27 | OCCURRENCE CODE 28 29 | REPORT TYPE 30 | — 31 | REVISION NO. 32

ACTION TAKEN 33 (18) | FUTURE ACTION 34 (19) | EFFECT ON PLANT 35 (20) | SHUTDOWN METHOD 36 (21) | HOURS 37 40 (22) | ATTACHMENT SUBMITTED 41 (23) | NPRD-4 FORM SUB. 42 (24) | PRIME COMP. SUPPLIER 43 (25) | COMPONENT MANUFACTURER 44 47 (26)

CAUSE DESCRIPTION AND CORRECTIVE ACTIONS (27)

1 0

1 1

1 2

1 3

1 4

7 8 9 80

1 5 | 7 8 | FACILITY STATUS 9 (28) | % POWER 10 12 (29) | OTHER STATUS 13 44 (30) | METHOD OF DISCOVERY 45 (31) | DISCOVERY DESCRIPTION 46 80 (32)

1 6 | 7 8 | ACTIVITY RELEASED 9 (33) | CONTENT OF RELEASE 10 (34) | AMOUNT OF ACTIVITY 11 44 (35) | LOCATION OF RELEASE 45 80 (36)

PERSONNEL EXPOSURES

1 7 | 7 8 | NUMBER 9 11 (37) | TYPE 12 (38) | DESCRIPTION 13 80 (39)

PERSONNEL INJURIES

1 8 | 7 8 | NUMBER 9 11 (40) | DESCRIPTION 12 80 (41)

LOSS OF OR DAMAGE TO FACILITY (43)

1 9 | 7 8 | TYPE 9 (42) | DESCRIPTION 10 80

PUBLICITY

2 0 | 7 8 | ISSUED 9 (44) | DESCRIPTION 10 68 (45) | NRC USE ONLY 69 80

NAME OF PREPARER ______________________ PHONE: ______________________

FIGURE 2

LER Form

occurred.* Seventy system codes are provided for reactors, as well as a code for "other systems" and a code for use when an event is not system-related. The system codes are the first two letters of the Nuclear Plant Reliability Data System codes, providing a potential linkage between this system and the LER file.

Content of LERs - not their potential consequences or quality - is of major importance in revealing licensee action and attitude. Item 10 on the LER form is a 504-character field containing a description of the event. This description includes the activity in progress when the event occurred, the circumstances leading to the event, the event itself in terms of which technical specification or license requirement was not met, any significant occurrences resulting from the event, and a further discussion of related or similar events if applicable. Only the concise 504-character description is entered in the computer, but more complete descriptions may be attached to the form and are available at OMIPC. Since data can be retrieved from the LER field by word search, only generally accepted terminology, abbreviations, and acronyms should be used. Where possible, an even greater degree of standardized wording will in the future make similar events easier to identify through a word search of the descriptive field.

The LER file also provides information on the cause of the event. The proximate cause code (item 12), the cause subcode (item 13), and a 360-character field (item 27) in which the cause and corrective action taken are described provide the major portion of the data for analysis of the cause of an event. Six cause codes are provided, covering (1) personnel error, (2) design, manufacturing, construction/installation, (3) external causes, (4) defective procedures, (5) component failure, and (6) other

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*In any facility, systems are the common point of origin of events. Events in the same system may have a common cause. Causally-linked groups of events and repeated events are important elements in a licensee's performance pattern. Section 3.3.2.2 discusses these points more fully.

causes, for use when no other category is applicable or the cause cannot be determined. The cause subcode defines the cause more specifically when the proximate cause of the event is personnel error; design, manufacturing, construction/installation; or component failure. The cause subcode is a new item and little of the existing file data includes it, but it should substantially improve the ease of searching the file for events with particular stated causes.

The descriptive field (item 27) is essential to determining the actual cause of an event. The description includes the root cause of the problem, if known, expanded information on the personnel or components involved, and the immediate action taken and action planned to prevent recurrence. If a licensee cannot immediately determine the cause of an event, the description so states and the licensee must file an updated LER when the information becomes available. Attachments may be submitted for the physical LER file, but only 360 characters can be entered into the computer. As with the event description, more and improved information could be gained from a word search if wording were standardized.

Two new items will permit information on action taken and future action planned to prevent recurrence to be obtained more easily. Items 18 and 19 provide coded fields for this information, which must now be extracted from the cause description. The description must expand upon the information in the coded fields; the coded fields will not lessen the usefulness of the descriptive field.

Codes for the component, its supplier, and its manufacturer (items 14, 15, 16, 25, and 26), while not an essential part of the data needed for performance evaluation, make it possible to use the LERs for a far-flung statistical evaluation of components, manufacturers, and vendors.

Area of Concern: Quality of LER Data

The amount of data in the LER file for most operating power reactors is certainly sufficient for use in evaluating their performance. Other classes of licensees are substantially less well represented: as mentioned earlier, only 137 LERs are in the file for test and research reactors, fuel facilities, and materials licensees for 1976 and 1977. The quality of the data and people's perception of both the quality and the quantity deserve some comment.

Quality has two aspects: how well the data in the LER file matches the written LERs (data "goodness") and how well events are reported by the licensee. Two mechanisms are used to assure that the data are "good." First, OMIPC personnel check each licensee-coded LER form against the written description that accompanies practically all LERs (only very minor events that can be completely described in the descriptive fields need not be accompanied by a description). This check ensures that all required data are on the LER form, that there is a reasonable match between the attached description and the concise description in the LER form, and that there are no obvious errors, such as stating that the event occurred after the date of the report. The OMIPC staff generally does not question the coding of causes or the licensee responses because it lacks the technical expertise to do so. (The regional office sometimes does "change" the cause coding for its own use in focusing its inspection effort for a particular licensee; these "changes" in no way affect the data in the LER file.) This procedure is repeated as a manual "audit" after the data is keypunched but before the file is updated.

The second measure that assures "good" data is a mechanized edit check, which duplicates to some extent the check performed by OMIPC personnel and also catches keypunch errors. The LER check program has two levels. The simplest and first check is for the presence of the correct type of data: is there an entry in all required places and is it of the correct form (alpha or numeric). Next a check is made to see if the data entered are internally consistent (if item A is present, then item B must be present).* Only then is the file actually updated to include the new entry.

The second aspect of quality involves how the licensees report events, both in accuracy and quantity. NRC personnel feel that licensee reporting of events is not "uniform." One feeling is that some personnel errors are reported as component failures, because component failure "looks better" - is somehow more acceptable from the point of view of competency - than personnel error. We believe that repeated or similar events reasonably related in time may indicate either the failure of personnel to follow the established procedures, the absence of those procedures, or that plant management's QA program permitted the installation of inadequate components in the first place. The FPM model's stress on the content and common origin of events eliminates the problem of reporting personnel and management error as component failure.

Area of Concern: Differing Technical Specifications

Some NRC personnel also feel that certain licensees report more events than do others because their technical specifications are more numerous or more stringent. This quantitative difference is sometimes cited as a reason for discounting the information present in the LERs. Technical specifications do differ from one licensee to the next, and by type and age of plant. In general, failure to either follow procedures or to establish proper procedures as required by the technical specifications will result in their violation. But since we analyze the content of LERs, rather than counting them, this issue pales. First, violations of the technical specifications and license conditions are to be reported rather than compliance with them - a factor that reduces numerical difference rather than exaggerating it. Stringency and quantity of technical specifications have changed, but at

*A complete edit check includes a third level, in which the new entry is matched against the previous file entry to assure that the new entry is consistent with the other data in the file (for example, the date of the newest entry must be later than the date of the previous entry). The nature of the LER data makes this third check unnecessary.

each point in time, an applicant engaged in the NRC licensing process must be able to operate within the bounds of those specifications. And a licensee who does not report events that occur has violated the terms and conditions under which he received his license, and is highly likely to be reprimanded by NRC.

Three features of the case studies were directed toward evaluating the sensitivity of the FPM methodology to differences in licensee reporting and differences in technical specifications. First, we selected two similar facilities (Prairie Island Unit 1 and Zion Unit 1) with similar technical specifications as verified by the NRC regional management and one facility with less stringent technical specifications (Point Beach Unit 1).

Second, when we reviewed inspection reports associated with items of non-compliance identified in the 766 File, we noted the number of LERs reviewed by the inspector and whether the inspector agreed with the adequacy of the licensee's reporting of each LER. This established the quality of the reported LER data. Review of the data for the three cases studied indicated that for the "good" performers (Point Beach Unit 1 and Prairie Island Unit 1), there was nearly total agreement by the inspectors on the adequacy and completeness of LER reporting; for Zion Unit 1, a "poorer" performer, the inspectors agreed with the reporting of LERs 88 percent of the time. This information leads us to believe that the LER data is a reasonable reflection of what is actually happening in the facility for both "good" and "poor" performers.

Finally, in order to evaluate the impact of differences in technical specifications on reporting, we identified those LERs due to violations of technical specifications and calculated the proportion of these to total LERs. Table 2 presents this information for the three case studies performed thus far. We did not include LERs that report violation of environmental technical specification limits for two reasons:

Table 2

LERs Due to Violation of Technical Specifications

	Point Beach Unit 1	Prairie Island Unit 1	Zion Unit 1
Total LERs(1)	26	53	128
Total LERs due to violation of technical specifications(1)	4	7	19
Percent of LERs due to technical specification violations	15%	11%	15%

Note

(1) Not including LERs due to violation of environmental technical specifications.

- Violations of environmental technical specifications were due in part to seasonal variations in weather and to fish migrating 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.

Table 2 shows that the percentage of LERs due to violation of technical specifications for the case studies is relatively constant for both "good" and "poor" performers and for both "stringent" technical specifications and "looser" ones.

Technical specifications represent the limiting conditions in the proper performance of existing procedures. The existence of the technical specifications may influence the character of the procedure and may even require more procedures. However, it appears with few exceptions that the differences in stringency of technical specifications do not provide an obstacle to meaningful comparison of the performance of licensees. In fact, our work to date suggests that these differences are far less important than how well different licensees actually implement procedures necessary to meet specification requirements. Effective implementation appears to be less influenced by technical specification stringency than by management's motivation.

Area of Concern: Licensee Attitudes Toward LER Reporting

A factor of which both NRC and licensees are aware is the 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 clearly must be reported. There appear to be three "areas" of events - clearly reportable, clearly unreportable, and a middle "grey area." It is this "grey area" that reflects attitude differences among licensees. Those with a good corporate attitude, who are cooperative toward the NRC, and who have a systematic approach to detecting and identifying reportable occurrences, probably do file more LERs. But those same conversations with licensees lead us to believe that essentially all licensees report to the "baseline" of clearly reportable events; this category of events appears sufficient to form a solid base on which one licensee can be compared with another. As seen above, inspectors agree highly with licensees' reporting of events. Further, the content of LERs in the "grey area" often shows that immediate steps are taken to correct a problem, or that a number of the events are unrelated. In short, the content of LERs can reveal good management response; numbers of LERs are not a major factor.

Effect of the Resident Inspector Program on LERs

The presence of a resident inspector in a plant may affect the "grey are" in filing LERs, by providing the plant with immediate NRC feedback on whether an event is reportable or not. This may be bad rather than good for the purpose of evaluating licensee performance, because the LERs will begin to reflect the differences in inspector interpretation of events, rather than the licensee's interpretation. A fruitful source of information on the licensee's decision-making processes may be removed. On the positive side, LER reporting may become more "uniform," but only if a high degree of uniformity in interpreting event significance exists among the resident inspectors.

3.3.2.2 Use of Licensee Event Report Data in the FPM Model

For each case study, Teknekron reviewed the NRC Licensee Event Report file (the LER file) from the perspective of the FPM model described in Section 3.2. Using the FPM model places two essential requirements on collection and analysis of LER data:

- The FPM model yields patterns of performance over time, so the temporal relationship among events is important. Therefore each LER file event was identified, reviewed, and considered in the light of previous events. Our review of each event produced a data set that contained the event cause code and event date. As explained in Section 3.2, we did not categorize events by severity, because the analysis of each event focused on the action of the licensee rather than on the potential consequences of the event.

- The FPM model explicitly defines how performance responsibility is to be assigned to Facility, Personnel, or Management. It can also relate these elements to each other through the content of the FPM "arrows." The "Proximate Cause Code" definitions used in the LER file are not clear or detailed enough to match the cause codes with the content of the FPM "arrows," but we were able to establish a parallelism between the major FPM model elements and the existing LER file "Proximate Cause Code" definitions.

These requirements, together with guidance implicit in the FPM "arrows," provided the basis for our review of the LER file for each case study. Our use of the LER data involved two processes: first, an organization and translation process to bring the LER data into the FPM data domain, and second, the analysis of that FPM data domain to reveal patterns of performance.

Creating the FPM Data Domain

As stated earlier, the relationship of events in time can provide insight into the nature and quality of licensee performance. Thus, one critical element is the date of each event, and our initial step was to review each event in chronological order.

The FPM model also allows the primary cause of a performance defect or deficiency to be assigned to one of the FPM elements. When a licensee reports an event, he assigns a "Proximate Cause Code" in accordance with NUREG-0161. To use LER data in the FPM methodology, we developed a set of event cause codes directly related to the definitions associated with the FPM model elements (management, personnel, and facility) and then identified their parallels with the Proximate Cause Codes. We have called our codes "Event Responsibility Codes" (ERCs); their definitions, together with the parallel Proximate Cause Codes, are shown in Table 3. The ERC code for each event was derived by converting the LER Proximate Cause Code on the basis of the parallelisms shown in Table 3.

Because the LERs represent real events, the recorded ERCs are linked to particular, real situations. In order to gain a comprehensive and insightful view of the licensee's response to situations and to determine patterns in this response, events must be reviewed in the light of their common point of origin. The common point of origin of events within a licensed facility is at the facility system level, and event report data are coded into the LER file by system, subsystem, and component. Our third step was therefore to organize the Teknekron Event File by system.

This rationale is at the heart of the methodology for organizing the LER file data. In summary, all events in the NRC LER file are reorganized and reclassified by:

TABLE 3

LER PROXIMATE CAUSE CODES AND TEKNEKRON EVENT RESPONSIBILITY CODES

Proximate Cause Code	Definition	Definition	Event Responsibility Code
A	Defective Procedures	All actions falling within the purview of management responsibility, excluding "hands on" operation of the facility.	M
B	Personnel Error	All actions and responsibilities accruing to those with responsibility for "hands on" operation of the facility.	P
C	Component Failure	The failure of a component or system within the facility, not caused by personnel error in the maintenance or operation of the facility.	F
D	External Cause/Other	All events which are not related to a failure of management, personnel, or the random failure of a component. These events are unimportant to the Teknekron analysis and are grouped and designated as such.	O

- System: This establishes the common point of event origin within the facility and provides a sensitive parameter for the isolation of performance patterns.

- Chronological order of event occurrence: This permits the sequence of events over time to be examined. Such examination may show specific relationships among events (causal linkages).

- Teknekron "Event Responsibility Code": This allows a deficiency in performance to be assigned to one of the FPM model elements.

One the data are in this format, they have been transferred into the FPM data domain and are in a form that allows meaningful analysis and identification of performance patterns.

Analysis of the FPM Data Domain

To use existing LER data with the FPM model, the "Proximate Cause Code" assigned by the licensee to each event is subjected to a two-step transformation:

1) "Straight-across" conversion into an ERC, using Table 3 as previously discussed, and

2) In some cases, changing the initially assigned ERC (for example, from F to P), if the events are found to be causally linked after analyzing their relationship within the facility system.

We stated earlier that events were analyzed by system and in chronological order of occurrence. To identify event relationships, we compared each event in a system with previous events in that system, searching for these cues:

- the similarity of involved components

- the similarity of and relationship to subsystems, and

- the similarity of human response and involvement

If any of these cues was common to two events in a system, these events were considered to be causally linked. When we identified a second event as being causally linked to a prior event we always changed the Event Responsibility Code (ERC) for the subsequent event. In general, we changed the code of the second event in any causally linked group of events to ERC-M (management responsibility), on the basis that the repetition of an initially random event was due to a failure by management to <u>identify</u> and <u>rectify</u> the fundamental event cause and apply generically the lessons and information learned from the event.

We feel that use of the second event to establish the onset of causal linkage is justified, because it provides:

- conservatism--it is the earliest possible point for establishing systematic management deficiencies, and
- maximum sensitivity to detect the character of "good" and "poor" licensee performance--since an abrupt end to a series of causally linked events establishes positive licensee management performance.

It is possible that a licensee may react to a first event by recognizing that a design change or technical specification modification is required and by taking appropriate action. Under these conditions it would inappropriate to assign further events to ERC-M. In performing the e case studies (keeping in mind they were mature plants), we found that events for which either a design change or technical specification change was required to prevent recurrence were quite rare. We also found that when a design change was required, the licensee noted this information in the event report; the event report describing the need for the design change usually either marked the end or was the close to the end of a causally linked group of events.

Time is a dependent variable in our analysis, since the licensee's deficient performance determines the frequency of occurrence of the causally linked events, as well as the number of causally linked event groups that exist in any time period.

After analyzing the data for a particular system, using the cues of similar components, similar or related subsystems, and similar human involvement to search for linked events, those data may yield a pattern significantly different from the pattern formed when they were translated "straight across" into the FPM data domain. These differences are evident as:

- A marked increase of events coded ERC-M, which were initially classified as ERC-F.
- A marked increase of events coded ERC-M, which were initially classified as ERC-P.
- The identification of causally linked groups of events within systems in which codes ERC-F were changed to ERC-M.

The patterns that emerge from the analysis of the data permit inferential judgments of licensee performance. Conversely, the absence of these patterns is also an indicator of performance. The fact that the patterns of performance are manifested on a system basis is due to the structure of the analytical technique; these patterns should not be presumed to be absent from other areas of facility operation or licensee performance, and may also hold across systems, as well as within them.

Changing Codes and Identifying Causally Linked Groups of Events: Examples

To demonstrate analysis of the FPM data domain and how we used the previously mentioned cues to find causally linked events, we have provided excerpts from the case studies in Appendix A. The first set of causally linked events occurred in the "Containment Isolation System" of Zion Unit 1. When reviewing this excerpt, note the following:

1) The similarity of involved components--solenoid valves
2) The similarity of and relationship to subsystems--the failure of each valve is linked to the instrument air supply

3) The similarity of human response and involvement--the licensee identified the first event as being due to a valve stuck open by "crud and rust." The second and subsequent events were due to "impurities in the instrument air system" and "varnish buildup." One year after the first event--and six events later--the licensee stated that new equipment was being installed; however, it is not clear what the new equipment was, since there were two subsequent events.

The date of the causally linked events, together with the cause assigned by the licensee and Teknekron's ERC Code, are:

<u>Date (Licensee Code/ERC)</u>

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 cause 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.

All but the first event was upgraded from ERC-F to ERC-M, because the analysis of the first event (crud and rust causing the valve to stick) did not indicate that the licensee sought the broader implications of the specific event (possible contamination of the instrument air system) or considered generic remedies (cleaning impurities out of the instrument air system). These actions are the responsibility of management, as defined in the ERCs. Management's failure to thoroughly analyze the information gained in the first event and to conclude that an inspection should be performed to determine

1) if the cause of the crud and rust on a valve in the closed system was due to instrument air system impurities, and
2) the potential impact and implications of this event on other components in contact with the instrument air supply

probably contributed to the occurrence of subsequent events in the system, or at the very least did nothing to prevent them.

The preceeding example and discussion illustrate the use of cues in making code changes as well as establishing causal linkage among events. They also provide a first hand view of "poor" performance.

A second example will further illustrate code changes. The following set of events occurred in the "Reactor Containment System" of Prairie Island Unit 1 during 1976 and 1977. While several of the events are causally linked, the type of code changes are distinctly different from the previous example.

Date (Licensee Code/ERC)

5-04-76(P)

8-25-76(P/M)

10-23-76(P)

3-16-77(F)

9-29-77(P/M)

12-09-77(F)

On the basis of our review, events on 5-04-76 and 10-23-76 clearly are the result of isolated personnel error. But the events of 8-25-76(P/M) and 9-29-77(P/M) appear to be causally linked through apparent management failure to develop and implement administrative controls for the auxiliary building special ventilation 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.

The change of cause code from P to M in the case of the 8-25-76 event was made because the doors should have been under administrative control. The event reflected a defect in existing procedures for which management and not personnel are responsible, according to the ERC definitions. The 9-29-77 event was similar to the 8-25-76 event in that both involved a breach of ventilation zone integrity by personnel; however, the 9-29-77 event resulted from incomplete administrative control as stated by the licensee. 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 demonstration of how the facility management performs its role in responding to events.

Our last example demonstrates a case of licensee management response to an event in which the potential cues for causal linkage to subsequent events are nonexistent. The event occurred in the "Hangers, Supports, Shock

Suppressors" system* for Point Beach Unit 1. During refueling outage surveillance testing of safety-related shock suppressors (snubbers), a snubber failed to lock up when the specified load rate was applied. The licensee found that the control valve on the snubber was improperly set, and attributed the event to personnel (ERC-P). The licensee stated in the event report that similar snubber control valves were checked. There were not other events in this system category during the study period. This event demonstrates:

1) the licensee's awareness of the similarity of the components involved in this event to others in the facility
2) the licensee's determination to identify the generic event cause--in this case a highly specific personnel error
3) the licensee's response to the generic event cause, concern for the potential impact of the generic event cause on other plant systems, and willingness to apply a generic remedy to a potential cause of additional events.

Performance Profiles

The patterns of a licensee's performance can be graphically presented as profiles either showing events in a single system or all events attributable to human causes or to component failure. A profile of all events for the Containment Isolation System at Zion Unit 1 is shown in Figure 3 and a profile for the Reactor Containment System at Prairie Island Unit 1 in Figure 4. Time forms the x-axis; the Event Responsibility Codes are arranged on the y-axis so that ERC-M has the greatest ordinal value and ERC-O the least. Each event is recorded as a bar located on the x-axis at the time it occurred; the height of the bar corresponds to its final

*This is not a system code in the LER file, but the component subcode makes these events readily identifiable.

PROFILE OF TOTAL REPORTED EVENTS IN

CONTAINMENT ISOLATION SYSTEM

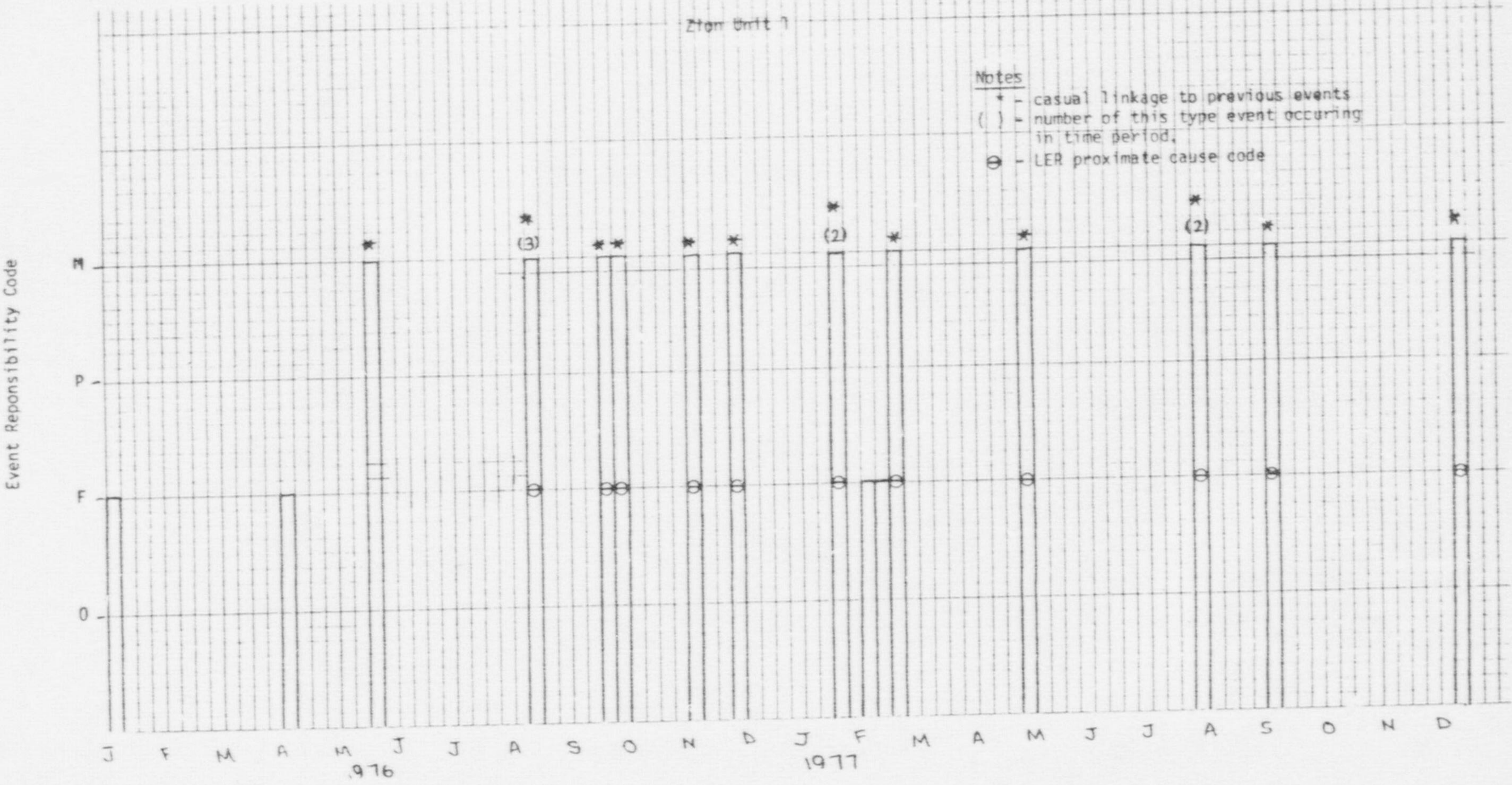
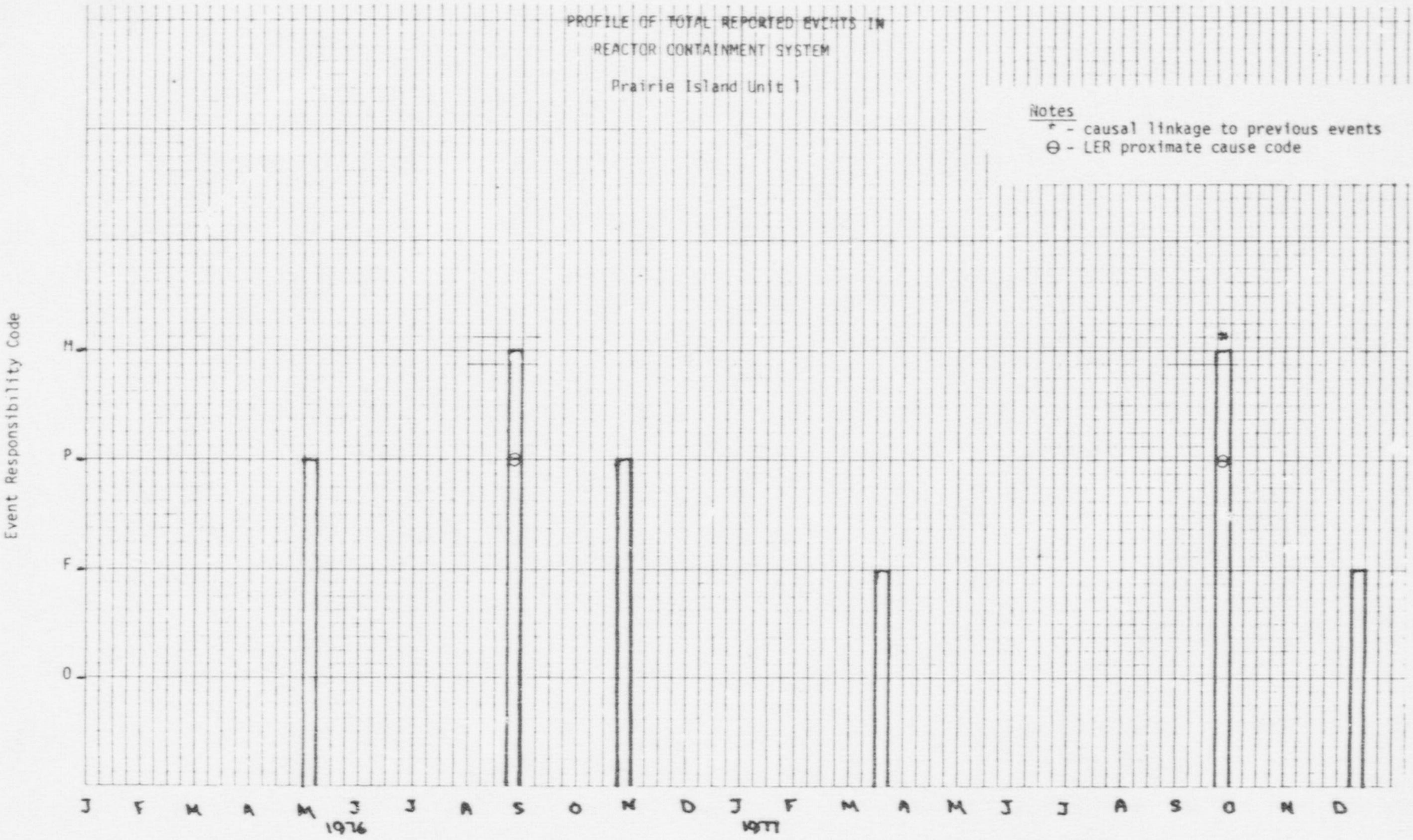


FIGURE 3



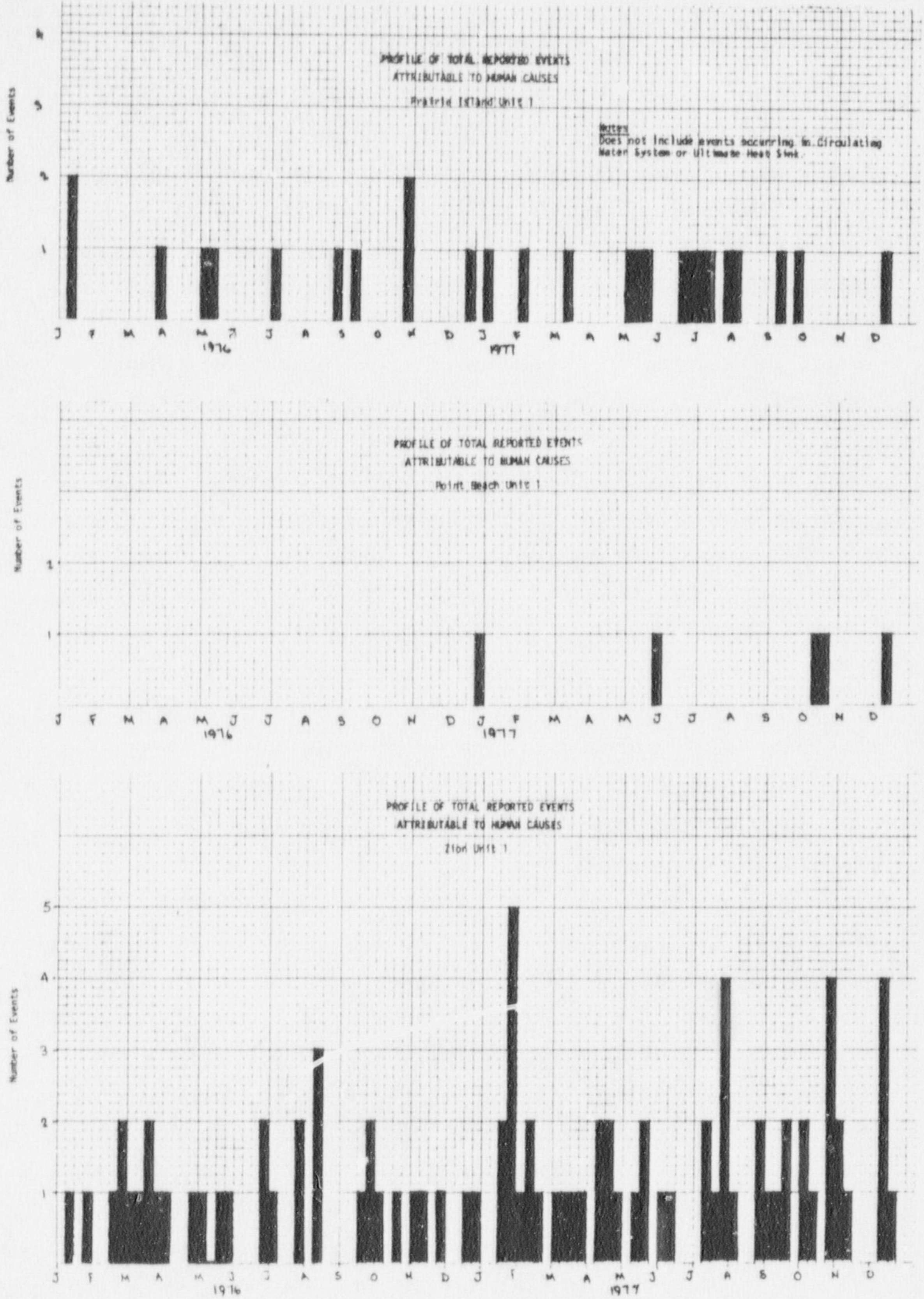
PROFILE OF TOTAL REPORTED EVENTS IN
REACTOR CONTAINMENT SYSTEM
Prairie Island Unit 1
Notes
* - causal linkage to previous events
Θ - LER proximate cause code
Event Responsibility Code
M
P
F
O
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
1976
1977

FIGURE 4

ERC. If our analysis required a change in ERC, the licensee's reported ERC for the event is noted by a "Θ" on the bar. The asterisk notation "*" above a bar indicates that the event is causally linked to a previous event. Note that any system profile may include several groups of causally linked events. We have not identified different groups of causally linked events on the graphic profiles, though this could be done; the total number of causally linked events occurring within a specific time period is a sensitive indicator of licensee performance because it appears to indicate a systematic breakdown in management control.

