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# Exploratory Trend and Pattern Analysis of 1981 Licensee Event Report Data

Prepared by O. V. Hester, C. D. Gentillon

**EG&G Idaho, Inc.**

**Prepared for**
**U.S. Nuclear Regulatory Commission**

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# ABSTRACT

This report presents an overview of the 1981 Sequence Coding and Search System (SCSS) data base that contains nuclear power plant operational data derived from Licensee Event Reports (LERs) submitted to the United States Nuclear Regulatory Commission. Both overall event reporting and events related to specific components, subsystems, systems, and personnel are discussed. At all of these levels of information, software is used to generate count data for contingency tables. Contingency table analysis is the main tool for the trend and pattern analysis.

The tables primarily focus on faults associated with various components and other items of interest across different plants. The abstracts and other SCSS information on the LERs accounting for unusual counts in the tables were examined to gain insights from the events.

FIN No. A6231—Automated Trends and Patterns Analysis for Operational Data

# EXECUTIVE SUMMARY

Operators of commercial nuclear power plants are required to file Licensee Event Reports (LERs) describing certain events. The Sequence Coding and Search System (SCSS) is a system developed by the United States Nuclear Regulatory Commission (USNRC), Office for Analysis and Evaluation of Operational Data (AEOD) in conjunction with Oak Ridge National Laboratory for storing the operational event data contained in the LERs in a computer readable, searchable format. In the SCSS, reported events are broken down into step-by-step sequences of occurrences. A copy of the SCSS was established at the Idaho National Engineering Laboratory (INEL) to facilitate trend and pattern analysis of these data. The purpose of the trend and pattern analysis is to identify outliers among the data and anomalous conditions that would be good candidates for detailed engineering followup. This report provides an overview of the 1981 SCSS data on three levels: the LERs themselves, the sequences, and the individual hardware, personnel, subsystem, and system occurrences.

The main tool for this overview is the display of automatically-generated contingency tables that provide information about the frequency of occurrence of selected sets of similar incidents or selected *patterns* in the SCSS data base. The objective is to identify patterns in the reported data that may be of interest due to their frequency of occurrence. In addition, trend analysis is possible since the LERs, sequences, or incidents can be further grouped by the LER event dates.

In the study of LER reporting and sequence counts for 1981, the LER and sequence counts were tabulated by plant (nuclear generating unit) for the months of 1981. All plants filing LERs in 1981 were included in the initial screening; three plants receiving operating licenses in 1981 were omitted from subsequent comparative analysis because they had only a partial year of data. Remaining were 25 boiling water reactor (BWR) plants and 46 pressurized water reactor (PWR) plants. The resulting tables show that BWR plants reported an average of 57 LERs per plant in 1981 while PWR plants reported 51 LERs per plant on the average. However, the reporting patterns for individual plants of both types vary widely. Sequence counts, which reflect the fact that more than one individual event may be reported in one LER, are on the average ∿8% higher than LER counts for both types of plants. Variation in frequencies of events per month for both plant types was observed, but there was no recognizable pattern.

For each sequence, the SCSS captures information reported in the LERs about the initial condition or status of the plants and whether the event had a plant effect changing that status. Exploratory trend and pattern analysis of this information shows that for both BWRs and PWRs slightly over half of the reported initial conditions fell into the steady state operating category with the remaining distribution of conditions varying considerably from plant to plant. Rarely did the 1981 events reported in LERs lead to power reductions or other plant effects having direct impact on balance-of-plant operation.

Sequence information describes environmental effects in addition to plant effects. Release of radioactivity or effluents to the environment was extremely infrequent; about 2% of the sequences showed this effect. Reported incidents of personnel overexposure were uncommon, with only 2 and 8 occurrences, respectively, for BWRs and PWRs.

The main information reported in an LER is captured in the SCSS in an event matrix whose rows are called steps records. Each of these records describes a single incidence of hardware fault or human error; the intent is to describe such occurrences at the limit of resolution permitted by the information in an LER. The key field in the step records is the component field. However, each step record has a number of other fields that help describe it. For example, attributes such as cause and effect for the most part provide additional meaning in relation to the component field. Therefore, most of the tables presented show counts based on the component fields for the different plants.