System profiles (except those that involve environmental technical specifications such as the Circulating Water System and in some cases the Ultimate Heat Sink System) can be combined to produce a profile of all the reported events that were attributable to human causes. Profiles of this type are shown in Figure 5 for Prairie Island Unit 1, Zion Unit 1 and Point Beach Unit 1. Time agin forms the x-axis, but in this case the y-axis represents numbers of events. For each point on the x-axis, the events in all systems with codes ERC-P and ERC-M are added; the total number determines the height of the bar. The ERC for each event in this aggregate presentation is the final or "upgraded" categorization of the event, not necessarily that reported by the licensee.

An aggregate profile of events attributable to component failure can be produced by summing all events ultimately classified as ERC-F for all facility systems. These profiles are shown in Figure 6 for Prairie Island Unit 1, Zion Unit 1, and Point Beach Unit 1. The information contained in these component future profiles appears to provide a less direct indication of licensee performance than profiles of events attributable to human causes, since the three profiles in Figure 6 bear far more similarity to each other than those in Figure 5, the "Profiles of Total Reported Events Attributable to Human Causes." We believe this indicates that genuine component failures are in large part random, since the major portion of those



FIGU.." 5

Comparison of LER Profiles

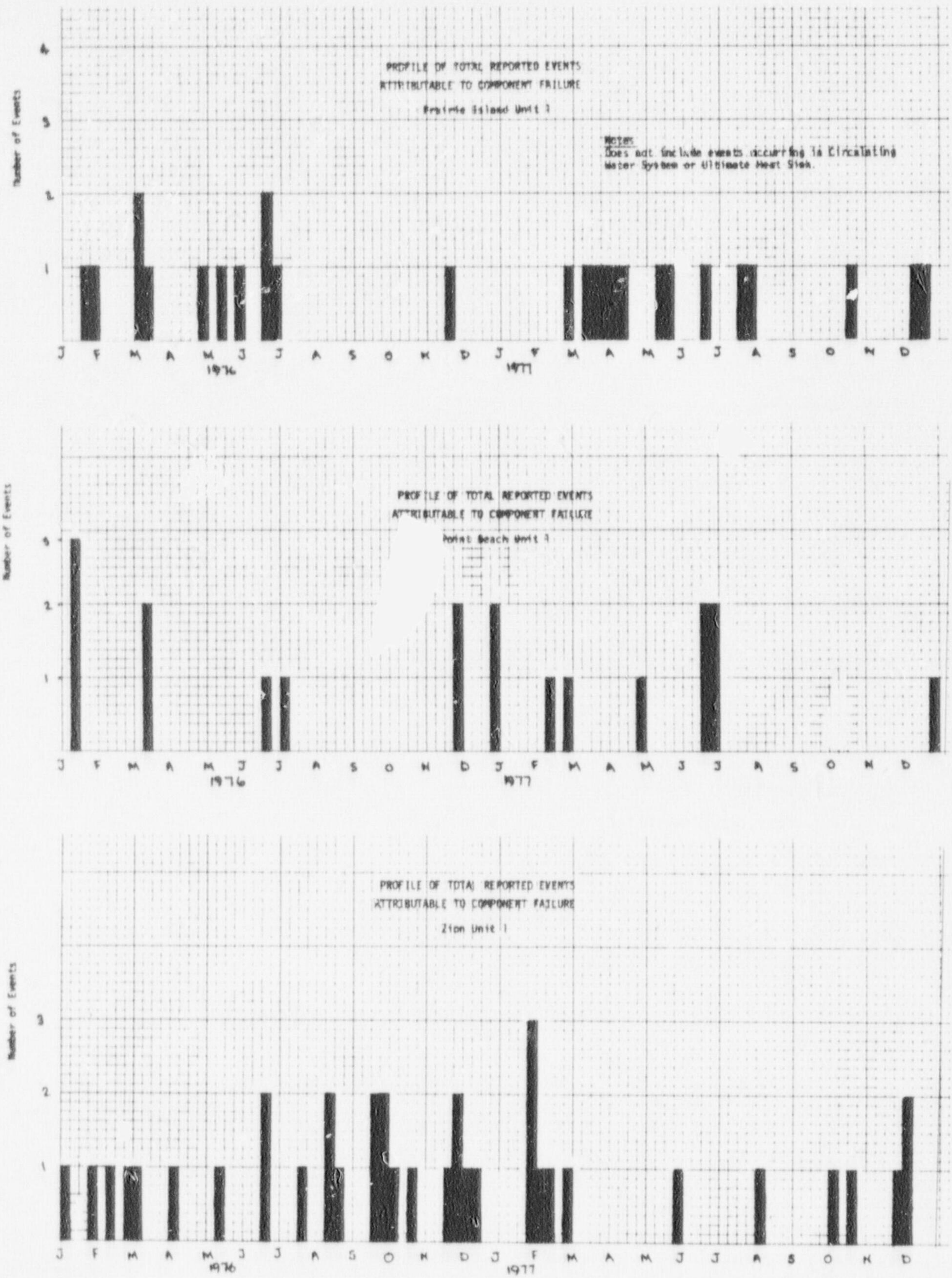


FIGURE 6

Comparison of Component Failure Profiles component failures that on analysis are due to systematic failures in human performance have been reclassified as ERC-P or ERC-M through identification of causal linkages.

We recommend that the reader review the detailed case studies presented in Appendix A for a fuller appreciation of differences in licensee performance as revealed in the LER data.

Available Licensee Performance Indicators

The previous discussion described how we analyzed the LER data, constructed profiles of events by system and, for total reported events attributable to human causes, identified patterns of deficient and adequate performance.

In one of the case studies, events occurred due to human failure that were serious from the regulatory point of view. This licensee also exhibited substantial numbers of causally linked events in several systems. It may be possible, after further case studies are complete, to say that patterns of poor performance precede the occurrence of events that NRC determines are serious enough to warrant citation.

Because these profiles are based on licensee response to actual events, we believe that these profiles are insightful and sensitive indicators of licensee performance. The performance evaluation for each licensee should include at least:

- A profile of total reported events attributable to human causes
- Profiles of those systems in which causally linked events are identified. For some licensees, a substantial number of systems may contain causally linked events, and it may be possible to construct profiles for only those systems NRC feels are most relevant to safety or that have substantial numbers of recent events.

3.3.3 Noncompliance Data

3.3.3.1 Type and Extent of Noncompliance Data

The NRC's modularized inspection program produces vast quantities of information. The 766 system is a computerized data file used to capture, maintain, and report statistical and planning data on inspection, investigation, inquiry and enforcement actions conducted by I&E.* The system provides input to the Rainbow Books, which summarize the operation of licensees and the actions taken by I&E. The 766 file accommodates inspection data on all classes of licensees, but as with the LER file, most data exist on the operating power reactors. For the calendar years 1976 and 1977, the file contains data from 1,997 inspection reports for the roughly 90 reactors under construction; 247 reports are included for 93 test and research reactors. In the same period, there are 995 inspection reports covering 38 fuel facilities, and 4,737 reports are shown for the roughly 9,600 materials licensees.

The 766 system is really a dual system. The 766 form, both sides of which are shown in Figure 7, records the management information needed to track the status of the inspection and enforcement program as applied to a particular licensee. The information contained on form 766-S, shown in Figure 8, is more valuable for licensee performance analysis. The information on the 766-S form is entered into a part of the system known as the "enforcement text file," a title that accurately reflects the major data field on the form. The computerized 766 file has existed in its present form since July of 1975. Instructions for completing the forms from which data are entered into the computer were revised in February of 1978, to account for the fees that are now being charged by NRC for routine inspections.

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*As of October, 1977, licensee-identified noncompliances are no longer entered in the 766 file. Such noncompliances have been included in the case studies because the study period included 1976 and 1977. But note that these self-reported noncompliances were largely treated as deviations, and seldom were assigned cause codes.

MC 0535

FORM NRC 766
OCTOBER 1977
(MC 0535)

UNITED STATES NUCLEAR REGULATORY COMMISSION
INSPECTION & ENFORCEMENT – STATISTICAL DATA

FACILITY NAME ______ INSPECTOR(S) ______ PRINCIPAL INSPECTOR ______
LICENSEE/VENDOR ______ REVIEWER ______

AE
- TRANS-ACTION TYPE 1 (CHECK ONE): ☐ Delete ☐ Insert ☐ Modify
- DOCKET NUMBER (A) 2 – 9
- OR LICENSE NO. (BY PRODUCT) 2 – 14
- REPORT NO (B) 15 – 18
- DATES INQ/INVEST/INSP FROM (C) 19 – 24 M M D D Y Y; TO (D) 25 – 30 M M D D Y Y
- REGION CONDUCTING ACTIVITY (E) 31

F INSPECTION PERFORMED BY: 32
1 ☐ REGIONAL OFFICE STAFF 2 ☐ RESIDENT INSPECTOR
3 ☐ PERFORMANCE APPRAISAL TEAM

G TYPE OF ACTIVITY CONDUCTED (CHECK ONE BOX ONLY) 33-34

INSPECTION
- 01 ☐ ROUTINE (FEE)
- 02 ☐ ROUTINE (NO FEE)
- 03 ☐ INCIDENT
- 04 ☐ ENFORCEMENT
- 05 ☐ MANAGEMENT AUDIT
- 06 ☐ MANAGEMENT VISIT
- 07 ☐ SPECIAL
- 08 ☐ VENDOR
- 09 ☐ MATL ACCT
- 10 ☐ PLANT SEC
- 11 ☐ INVENT. VERIF
- 12 ☐ SHIPMENT/EXPORT
- 13 ☐ IMPORT

OTHER
- 14 ☐ INQUIRY
- 15 ☐ INVESTIGATION (IF INVEST. ALSO CHECK BLOCK R)

H INSPECTION OR INVESTIGATION WARNING: 35 1 ☐ ANNOUNCED 2 ☐ UNANNOUNCED

I PRIMARY INSPECTION SHIFT: 36 1 ☐ DAY 8AM-4PM 2 ☐ EVENING 4PM-12 MIDNIGHT 3 ☐ NIGHT 12 MID-8 AM

J INSPECTION/INVESTIGATION NOTIFICATION (CHECK ONE BOX ONLY) 37
1 ☐ 591 2 ☐ REGIONAL OFFICE LETTER 3 ☐ REFERRED TO HQS FOR ACTION 4 ☐ REGION LETTER & HQS FOR ACTION

K INSPECTION/INVESTIGATION FINDINGS (CHECK ONE BOX ONLY) 38
1 ☐ CLEAR 2 ☐ NONCOMPLIANCE 3 ☐ DEVIATION 4 ☐ NONCOMPLIANCE & DEVIATION

L ENFORCEMENT CONFERENCE HELD: 1 ☐ 39

M NUMBER OF NONCOMPLIANCE ITEMS IN LETTER TO LICENSEE: 40 41

N NUMBER OF DEVIATION ITEMS IN LETTER TO LICENSEE: 42 43

NOTE: CHANGE MUST BE SUBMITTED ON 766 WHENEVER PREVIOUSLY CITED ITEM OF NONCOMPLIANCE IS OFFICIALLY DELETED FROM THE RECORD

O NUMBER OF LICENSEE IDENTIFIED ITEMS 44 45

P NUMBER OF LICENSEE EVENTS 46 47

Q REGIONAL OFFICE LETTER OR REPORT TRANSMITTAL DATE FOR INSPECTION OR INVESTIGATION
- 591 OR LETTER ISSUED TO LICENSEE 48 – 53 M M D D Y Y
- REPORT SENT TO HQS FOR ACTION 54 – 59 M M D D Y Y
- IMMEDIATE ACTION LETTER 60 DATE 65 M M D D Y Y

R SUBJECT OF INVESTIGATION (CHECK ONE BOX ONLY) 66-67

TYPE A 10 CFR 20.403 TYPE B
- 01 ☐ INTERNAL OVEREXPOSURE 06 ☐
- 02 ☐ EXTERNAL OVEREXPOSURE 07 ☐
- 03 ☐ RELEASE TO UNREST. AREA 08 ☐
- 04 ☐ LOSS OF FACILITY 09 ☐
- 05 ☐ PROPERTY DAMAGE 10 ☐

10 CFR 20.405
- 11 ☐ INT. OVEREXPOSURE
- 12 ☐ EXT. OVEREXPOSURE
- 13 ☐ EXCESS RAD. LEVELS
- 14 ☐ EXCESS CONC. LEVELS

MISC.
- 15 ☐ CRITICALITY
- 16 ☐ LOSS/THEFT
- 17 ☐ MUF
- 18 ☐ TRANSPORTATION
- 19 ☐ CONTAM/LEAKING SOURCE
- 20 ☐ ENVIRONMENTAL EVENT
- 21 ☐ EQUIP. FAILURE
- 22 ☐ ALLEGATION/COMPLAINT
- 23 ☐ PUBLIC INTEREST
- 24 ☐ SABOTAGE
- 25 ☐ ABNORMAL OCCUR
- 26 ☐ OTHER

HEADQUARTERS ENTRIES

S HQS ACTION ON INSP/INVEST REFERRED BY REGION: 68 69 (See Reference List for Code)

T DATE HQS ENFORCEMENT LETTER, NOTICE, ORDER ISSUED: 70 – 75 M M D D Y Y

U CIVIL PENALTY ISSUED: 1 ☐ 76

V DATE 766 ENTERED INTO COMPUTER FILE (MO/YR): 77 – 80 M M Y Y

NOTE: BLOCKS K TO O MUST BE VERIFIED BY IE:HQS WHENEVER ENTRIES ARE MADE IN BLOCKS S, T, AND U

AITS REFERENCE: ______

FIGURE 7

766 Form - Front Side

FORM NRC 766 — SIDE 2

USNRC — INSPECTION & ENFORCEMENT STATISTICAL DATA

NOTE: % COMPLETE AND STATUS; LEAVE BLANK FOR MC 92, 93 & 94 PROCEDURES AND 30-702, 30-703 & 30-800

NOTE: STATUS CODING;
BLANK - TO REMAIN OPEN
C- CLOSED
L- REOPEN & LEAVE OPEN
P- REOPEN THIS TRANSACTION ONLY

NOTE: MODULE REQUIRING FOLLOWUP; USE ONLY WHEN MODULE INSPECTED IS 92-701B.

			MODULE TRACKING INFORMATION											NONCOMPLIANCE										
			MODULE NO. INSP.				DIRECT INSP EFFORT MAN HRS EXPENDED THIS INSP.	% COMPLETE TO DATE	STATUS	MODULE REQ. FOLLOWUP				N/C		N/C		N/C		N/C		N/C		
			PHASE	MANUAL CHAP.	PROC. NO.	LEVEL				PHASE	MANUAL CHAP.	PROC. NO.	LEVEL	CODE	SEV	CODE	SEV	CODE	SEV	CODE	SEV	CODE	SEV	LINE REPLACEMENT CODE (R)
B		0																						
B		1																						
B		2																						
B		3																						
B		4																						
B		5																						
B		6																						
B		7																						
B		8																						
B		9																						
1	2	3	4			10	11 13	14 16	17	18			24	25 28		29 32		33 36		37 40		41 44		45

LINE COLUMN NUMBER SHOWN IN BOTTOM LINE

☐ CONTINUES ON SUBSEQUENT SHEET

FIGURE 7 (continued)
766 Form - Back Side

FORM NRC-766-S
OCTOBER 1977
(MC 0635)

UNITED STATES NUCLEAR REGULATORY COMMISSION

INSPECTION & ENFORCEMENT—STATISTICAL DATA SUPPLEMENT

GENERAL INSTRUCTIONS: BLOCK A MUST BE CHECKED TO SHOW TYPE OF INFORMATION CONTAINED ON THE FORM. ONE FORM IS TO BE COMPLETED FOR EACH
(A) ITEM OF NONCOMPLIANCE CITED.
(B) ITEM OF NONCOMPLIANCE NOT CITED, AND,
(C) DEVIATION CITED IN ENFORCEMENT CORRESPONDENCE

DOCKET NUMBER ____________ OR LICENSE NUMBER ____________ REPORT NUMBER ____________

[5] 1

A—TYPE OF FINDINGS (CHECK ONE BOX ONLY)
2 A ☐ NONCOMPLIANCE
B ☐ LICENSEE IDENTIFIED ITEMS
C ☐ DEVIATION

B—SPECIFIC N/C CODE OR DEVIATION (3–7) ☐☐☐☐☐ | CAUSE (8) ☐ | PROCEDURE (9) ☐ | SEVERITY (10) ☐ | FUNCTIONAL AREA (11 12) ☐☐

C—MODULE NUMBER (13–19) ☐☐☐☐☐☐☐

D—HOW ITEM IDENTIFIED (CHECK ONE BOX ONLY)
20 L ☐ LICENSEE
I ☐ INSPECTOR
O ☐ OTHER

E—CONSEQUENCES (CHECK ONE BOX ONLY)
21 A ☐ CAUSE OR CONSTITUTED ACTUAL OCCURRENCE
P ☐ HAD POTENTIAL TO RESULT IN ACTUAL OCCURRENCE
N ☐ DID NOT HAVE POTENTIAL TO RESULT IN ACTUAL OCCURRENCE

F—EXEMPT INFORMATION
22 S ☐ CHECK BOX IF EXEMPT INFORMATION IS INCLUDED IN TEXT BELOW, PER 10 CFR 2.790

G—ADDITIONAL UNITS (ENTER "M" IN FIRST BOX FOLLOWED BY OTHER UNIT NUMBERS) (23–26) ☐☐☐☐

H—NONCOMPLIANCE REPETITIVE OCCURRENCE (IF FIRST OCCURRENCE ENTER "1") (27) ☐

I—TEXT (ENTER UP TO 2400 CHARACTERS FOR EACH ITEM. IF THE TEXT OF THE NONCOMPLIANCE OR DEVIATION EXCEEDS THIS NUMBER, IT WILL BE NECESSARY TO PARAPHRASE)

1 ______________________________ 50
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
(↓)
(48)

ɓ	E	N	D	ɓ

1 … 5

NOTE: DATA ENTRY CLERK—THE LAST LINE ENTERED MUST CONTAIN THIS INFORMATION.

FIGURE 8

766S Form

Since this change does not affect the information now in the file, the description here is based on the forms and instructions effective November 1977.

The November 1977 revision made four changes in the 766 form. It identified which shift conducted the inspection (block I), whether an enforcement conference was held (block L), the date an immediate action letter was sent, if any (block Q), and who performed the inspection (the resident inspector, performance appraisal team, or regional office inspectors (block F). Changes in the 766-S form added the module number associated with the noncompliance or deviation (block C) and a block to record whether the noncompliance had occurred before (block H). This item is potentially very useful in analyzing performance since repetitions, particularly if closely linked in time or type, may have a common cause that the licensee has not adequately addressed. But its current usefulness is hampered by the lack of definition of "repeated noncompliance" and by the differences in individual inspector's knowledge of the compliance history of a particular plant.

766 Data Elements Used in Licensee Performance Analysis

We used three main types of 766 file data in licensee performance analysis. First, information that identifies a licensee is essential, and this role is played by the docket number that appears in block A on form 766. The license number that also appears in block A is potentially useful in extracting data on a group of licensees for aggregate rather than individual evaluation. Second, the date the inspection concluded (block D) places any noncompliance items in time. Last we used the Primary Cause of Violation code (block B on form 766-S). There are 18 noncompliance cause codes, covering various types of management, personnel, and equipment failure, and a few categories that cover situations that the licensee cannot control. On first reading, the codes seem fairly specific in attributing cause to certain types of breakdown in behavior--"inadequate plans or procedures" (code G); "safety devices not maintained" (code M)--but discussions with NRC personnel and staff revealed that most inspectors have "favorite" codes, and that each inspector does not use the codes in the same way. To make the current detail in the codes more useful, we need to know how inspectors <u>actually use</u> the codes and whether there are definable regional differences in their interpretation. This information can be obtained through a survey of inspectors, using sample "noncompliances" designed to test their responses.

The text in the 766-S file, while it provides a brief description of the noncompliances, often is so brief that it reveals little about the circumstances surrounding the noncompliance, making it difficult to analyze the licensee's behavior.

<u>Area of Concern: Quality of 766 Data</u>

Data quality has two parts, and the 766 system does well on one of those. The first part of data quality is "mechanical"--how accurately the data is entered into the computer and how well the file data matches the written inspection reports. Accurate entry is ensured by mechanized "edit checks" that have three parts. The simplest and first check is for the simple presence of the correct type of data: is there an entry in all required places and is it of the correct form (alpha or numeric). Next a check is made to see if the data entered are internally consistent (if item A is present, then item B must be present). The third check matches the new entry against the previous file entry to assure that the new entry is consistent with the other data in the file (for example, the date of the newest entry must be later than the date of the previous entry). After all three checks are complete, the file is actually updated to include the new entry.

An <u>audit</u> determines how well the data in the file matches the written inspection reports. Table 10 in the Quarterly Report for the quarter ending September 1977 displays the results of an audit conducted in that year. Our statistical consultant has reviewed the methodology on which we were told the table is based, and he states that the methodology is statistically correct. But the number of reports selected for sampling was apparently not determined by the methodology, though the chosen reports were selected randomly. Because the methodology was not completely followed, it is not clear that Table 10 reflects the quality of the data in the 766 file.

In the course of reviewing two calendar years of 766 file data for our three case studies, we performed our own "mini-audit" by reading every inspection report that was associated with a noncompliance and some reports that document inspector followup of LERs. Our limited check left us with two impressions. First, we feel confident that the superficial data match between the 766 file and the inspection reports is quite good, but the apparent match between elements of the 766 data themselves is much poorer.* The root of this problem appears to lie in the noncompliance cause codes or their use by the inspectors, and the fact that the text is often too brief. <u>If</u> the 766 file cause code parameters are unable to fully describe the situation <u>in any case</u>, then the potential usefulness of the file data is diminished. To be assured that the data on file accurately reflect the inspection reports, we feel a new audit is necessary, based on accepted and sound statistical methods. Coupled with the survey of inspectors mentioned earlier, this would provide a more solid basis for use of the 766 file data.

Our second impression is that the 766 file, especially the 766-S text, is often a pale reflection of the information in the inspection reports. The use of the cause codes sometimes depends on their interpretation by individual inspectors; the 766-S text is often too brief to provide an adequate

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*Our "mini-audits" are recorded in the matrices included in the case studies for each licensee. The results of analyzing the matrices are discussed in Section 3.3.3.2.

representation of the circumstances surrounding a noncompliance. These factors make it difficult to analyze the content of the 766 file data to the same degree possible with the LER file. To be sure, the inspection reports themselves could be used in analyzing performance, but to read every inspection report for at least two years for every licensee is a formidable task. Computerized data must be used whenever possible, and the usefulness of the 766 file for licensee performance analysis could be considerably enhanced by expansion of the text and better definition and use of the cause codes.

The second aspect of data quality concerns timing, and this difficulty cannot be alleviated by improving the data quality of the 766 file. While inspection reports were generally filed within a month of the inspection, the noncompliances cited in those reports often were related to events that occurred some time past. For example, assume that a new calibration procedure was issued several months ago. The licensee calibrated his instrumentation using the new procedure, except in one area. Thus, his failure may have occurred much earlier than its detection by the inspection program. This point is discussed more fully in the next section, but in general, we feel that the usefulness of inspector-generated data is limited by the lack of a close time relation between a real action and its report through the inspection process.

3.3.3.2 Use of the NRC 766 System Data and Related Inspection Reports in the FPM Model

For each case study, we reviewed the NRC 766 system data and related inspection reports from the perspective of the FPM model. The FPM model places two essential requirements on the analysis of the 766 system data:

- The FPM model yields patterns of performance over time, so the temporal relationship among events is important. We therefore considered the factors in the inspection program that control the pattern of the noncompliance items identified by an inspector as a function of time. We also considered the temporal relationship of the performance of citable actions by the licensee to the "real time" of their detection. As explained in Section 3.2, we did not categorize noncompliance items by severity.

- The FPM model explicitly defines how performance responsibility is to be assigned to Facility, Personnel, or Management. It can also relate these elements to each other through the content of the FPM "arrows." While the "Primary Cause of Violation" codes (noncompliance cause codes) are reasonably detailed, they are not defined or used precisely enough to match the cause codes with the content of the FPM arrows. But, we were able to establish a parallelism between the major FPM model elements and the noncompliance cause code definitions.

These requirements, together with guidance implicit in the FPM "arrows," provided the basis for our review of the 766 file for each case study. Our approach is initially parallel to our review of the LER data, but it ultimately diverges. The reason for that divergence lies in the structure of the inspection program.

Specific Considerations in the Development of the 766 File Review Methodology

The relationship of events in time can provide insight into the nature and quality of licensee performance. Thus, one critical element is the date of each noncompliance or citable occurrence, and our initial step was to review each noncompliance in chronological order.

Noncompliances are either random lapses from good performance (random human error) or systematic lapses due to a performance defect or deficiency assignable to one of the FPM circles or arrows. When an inspector reports a noncompliance, he assigns a "Primary Cause of Violation Code." To use noncompliance data in the FPM methodology, we identified the parallels between the Event Responsibility Codes (ERCs) we developed for use with the LERs and the Primary Cause of Violation Codes. The relationships between ERCs and noncompliance cause codes are shown in Table 4.

TABLE 4

766 FILE CAUSE CODES AND EQUIVALENT TEKNEKRON EVENT RESPONSIBILITY CODES

NRC 766 FILE		TEKNEKRON EVENT FILE	
Primary Cause of Violation Code	Definition	Definition	Event Responsibility Code
C	Improper or Inadequate Design	All actions falling within the purview of management responsibility, exluding "hands on" operation of the facility.	M
D	Improper or Inadequate Construction		
E	Improper or Inadequate Maintenance		
G	Inadequate Plans or Procedures		
H	Inadequate Management		
J	Poor Housekeeping or Arrangement		
L	Safety Devices Not Provided		
R	Personnel -- Poor Selection or Improper Training for the Job		
T	Personnel -- Insufficient Supervision		
F	Improper or Inadequate Calibration	All actions and responsibilities accruing to those with responsibility for "hands on" operation of the facility.	P
M	Safety Devices Not Maintained		
N	Operator Error		
P	Failure to Follow Procedures		
S	Personnel -- Carelessness		
K	Equipment Failure or Faulty Equipment	The failure of a component or system within the facility not caused by personnel or error in the maintenance or operation of the facility.	F
A	Unavoidable -- Inherent Risk of Job which Could Not Have Been Reasonably Foreseen or Prevented	All events which are not related to a failure of either facility management, personnel, or the random failure of a component are unimportant to the Teknekron analysis and are grouped and designated as such.	O
B	Unavoidable -- Circumstances beyond Control; e.g., Natural Causes		
W	Causal Factor Not Determined		

As with LER data, these noncompliance ERCs are linked to real situations: in this case, citable occurrences. Citable occurrences, however, originate in two ways. First, they may stem from events occurring at the facility system level and reported by licensees in accordance with NRC's criteria for LER reporting (NUREG-0161). In some cases, inspector followup of these events results in items of noncompliance. For one of the licensees we studied, a significant number of LERs were identified as citable occurrences. In these cases, the inspection process is reacting to actual events.

The second way in which citable occurrences may originate is through detectable violations of license conditions. Under the current inspection system, detectability is a time function of:

- when the citable occurrence took place, and
- the inspection module under review.

Evaluation of citable occurrences as a function of time and according to their points of origin within the facility would lead to the identification of performance patterns. But the detection of these patterns is subject to the characteristics of the inspection program.

The NRC's modularized inspection program has its own pattern for detection of citable occurrences. The inspection modules are typically performed on a scheduled basis and some are performed repeatedly throughout the annual inspection cycle. The scheduling of some inspection modules is necessarily determined by facility status (plant shutdown for refueling). There are also I&E procedures (see MC 2515) that permit an inspection to be performed when required, independent of any preset schedule ("W" inspection code).

For these reasons, we found that the pattern of noncompliances detected by the existing inspection program is governed by the character of that program as reflected in the time dependency of the inspection modules. The inspection module becomes the "point of origin" for the detection of licensee performance patterns, a point often well removed from the actual event that created the citable occurrence. Since most module inspections occur relatively infrequently, the data produced through any single module, when viewed over time, are usually too scant to be meaningful. These factors tend to obscure a time-sensitive identification of patterns of deficient licensee performance. We conducted our analysis of the 766 file and the associated inspection reports in the light of these considerations.

Figure 9 shows the relationship to the licensee of each major dimension of available data (LER file and 766 file) that we have used in licensee performance analysis. The LER dimension more closely reflects the reality of the licensee's operation. The noncompliance dimension is a level removed, and noncompliances are detected through the filter of the inspection program.

Licensee Performance Profiles Based on Noncompliance Data

For each licensee studied, we constructed a performance profile based on the noncompliance data. In developing these profiles, we did not include noncompliance items cited in the physical protection area, since 1976 and 1977 marked the implementation of 10 CFR Part 73.55, attended by the difficulties associated with implementing any new regulation.

As explained above, the inspection module is the "point of origin" for the identifying patterns of licensee performance through noncompliances. Since most modules are inspected relatively infrequently, the data produced from any single module, when viewed over time, are usually too scant to be meaningful. To improve the density of the data, we took those noncompliances attributable to ERC-M and ERC-P and summed them to produce a profile of total licensee human performance as perceived by the regulatory process. While this summation potentially reduces the sensitivity of the data, it clearly improves its meaningfulness. When viewed from the perspective of the FPM model, a profile constructed in this way represents the aggregate deficient human performance as perceived by the inspection process.