Twenty-two groups of hardware components were explored in plant-specific detail in this study. The contingency tables for these groups were commonly characterized by sparse entries. The reporting of faults for these components varies widely from group to group, with as few as 10 and 17 faults reported for control rod drives, respectively, for BWRs and PWRs, and as many as 743 and 1083 faults for valves, respectively. The overall reporting frequencies for plants for the 22 groups tended to follow the overall distribution observed for LERs.

The SCSS also describes occurrences reported in LERs involving personnel errors. Information includes the type of personnel, the personnel activity, and whether the action was an omission or a commission. The main analysis in the report focused on the type of personnel. The average distribution of personnel types was similar for BWR and PWR plants. For example, for both plant types the reporting was often not specific about whether licensed operators or other utility personnel were involved in the events. However, individual plants deviated from the average pattern for their plant type. In addition to considering the type of personnel, selected personnel activities were studied as a function of plant type and event date for the plants having higher numbers of 1981 LERs. Log linear modeling was the tool used to study these attributes, with event dates divided into the four quarters of 1981. The results showed that, for the limited data used, there is an interaction between the personnel activity (maintenance, operation, etc.) and the plant type but the time effect was independent of these factors.

Finally, reported subsystem and system level occurrences are flagged in the SCSS. The most common subsystem level occurrences described in the 1981 SCSS data involve diesel generators, essential reactor auxiliary systems, and instrumentation and control systems, while the most common system level occurrences deal with primary reactor systems and structural systems as well as essential reactor auxiliary systems. All of these are subjects for further study. The subsystem events involve some form of loss of redundancy, but more information is needed from the licensees on existing populations of channels, trains, and subsystems to make this study more meaningful. On the system level, primary reactor and structural system events for the most part describe incidents having an impact that could not be easily assigned to a smaller entity, such as radioactive contamination of the reactor coolant water, rather than losses of system function. For both subsystem and system-level occurrences, the contingency tables showing an overview of plant reporting patterns are quite sparse.

The purpose of the trend and pattern analysis is to identify outliers among the data and anomalous conditions that would be good candidates for detailed engineering followup. The INEL trend and pattern analysis software includes a capability for statistical modeling of the contingency tables to describe how the pattern of counts relates to the levels of row and column attributes that define the table. If a general pattern is present, the statistical software has a potential to pinpoint the cells in the table not following the pattern. An example of this type of analysis is given in one of the appendices; broad application of the analysis itself is an iterative process beyond the scope of this study.

However, the contingency tables themselves often show cells having higher counts than the rest. Even without formal statistical analysis, such cells may deserve further investigation. In this report such investigations were made in a limited fashion for nearly all the configurations of plants and hardware or other occurrences presented. The investigations involved reading all the SCSS information for LERs having steps in such cells. The resulting insights are included in this report. These investigations provide discussion points for more detailed engineering followup.

The goal in studying the SCSS operational data is to separate indications in the data of real engineering problems that may be potential safety issues from outliers in the data caused by variations in LER reporting and in the encoding of the LERs in the SCSS format. Such investigations require not only an understanding of nuclear power plant engineering but also a detailed knowledge of how events are encoded in the SCSS data base. Because obtaining the count data for these analyses is automated, trend and pattern analysis permits a broad, sweeping look at the operational data encoded from the LERs. This report provides a first look at the type of analysis that is possible. With many possible combinations of values for fields defined in the SCSS data base and many possible counting options to choose from, the analysis contained in this report provides just a starting point for further investigations.

# FOREWORD

In recent years the USNRC and the nuclear industry have placed increasing emphasis on the systematic collection and review of nuclear power plant operational safety data. Manifestations of this emphasis have included: (a) the establishment of AEOD as a central organization dedicated to operational safety data review, (b) the writing of USNRC Manual Chapter 0515 that details the responsibilities of individual USNRC offices in an overall program for operational data review, (c) the establishment of the SEE-IN program by the Institute of Nuclear Power Operations (INPO), and (d) the post-TMI emphasis on the requirement for each licensee to have a program for operational data review.