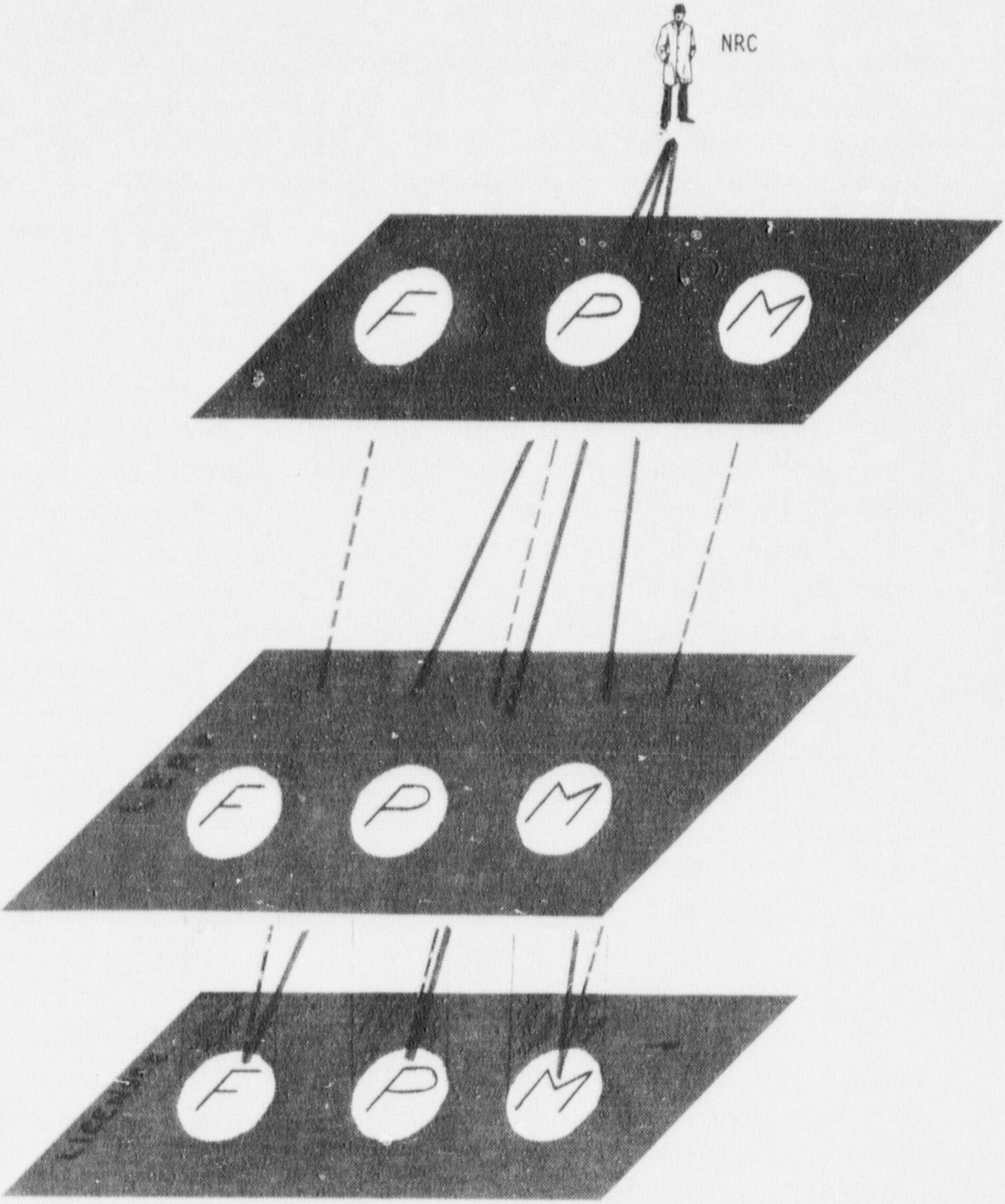


FIGURE 9

Data Dimensions for Performance Analysis

The noncompliance profiles we constructed for each of the three case study licensees are shown in Figure 10. The similarity between the profiles for Prairie Island Unit 1 and Point Beach Unit 1 is less striking than their difference from the Zion Unit 1 profile. The profiles of Point Beach Unit 1 and Prairie Island Unit 1, while unique to those licensees, are relatively similar in density, magnitude, and periodicity.

Figures 11, 12, and 13 show the noncompliance and LER profiles for each licensee we studied. Note that the vertical scale is different. Comparing each licensee's noncompliance profile to his LER profile provides an insight into the "performance" of the inspection program in handling different types of licensees. The total human noncompliance profiles are reasonably similar to the related profile of total human error in reported events for the "good" performers (Prairie Island Unit 1 and Point Beach Unit 1). However, the difference in apparent periodicity between the two profiles for Zion Unit 1 is substantial, and probably reflects the licensee's attempts to respond to regulation as well as the response of the regulatory process to the licensee. The apparent phase differences of the two profiles may be an indicator of the sensitivity of the interaction between the licensee and I&E.

In the case of the "good" performers, neither their total human noncompliance profiles nor their profiles of total events attributable to human error show sharp or sustained increases or decreases in numbers of events or noncompliances over time. The profiles exhibit a steady-state quality that can be termed the "noise" of operation. Further, the case studies in Appendix A show that Point Beach Unit 1 had very few instances of causally linked events, while Prairie Island Unit 1 experienced a somewhat larger number of causally linked events. However, both facilities appear to be reasonably free of systematic human error. But for Zion Unit 1, a "poor" performer, both the profile of total events attributable to human error and the profile of total human noncompliances show steep and sustained

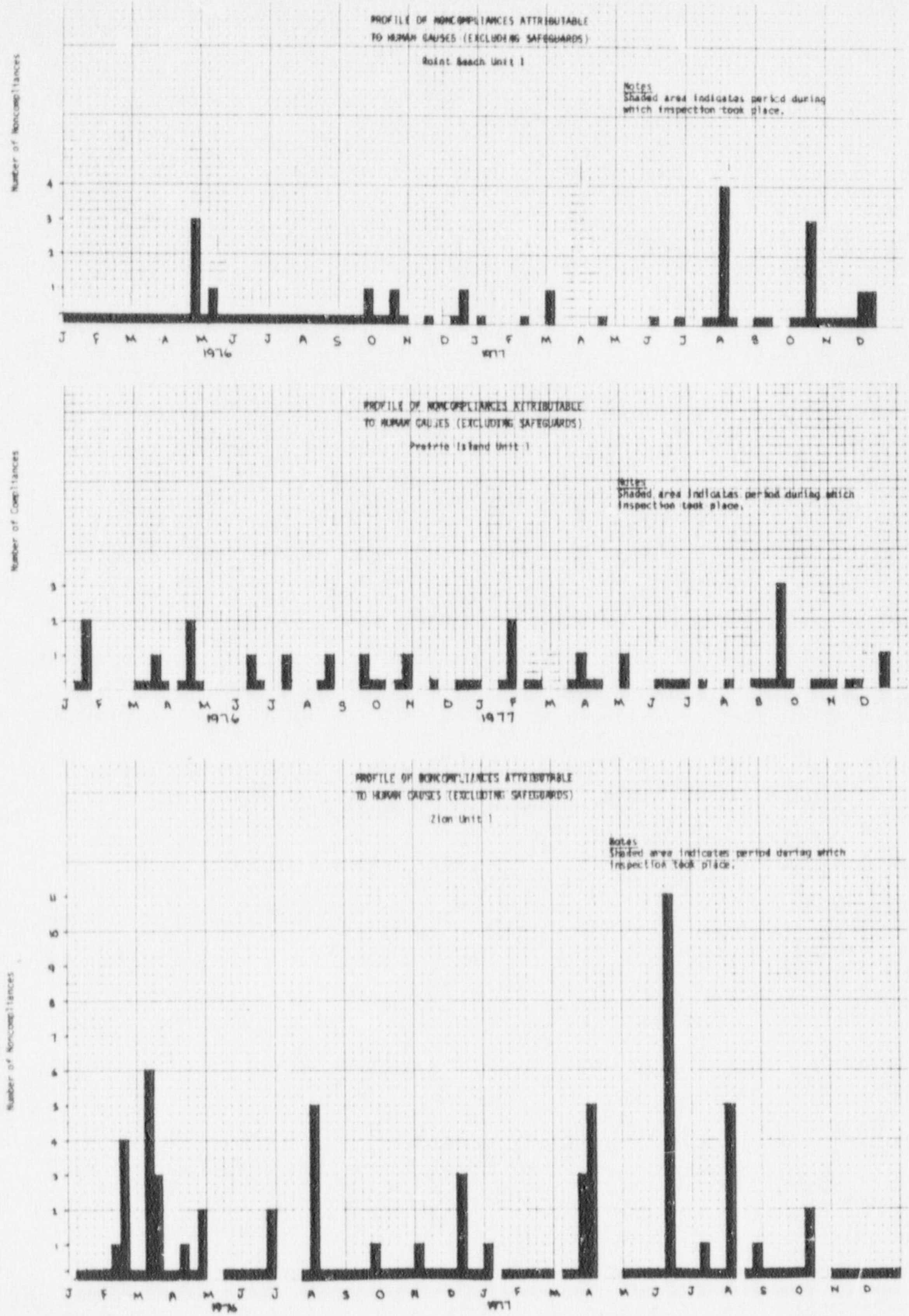
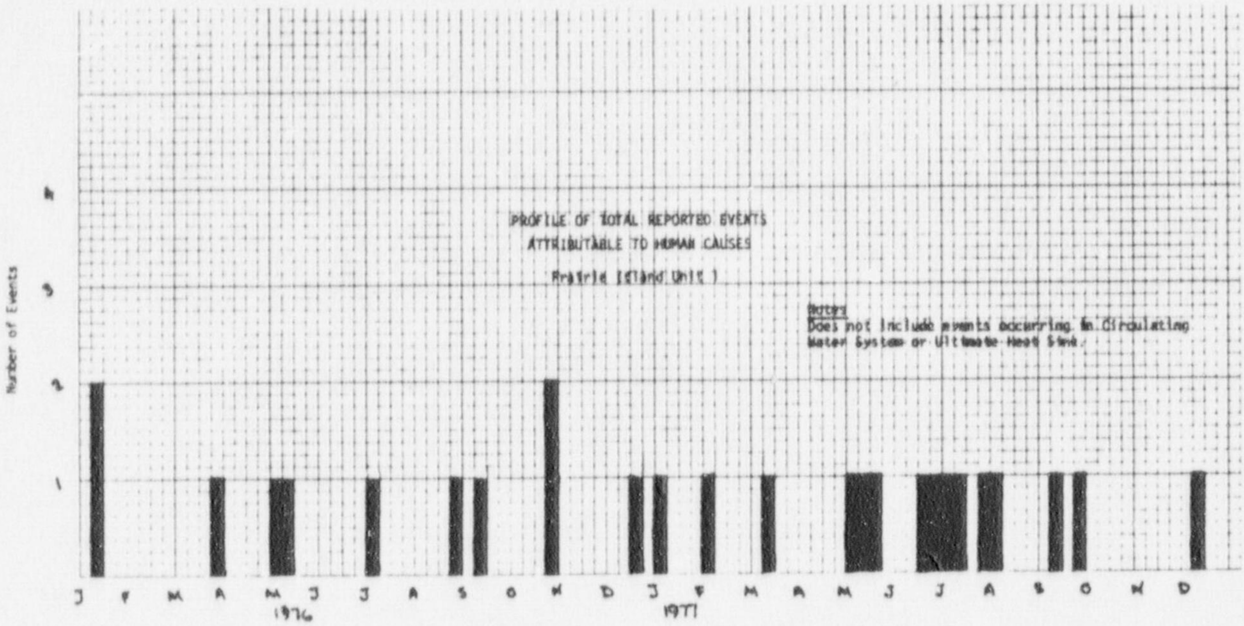


FIGURE 10
Comparison of Noncompliance Profiles



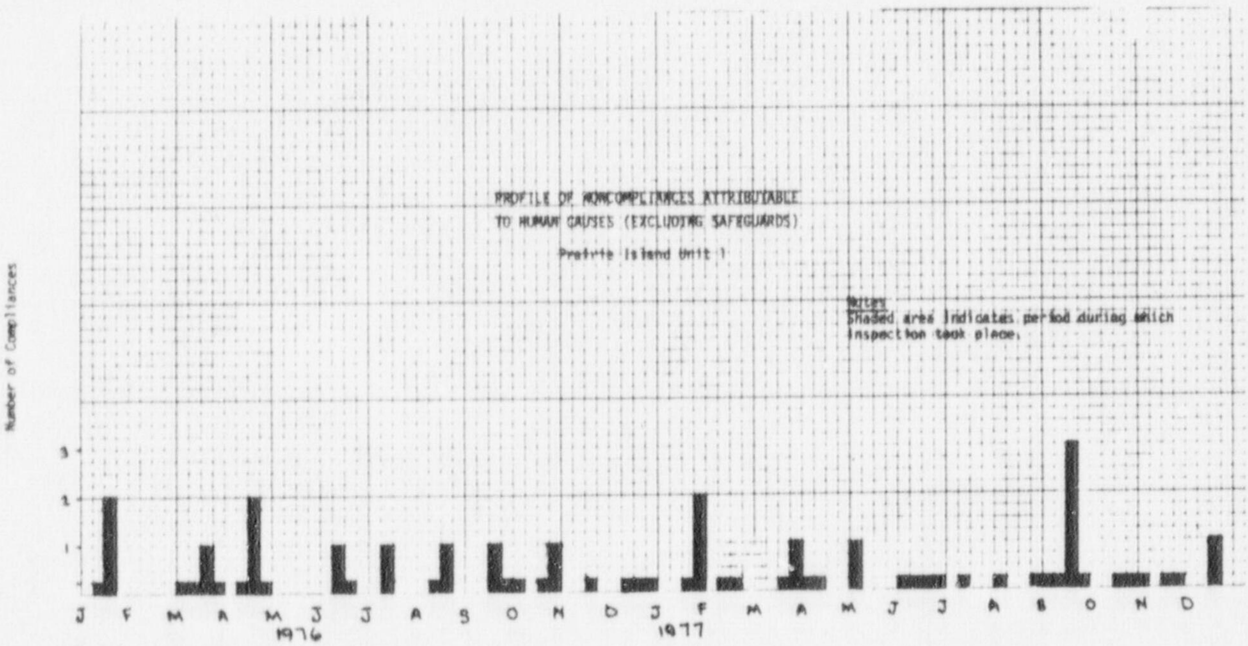
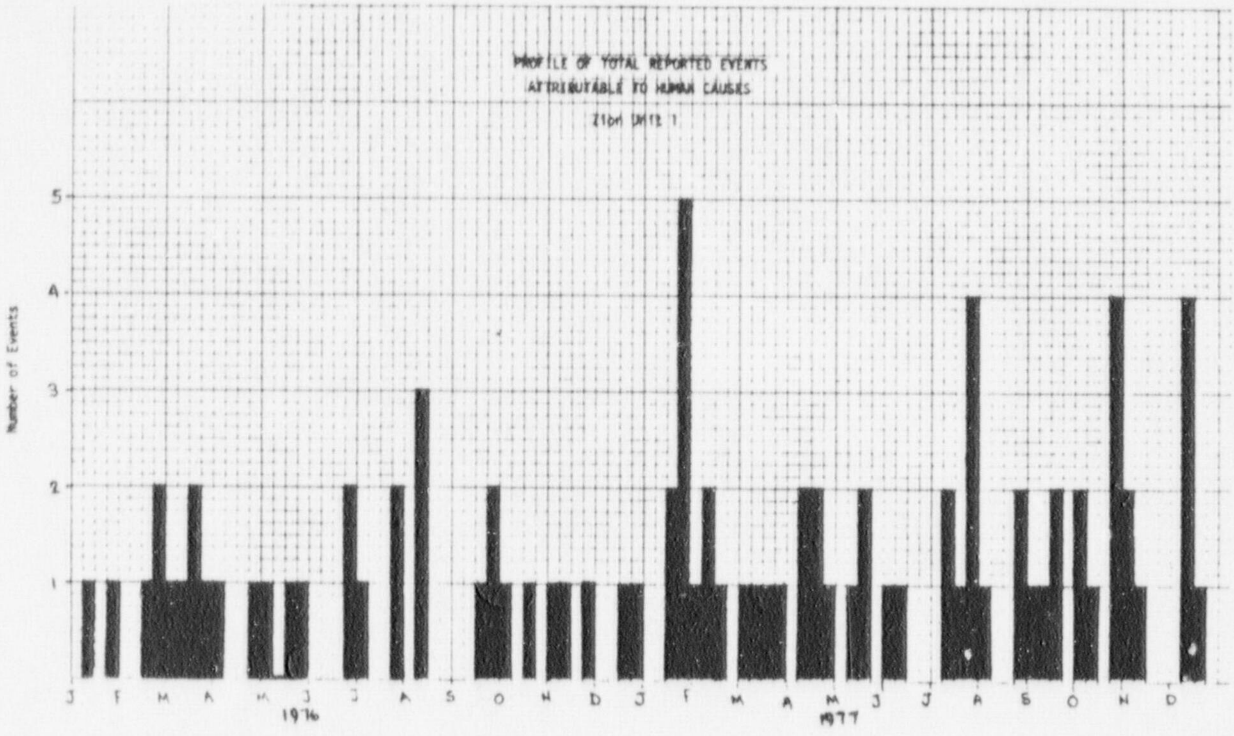


FIGURE 11

Prairie Island Unit 1 LER and Noncompliance Profiles



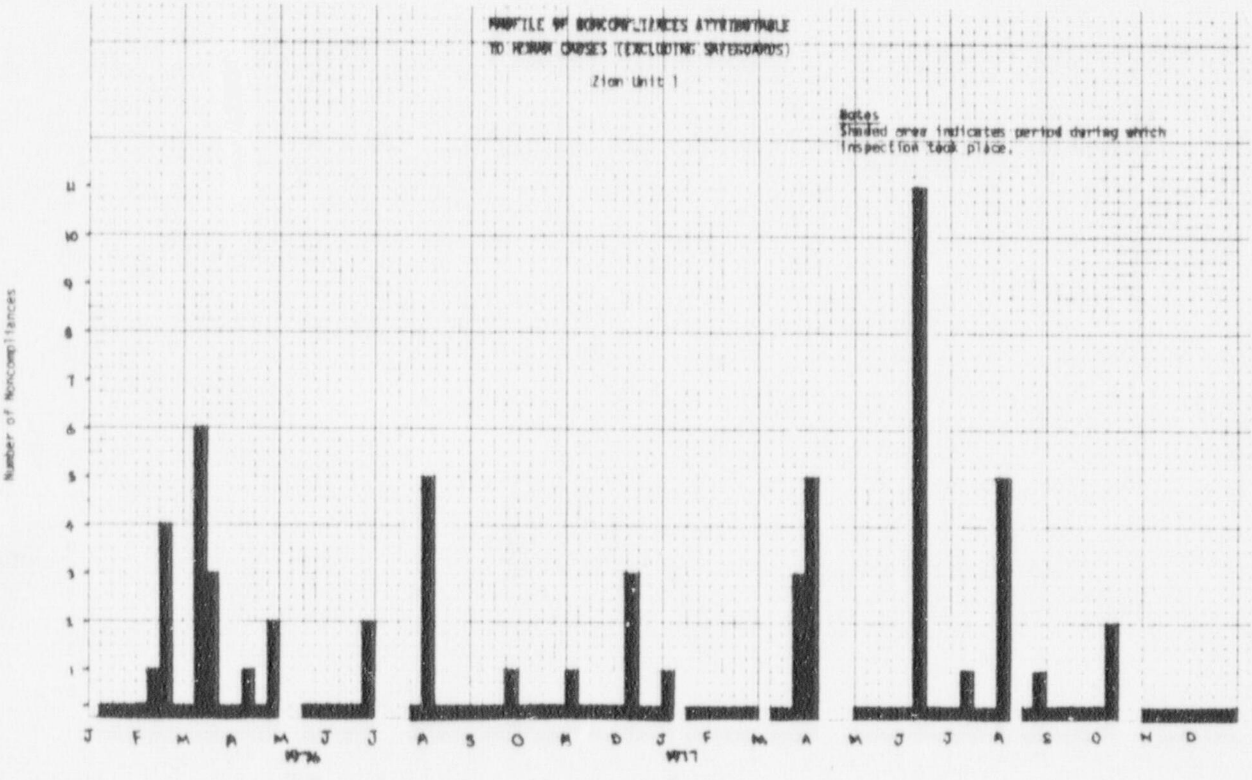
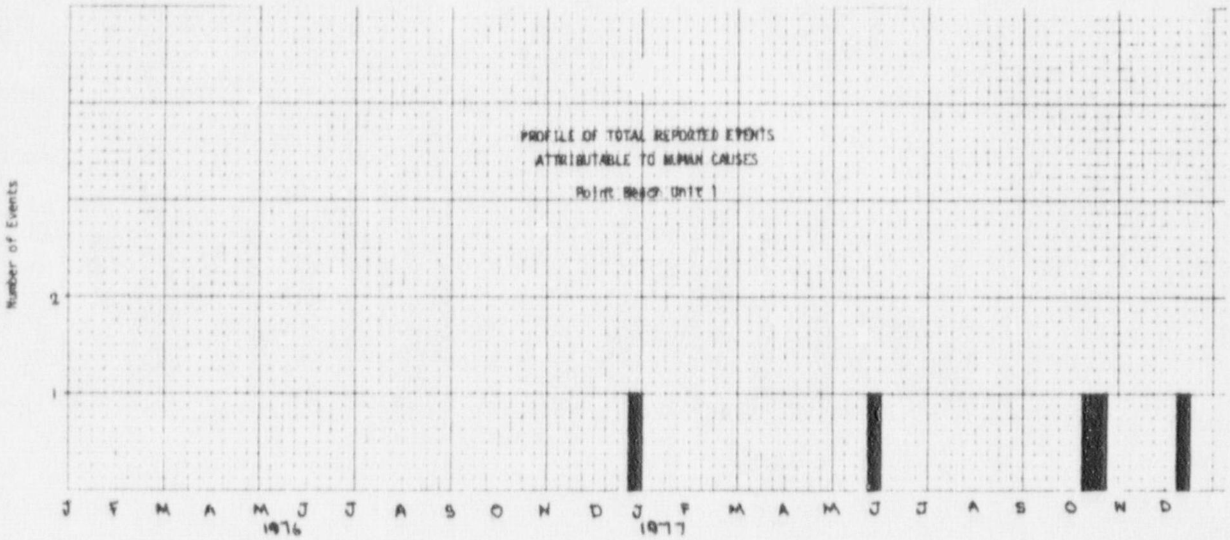


FIGURE 12

Zion Unit 1 LER and Noncompliance Profiles



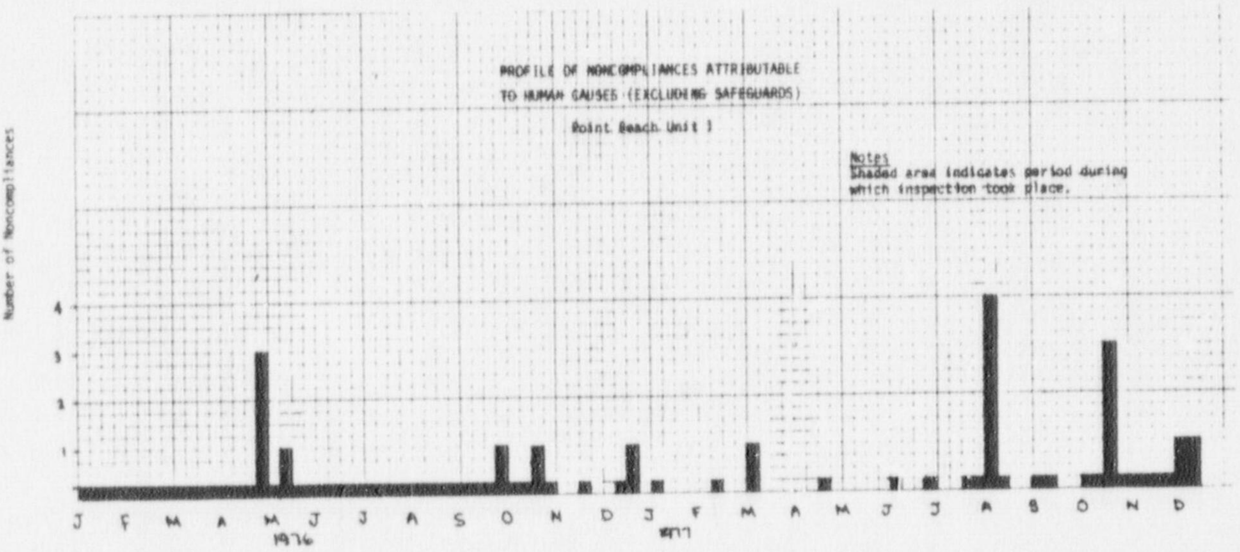


FIGURE 13

Point Beach Unit 1 LER and Noncompliance Profiles

increases or decreases in numbers of events or noncompliances over time. The case study shows that Zion Unit 1 had <u>many</u> causally linked events when compared to the "good" performers, which indicates that Zion's profile of total events attributable to human error is dominated by events due to systematic management deficiencies. While there is no direct basis for assuming that the profile of total human noncompliances displays causally-related defects in licensee performance (due to the modularized nature of the data), we believe that such defects <u>were</u> perceived by the inspection process. This is corroborated by a review of the NRC inspection reports of NRC management meetings with the licensee following incidents at the facility, as well as the inspector's perceptions of the licensee.

<u>Analysis of 766 File and Associated Inspection Reports</u>

As part of our review of the 766 file for each case study, we investigated the relationship of the 766 file to its written counterpart, the inspection reports. This "mini-audit" is briefly described in Section 3.3.3.1. The details of these investigations are provided in the case studies in Appendix A, in the form of summary matrices. Table 5 summarizes each case study matrix. Each matrix contains information on three specific relationships we felt were particularly important:

- The relationship of key 766 file data to the associated inspection reports: to use the 766 file data for analysis, we must know how well it agrees with the inspection reports.
- The relationship of inspector cues (LERs and licensee-identified items) to noncompliances: what guided the inspector in identifying citable occurrences?
- The relationship of the licensee to the regulatory process: his readiness to specify remedies to items of noncompliance, his action on previously identified enforcement items, and inspector agreement or disagreement with the licensee's reporting of LERs.

TABLE 5

SUMMARY OF COMPARISON OF 766 FILE DATA AND ASSOCIATED INSPECTION REPORTS FOR 1976 AND 1977

	Point Beach Unit 1	Prairie Island Unit 1	Zion Unit 1
Disagreement/ambiguity between I&E inspection report and 766 file non-compliance cause code	12%	20%	9%
Disagreement/ambiguity between 766 file noncompliance cause code and 766 file enforcement text	44%	37%	47%
Noncompliances associated with inspector cues (as percent of total noncompliances)			
LERs	0%	17%	32%
Licensee identified items	12%	11%	20%
Total	12%	28%	52%
Noncompliance remedies (as percent of total noncompliances) suggested by licensees in:			
Inspection report	36%	45%	50%
Followup letter	44%	31%	21%
Licensee action on previously identified enforcement items	Always complete	Complete (1 exception)	Deficient in one or more items, 70% of the time this was reviewed by inspector.
Repeat noncompliances	0	0	5 (in 1976)
Serious events due to human error	0	0	3

1. Relationship of 766 File to Associated Inspection Reports

The level of disagreement between the 766 file noncompliance cause code and the associated inspection report details ranged from a low of 9% to a high of 20% (Table 5). This represents fairly good agreement and suggests that it would be possible to have inspectors gather data according to FPM model definitions. Because the FPM definitions are considerably more precise and offer less opportunity for ambiguous application than the 766 file noncompliance cause codes, we believe that the data gathered in this way would be reliable and consistent in character.

Disagreement between the 766 file noncompliance cause code and the 766 file enforcement text ranged from a low of 37% to a high of 47%. This indicates that the 766 text and associated noncompliance codes cannot provide a confident understanding of the circumstances surrounding a noncompliance. In most cases, we had to use the associated inspection report to gain insight into the cause of a noncompliance. However, we found strong agreement between the 766 file enforcement texts and the summaries of the noncompliance items in the inspection reports. Therefore, the major difficulty in understanding the actual cause of a noncompliance from the 766 file information lies in the interpretation and use of the 766 noncompliance cause codes; the enforcement text does not provide enough supporting detail. A study to determine how inspectors use these codes could help to substantially improve the codes' precision and make the 766 file data more useful in the future.

Data are coded on the 766 file input forms in the regions, and the inspection report is prepared simultaneously. A "stratified" statistical sampling program on a regional basis is required to determine the precise level of agreement that actually exists between primary 766 file data elements and associated inspection reports. This program would permit NRC headquarters to identify error-input sources into the 766 file and, at the same time, would indicate differences in regional attitudes toward the data base by illuminating the way in which the information is handled.

2. Relationship of Noncompliance Items to Inspector Cues

We next examined the relationship of noncompliance items to cues (LERs and licensee-identified items) to the inspector. These cues are an obvious source for identifying citable occurrences, but their use varied considerably from one licensee to another. For example, 32 percent of noncompliances at Zion Unit 1 were related to inspector followup of LERs; in contrast, this percentage was zero for Point Beach Unit 1 and 17 for Prairie Island Unit 1. The second source of inspector cues (licensee-identified items such as procedure changes) produced 20 percent of the total noncompliance count at Zion Unit 1, but only 12 percent at Point Beach Unit 1 and 11 percent at Prairie Island Unit 1.

As part of our analysis, we determined the overall inspection results (noncompliance items/100 module hours) by year for each licensee studied. These results are shown in Table 6. As stated earlier, we did not include inspection hours or noncompliances related to physical protection. Table 6 also shows the results from that part of the inspection process that detects noncompliances <u>without</u> using cues provided by the licensee. (These results show the ability of the unaided inspection process to detect noncompliances.) Note that for 1977, Point Beach Unit 1 shows a somewhat higher result (2.1) in non-cued yield than Zion Unit 1 (1.8). This is strikingly inconsistent with the overall performance patterns and case studies for these plants, which show that Point Beach Unit 1 is the better-managed facility of the two.

We believe that results of the kind shown in Table 6 may say more about the inspection process than about the licensees toward whom the process is directed. On the basis of these three case studies, it appears that the inspection process in its current form can make gross distinctions between licensees in terms of "good" and "poor" performance, if cues are utilized by the inspectors. But in the case of Zion Unit 1, the <u>perception</u> of "poor"

TABLE 6

INSPECTION RESULTS

Total Module Hrs.(1)	Point Beach Unit 1	Prairie Island Unit 1	Zion Unit 1
1976	490	464	904
1977	378	595	1032
Total N/C's(1)			
1976	6	10	37
1977	10	8	31
Overall Results: N/C's per 100 Module Hrs.			
1976	1.2	2.2	4.1
1977	2.6	1.3	3.0
Total N/C's not due to inspector cues(1)			
1976	5	7	12
1977	8	4	19(2)
N/C's not due to inspector cues per 100 module hrs(3)			
1976	1.0	1.5	1.3
1977	2.1	0.7	1.8

NOTES:

(1) Does not include time or noncompliances related to physical protection.

(2) Includes six noncompliances for which reports were not available. These noncompliances were not related to physical protection; including them as uncued findings gives maximum weight to the inspection process.