There are several approaches to operational data analyses. Operational data comprise expected and unexpected situations, events, or failures having a wide range of frequency of occurrence and safety importance. For example, the following remark was made by the French Groupe Permanent Reactor at a meeting with the Advisory Committee on Reactor Safeguards (ACRS):

> "The incidents which arise at a plant are many and varied. One can divide them into two classes:
>
> - The first, taken individually, do not have particular safety significance, but their repetition can render them precursors,
>
> - The second, which have safety significance, are liable to be precursors."

This language reflects a two-tiered assessment approach to data reviews. One tier is to focus upon the data from a statistical perspective in order to detect potential *trends and patterns* that may signify an unrecognized safety concern. The other is to focus upon individual significant events in order to assess their potential as *precursors* to potentially serious incidents or accidents. These approaches are discussed individually below.

Those incidents that have *particular* safety significance are usually selected using guiding criteria that embody consideration of: how the observed incident sequence differed from the expected sequence; or the probability of alterations to the observed sequence, which, if they occurred, would have lead to a much worse outcome.

The detailed analysis of such individually significant events has been carried out by the USNRC for many years, and has served as the basis for numerous licensing actions, as well as extensive feedback to the industry (e.g., IE Bulletins, NRR Generic Letters, Abnormal Occurrence Reports). In several cases (e.g., the TMI-2 accident, the Browns Ferry fire, the Salem ATWS) these individual events have been the subject of extensive and intensive analyses and evaluations that have significantly altered the nuclear industry.

More recently, the precursor analysis [Accident Sequence Precursor Study (ASPS)] sponsored by the USNRC Office of Research is attempting to standardize and make explicit one facet of this kind of analysis. In addition, AEOD is also pursuing the use of a computerized sequence-of-events model (event tree/fault tree) for individual event assessment.

As opposed to analyzing individually significant events, the phrase *trends and patterns* is usually reserved for use with incidents of low individual significance for which repetition or, more accurately, frequency is the element that lends significance. The following definitions generally apply:

1. Pattern: The observed distribution of similar occurrences (incidents), among a set of given classifications (e.g., plants, systems, causes)

2. Trend: A pattern that consists of a decrease or increase in occurrence rate as a function of time.

There are a number of ways that a trend or pattern can be identified. In its simplest form, identification of a pattern or trend can originate with a single engineer reviewing an individual Licensee Event Report (LER). This occurs as a result of:

1. The engineer reading the description of an event and recalling from memory similar events in other reports, and/or

2. The event report (e.g., LER) identifying previous occurrences.

In either of these instances, the engineer would review the additional reports to ascertain the true extent of the pattern or trend (number, date, and location).

Another way to identify a pattern or trend is by the a priori postulation of a concern. This concern could be entirely hypothetical (e.g., "I wonder what the experience has been with Target Rock relief valves?") or it could be based on nonspecific recall of information reviewed over a period of time (e.g., "It seems to me that we've seen a lot of failures of Target Rock relief valves recently"). The engineer would proceed to collect and review data to identify the events where the concern has occurred. Such analysis has been undertaken in the past and forms the basis for numerous contractor and USNRC reports (e.g., AEOD case studies and engineering evaluations).

A primary objective of a more systematic and statistical trends and patterns analysis is to implement a review process that is not dependent on the a priori formulation of a particular concern. Rather, it is driven by the data, allowing the data to point to imbalances, nonuniformities, and to increasing or decreasing frequencies of occurrence. Thus, systematic trend and pattern analysis provides additional assurance that no major problem areas have been overlooked and thereby performs an important quality assurance function for operational data review, which by itself is of value even if no new problems are discovered. This report is our first attempt to perform such an analysis.

To accomplish this objective requires a computer data base that permits consistent retrieval of data because of the large amount of data to be looked at simultaneously. The development and implementation of the Sequence Coding and Search System (SCSS) was undertaken in part to satisfy this requirement. SCSS will, for the first time, allow the LER information to be stored, coded, and retrieved in a satisfactory manner for a statistically-based pattern and trend analysis.

However, just as we run the risk of missing the *big picture* by focusing too closely on individual events, there are a number of difficulties associated with any collective analysis. Most obviously, events must be reduced to counts that then lose their individual identity. This homogenization means all events are treated as if they had the same individual significance—which may not always be the case.