(3) Module hours spent on followup of licensee-provided cues were not removed, since noncompliances resulting from cues were spread rather uniformly throughout the inspections and time spent specifically on these items was seldom separately shown.

performance through the inspection process, even using cues, appears to have lagged the timely performance shown in the LERs. The inspection process also appeared to have no particularly sensitive licensee performance indicator similar to the causally linked events of the LER data analysis. This apparent lack, together with the apparent usefulness of licensee-provided cues, tends to support the view that the inspection process in its current form may lack the sensitivity or direction needed to foster licensee performance analyses that are both accurate in terms of quality and at least approximately correct in terms of magnitude.

3. Relationship of the Licensee to the Regulatory Process

Ideally, the licensee/regulatory relationship is interactive. On one hand, NRC must monitor the level to which licensees adhere to required operating and other functional states and conditions. It is also NRC's obligation to cite departures from license conditions and to impose sanctions if these are considered necessary and appropriate. Some may argue that in the interest of public welfare, the agency should provide help and guidance to the licensee if required, even though this function clearly lies outside of the literally interpreted regulatory domain.

On the other hand, the licensee's relationship to the regulatory agency obligates him to:

1) operate his facility in such a way that he violates the original license conditions to the least possible extent; and

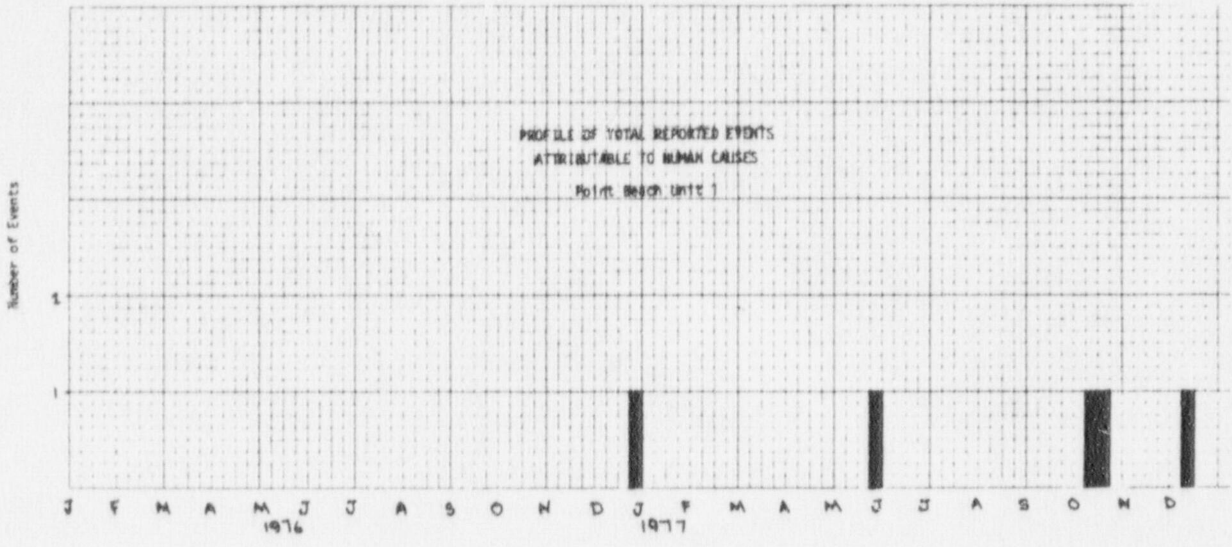
2) institute adequate remedial measures in the least possible time period if such violations occur.

As the licensee fulfills these obligations, it is wholly immaterial whether a violation is initially identified by the licensee or by the NRC inspector. The key factor is the licensee's willingness and ability to respond effectively to the identified situation.

The concepts set forth above are expressed in extremely general terms. In the following discussion we will show how these concepts can be specifically applied to making accurate distinctions, on the basis of currently available data, between licensees who may be considered "good performers" and "poor performers."

Although the licensee is obligated to minimize the frequency of his departure from operating license conditions (in the case of the "perfect performer" this departure would be zero), it is inevitable that "good performers" as well as "poor performers" will experience events, noncompliances, and other lapses. We may expect such lapses, whether identified by the licensee or by NRC I&E, to occur with greater frequency in the case of "poor" as opposed to "good" performers. But it does not necessarily follow that numbers of lapses provide reliable absolute indicators of overall licensee performance levels. We cannot assume that, because Facility A has twice as many lapses as Facility B over a similar time period, that Facility A is only half as safe as Facility B. From both LER and NRC inspection data, this study shows that lapse recurrence is a far more sensitive indicator of licensee performance (particularly managerial performance) than lapse frequency as such. The data presented in Table 6 show that lapse frequency cannot stand alone as a performance indicator. The overall inspection result in 1977 was 3.0 for Zion Unit 1; for Point Beach Unit 1 it was 2.6. These two numbers are quite similar. But the performance profiles based on the LER data shown in Figure 14 make it immediately apparent that the performance difference bewteen these two licensees is substantial, a difference that is obliterated by the overall inspection result indexes.

While Table 6 shows that frequency alone is a poor performance indicator, Table 5 shows that recurrence is far more sensitive. Table 5 shows that all three licensees are similar in their readiness to suggest remedies to noncompliance items. But when we examine 766 file data on the recurrence of identical noncompliance items, we see that five such instances occurred



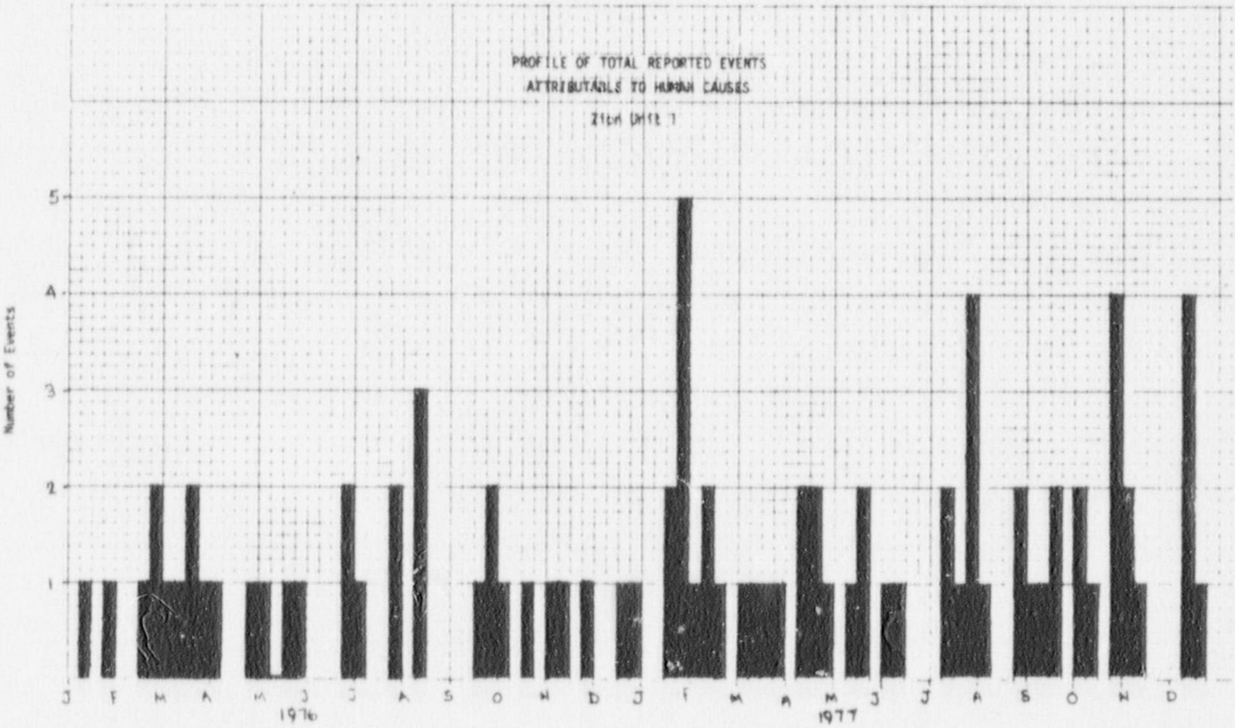


FIGURE 14

LER Profiles for Point Beach Unit 1 and Zion Unit 1 in 1976 at Zion Unit 1; Point Beach Unit 1 and Prairie Island Unit 1 had no repeat noncompliances.

The record of licensee action on identified items in Table 5 supports this. Point Beach Unit 1 actions were always complete, and with one exception, Prairie Island Unit 1 actions were also complete. But at Zion Unit 1 at least one action deficiency was noted during 70 percent of the inspections in which licensee followup was performed. Recurrence is an inverse measure of a licensee's ability and willingness to respond effectively. These findings on the relative sensitivity of frequency and occurrence as performance indicators are consistent with the licensee performance patterns developed from the LER data.

Available Licensee Performance Indicators

Based on the previous discussion, these indices provide a context for licensee performance:

- Percentage of noncompliance items identified due to inspector cues (followup of LERs and licensee-identified items).
- Percentage of noncompliance items for which the licensee has proposed remedies. This is a measure of stated licensee responsiveness to the inspection process.
- A "stratified" and regionalized sample to determine the error that actually exists between the 766 file data and associated inspection reports. This will indicate differences in regional attitudes toward the data base as well as demonstrate the quality of the data being used for performance evaluation.

Once this contextual information is available, useful indicators of licensee performance are:

- Licensee action on identified noncompliance items. This indicates actual licensee willingness and ability to comply once the problem is identified.
- Repeat noncompliance items. These reflect licensee ability to implement changes to and maintain the program.

- A profile of licensee performance based on the noncompliances attributable to human causes. This measures perceived aggregate deficient licensee performance. However, when this profile is compared with the associated LER profile of total reported events attributable to human causes, it provides insights into the licensee's relationship to regulatory process, the licensee's response to the process, and perhaps the applicability of the process to the licensee.

3.4 SUMMARY OF THE THREE CASE STUDIES

We have illustrated our use of the LER and noncompliance data with examples from the three case studies. From the outset of this project it was clear that case studies were necessary to empirically test the validity of the chosen approach. Since our approach was to develop a comprehensive model and procedure applicable to all classes of licensees, we chose to perform case studies of operating power reactors to test the FPM model, methodology, and performance indiactors against the most complex of NRC's licensees. Further, the data available for operating power reactors are the most complete.

The full case studies are presented in Appendix A. The rationale for choosing which licensees to study and a summary of the results of these studies are presented here so that the main body of this report can stand alone.

Selecting the Case Studies

To eliminate any possible regional effects that could diminish the meaningful comparison of one case study with another, we performed all the case studies in one NRC region. To prevent the possible bias of cross-NSSS vendor comparison, we searched for facilities using the same equipment. Third, based on discussions with NRC personnel, we felt that any facility must have been operating for more than two years, to prevent a "learning curve" effect from destroying meaningful comparison and possibly obscuring the patterns or indicators that might otherwise be evident in a mature facility.

Finally, we decided to study at least two facilities, one perceived by NRC as a "weak" performer and the other as a "good" performer. This provided us with the opportunity to empirically identify patterns and indicators related to each performance category ("poor" and "good"). It also offered the chance to gain insight into underlying causal factors associated with the dichotomy of performance.

For these reasons, we selected Zion Unit 1 and Point Beach Unit 1. Both are in Region 3, both are Westinghouse plants, and last, both had more than two years of operating experience by the beginning of 1976. When we discussed our choices with Region 3 management, it was mentioned that the differences in technical specifications and reporting requirements between Zion Unit 1 and Point Beach Unit 1 were considerable. Region 3 felt that we should consider studying a third performer with reporting requirements and technical specifications similar to Zion Unit 1, and suggested Prairie Island Unit 1. Consequently, we studied three licensees--Zion Unit 1, Point Beach Unit 1, and Prairie Island Unit 1. This gave us the additional opportunity to begin to examine the impact of differences in reporting requirements and technical specifications on the FPM model and methodology.

Performing the Case Studies

We performed the case studies in accordance with the FPM model and methodology discussed in Section 3.2, and we analyzed the LER file data and the 766 file data as described in Section 3.3.2.2 and 3.3.3.2 of this report. The study period covered calendar years 1976 and 1977, in order to produce profiles extending over a sufficient length of time to allow potential changes in performance to be seen and assessed. In any ongoing performance analysis, the study period should obviously be current, and each of these three case studies can be readily updated.

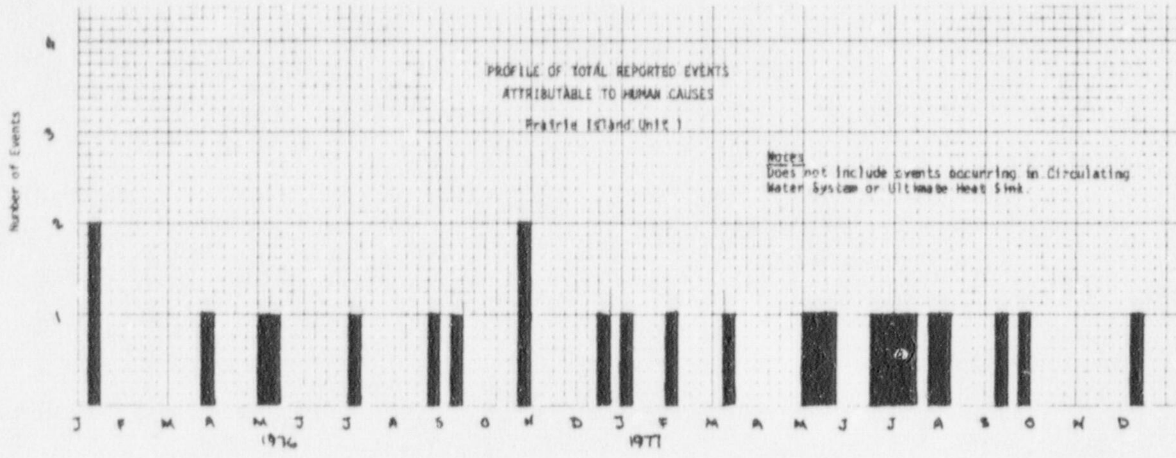
Presenting the Case Studies

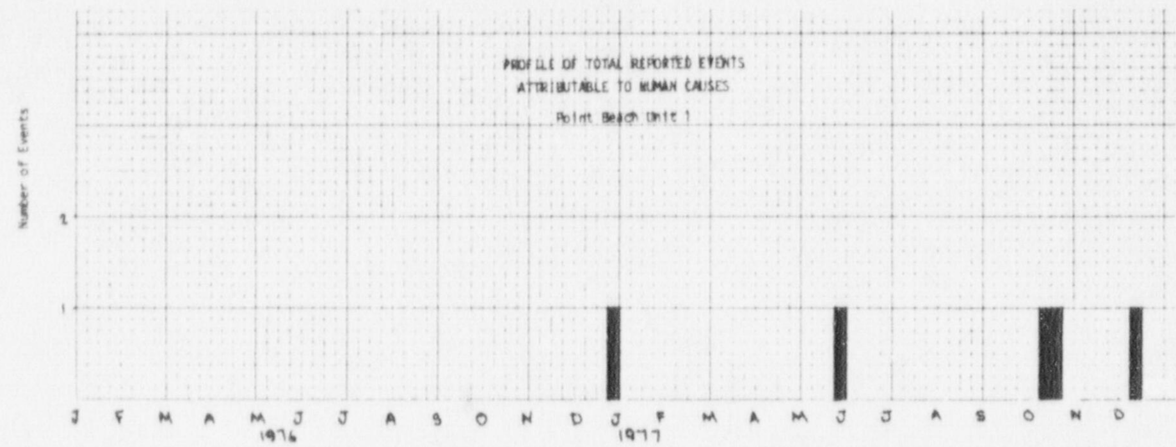
Each case study is presented in two separate parts that reflect the two different data dimensions--LER data and 766 data--used in the study. This allows the reader to gain an appreciation of the types of insights each data source provides as well as an appreciation of the sensitivity of each source to specific aspects of licensee performance. Performance profiles and supporting data sheets help the reader gain insight into the foundations of the case study effort as well as an appreciation of the study details.

Summary of Case Study Conclusions

The FPM model and methodology, using existing LER and 766 file data, appear to have both the capacity and sensitivity to differentiate "poor" from "good" performers. Figure 15 presents the profiles of total reported events attributable to human causes for the three licensees; the profiles for Prairie Island Unit 1 and Point Beach Unit 1, the "good" performers are clearly different from that for Zion Unit 1. Figure 16 shows the profiles of noncompliances (excluding safeguards) attributable to human causes, and again the differences are clear.

We found the LER file data essential to gaining insight into why the licensees perform as they do. As discussed in Sections 3.3.2.1 and 3.3.2.2, LERs promptly report real events occurring within facility systems. This close link to the "plant operating reality" offers the insight into management and personnel response to actual situations. The 766 file data was a less meaningful and sensitive performance indicator than we had anticipated at the start of our work. The cause codes in the data file are not precise and their use sometimes reflects inspectors' interpretations; the enforcement text is often too brief to establish the actual content of a noncompliance. Also, the discovery of noncompliances through the inspection program is often widely separated in time from their actual occurrence, due to the





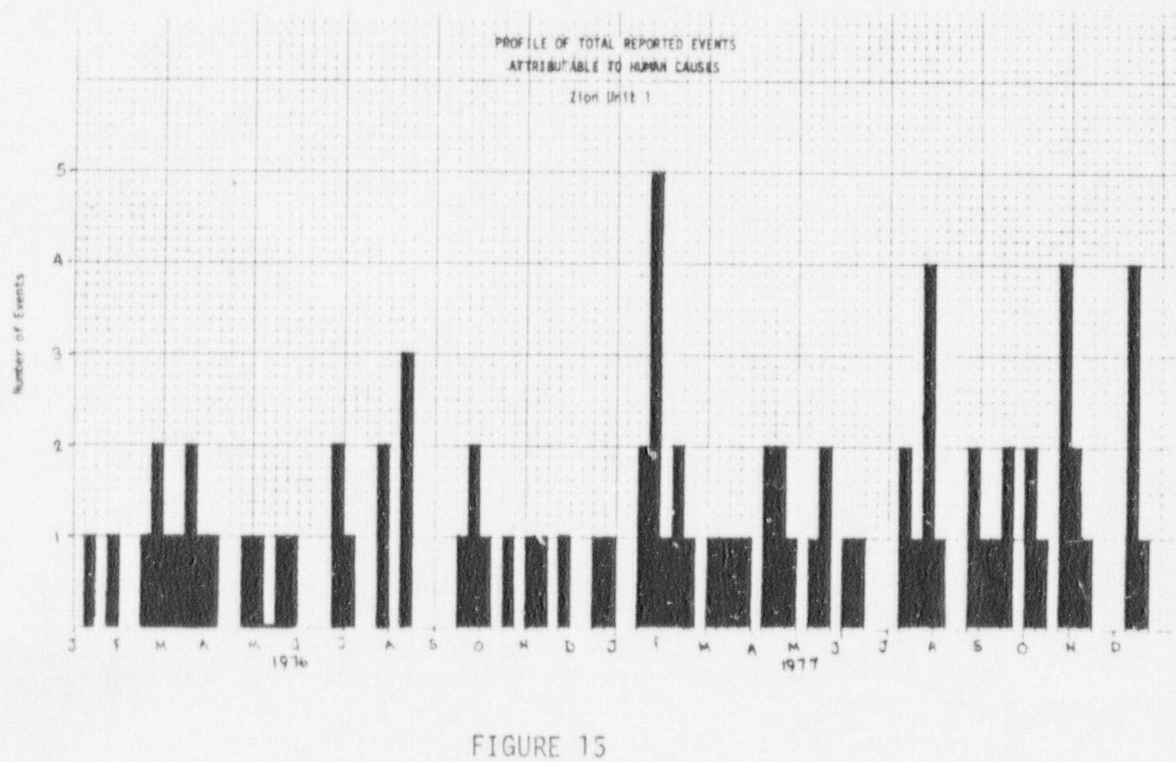


FIGURE 15

Comparison of LER Profiles

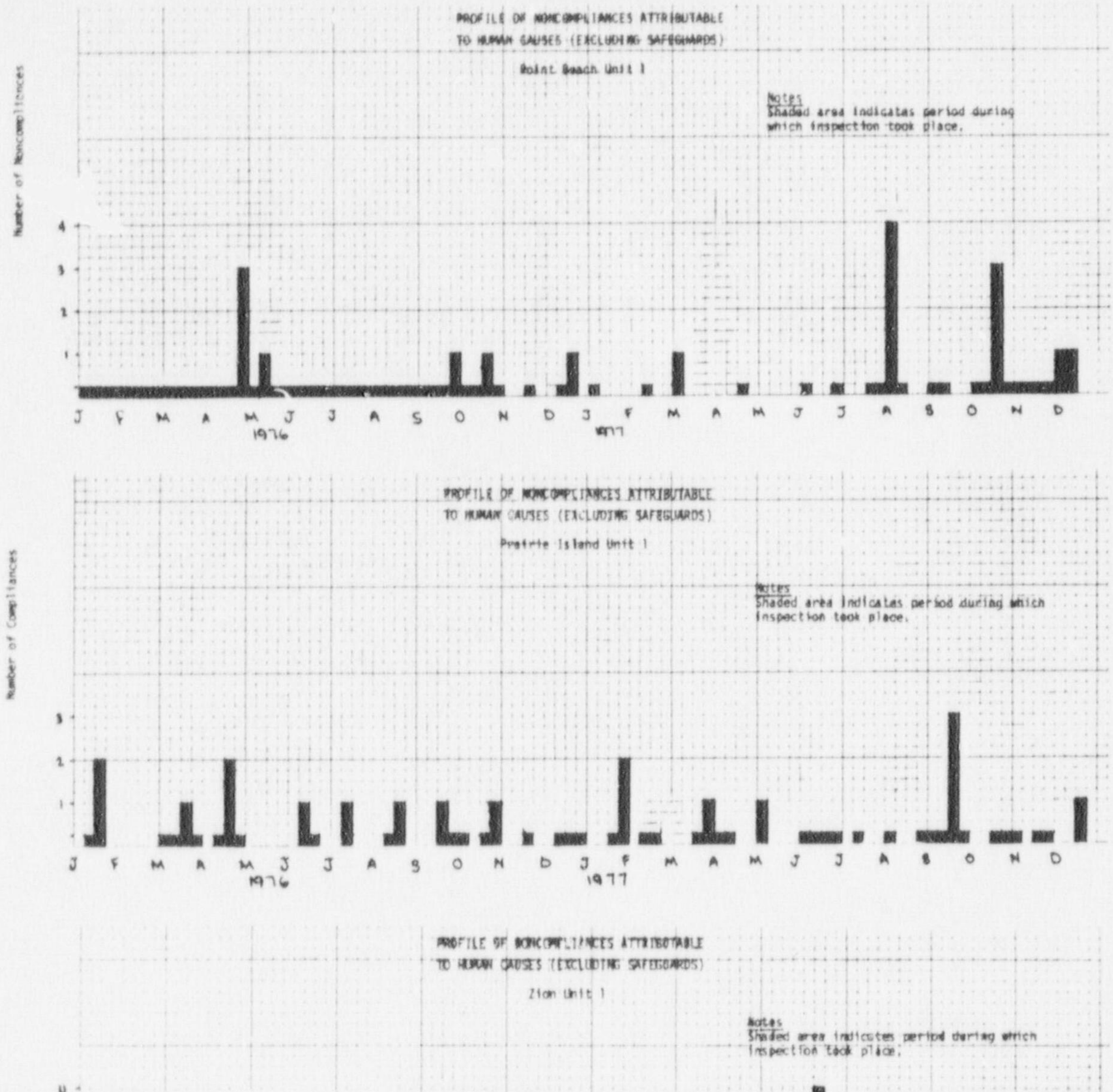


FIGURE 16

Comparison of Noncompliance Profiles

structuring of the program into time-dependent modules. These findings are discussed fully in Sections 3.3.3.1 and 3.3.3.2.

Differences in reporting requirements and technical specifications appeared to have little impact on the performance analysis results. We had expected little impact, since the FPM model is not inherently influenced by differences in technical specifications. But the empirical proof was in the performance profiles, as shown in Figure 17. The LER performance profiles for Point Beach Unit 1 and Prairie Island Unit 1, with different technical specifications, were relatively similar to each other. Zion Unit 1 technical specifications are similar to those for Prairie Island Unit 1, but Zion's LER profile is substantially different from both Prairie Island's and Point Beach's. Table 2, on page 38, establishes that technical specifications had little effect, at least for these three licensees. Further case studies will provide more indication of the sensitivity of the model to reporting and technical specification differences. We also expect that case studies of BWRs will permit comparisons that have until now been difficult.

Finally, we found that comparing the LER profile and noncompliance profile for a licensee provides insight into the capability and effectiveness of the regulatory process in managing the licensee's performance. This regulatory/licensee relationship may vary from region to region. Figure 18 shows these profiles for Zion Unit 1: the differences in phasing and frequency between the LER and noncompliance profiles are apparent, and the LER profile continues to show high levels of human error. Figures 19 and 20 show the profiles for Point Beach Unit 1 and Prairie Island Unit 1, where phasing and frequency are more similar.

3.5 LICENSEE PERFORMANCE ANALYSIS AND THE PERFORMANCE APPRAISAL TEAM PROGRAM

While the outlines and goals of the Performance Appraisal Team (PAT) Program are reasonably firm, the actual activities PAT will perform to meet those

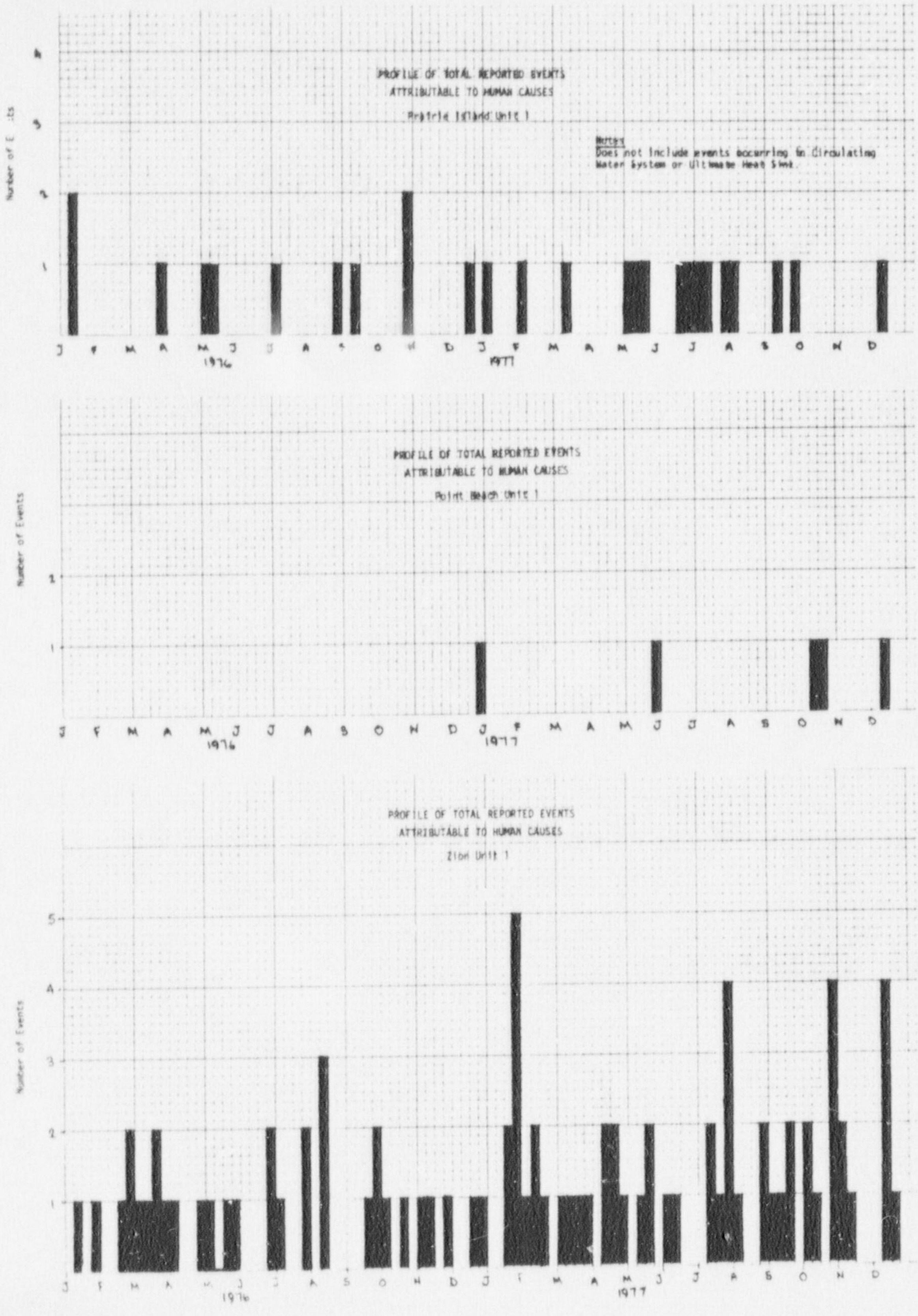


FIGURE 17

Comparison of LER Profiles

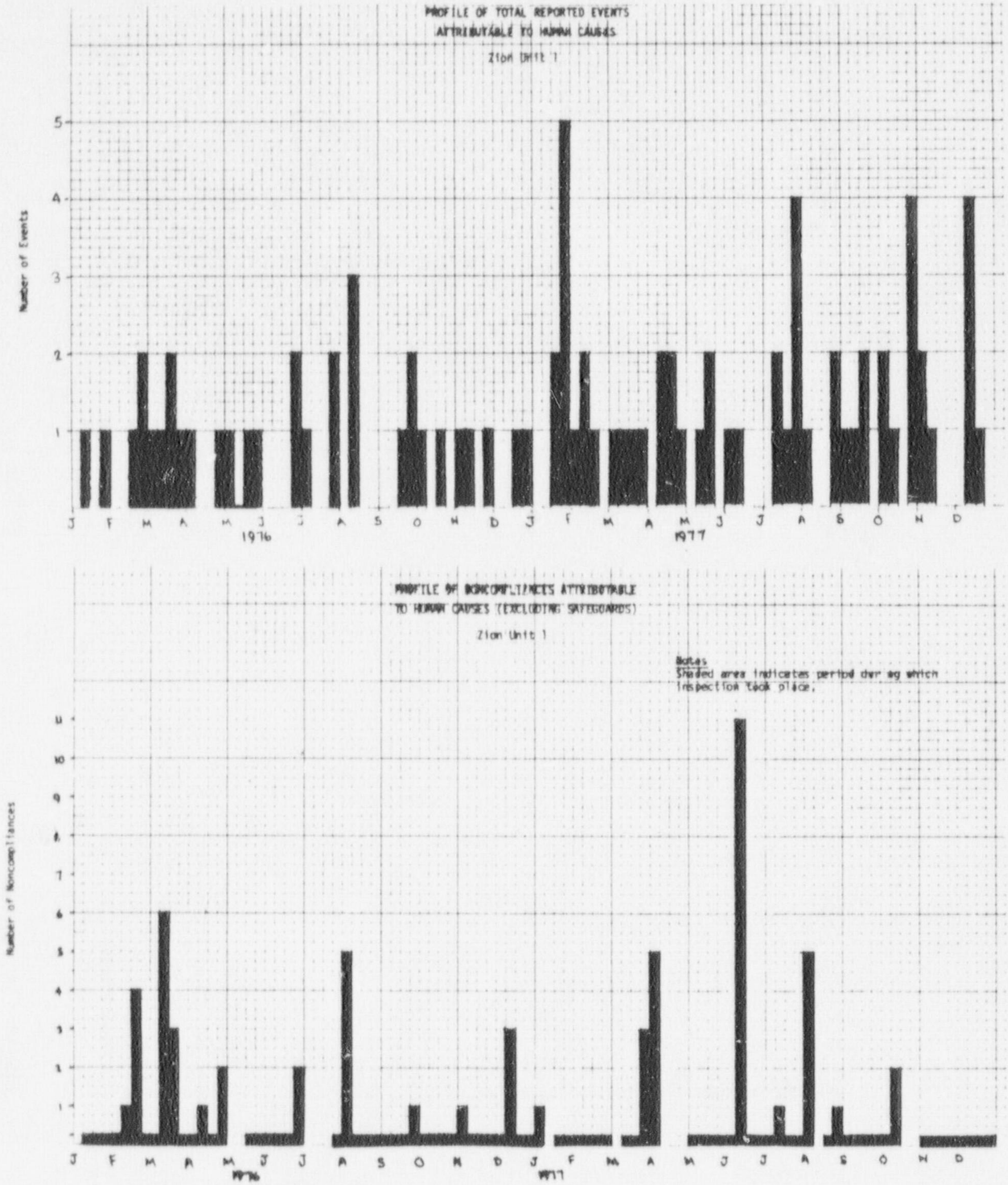
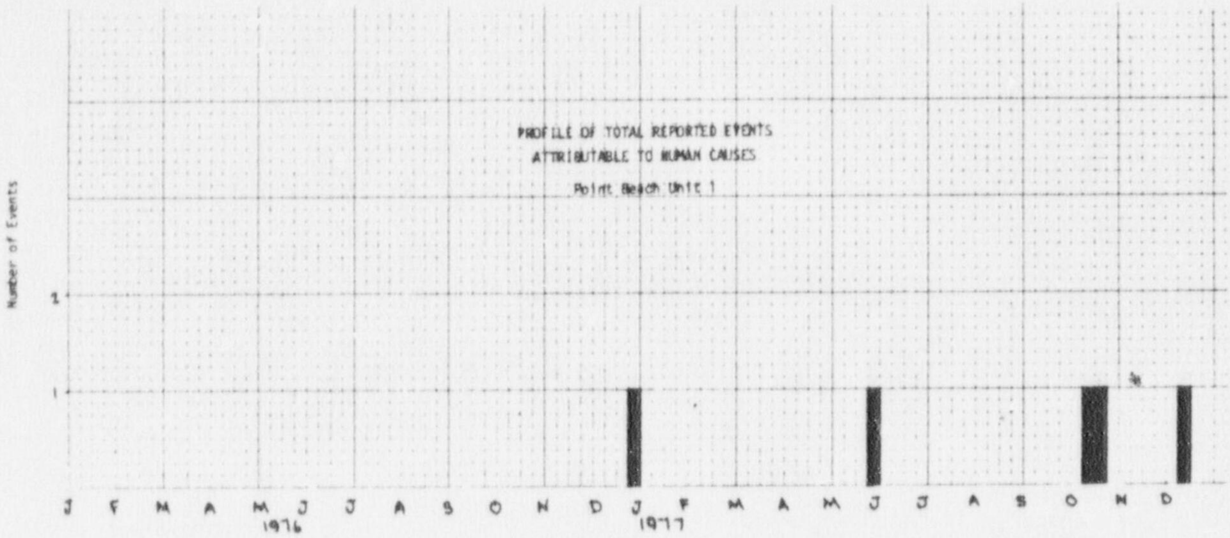