Also, any variation that is due to factors other than differences in actual safety performance will give us a spurious indication of a problem. Such variations are discussed in Appendix E of NUREG-0572, "Review of Licensee Event Reports," which was prepared by the ACRS in 1979. The principal points from Appendix E are paraphrased below.

Approximately 8,700 LERs were submitted by the licensees of U.S. commercial nuclear power plants during the years 1976, 1977, and 1978. For several reasons the number of LERs varied from unit to unit. These variations are important because, rightly or wrongly, they are often viewed by government agencies and the public as indications of relative safety. While such variations may be indicative of actual differences in safety among nuclear power units, they frequently have other explanations. For example:

1. Certain differences in the frequency of submission of LERs from unit to unit will occur as a result of the apparent random nature of the events being reported. Because of this *randomness*, it is possible—in fact, probable—that, even among identical nuclear power plant facilities with identical failure probabilities, there will be variations in the reporting rate for LERs. In reality, however, variations beyond those due to *randomness* are also frequently observed.

2. Event reporting is often based on Technical Specifications, particularly the limiting conditions for operation and the surveillance requirements, as well as license provisions, and all of these vary among nuclear power plant facilities. The variations are the result of differences in reactor suppliers, architect/engineers, and constructors; and changes in designs over the years.

3. There is a tendency at some facilities to report events more readily than at others in cases of marginal reportability. This tendency can also change with time.

4. The occurrences of an event may affect the probability of future events. Repair of a faulty component or improvement of a deficient procedure may significantly reduce the likelihood of a subsequent event. On the other hand, ineffective corrective action following an event may permit its repeated occurrence.

5. The mode of operation (e.g., on-line or shutdown) affects the frequency of various kinds of inspections and the susceptibility of systems to failures. The amount of time that the reactor was shutdown during a period, for example, may affect the frequency with which reportable events occur.

6. Differences in interpretation of reporting requirements by licensee or USNRC personnel involved in the preparation, submission, and processing of LERs can affect relative reporting frequencies.

7. At some multi-unit power stations (e.g., Oconee and Browns Ferry) events that involve plant systems or components common to all units, such as swing diesels and electrical switchyards, are filed under the docket number of the first unit.

The actual presence of more safety-related deficiencies in a system at an individual facility should result in more frequent submission of LERs. Differences in the number of LERs due to this cause would be a measure of relative safety.

The ACRS study demonstrated the potential usefulness of statistical analyses in the evaluation of LER data submitted by licensees. Such analyses make it possible to distinguish deviations in the number of events that would be expected on the basis of randomness from those that almost certainly would not. However, the latter can be used only as a means for the identification of areas for possible further investigations. Because of the deviations noted, any nonrandomness (i.e., trend or pattern) in the data does not necessarily imply safety-related problems, it merely identifies a question that must be pursued to determine the true implications.

We want to emphasize these cautions in particular in the case of counting the reporting instruments themselves (i.e., the LERs). We feel that examination of LER reporting pattern and frequency is a legitimate and useful activity if the objective is to describe and characterize the source of our event information with a view toward a better understanding of the factors that affect the reported frequency of undesired events. However, because of these variations and because an LER can describe anything from instrument set point drift to core damage, it is most inappropriate and misleading to use raw LER counts as a relative or absolute measure of safety performance. In addition to being misleading, this practice has the undesired side effect of motivating licensees to minimize the number of LERs instead of sharing information for the benefit of all.

In the next few paragraphs we present a simple example of trend and pattern analysis in order to further demonstrate the type of information we are seeking. The simplest form of statistical pattern analysis involves selection of one of the classes of occurrences in SCSS (e.g., component failures, personnel errors), sorting the occurrences according to the values of a categorical variable (e.g., the component involved), and then counting the occurrences as a function of that variable. The table below displays such a tabulation. This tabulation would most likely be examined in terms of the percentage of the total counts found in each category.

FAULT COUNTS OF SELECTED COMPONENTS

| Component Type | | | | |
| --- | --- | --- | --- | --- |
| Undervoltage Relay | ac Circuit Breaker | dc Circuit Breaker | Unknown Type Circuit Breaker | Total |
| 49 | 331 | 32 | 10 | 422 |

This simple analysis can be substantially refined by adding another dimension to the occurrence sorting (e.g., plant name). Mechanically this involves taking the total count for each type of component and breaking it up among the various plants doing the reporting. This results in a two-way table defined by the categorical variables plant and component. An example is shown below.