FIGURE 18

Zion Unit 1 LER and Noncompliance Profiles



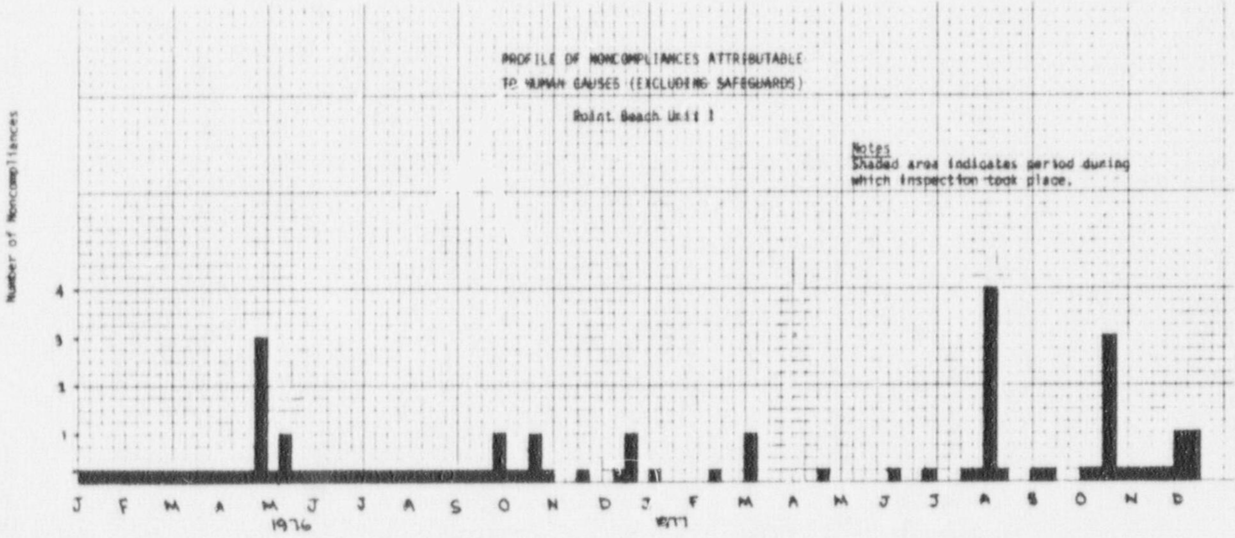
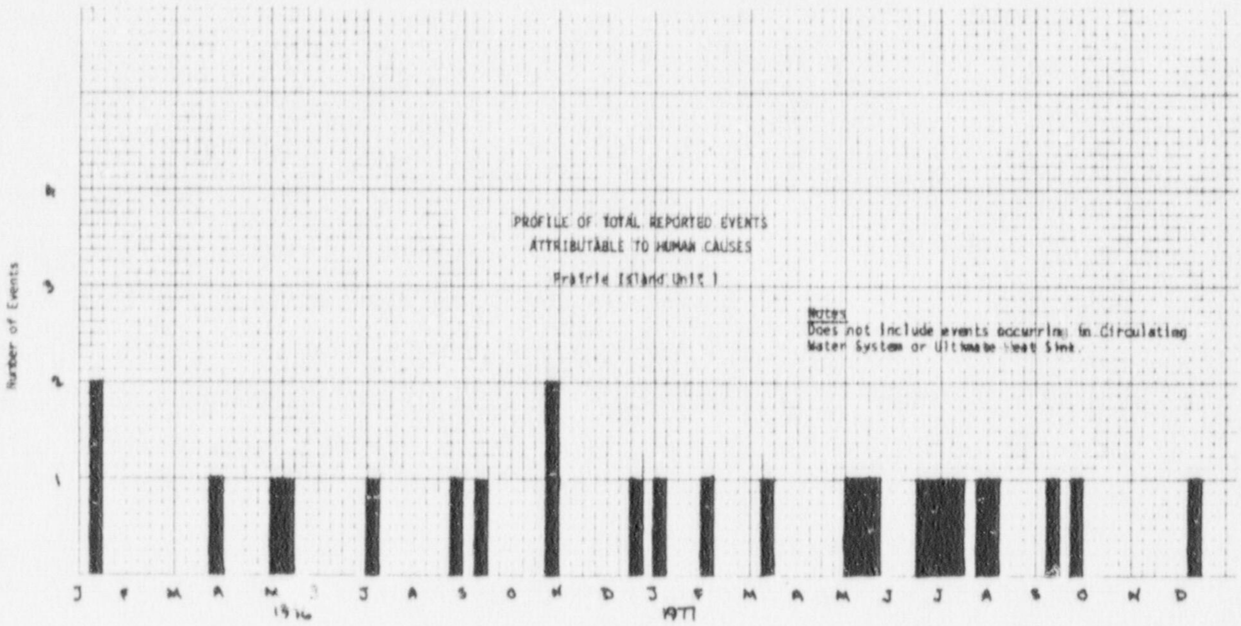


FIGURE 19

Point Beach Unit 1 LER and Noncompliance Profiles



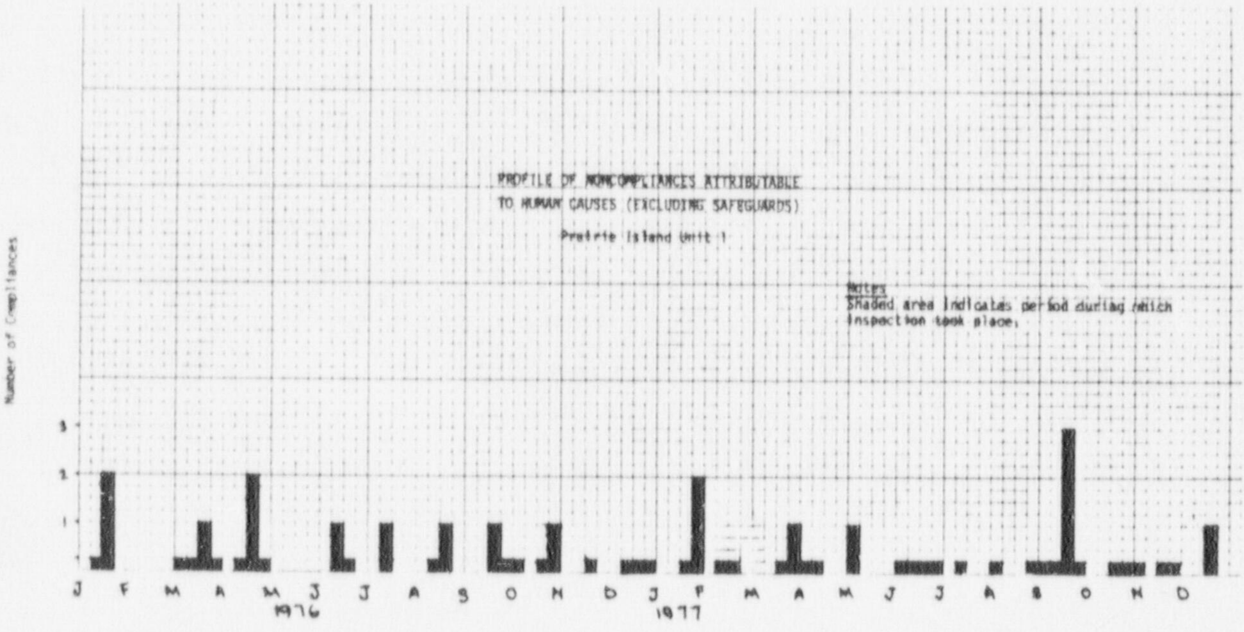


FIGURE 20

Prairie Island Unit 1 LER and Noncompliance Profiles

goals are not. Licensee Performance Analysis seems to have substantial links to PAT.

PAT has a dual purpose--to provide national perspective in analyzing licensee performance and to assess the effectiveness of NRC's own inspection program. At this time, PAT personnel have begun to devise the methodology they will use in Phase I of their program. Phase I is to include a subjective evaluation of plants, probably attempting to place them in "high, medium, and low" categories. This subjective evaluation will be based on the results of management inspections, routine inspections, and the resident inspection program. Each inspector will complete an evaluation sheet estimating the performance quality of each power reactor they visit. PAT will use these evaluations and other factors, such as the number of noncompliances, to arrive at a subjective evaluation of each plant.

Using the FPM model and the licensee performance analysis methodology can augment or replace the subjective evaluation of licensees. At a minimum, it should serve as an input to the PAT program. Performance analysis can also serve as a tool for evaluating the effectiveness of the inspection program in improving the performance of individual licensees. It is clear that the NRC regions differ in their management styles; these differences are reflected in varying results (number of noncompliances generated per 100 hours of inspection) and in varying methods of allocating inspector manpower. Performance analysis through the FPM model can help determine whether the inspection program is effective by comparing the profile of licensee response to events and the profile of NRC noncompliances to see the relationship between them. Ideally, action taken by NRC should improve the licensee's response: this is practically a definition of an effective program.

Presentation of License Performance Analysis

Continuously-updated and accessible licensee performance analyses could be highly valuable in directing the attention of regional personnel and the PAT teams to those licensees whose performance requires improvement.

The most obvious possibility is to place an interactive computer terminal in each region and at PAT headquarters, where personnel could immediately see the current performance profile for any licensee. The data base would be continuously and automatically updated through links with the LER and 766 files.

The "Rainbow Book" format is a second possibility. Figures 21a-c offer one possible format.

3.6 APPLYING THE MODEL TO EACH CLASS OF LICENSEE

3.6.1 Tailoring the Model

In our proposal, we stated that we would first develop a comprehensive assessment methodology designed to handle the most complex class of licensees--the operating power reactors. We also indicated that by deleting or combining elements, the same methodology could be applied to less complex licensees (materials licensees). The FPM model represents the "general" licensee to ensure that consideration of possible performance indicators would be both systematic and comprehensive.

Applying the FPM model to operating power reactors, we found that the model offered insight into the reasons for performance and was sensitive to actual differences in licensee performance. The model is equally applicable to less complex classes of licensees, since the general model elements ("F", "P", and "M") have clear parallels in each licensee category. Using the medical materials licensee group as an example, "F" is the radioactive source and the supporting physical facility, "P" is the technicians and doctors using and calibrating the device, and "M" is the hospital or clinic management responsible for operations other than "hands on."

LICENSEE PERFORMANCE ANALYSIS - 1976 and 1977

Point Beach Unit 1

INDEXES

Per cent noncompliances due to inspector cues: 12%

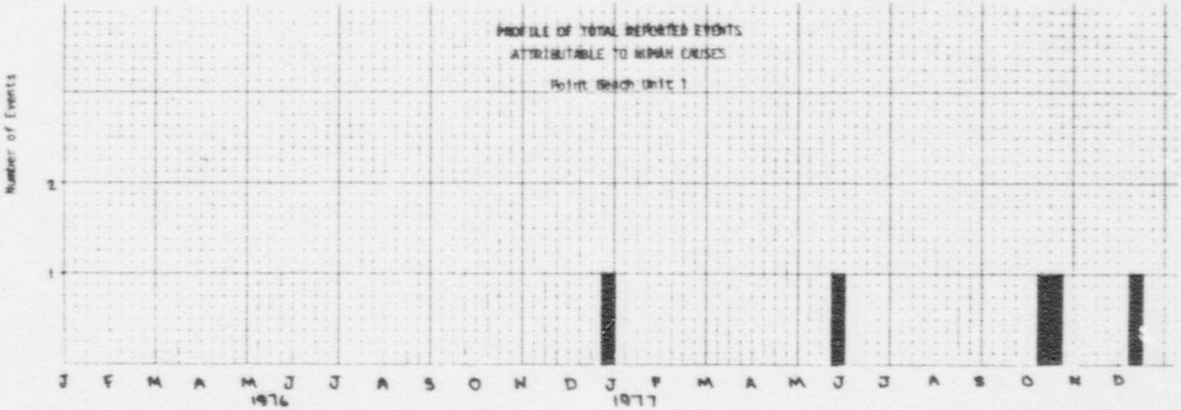
Licensee remedies proposed in inspection report: 36%

Per cent regional error in 766 system input: not available

INDICATORS

Licensee action on identified noncompliance items: always complete

Repeat noncompliances in two-year period: 0



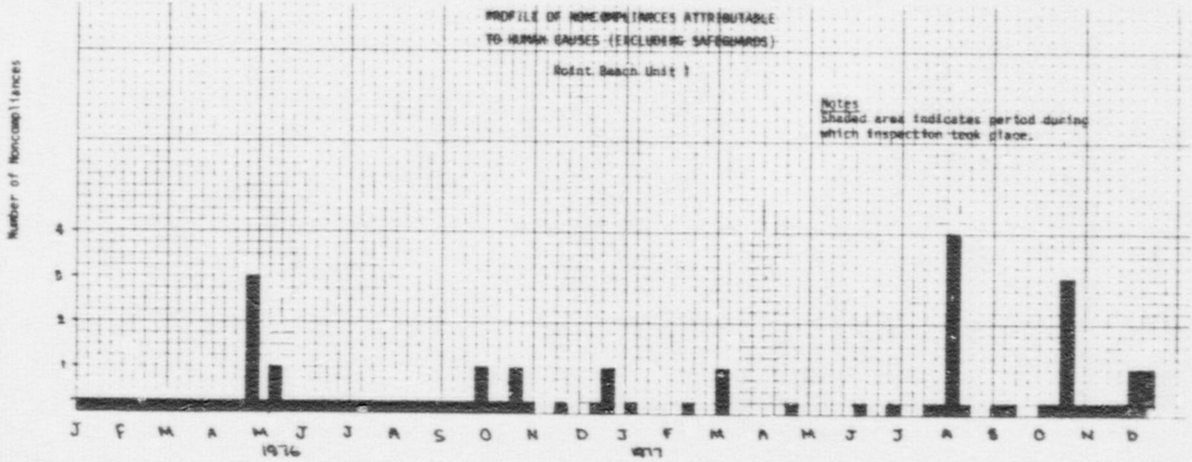


FIGURE 21a

Zion Unit 1

<u>INDEXES</u>

Per cent noncompliances due to inspector cues: <u>52%</u>

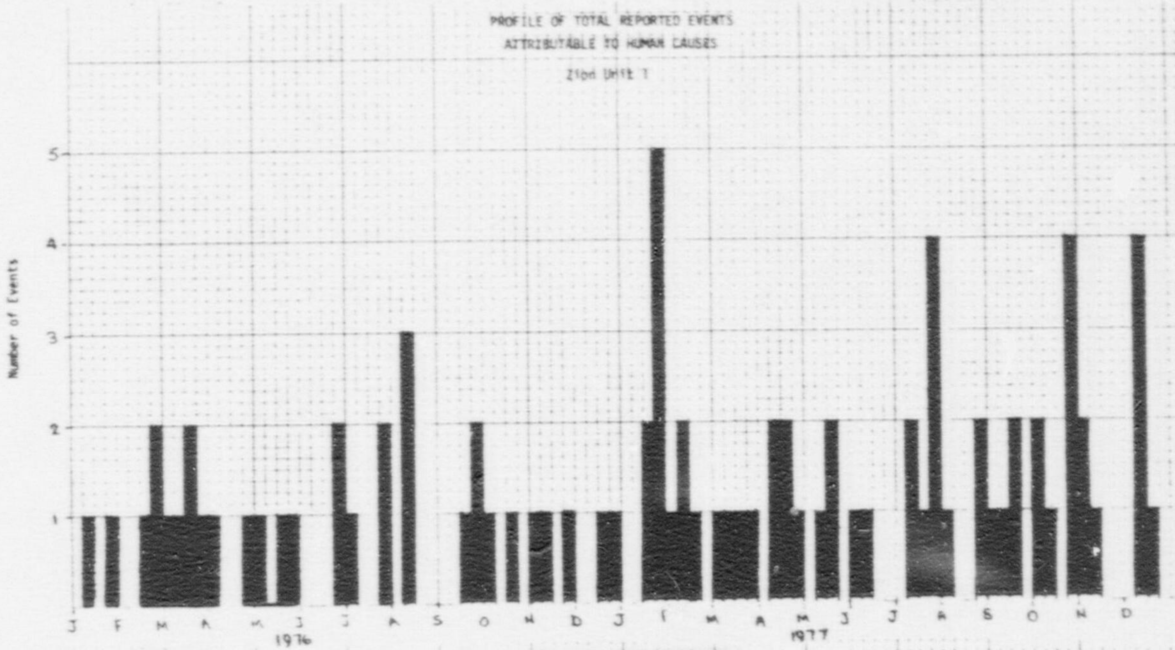
Licensee remedies proposed in inspection report: <u>50%</u>

Per cent regional error in 766 system input: <u>not available</u>

<u>INDICATORS</u>

Licensee action on identified noncompliance items: <u>70% deficient</u>

Repeat noncompliances in two-year period: <u>5</u>



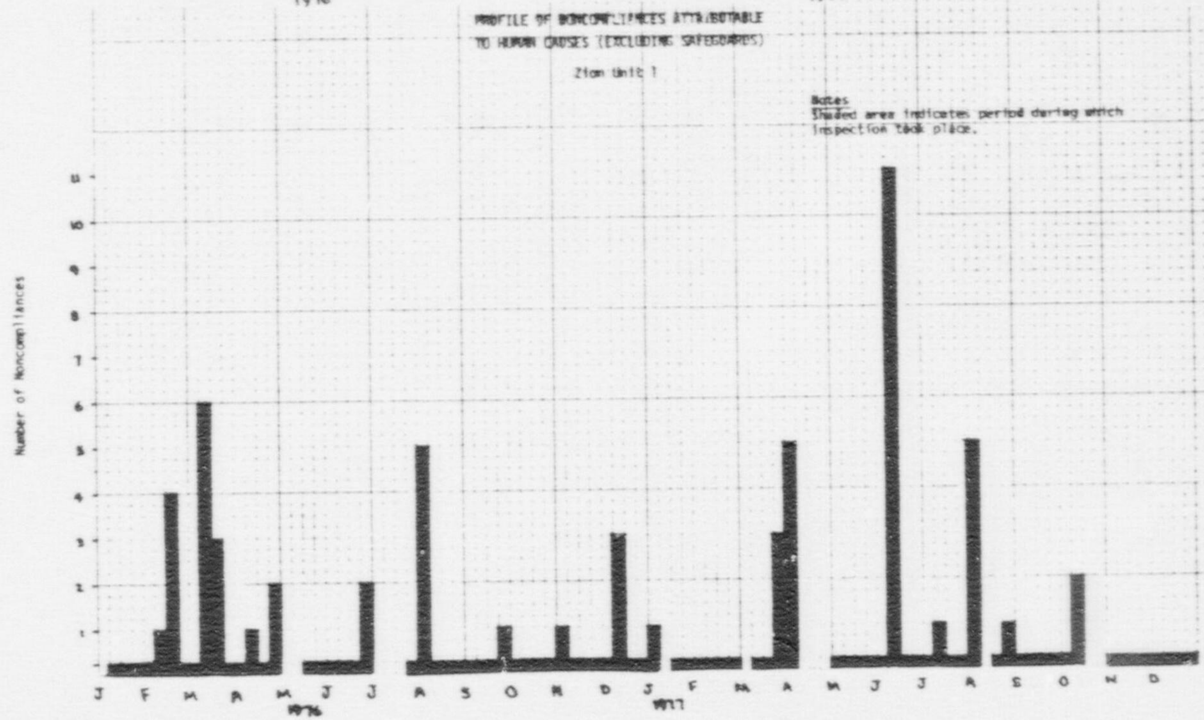


FIGURE 21b

LICENSEE PERFORMANCE ANALYSIS - 1976 and 1977

Prairie Island Unit 1

INDEXES

Per cent noncompliances due to inspector cues: 28%

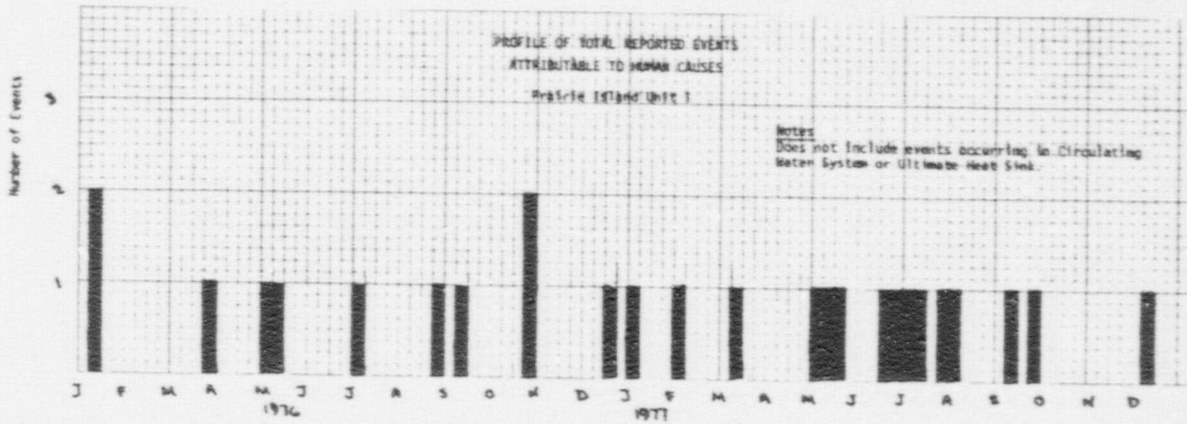
Licensee remedies proposed in inspection report: 45%

Per cent regional error in 766 system input: not available

INDICATORS

Licensee action on identified noncompliance items: complete (1 exception)

Repeat noncompliances in two-year period: 0



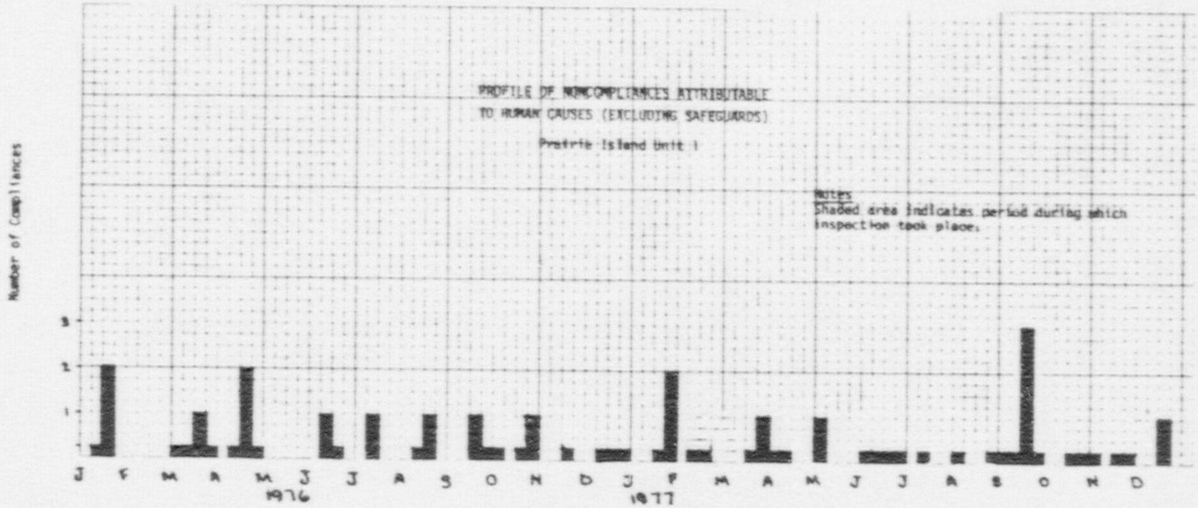


FIGURE 21

3.6.2 Performing the Assessment

There is no question that the model is fundamentally applicable to each individual licensee. But whether it is possible to use the model to analyze performance of any class of licensee depends on:

- the availability of necessary data, and
- the availability of manpower resources to perform the analysis.

Availability of Data

Availability of data is briefly discussed in Sections 3.3.2.1 and 3.3.3.1. Here, we summarize whether sufficient data are available to make performance analysis possible for each class of licensee. The stress here is on computerized data in the LER and 766 files, since use of non-automated data, while possible, is less practical.

Operating Power Reactors

There are sufficient data in the 766 file and the LER file to analyze the performance of each licensee in this class.

Reactors Under Construction

For the 51 sites on which 93 reactors are under construction, there are only 78 construction deficiency reports for 28 sites in the LER file for 1976 and 1977. The rest of the construction deficiency report exist in written form (as 50.55e reports), primarily in the regions. Without resorting to the regional reports, the LER data are too scant to be used in performance analysis.

The 766 system contains data from 1,997 inspection reports in reactors under construction per year. This data density is probably adequate for performance analysis, keeping in mind the *caveats* of Section 3.3.3.2.

Test and Research Reactors, Fuel Facilities, and Materials Licensees

For the 93 test and research reactors, there are data from 247 inspection reports in the 766 file for 1976 and 1977, an average of 1.3 reports for each reactor per year. This data density is probably not adequate for performance analysis.

There were data from 995 inspection reports in the 766 file for the 38 fuel cycle facilities in 1976 and 1977, an average of 13 reports per facility per year. This data density is adequate for performance analysis. There were 4,737 inspection reports prepared for the more than 9,600 materials licensees in 1976 and 1977, an average of less than .25 reports per licensee per year. This data density is clearly inadequate for performance analysis.

LER data for these three licensee classes are practically nonexistent. In 1976 and 1977, a total of 137 events were entered into the LER file for all these classes combined. Most of these LERs are for the 93 test and research reactors and the 38 fuel facilities, producing an average of .5 report per year for those 131 licensees. The data density is inadequate for performance evaluation for these classes of licensees.

To summarize, we believe it is possible to perform meaningful two-dimensional performance analyses (using LER file and 766 file data) only for operating power reactors at this time. Only the single dimension of 766 data is adequate to analyze performance for reactors under construction and for fuel facilities. However, due to data limitations as discussed in Section 3.3.3.2, this one-dimensional analysis will not provide a comprehensive evaluation of licensee performance nor the necessary insights into the reasons for that performance.

Availability of Program Resources for Performance Evaluation

The FPM model and methodology permits the performance of licensees to be analyzed individually. For certain classes of licensees, particularly the operating power reactors, sufficient data makes individual analysis possible. However, there are classes of licensees - materials licensees, for example - for which the existing data are scant and manpower and time to gather more data may not be available. But we believe that the performance of these classes can be analyzed in the aggregate through inspection of a "stratified" statistical sample of the class. As used in this context, statistical sampling is similar in principle but differs from previous uses NRC has made of this technique. NRC has in the past considered statistical sampling to determine the number of items to be inspected for each licensee, as in the Statistical Sampling Inspection Program discussed in Section 2.5.1 of this report. We propose to use statistical sampling techniques to determine the total number of licensees upon which inspection resources would temporarily be focused.

A performance profile can be established for each licensee in the statistically selected sample group and licensees with similar profiles within sample group can be identified. The result will be a statistically selected sample of licensees that can be grouped on the basis of similarity in performance profiles. This method will permit NRC to make statistically valid statements that characterize:

- The performance of a licensee class in terms of what percentage is represented by each profile--the establishment of "class performance groups."
- The risk presented by a class of licensees on the basis of the "class performance groups."

This type of analysis will permit the NRC to focus its resources on those sub-classes of licensees that require further attention. It will also permit the NRC to evaluate the type and amount of additional regulatory attention it should devote to a particular class of licensee.

4.0 RESPONSE TO REQUIREMENTS OF THE NRC REQUEST FOR PROPOSAL

4.1 SUPPORT FOR NRC'S MISSION AND GOALS

NRC must continually ask whether its actions effectively support its mission to protect the public health and safety, to safeguard nuclear materials, and to maintain environmental quality. This question is especially important in a program that may be somewhat controversial. We believe that licensee performance analysis fully supports NRC's mission and goals for several reasons:

- Licensee performance analysis can be used as a tool for effectively allocating inspection resources. If increased attention to a licensee can help him improve his operational safety, then that improvement directly supports NRC's mission.
- Our study to date indicates that licensees whose performance patterns display sequences of causally linked events either at the system level or in aggregate are more likely to experience future significant events than those whose patterns suggest more effective managerial control. This inference could prove helpful to NRC through alerting the agency to the need for appropriate action.
- NRC must have an effective enforcement program, and the performance profiles can be used to establish a context for determining the severity of sanctions when noncompliance occurs.
- A properly structured performance analysis tool can improve relationships between NRC and the licensees by more clearly defining a level of acceptable performance. A poor relationship between NRC and the licensees affects the ability of both parties to protect public health and safety in an efficient and effective way.