COMPONENT FAULT COUNTS DISPLAYED BY PLANT

| | Component Type | | | | |
|---|---|---|---|---|---|
| Plant | Undervoltage Relay | ac Circuit Breaker | dc Circuit Breaker | Unknown Type Circuit Breaker | Total |
| Plant A | 1 | 3 | 2 | 0 | 6 |
| Plant B | 0 | 6 | 2 | 0 | 8 |
| . | . | . | . | . | . |
| . | . | . | . | . | . |
| . | . | . | . | . | . |
| Plant Z | 0 | 7 | 2 | 0 | 9 |
| Total | 49 | 331 | 32 | 10 | 422 |

This process can be continued, adding dimensions to break up the data into more and more restrictive categories. Adding time can be accomplished by breaking a time line into discrete pieces (e.g., months) and assigning occurrences to each piece based on event date. The example would then be a three-way table defined by plant, component, and time. Examination of the three-way pattern would also involve calculation of the percentage of total occurrences found in each category.

EG&G Idaho, Inc., under contract to AEOD, has developed a computer capability to perform such analysis. This analysis and the associated tables that it produces are the basis of this study.

Once the count tables described above are developed, there are a number of statistical techniques that can be used to evaluate the data and identify trends or patterns. Using some idealized examples some patterns that can be recognized by using such techniques are illustrated below.

Suppose we have the following table of counts of pump failures for the annual time intervals indicated:

| | 1980 | 1981 | 1982 | 1983 | Total |
|---|---|---|---|---|---|
| Plant 1 | 9 | 8 | 8 | 9 | 34 |
| Plant 2 | 8 | 9 | 8 | 8 | 33 |
| Plant 3 | 8 | 8 | 9 | 8 | 33 |
| | 25 | 25 | 25 | 25 | 100 |

This table displays almost perfect uniformity. Things do not change as a function of time or plant. Such a result would be useful information for summarizing what the data show; but, in the absence of any additional information (e.g., number of pumps per plant), it would not prompt any further investigation.

The example below shows a more interesting pattern.

| | 1980 | 1981 | 1982 | 1983 | Total |
|---|---|---|---|---|---|
| Plant 1 | 5 | 5 | 5 | 5 | 20 |
| Plant 2 | 8 | 8 | 8 | 8 | 32 |
| Plant 3 | 12 | 12 | 12 | 12 | 48 |
| | 25 | 25 | 25 | 25 | 100 |

In this case time does not play a role. For each plant and for the total across plants, the fraction does not change as a function of time. However, *plant* does play a role, as the counts or fractions vary noticeably from plant to plant.

At this point it is essential to recognize the cautions discussed above. The fact that Plant 3 has more failures does not necessarily mean that there is a problem at Plant 3 (e.g., Plant 3 may have different reporting requirements, or may have a more liberal attitude toward reporting, or may have more pumps). An engineer must evaluate the data and try to determine the factors underlying the disparate plant behavior. This is a frequently overlooked aspect of trends and patterns analysis. A computer can produce and analyze tables such as those described above with great speed. However, an engineer must evaluate the results to identify the real safety problems. This evaluation is often very time consuming; and, unfortunately, because plants, reporting requirements, reporting philosophies, etc., are not consistent, many of the patterns will be due to factors other than genuine safety problems (i.e., there is a lot of chaff mixed in with the wheat).

The table below shows a third variation.

| | 1980 | 1981 | 1982 | 1983 | Total |
|---|---|---|---|---|---|
| Plant 1 | 3 | 3 | 3 | 3 | 12 |
| Plant 2 | 6 | 6 | 6 | 6 | 24 |
| Plant 3 | 9 | 27 | 9 | 9 | 54 |
| | 18 | 36 | 18 | 18 | 100 |

This example shows an extreme case of an outlier or anomaly; the 27 counts for Plant 3 in 1981 perturbs an otherwise very consistent pattern. Such a cell would deserve additional followup.