We are also convinced that licensee performance analysis offers insight into the safety differences among licensees. Mechanical safety of a plant is the result of the licensing process, and to the extent that the licensing process does its job, all plants should meet minimum safety requirements when an operating license is issued. After a plant begins operating, safety is much more a function of the management and personnel than of equipment. Licensee performance analysis is capable of revealing management and personnel response to the "signals" provided by the plant through checking for chains of causally linked events. A small number of related events show that management and personnel can accurately pinpoint problems and solve them; many related events indicate the failure to react adequately.

The question of publishing the results of licensee performance analysis should not assume a major weight, but it must be considered. There is little doubt that the results of the analyses will be published in some form, simply because NRC has an obligation to report to the public. The existence of the Freedom of Information Act guarantees that the obligation will be met. The real issue is the form in which the analyses will be released; the potential public use or misuse may influence that form. The information released should be factual rather than inferential; one possible format is an annual "rainbow book" presenting profiles for each licensee together with other information such as inspection hours and numbers of noncompliances.

4.2 MEETING THE NRC'S "EVALUATION CONSIDERATIONS"

In its Request for Proposal, NRC identified several "Evaluation Considerations" against which the developed evaluation methodology was to be tested. Each of these considerations is presented below together with responses based on the FPM model and methodology.

- 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.

  Response: LERs are indicators of "out-of-bounds" operation; thus analysis of their content can provide insight into potential safety problems.

- 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 factors, unless it can be demonstrated that those factors relate to NRC requirements or to the safety of a licensed operation. Areas where NRC's regulatory authority should be expanded will be identified.

Response: The FPM methodology can be fully applied within the current scope of NRC's regulatory authority.

- 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.

  Response: To effectively use the model, the content of data must be analyzed in appreciable depth. For example, licensee performance patterns based on LERs are derived from the contents of these reports, which must be carefully analyzed and evaluated if the end results are to be meaningful and useful.

- 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.

  Response: The FPM methodology is not quantitative in the sense implied above because its purpose is to achieve both a temporal assessment of the licensee's performance patterns and an insight into the reasons for the shapes of these patterns.

- 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 is obtainable with reasonable effort. The contractor will identify data that should be made available and suggest appropriate methods for its collection.

  Response: The case studies included in this report were all based on currently available computerized data. The subject of what data would be most useful for application in the methodology described, including the question of appropriate collection means, is complex and is discussed in Section 6.0 of this report.

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

  Response: This is a valid consideration, and the FPM methodology ignores factors not within the control of the licensee.

- 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.

  Response: This methodology is applied uniformly to the members of a given licensee class and in a form appropriate to that class.

- 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.

  Response: In the case studies, we developed performance patterns for overall licensee performance and for performance as reflected by event histories of specific facility systems. The FPM methodology is inherently suitable for evaluating performance in various areas of responsibility, provided that appropriate data can be made available.

- 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.

  Response: The FPM methodology permits evaluations of both types. It is not, however, designed for the ranking of licensees on a numerical scale.

- 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.

  Response: This methodology does not combine diverse performance indicators within a single end measure, but instead portrays licensee performance as a pattern over time. The question of factor weighting is not relevant to the FPM methodology.

5.0 PLAN OF ACTION FOR PHASE II

This section presents our proposed plan of work for Phase II of this study. Originally, Phase I was to be a feasibility study, and a methodology was to be developed in Task II and applied to Task III, both components of Phase II. Our Phase I work meets all the requirements of Phase I and Task II. We developed the FPM model and found that it applies to all classes of licensees in principle (see Section 3.4.1) but that currently available data are insufficient to permit meaningful performance analysis of licensees other than operating power reactors (see Section 3.4.2). Potential solutions to this problem are discussed in Section 6.1 as "Work Area 3." We have also begun to meet Task III, by applying the analysis methodology to three operating power reactors to test its worth and sensitivity to performance differences; it appears capable of producing performance patterns that not only distinguish "good" from "poor" performers but that illustrate the reasons for those distinctions.

5.1 PHASE II WORK PLAN

In Phase II, we plan to continue to test and refine the FPM model by conducting licensee performance analyses of seventeen additional power reactors. I&E management has already identified seven licensees in this group:

1) Trojan
2) San Onofre 1
3) H.B. Robinson
4) Indian Point 2
5) Oconee 1
6) Browns Ferry 1
7) Arkansas 1

In the original RFP statement of work, NRC proposed analyzing "twenty reportable events that had potential safety significance...." The Phase I work has demonstrated that a far more complete and searching study of licensee performance is essential if an event or combination of events is to be viewed in a meaningful perspective. It is for this reason that the remaining case study effort will be expanded considerably beyond the scope that NRC had originally envisaged.

The seventeen case studies to be performed, together with those originally conducted, will include operating power reactor licensees selected from all five NRC regions. The Phase II analyses will follow the methodology described in this report and, to provide consistent data, will cover the same two-year period of 1976 and 1977. Reviewing and interpreting the analyses from this larger population should expand the insight into the causal mechanisms explaining licensee behavior, and will help determine the effect (if any) of different reporting requirements and technical specifications. Comparing and analyzing a large number of licensee performance profiles may reveal indicators of the probability of future event occurrences.

The complete description of work performed in Phase II, together with analyses and interpretations of the case study findings, will be provided in the Phase II report. This report will deal primarily with specific licensee analyses rather than general methodological considerations.

5.2 PHASE II REVISED ESTIMATE OF EFFORT

Even though, as explained above, the Phase II work effort to be performed exceeds that originally envisioned, we believe that the work can probably be accomplished within the remaining contract resources. However, we have found that the resources required per case study vary considerably. As an example, we analyzed roughly five times as many LERs for Zion Unit 1 as we did for Point Beach Unit 1. Obviously, these factors make it difficult to predict the aggregate Phase II level of effort with precision.

If the magnitude of the total available data for the remaining seventeen cases should prove to be quite large, we would seriously consider its reduction and analysis by computer, as was discussed in our original technical proposal. It is expected that a judgment will be made early during the Phase II work period regarding the benefits and costs of this approach. The Project Officer will be immediately informed of this judgment and its implications for project resources to allow him to come to a prompt decision.

6.0 RECOMMENDATIONS FOR CONSIDERATION BY THE NRC

This section sets out several work areas identified during the Phase I effort which, although outside of the current scope of work, should be given consideration by the NRC. These areas relate either directly to licensee performance analysis or to NRC's inspection program. In virtually all cases these areas could not have been precisely defined prior to the performance of the work described in this report. Largely as a consequence of studies to date and to some degree as a result of discussion of our preliminary results with I&E staff personnel, it is clear that the recommendations summarized below address agency needs that are coming into sharper focus:

The recommended study areas fall into two categories:

- Direct extensions of the current effort: These work areas address necessary refinements and expansions of the licensee performance analysis methodology already developed. They also include applying this methodology to earlier phases of power reactor operating history than have been considered to date.
- Supplements to the current effort. In a strict sense, these topical areas fall outside of licensee performance analysis as a methodology, since they relate to the formal structure and the practical implementation of the NRC inspection process.

6.1 DIRECT EXTENSIONS OF THE CURRENT EFFORT

Work Area 1. Data Quality Improvement for Licensee Performance Analysis

In Sections 3.3.2 and 3.3.3, we identified the inadequacies in the currently existing computerized data for operating power reactors and discussed how we adapted those data for use in the FPM model. To use the FPM model to its fullest capacity, it is essential that these data be made available to the licensee performance analyst in a form that permits the analyst to draw complete and accurate inferences about the information within the FPM model arrows and the actions within the FPM circles. It is equally important that data accuracy and completeness be well standarized among the NRC regions. Current criteria for LER reporting must be carefully reviewed to make these criteria more specific, particularly with respect to the "grey area." At present, it is not uncommon for a licensee to seek guidance from I&E as to whether an LER is required, especially when the severity of the event in question is marginal.

We recommend that both the LER and 766 reporting formats and requirements be modified to provide more directly useful information for licensee performance analysis. Appropriate codification of this restructured data will permit licensee performance patterns to be generated by computer.

Work Area 2. Automation of Licensee Performance Analysis for Operating Power Reactors

In Section 3.5, we discussed the relationship of the FPM methodology to the PAT program and suggested the possibility of applying that methodology through interactive computer capability. This would permit "real time" performance profiles to be continuously and automatically produced and updated through links with the 766 and LER data systems.

Work area 1 was concerned with achieving a data form compatible with the FPM model and amenable to automated processing. Once these necessary steps have been taken, appropriate software for licensee performance pattern generation and interpretation can be developed.

Automation of licensee performance analysis will serve I&E interests in two key respects:

- It will relieve scarce personnel resources of the burder of generating and interpreting performance profiles by "hand and eye."
- Uniformity of pattern interpretation will be enhanced by excluding variable human judgment.

This work area cannot be implemented until or near the conclusion of the previous work area effort.

Work Area 3. The Data Availability Problem (Licensees other than Operating Reactors)

As explained in Section 3.6.1, the FPM model is general in concept and is inherently applicable to all classes of NRC licensees. The difficulty in applying the model to classes of licensees other than operating power reactors lies in the paucity of reliable data. For example (see Section 3.6.2), in the two-year period of 1976 and 1977, there are only 137 LERs in the NRC computer file for the 93 test and research reactors, 38 fuel cycle facilities, and the more than 9,600 materials licensees. For this same period there are 247 inspection reports for 93 test and research reactors, 995 inspection reports for the 38 fuel cycle facilities and 4,737 inspection reports for the more than 9,600 materials licensees. While the density of 766 data is acceptable for most licensees (except for materials licensees and test and research reactors), the LER data for licensees other than operating reactors is not adequate to permit meaningful performance analysis.

We believe that the density of LERs could be increased if reporting requirement were specifically tailored to reflect the performance-sensitive characteristics of each licensee class. At present, it does not appear likely that the density of inspection reports for those licensee classes in which it is now low can be materially increased because of I&E personnel resource limitations. It is possible, however, that applying appropriate population sampling techniques can appreciably augment the inspection information density for the sample. This will permit valid statistical inferences about the different licensee classes.

Work Area 4. Performance Profiles of Immature Operating Power Reactor Licensees

It is a matter of common knowledge that personnel performance tends to improve as a new task is gradually assimilated and mastered. The rate of improvement in new task performance with time can be graphically shown as a "learning curve." By analogy, in the case of operating power reactors, the significant event occurrence rate usually decreases as the operating history lengthens. This consideration was taken into account in the case studies presented in Appendix A, since each plant had been operating more than two years prior to the period of analysis. To the degree that it is reasonable to assume that the level of risk presented by newer plants (particularly during the startup phase) is greater than the level associated with more mature facilities, there could be a real advantage in developing and analyzing licensee "learning curves" based on data from the first three years of operation. It is quite possible that analysis may reveal performance patterns that are characteristic of early but not late periods of facility operation. These patterns can be extremely valuable to I&E in its effort to reduce the risk associated with facility operation during its immature period. We recommend that the early performance of about 10 plants be studied. These plants should have commenced operation not earlier than 1973, because the LER system was activated in that year.

6.2 SUPPLEMENTS TO THE CURRENT EFFORT

Work Area 5. Realignment of the Inspection Process

In Section 3.3.3.2, we discussed why the modularized inspection program does not lend itself to revealing the reasons for performance. The module under inspection is the "point of origin" of noncompliances, a point often well-removed from the actual event occurrence. The scheduling of the modules makes the noncompliance data in the 766 file reflect a time-dependence that is not inherent in the events, but in the program. Testing the 766 data against the model pointed out how certain aspects of the current inspection methods could be modified in a manner most beneficial to licensee performance analysis.

At this point, we believe it is important to distinguish between an inspection process in principle and the particular form in which that principle is implemented. For this reason, we propose to consider elments of program form that govern the output of the inspection process. At least five of these elements are: 1) time-dependence; 2) program area; 3) inspection unit (system or module); 4) use of inspector cues (reactivity); and 5) inspectable performance indicators other than noncompliances. These elements are highly interdependent. Therefore, we propose to develop experimental inspection programs with various "mixes" of the formal elements and to test the output of these experimental programs against the FPM model. The key objective of this redirection would be to enhance the informational value of the inspection process in the context of performance analysis; this redirection is in no way intended or designed to impair the critical role of the inspection process as a basis of safety assurance.

Work Area 6. I&E Regional Performance Analysis

NRC headquarters personnel, regional personnel, and the licensees all state that the regions vary in their management of inspection resources and in their general management approach. Whether the regional inspection program operations reflect the relative qualities of "good" and "poor" performing licensees is unknown. Regional program variations of this type can in part be observed through examining the temporal phase differences seen between the LER- and noncompliance-derived performance profiles. We believe that an inter-regional analysis whose objectives include the identification of correlations between phase lag magnitudes and noncompliance inspection yields will provide a useful tool for understanding differences among the regional operating philosophies (the relative preferences of regional directors for high non-compliance yields vs. short lags).

We do not suggest that the regional performance indicators mentioned above include all those most appropriate for identifying and assessing inter-regional differences. As in the case of licensee performance analysis, it will be necessary to construct an insightful model of I&E regional structure and operation (RSO model). Once this has been accomplished, the model will directly guide us to those parameters that are both meaningful and sensitive.

APPENDIX A
CASE STUDIES

INTRODUCTION

From the outset of this project it was clear that case studies were necessary to empirically test the validity of the chosen approach. Since our approach was to develop a comprehensive model and procedure applicable to all classes of licensees, we chose to perform case studies of operating power reactors to test the FPM model, methodology, and performance indicators against the most complex of NRC's licensees. Further, the data available for operating power reactors are the most complete.

Selecting the Case Studies

To eliminate any possible regional effects that could diminish the meaningful comparison of one case study with another, we performed all the case studies in one NRC region. To prevent the possible bias of cross-NSSS vendor comparison, we searched for facilities using the same equipment. Third, based on discussions with NRC personnel, we felt that any facility must have been operating for more than two years, to prevent a "learning curve" effect from destroying meaningful comparison and possibly obscuring the patterns or indicators that might otherwise be evident in a mature facility.

Finally, we decided to study at least two facilities, one perceived by NRC as a "weak" performer and the other as a "good" performer. This provided us with the opportunity to empirically identify patterns and indicators related to each performance category ("poor" and "good"). It also offered the chance to gain insight into underlying causal factors associated with the dichotomy of performance.

For these reasons, we selected Zion Unit 1 and Point Beach Unit 1. Both are in Region 3, both are Westinghouse plants, and last, both had more than two years of operating experience by the beginning of 1976. When we discussed our choices with Region 3 management, it was mentioned that the differences in technical specifications and reporting requirements between Zion Unit 1 and Point Beach Unit 1 were considerable. Region 3 felt that we should consider studying a third performer with reporting requirements and technical specifications similar to Zion Unit 1, and suggested Prairie Island Unit 1. Consequently, we studied three licensees--Zion Unit 1, Point Beach Unit 1, and Prairie Island Unit 1. This gave us the additional opportunity to begin to examine the impact of differences in reporting requirements and technical specifications on the FPM model and methodology.

Performing the Case Studies

We performed the case studies in accordance with the FPM model and methodology discussed in Section 3.2, and we analyzed the LER file data and the 766 file data as described in Section 3.3.2.2 and 3.3.3.2 of this report. The study period covered calendar years 1976 and 1977, in order to produce profiles extending over a sufficient length of time to allow potential changes in performance to be seen and assessed. In any ongoing performance analysis, the study period should obviously be current, and each of these three case studies can be readily updated.

Presenting the Case Studies

Each case study is presented in two separate parts that reflect the two different data dimensions--LER data and 766 data--used in the study. This allows the reader to gain an appreciation of the types of insights each data source provides as well as an appreciation of the sensitivity of each source to specific aspects of licensee performance. Performance profiles and supporting data sheets help the reader gain insight into the foundations of the case study effort as well as an appreciation of the study details.

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-1 on page A-11. The Circulating Water System sustained an extraordinarily 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

The profile for this system is shown in Figure A-1. This system had nine events in 24 months, and we noted two groups of causally linked events. The first group involved three events spanning a 19-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)

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.

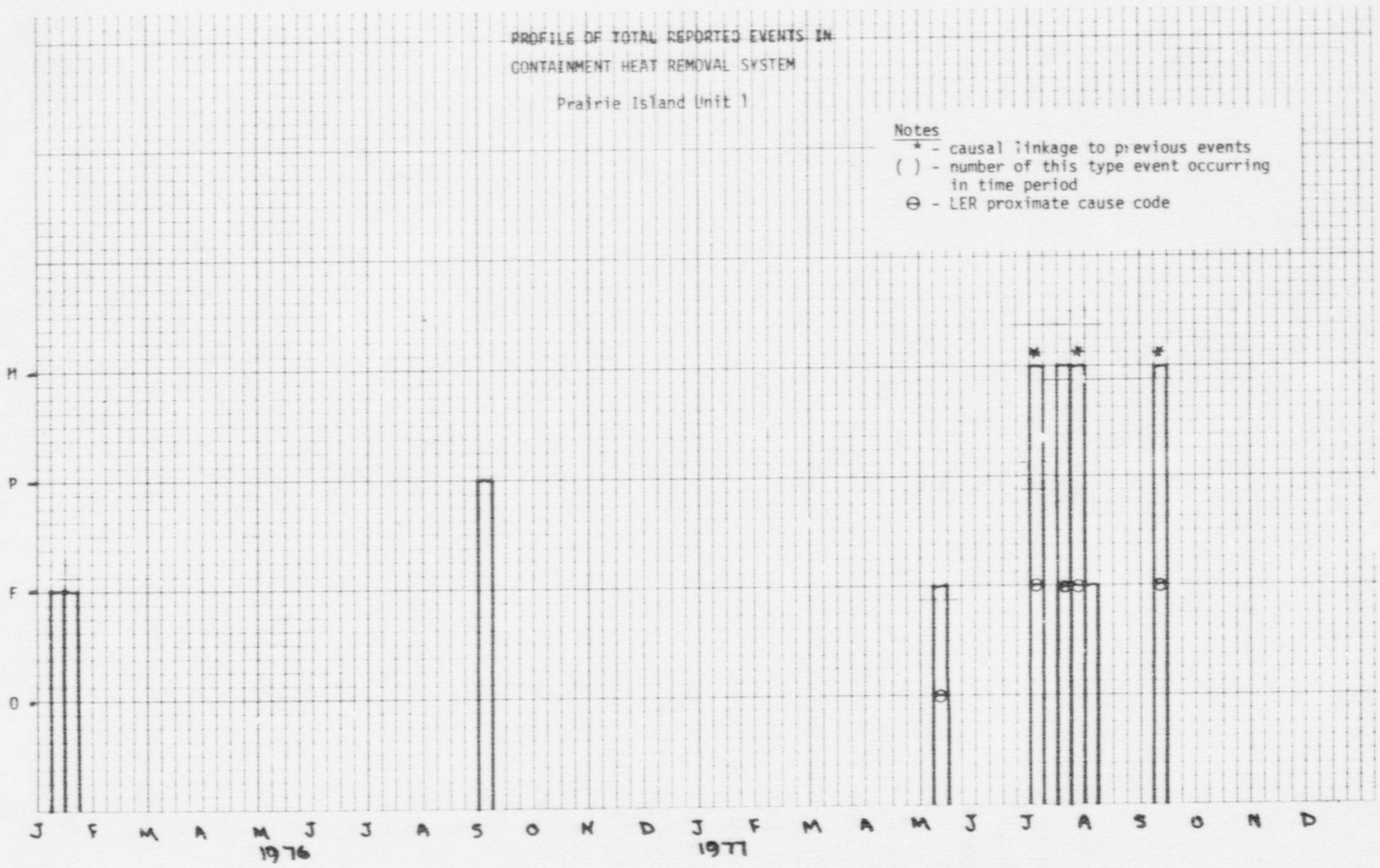

PROFILE OF TOTAL REPORTED EVENTS IN
CONTAINMENT HEAT REMOVAL SYSTEM
Prairie Island Unit 1
Notes
* - causal linkage to previous events
( ) - number of this type event occurring in time period
⊖ - LER proximate cause code
Event Responsibility Code
M
P
F
O
J F M A M J J A S O N D J F M A M J J A S O N D
1976
1977

FIGURE A-1

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

As the system profile in Figure A-2 shows, 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)

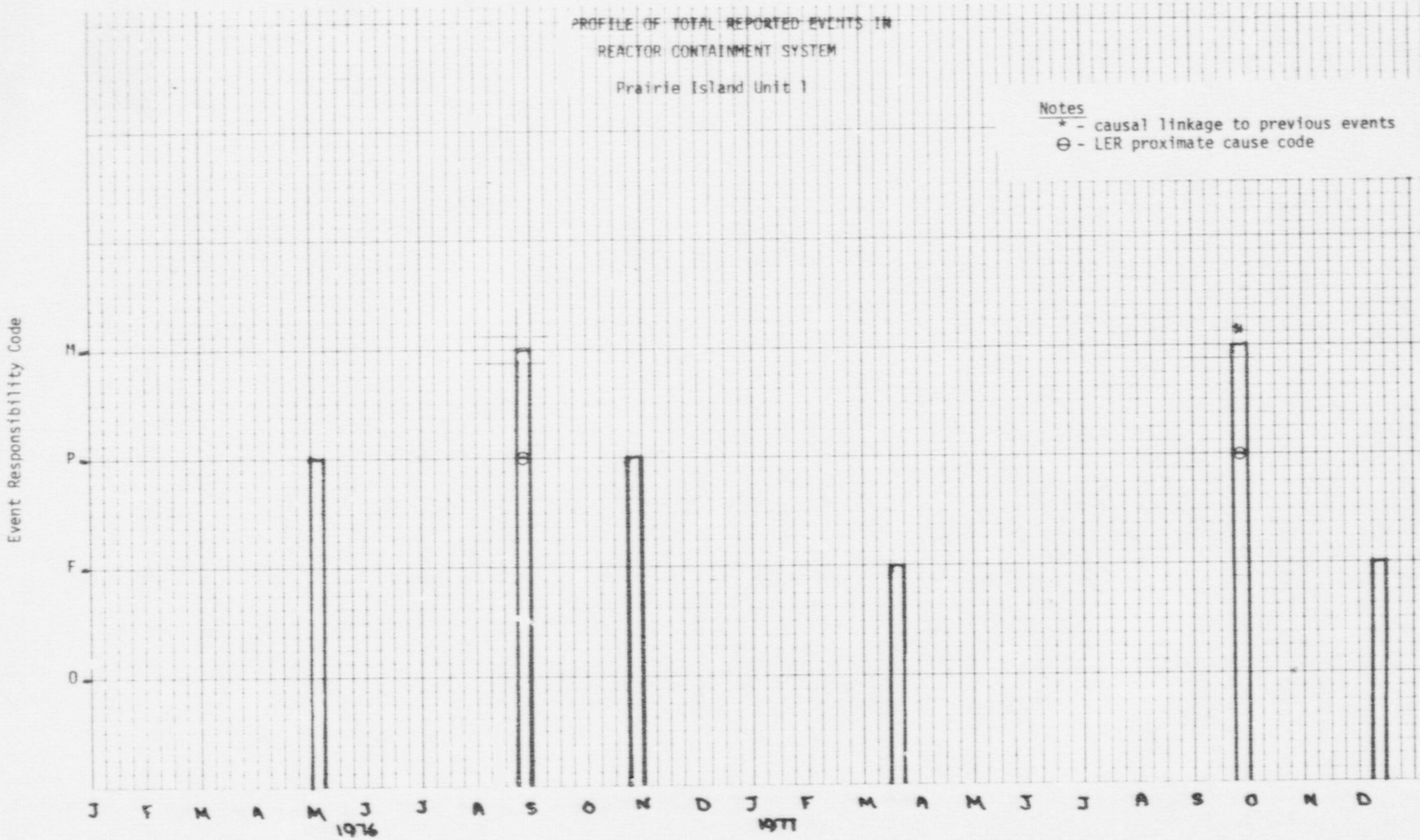

PROFILE OF TOTAL REPORTED EVENTS IN
REACTOR CONTAINMENT SYSTEM
Prairie Island Unit 1
Notes
* - causal linkage to previous events
⊖ - LER proximate cause code
Event Responsibility Code
M
P
F
O
J F M A M J J A S O N D J F M A M J J A S O N D
1976
1977

FIGURE A-2

and 9-29-77 (P/M) appear to be causally linked through apparent management failure to develop and implement administrative controls for the auxiliary building special ventilation 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.

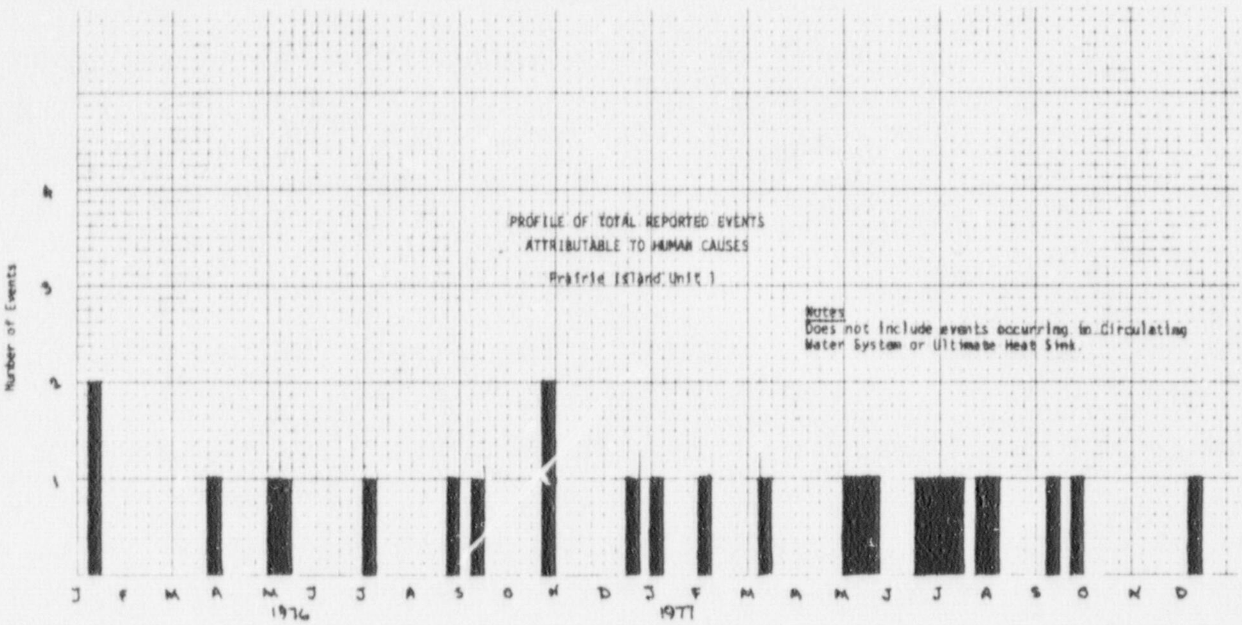
System Code Not Applicable

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 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.

The two profiles in Figure A-3 show the overall facility pattern of the cause of events. The top profile shows human error (management and personnel) as a function of time. Human error for this facility appears to uniformly distributed, indicating a well-managed facility operating in the "noise" band of event data. The bottom display shows component failure as a function of



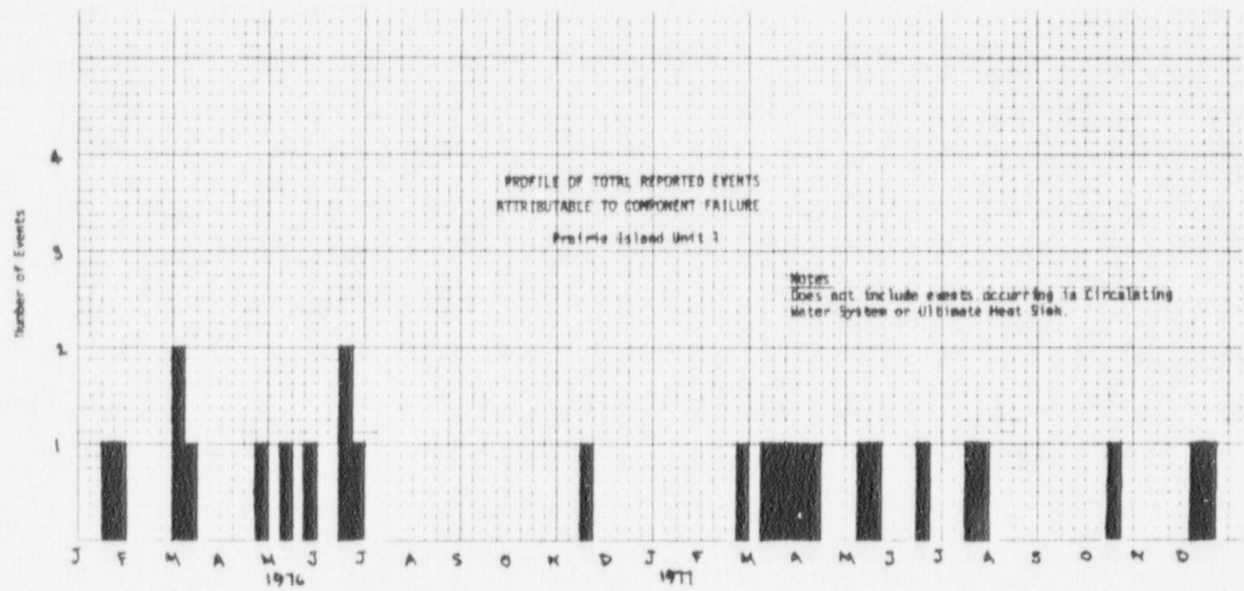


FIGURE A-3

Prairie Island Unit 1 Performance Profiles

Table A-1

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-1 (cont.)

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)	3-08-76(O/F)	4-24-76(F)	8-04-76(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(C/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-1 (cont.)

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]			

NOTES: FOR TABLE A-1

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 [illegible]-21-76 event - appears to be failure of management oversite in schedu[illegible] 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.

time. This display indicates a certain periodicity with a fairly uniform distribution at periodic intervals. Since most component failures were identified during routine surveillance testing, the apparent periodicity may be associated with the surveillance test frequency and mode of facility operation.

Review of 766 System Data File and Inspection Reports for Prairie Island 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. 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-1 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 agreed 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-1

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		

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)	

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	8 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)	

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

Prairie Island Unit 1 means that a review of the 766 enforcement 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 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.

Figure A-4 is a profile of the total noncompliances attributable to human causes, excluding safeguards.

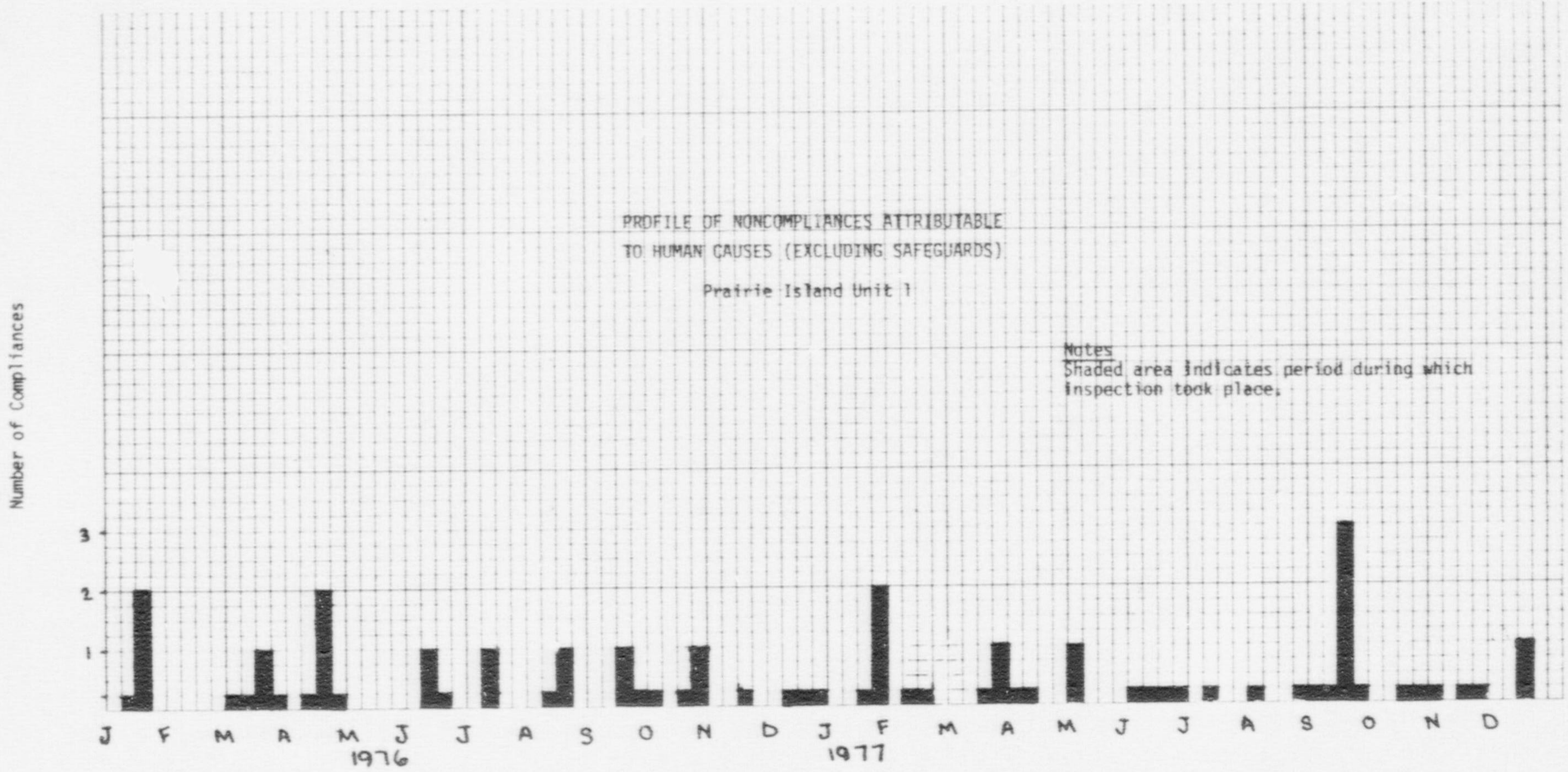

PROFILE OF NONCOMPLIANCES ATTRIBUTABLE
TO HUMAN CAUSES (EXCLUDING SAFEGUARDS)
Prairie Island Unit 1
Notes
Shaded area indicates period during which inspection took place.
Number of Compliances
3
2
1
J F M A M J J A S O N D
1976
J F M A M J J A S O N D
1977

FIGURE A-4

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-2 on page A-35. 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, as shown in Figure A-5. 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

*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.

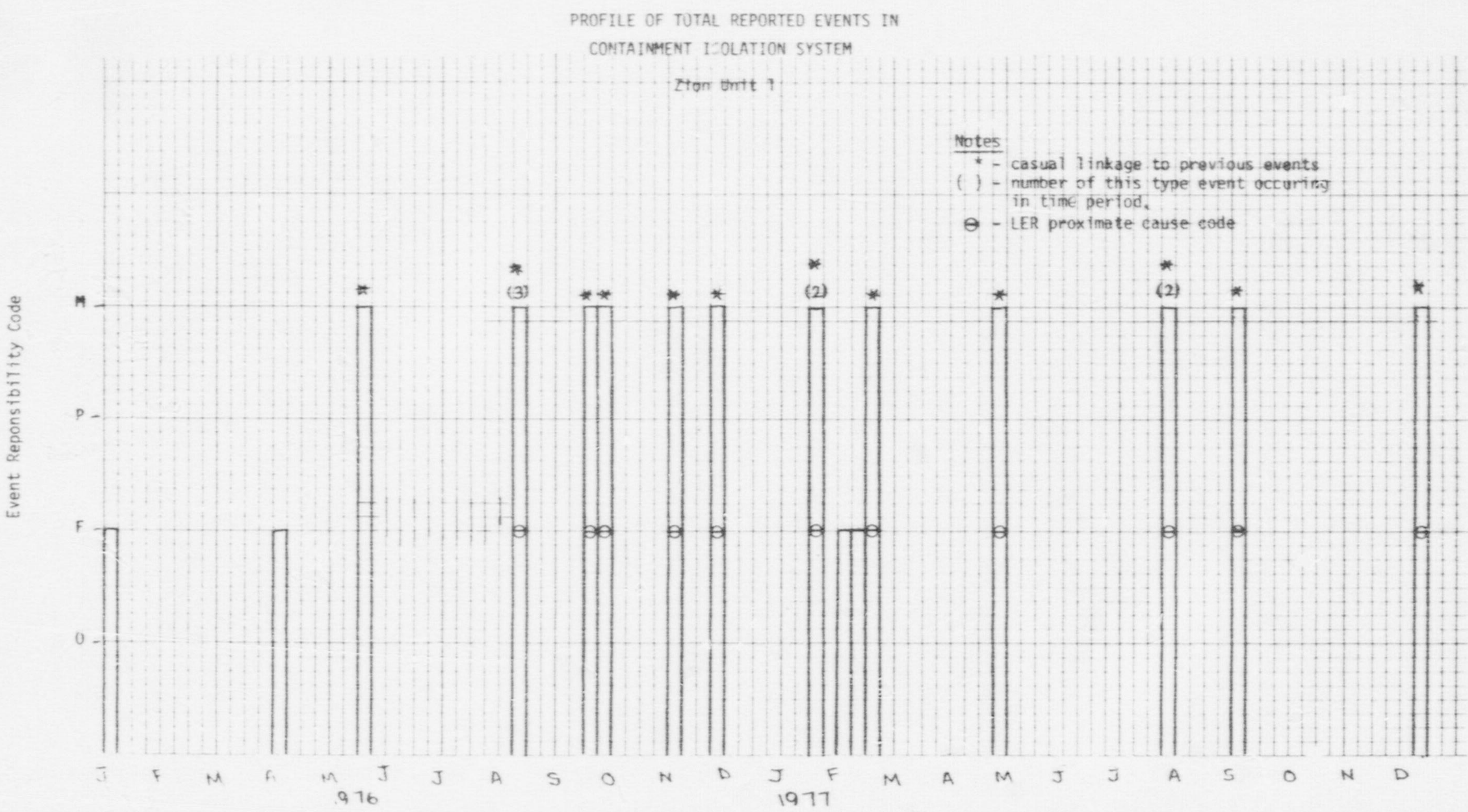

PROFILE OF TOTAL REPORTED EVENTS IN
CONTAINMENT ISOLATION SYSTEM
Zion Unit 1
Notes
* - casual linkage to previous events
( ) - number of this type event occuring in time period.
⊖ - LER proximate cause code
Event Reponsibility Code
M
P
F
O
(3)
(2)
(2)
J F M A M J J A S O N D J F M A M J J A S O N D
1976
1977

FIGURE A-5

three causally linked groups that 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.

Reactor Trip System

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 system profile is shown in Figure A-6.

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)

PROFILE OF TOTAL REPORTED EVENTS IN

REACTOR TRIP SYSTEM

Zion Unit 1

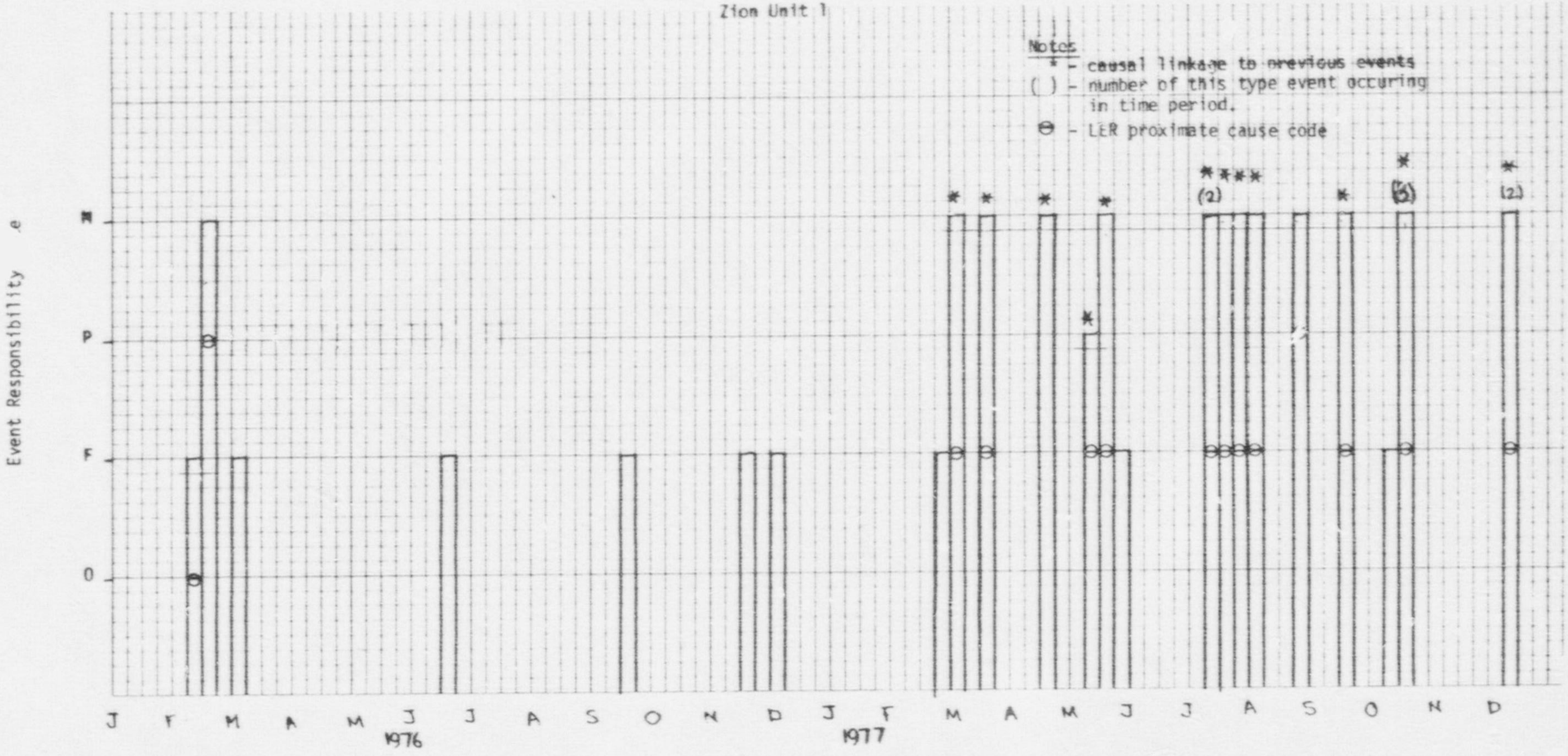


FIGURE A-6

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 l[illegible] 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, and the system profile is shown in Figure A-7. 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

PROFILE OF TOTAL REPORTED EVENTS IN

AIRBORNE RADIOACTIVE MONITORING SYSTEM

Zion Unit 1

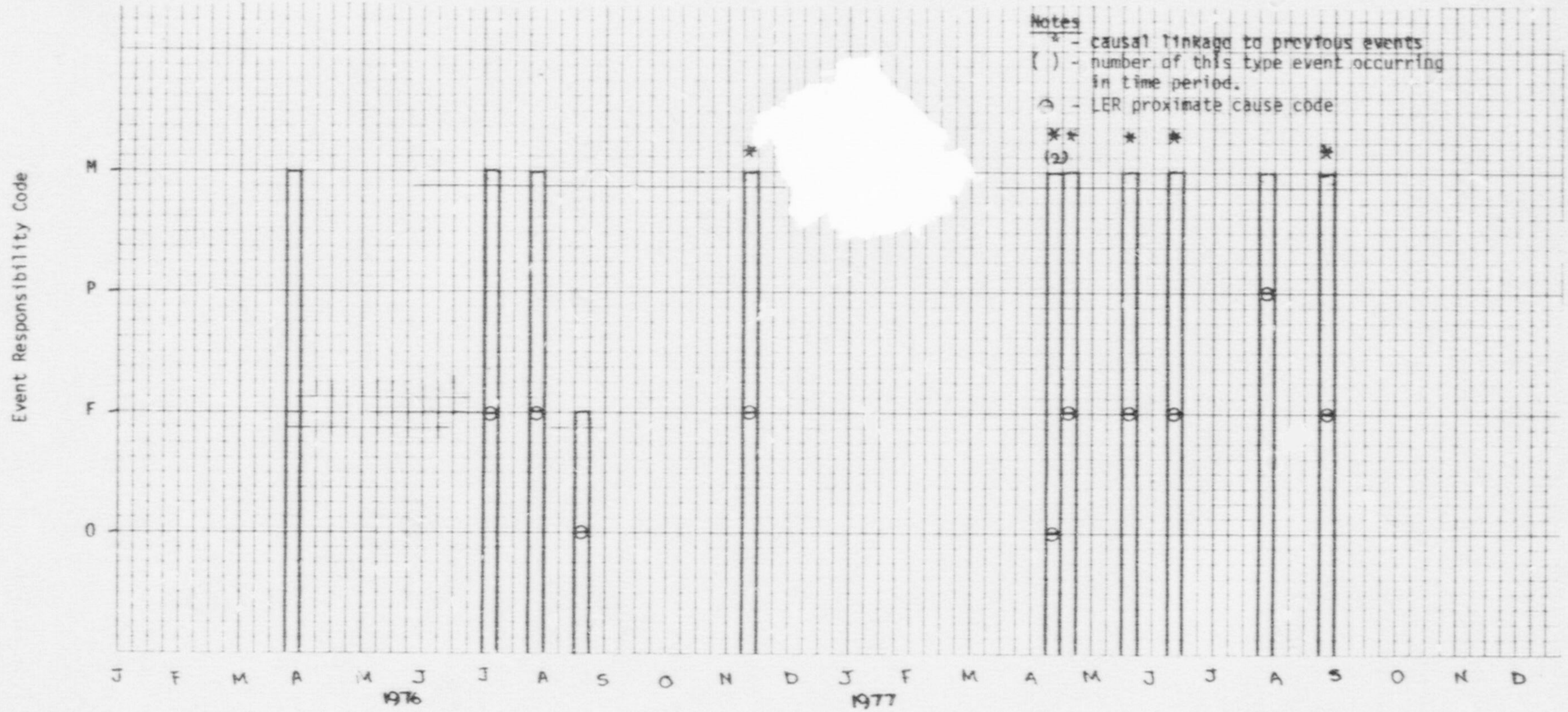


FIGURE A-7

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:

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

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.

<u>Hangers, Supports, and Shock Suppressors</u>

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-2

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)	5-04-76(O)	2-03-76(F)	2-21-76(P/M)	9-22-77(F/P)
5-18-76(M)[3]	1-27-77(F)	3-19-76(M)	5-26-76(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)			[illegible]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]	

Table A-2 (Cont.)

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)	3-24-75(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]		8-13-76(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]		

Table A-2 (Cont.)

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]		

Table A-2 (Cont.)

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]						

NOTES: FOR TABLE A-2

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.

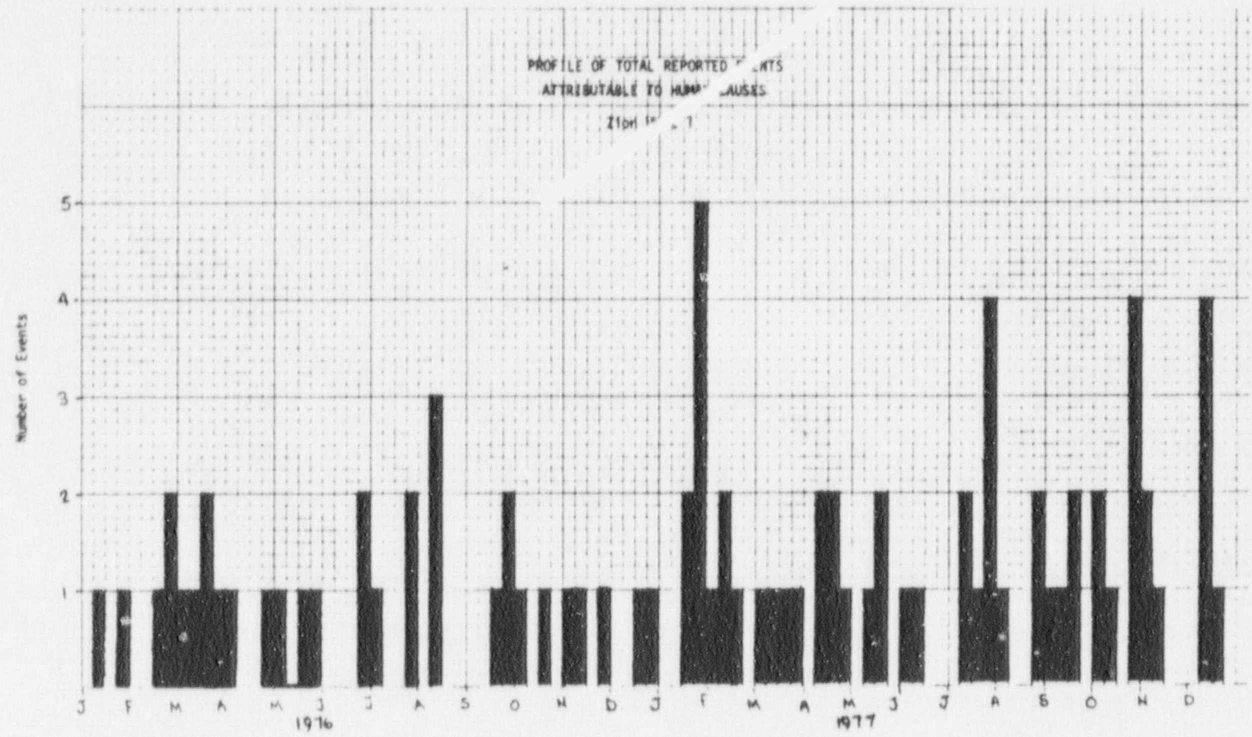
35. Related to 8-06-77 event in that management did not apparently view the problem generically.

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.



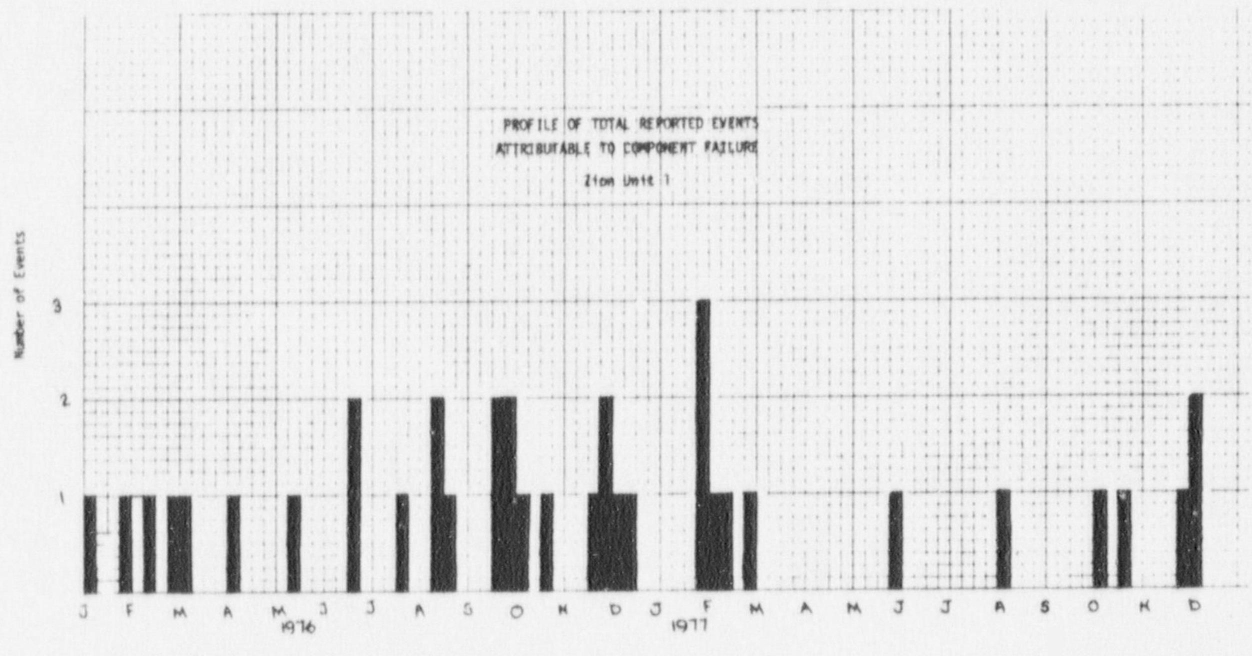


FIGURE A-8

Zion Unit 1 Performance Profiles

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.*

Figure A-8 on the previous page shows the Zion Unit 1 profiles of total reported events attributable to human causes together with the profile of events attributable to component failure.

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 improperly set. Control valve was properly set, and snubber retested satisfactorily. Similar snubber control valves are being rechecked." The response of Point Beach Unit 1 in checking similar snubber control valves shows that some licensees look for generic implications beyond the "conventional" system level.

Matrix A-2 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.

MATRIX A-2

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

NAME ZION 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?)
	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

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 TF.L	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.	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 Speci-fied Remedies to Preclude Recurrence as Stated in IE Report	Licensee Action on Previously-Identi-fied enforce-ment 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

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	NO	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	FJP3	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.

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	M	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/DIS-AGREE
(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		
	FJE2	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.

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?)
	FJK3	M	YES	NO	YES	NO	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		

NAME ZION 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?)
	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.

NAME ZION 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?)
	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.	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?)
	RMD2	M	YES	CAN'T TELL	YES	NO	NO	YES		
	RML3	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					

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. <u>Problems Revealed by this Incident</u>

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 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 incorrect (paragraphs B and C of the description) or missing 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.

Water Hammer and Safety Injection Event - July 8, 1977 (As described in I&E Inspection Report No. 50-295/77-16)

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.

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 <u>incorrect</u> or <u>missing</u> components of the information flow along <u>one or more of the arrows</u> 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.

Figure A-9 shows the noncompliance profile for Zion Unit 1.

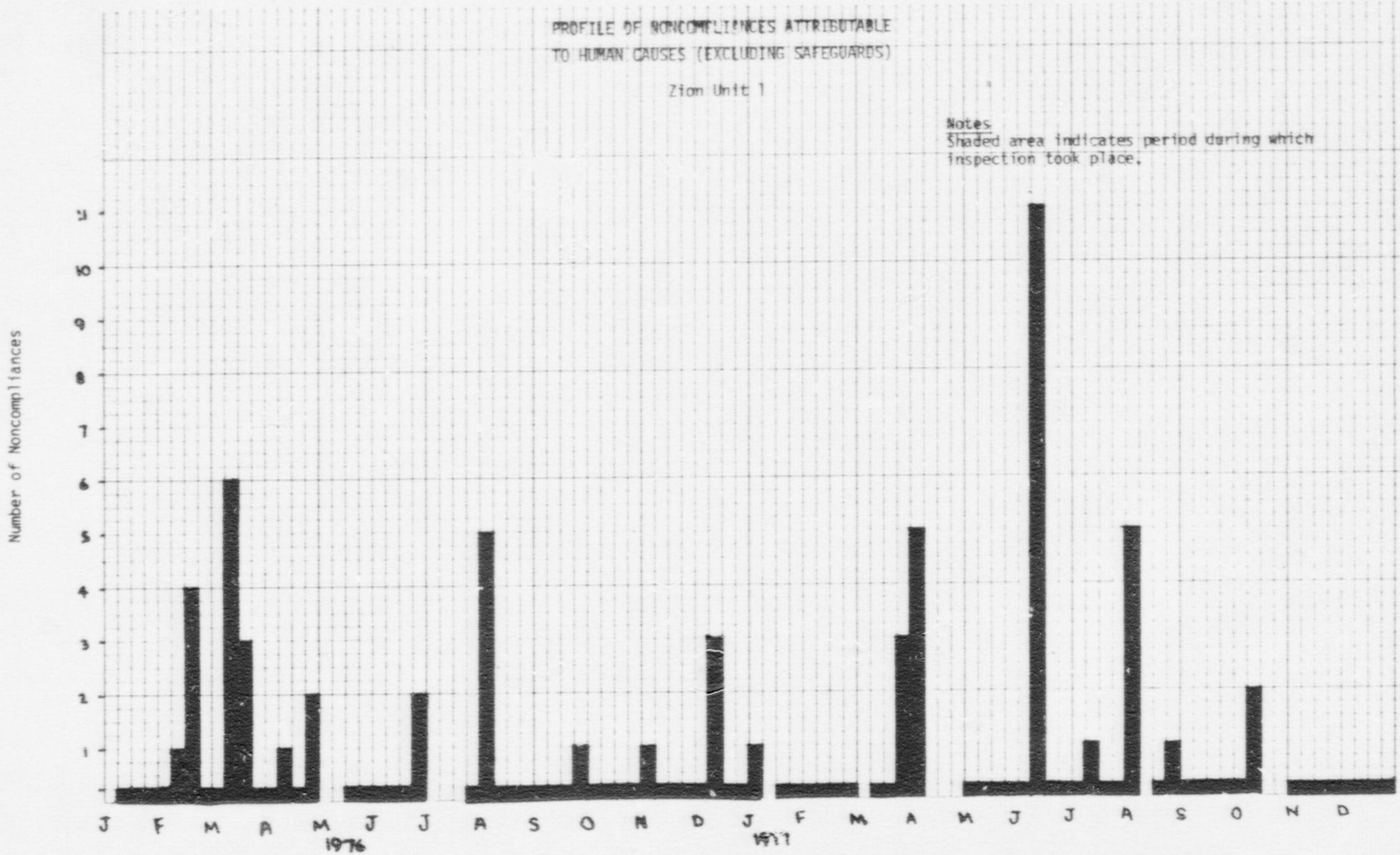

PROFILE OF NONCOMPLIANCES ATTRIBUTABLE
TO HUMAN CAUSES (EXCLUDING SAFEGUARDS)
Zion Unit 1
Notes
Shaded area indicates period during which inspection took place.
Number of Noncompliances
1
2
3
4
5
6
7
8
9
10
11
J
F
M
A
M
J
J
A
S
O
N
D
1976
J
F
M
A
M
J
J
A
S
O
N
D
1977

FIGURE A-9

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-3 on page A-63. 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.

Table A-3

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-3 (Cont.)

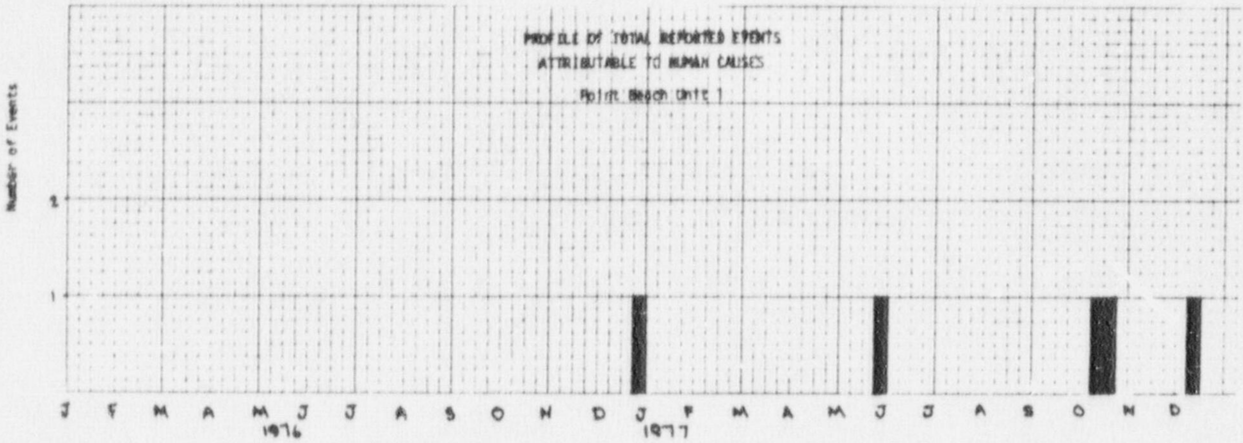
LERs BY SYSTEM AT POINT BEACH UNIT 1 - 1976 and 1977

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)		

NOTES: FOR TABLE A-3

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 si lar 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.



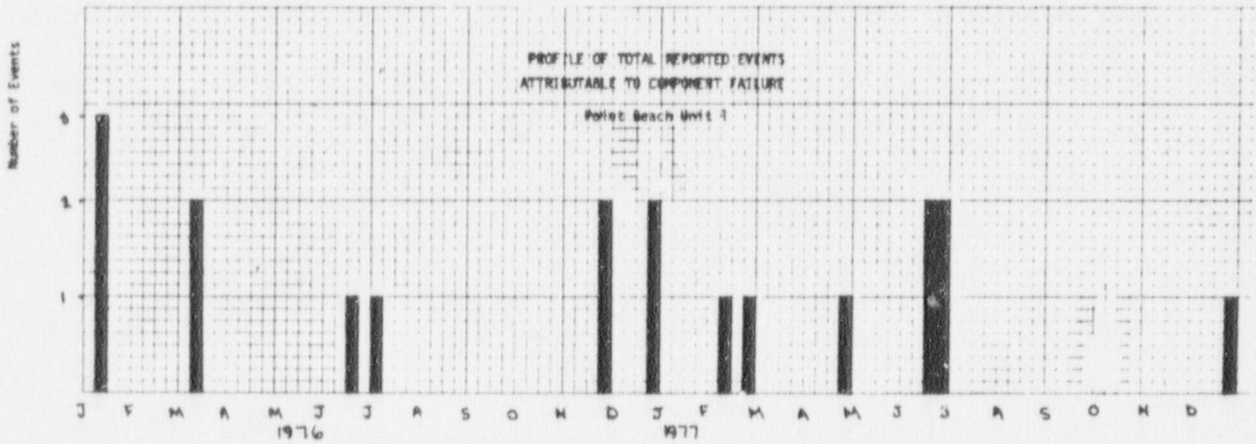


FIGURE A-10

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.

Figure A-10 on the previous page shows the profile of total reported events due to human causes and the profile of events due to component failure.

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-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, 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-3

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)	

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	FPF	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		

NAME POINT BEACH 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?)
77-09	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		

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 765 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 Actica 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		

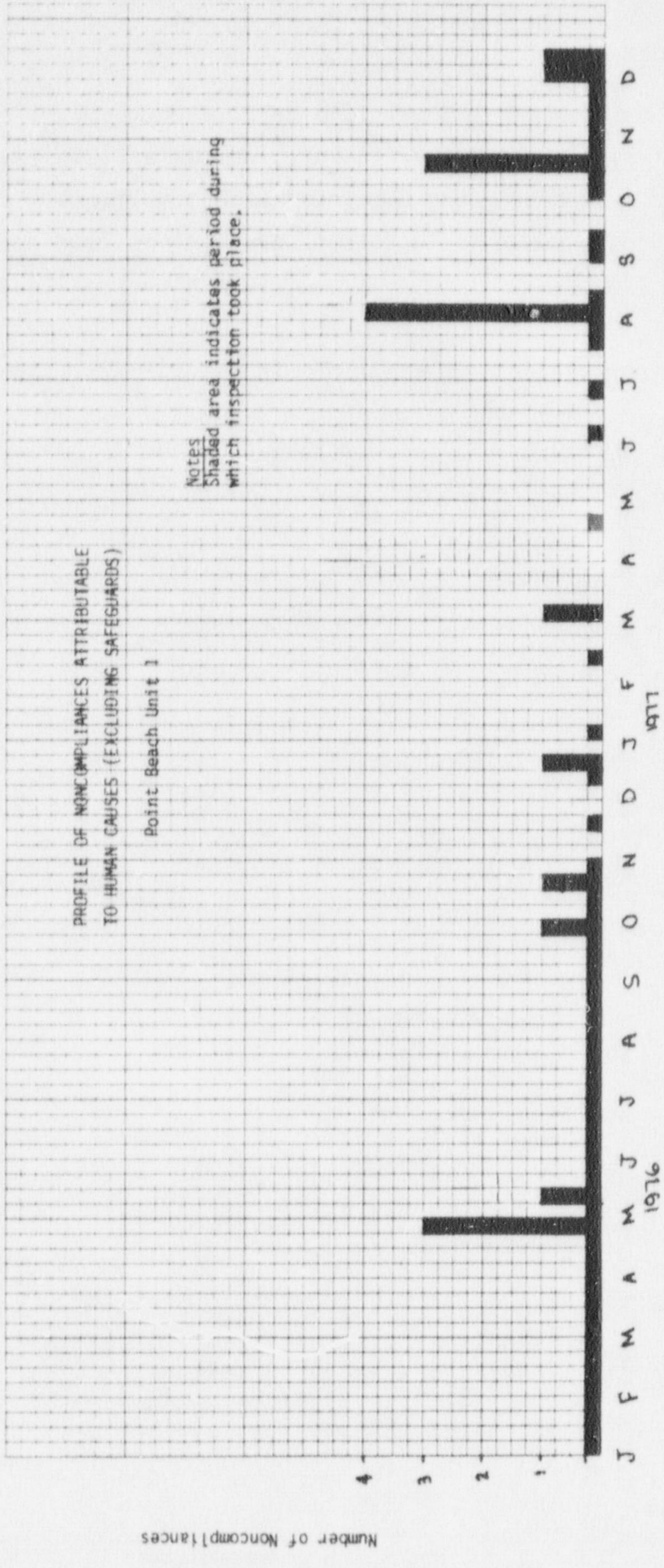
section of the inspection report. Less than 12 percent of the noncompliance cause codes either were ambiguous or did not agree with the associated inspection report details. The inspector's perception of the underlying cause of the noncompliance and his ability to communicate that perception in terms 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 without 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.

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.

Figure A-11 shows the noncompliance profile for Point Beach Unit 1.



PROFILE OF NONCOMPLIANCES ATTRIBUTABLE
TO HUMAN CAUSES (EXCLUDING SAFEGUARDS)
Point Beach Unit 1
Notes
Shaded area indicates period during
which inspection took place.
Number of Noncompliances
4
3
2
1
J F M A M J J A S O N D J F M A M J J A S O N D
1976
1977

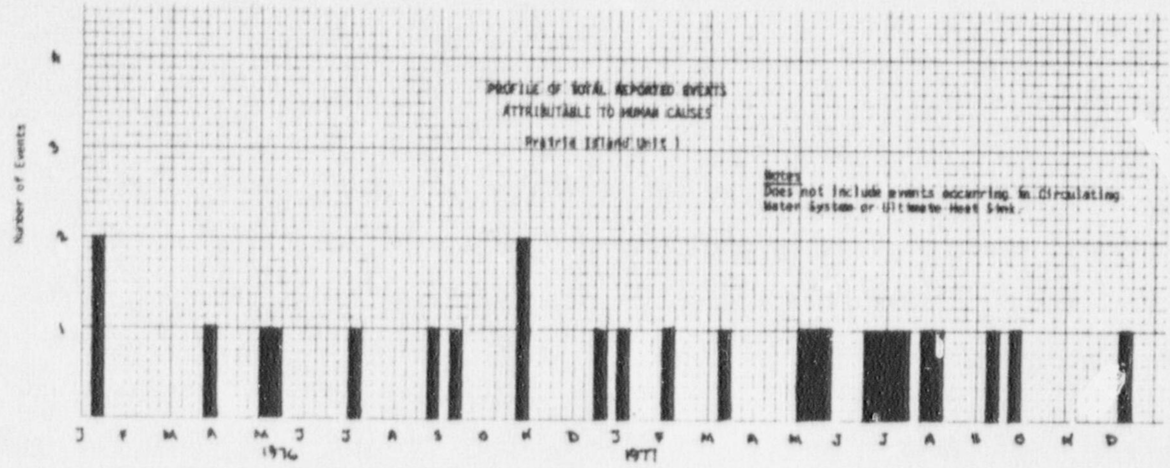
FIGURE A-11

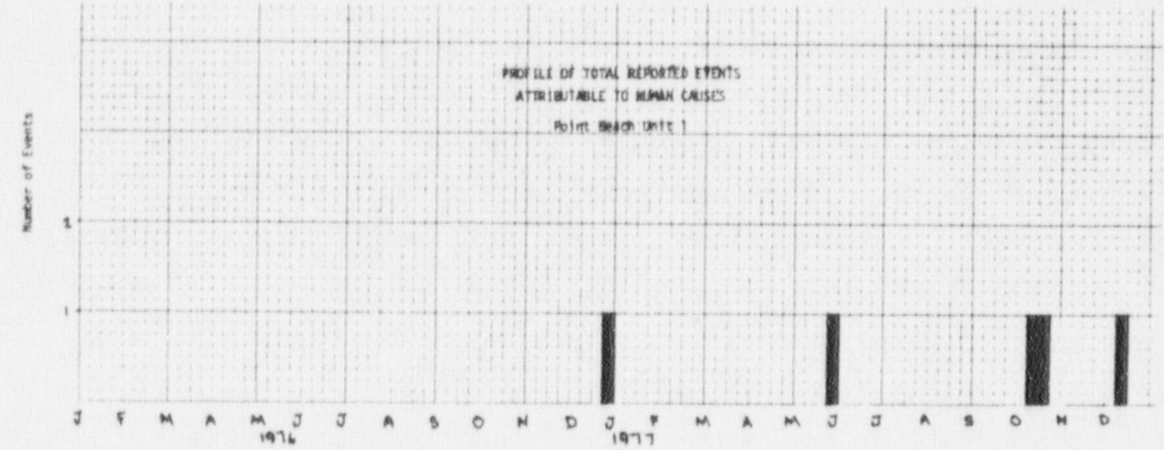
Conclusion

The FPM model and methodology, using existing LER and 766 file data, appear to have both the capacity and sensitivity to differentiate "poor" from "good" performers. Figure A-12 presents the profiles of total reported events attributable to human causes for the three licensees; the profiles for Prairie Island Unit 1 and Point Beach Unit 1, the "good" performers, are clearly different from that for Zion Unit 1. Figure A-13 shows the profiles of noncompliances (excluding safeguards) attributable to human causes, and again the differences are clear.

We found the LER file data essential to gaining insight into why the licensees perform as they do. As discussed in Sections 3.3.2.1 and 3.3.2.2, LERs promptly report real events occurring within facility systems. This close link to the "plant operating reality" offers the insight into management and personnel response to actual situations. The 766 file data was a less meaningful and sensitive performance indicator than we had anticipated at the start of our work. The cause codes in the data file are not precise and their use sometimes reflects inspectors' interpretations; the enforcement text is often too brief to establish the actual content of a noncompliance. Also, the discovery of noncompliances through the inspection program is often widely separated in time from their actual occurrence, due to the structuring of the program into time-dependent modules. These findings are discussed fully in Sections 3.3.3.1 and 3.3.3.2.

Differences in reporting requirements and technical specifications appeared to have little impact on the performance analysis results. We had expected little impact, since the FPM model is not inherently influenced by differences in technical specifications. But the empirical proof was in the performance profiles, as shown in Figure A-12. The LER performance profiles for Point Beach Unit 1 and Prairie Island Unit 1, with different technical specifications, were relatively similar to each other. Zion Unit 1 technical specifications are similar to those for Prairie Island Unit 1, but Zion's





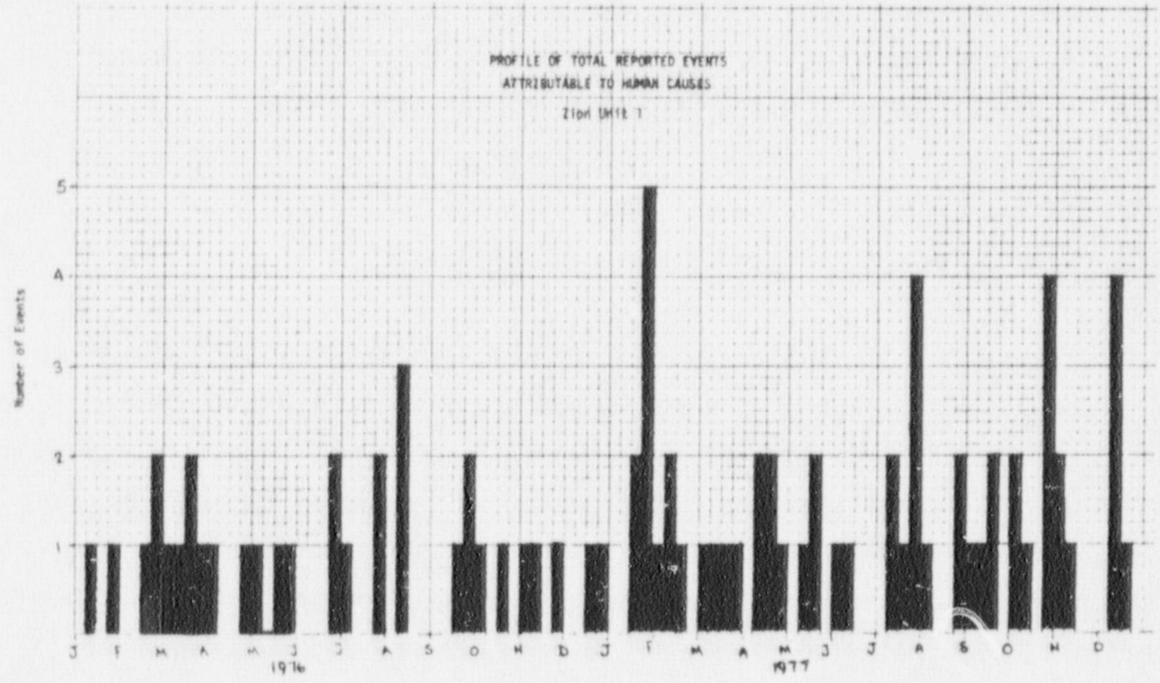


FIGURE A-12

Comparison of LER Profiles

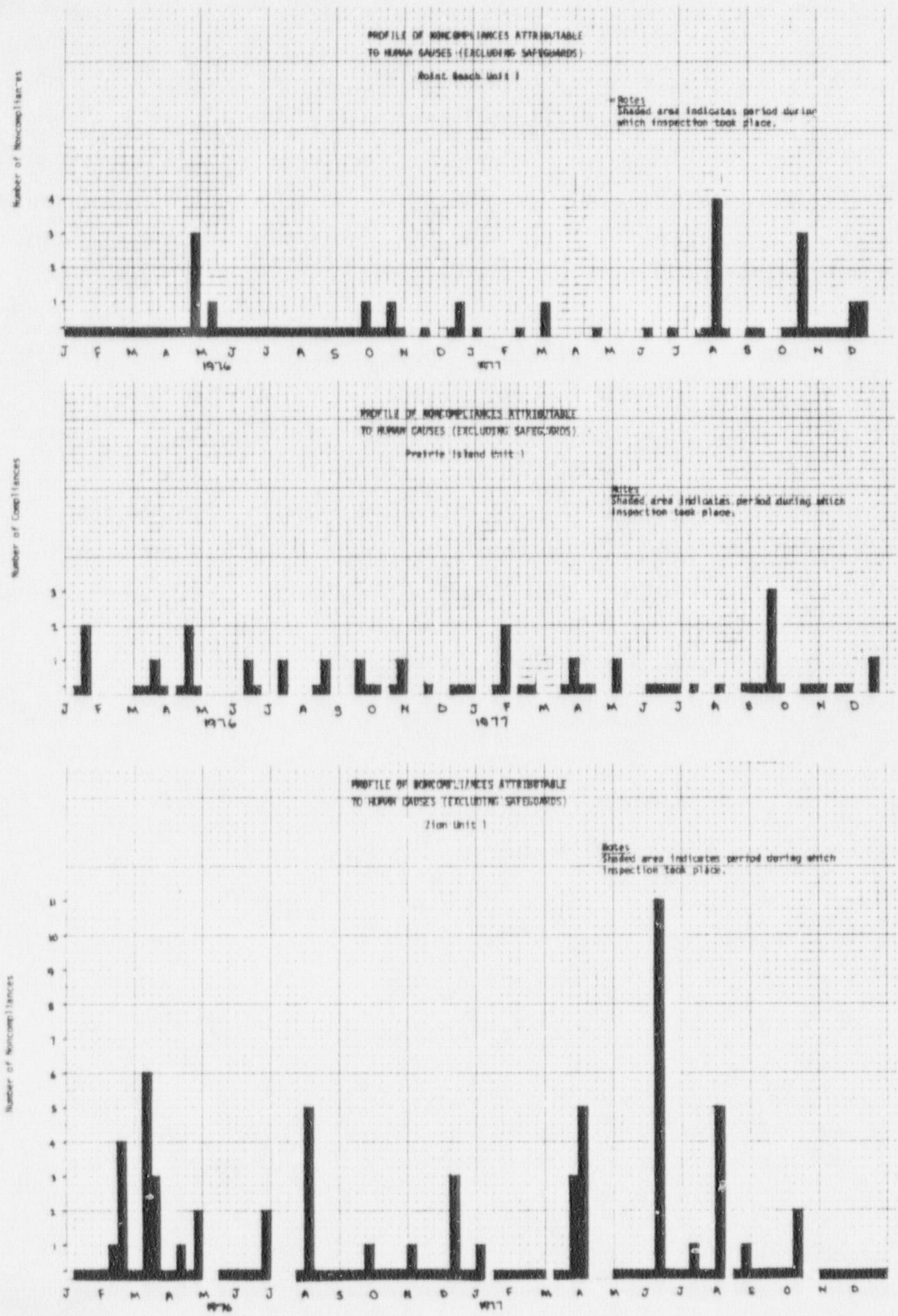
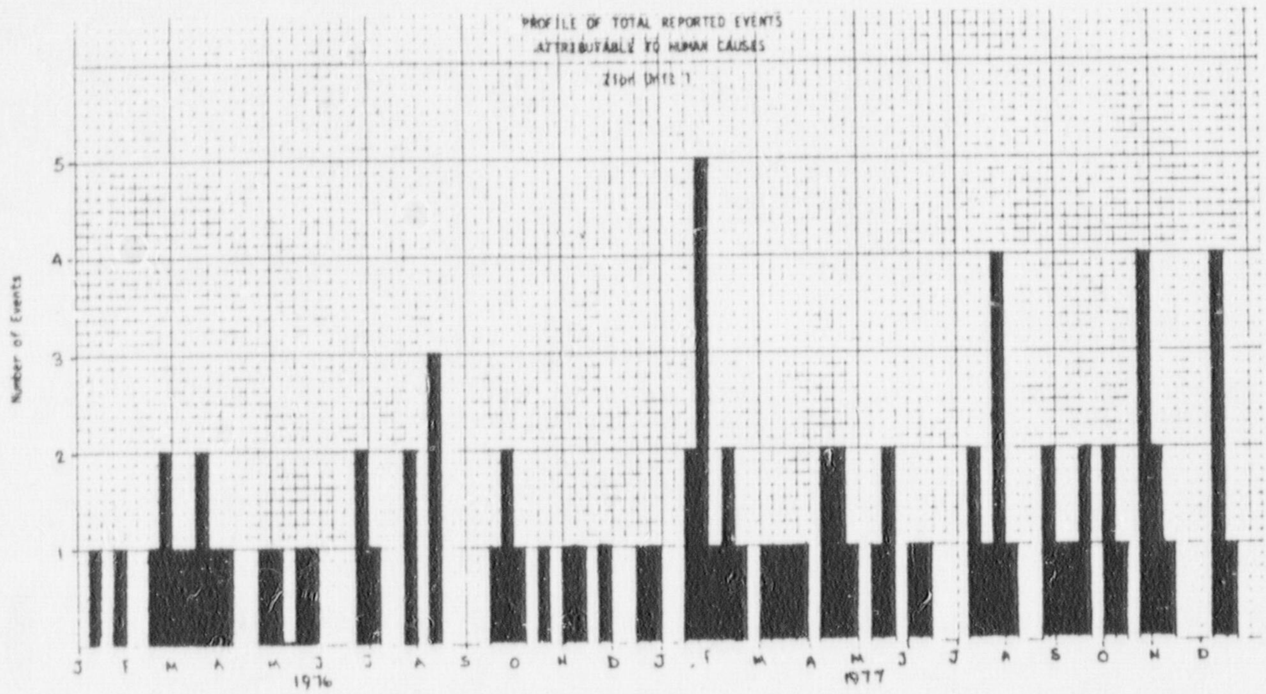


FIGURE A-13
Comparison of Noncompliance Profiles

LER profile is substantially different from both Prairie Island's and Point Beach's. Table 2, on page 38, establishes that technical specifications had little effect, at least for these three licensees. Further case studies will provide more indication of the sensitivity of the model to reporting and technical specification differences. We also expect that case studies of BWRs will permit comparisons that have until now been difficult.

Finally, we found that comparing the LER profile and noncompliance profile for a licensee provides insight into the capability and effectiveness of the regulatory process in managing the licensee's performance. This regulatory/licensee relationship may vary from region to region. Figure A-14 shows these profiles for Zion Unit 1: the differences in phasing and frequency between the LER and noncompliance profiles are apparent, and the LER profile continues to show high levels of human error. Figures A-15 and A-16 show the profiles for Point Beach Unit 1 and Prairie Island Unit 1, where phasing and frequency are more similar.



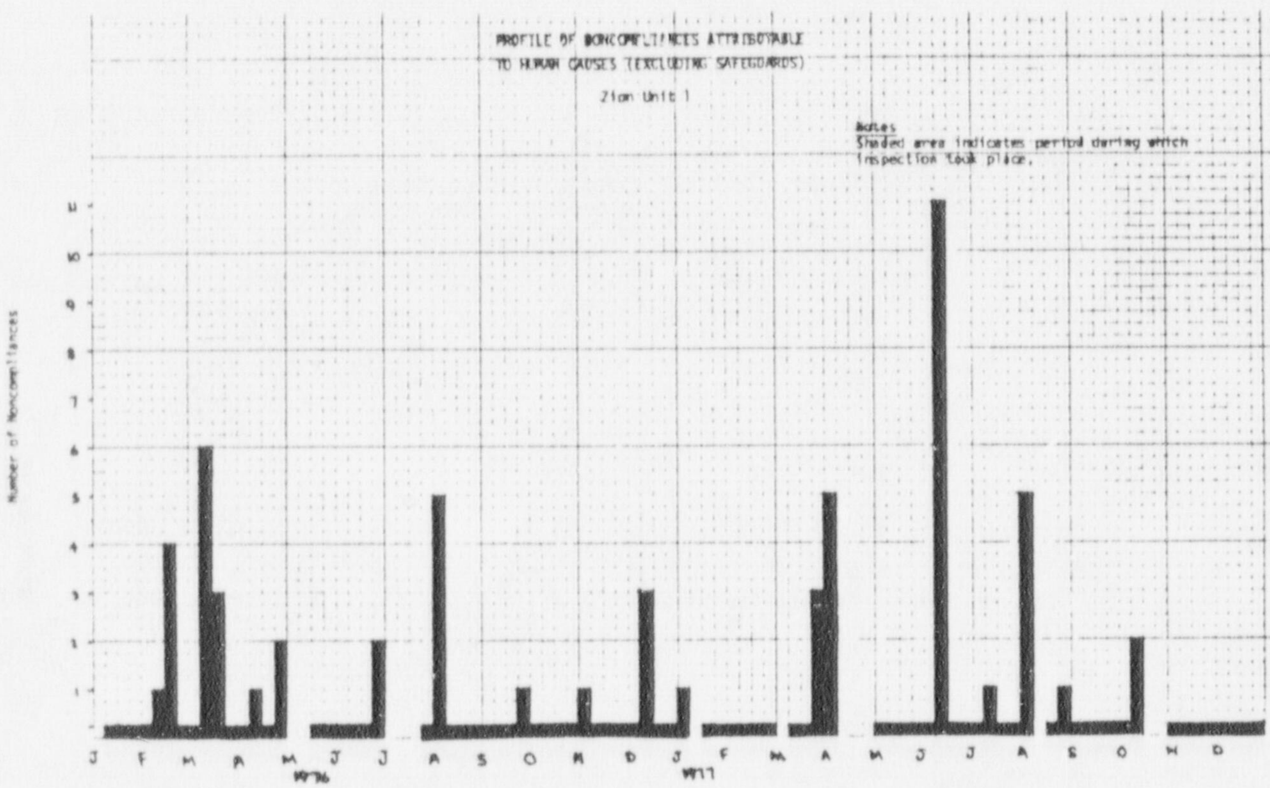
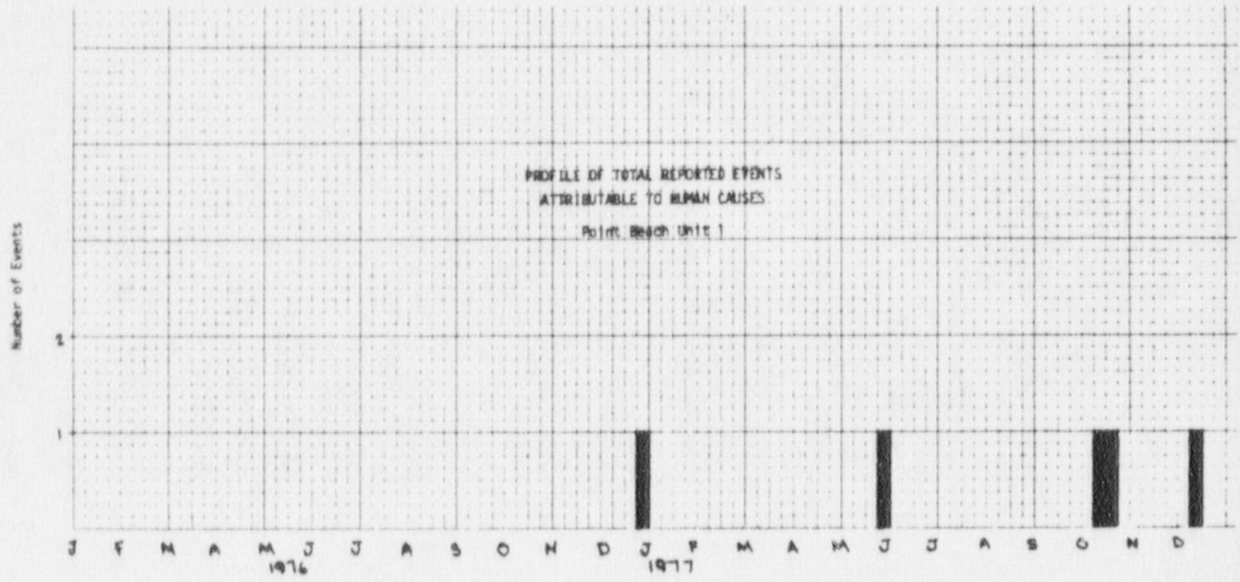


FIGURE A-14

Zion Unit 1 LER and Noncompliance Profiles



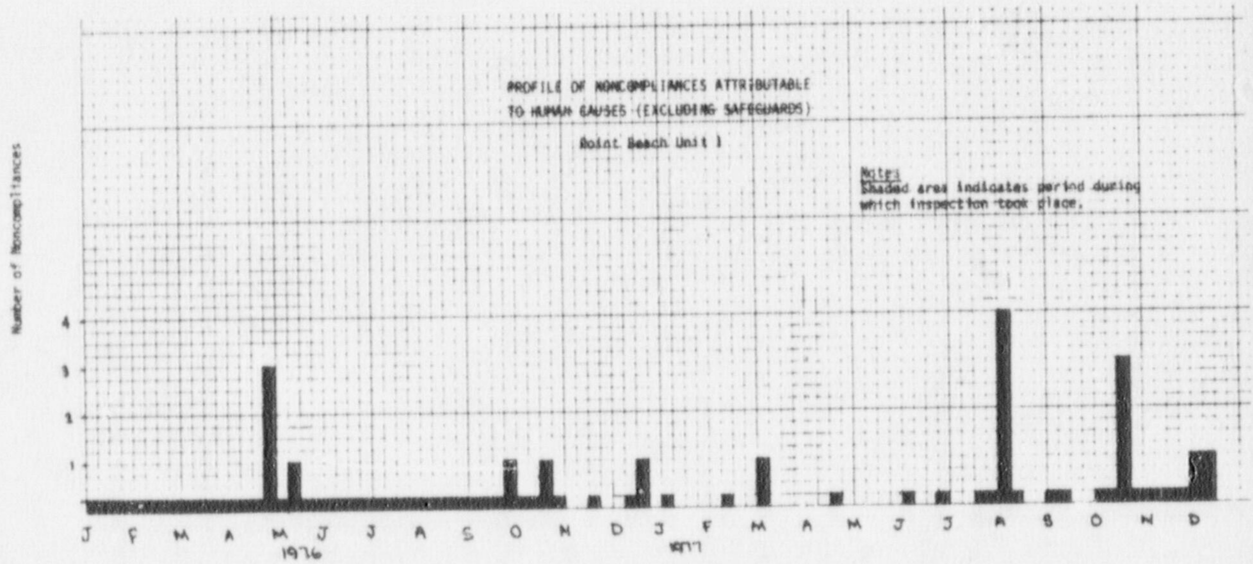
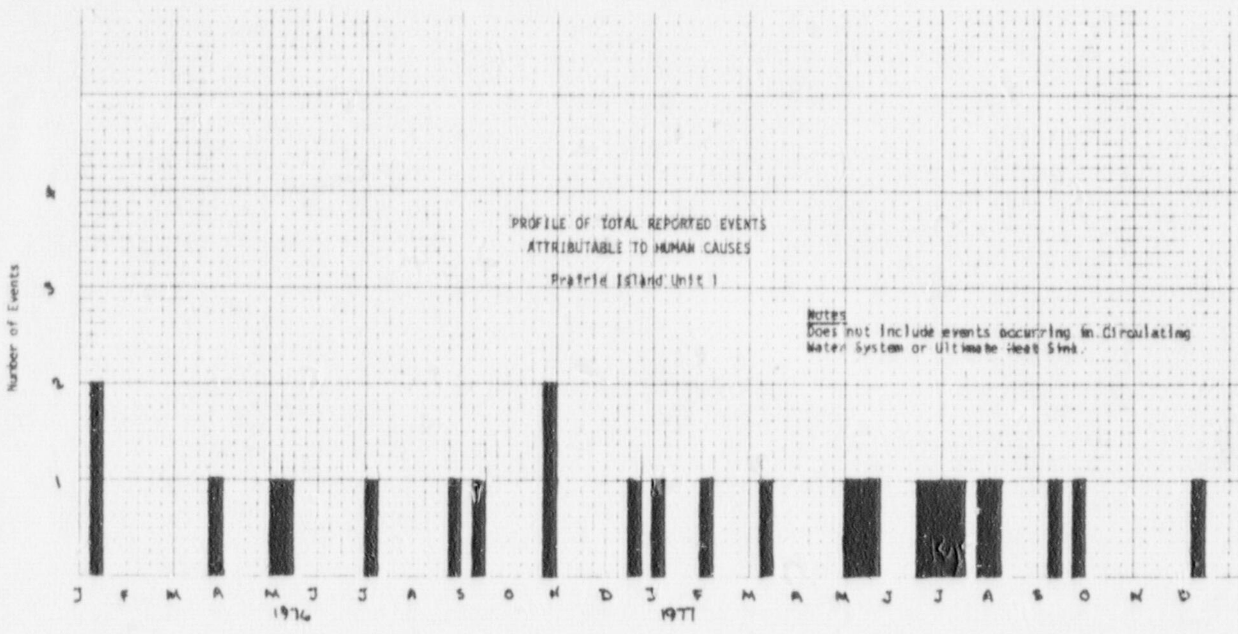


FIGURE A-15

Point Beach Unit 1 LER and Noncompliance Profiles



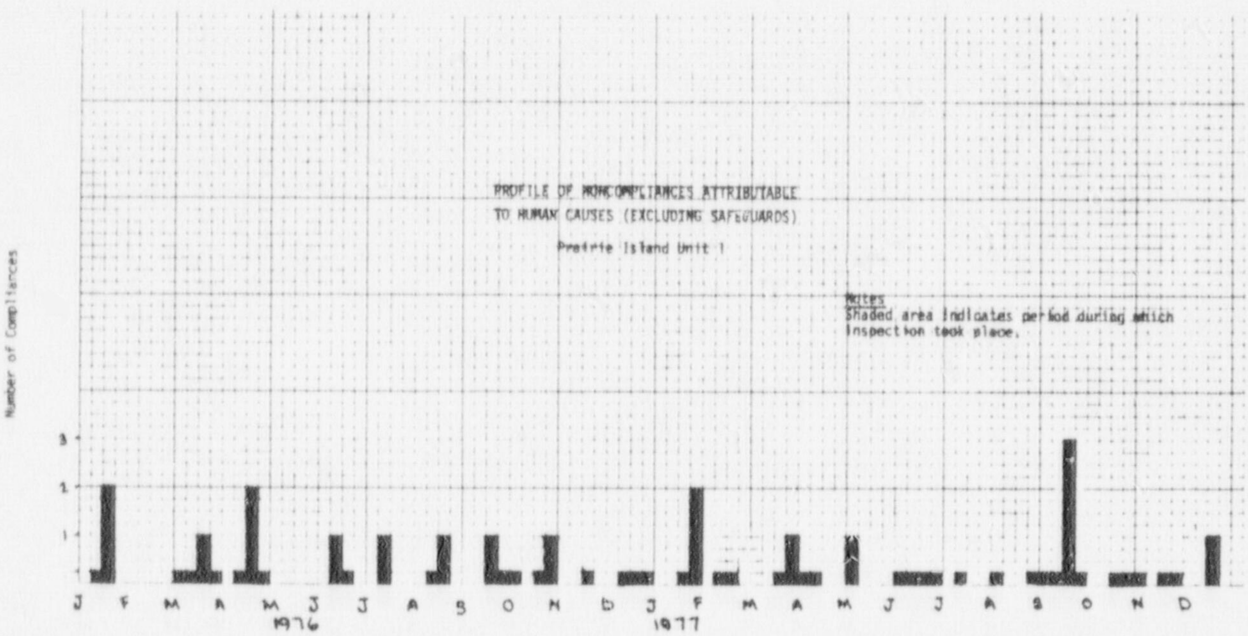


FIGURE A-16

Prairie Island Unit 1 LER and Noncompliance Profiles

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16. ABSTRACT (200 words or less)
This report documents a methodology that NRC may use to evaluate the regulatory performance of its licensees. The purpose of such an evaluation is to permit NRC to identify those licensees whose regulatory performance is marginal. The methodology proposed in this report emphasizes the detailed analysis of the content and trends in Licensee Event Reports (LERs) submitted by licensees. In principle, the methodology can be applied to any class of NRC licensees; however, performance data is relatively sparse for licensee classes other than operating power reactors. Case studies applying the methodology to the examination of three operating power reactor licensees in NRC's Region III suggests that the methodology may permit NRC to identify repetitive, or casually-linked, events that can be attributed to licensee human error. This information will allow NRC to deal with licensees and regulatory problems in a uniform, consistent, and timely manner; permit more effective and efficient use of NRC inspection resources; and provide better feedback to licensees to facilitate their self-improvement efforts. The three case studies tend to confirm previously suspected differences in the regulatory performance of the three licensees.

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