For these examples, visual observation points to patterns of interest. In real cases, analysis by inspection may not generally be possible because there will be (a) less regularity in the observed counts, (b) a larger number of cells for each factor (e.g., there are over 70 operating plants), and/or (c) more dimensions (e.g., plant, system, time) used to define a table. Analysis of more extensive and complex tables is performed using statistical software and supporting software that automatically accumulates and passes count data from SCSS to the statistical program.

In conclusion, this report constitutes the first attempt by AEOD to perform a systematic trends and patterns analysis. Although this analysis can provide important insights into the data reported in LERs, it is not a panacea. Such analysis will never produce answers (e.g., there is a safety significant problem with reactor trip breakers, or Plant XYZ is poorly run); it will only produce questions (e.g., there is something unusual or anomalous about the pattern of operating experience associated with breakers, or Plant XYZ has reported more personnel errors than other plants). These questions must be analyzed by engineers to identify the underlying cause of the pattern and to determine if the cause is a safety significant problem worthy of corrective action. However, this process provides additional assurance that no major problem areas have been overlooked, and is valuable even if no new problems are identified.

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## TABLES

# ACRONYMS AND TERMINOLOGY

| | |
|---|---|
| BWR | Boiling water reactor. |
| Calendar hours | A unit of measure of nuclear power plant exposure time that includes shutdown periods. |
| Category | A field value; the level of an attribute; a code contained in a field. |
| Cause | A field in the SCSS step data; the proximate cause of an occurrence. The immediate reason for the observed state or action coded in the effect field; often describing the physical condition of the component. |
| Cell | A set of values that the set of characteristics or fields in a configuration can take on. The set of categorical values associated with a single entry in a contingency table. |
| Component | A field in the SCSS step data that generally represents an item of hardware. The field may also describe a person, another nuclear unit, or a designation for a train or subsystem or all trains of a system. |
| Contingency table | 1. A table of counts for a set of conditions. The conditions are levels of specified categorical variables.<br>2. In this report, the count data input to such a table. |
| Configuration | In this report, a set of fields from the SCSS and specified categories for each field. |
| Critical hours | A unit of measure of nuclear power plant exposure time that excludes shutdown periods. |
| Detection | A field in the SCSS step data for indicating how an occurrence was discovered. |
| ESF | Engineered safety features. |
| Effect | A field in the SCSS step data for the observed component state, action, or output. |
| Exposure time | The length of the time period during which a nuclear power plant could experience reportable events. Used to normalize count data and obtain occurrence rates. |

| | |
|---|---|
| Facility ID (FID) | A field in the INEL SCSS step data; the four character alphanumeric Licensee Code reported in the LERs that uniquely identifies each licensed power reactor. The first three characters designate the site, while the last character is the nuclear unit number. The site codes are similar to the site names; many end in **P** for plant (**EP**: electric plant; **NP**: nuclear plant) or **S** for station (**NS**: nuclear station; **GS**: generating station; **PS**: power station). |
| Fault | The inability of a component or system to perform its intended function. |
| Field | A variable, characteristic, or attribute of a record in the SCSS data base. |
| I&C | Instrumentation and control. |
| Initial fit table | A table of initial values used in log-linear analysis of contingency tables. In SCSS trend and pattern analysis, quantities proportional to exposure time used to statistically model rates instead of raw counts. |
| Interfacing system | A field in the SCSS step data providing additional system information for components at system boundaries. |
| LCO | Limiting condition for operation. |
| LER | Licensee Event Report; an event report filed by the operator of a nuclear power plant in accordance with NRC license requirements. |
| Occurrence | A human, component or system action or change of state at the limit of resolution permitted by the information in an LER. |
| PWR | Pressurized water reactor. |
| Performance | A field in the SCSS step data for indicating whether the overall combination (component and effect, in conjunction with cause and timing) describing an occurrence represents a partial or total fault or no fault; and whether repair is required. |
| Potential occurrence | An occurrence that did not happen but would have happened eventually if no corrective action were taken for conditions that were reported in an LER. |
| Primary system | A field in the SCSS step data representing the system in which a component is installed or, in the case of personnel, the activity engaged in when the error occurred. Special system codes flag additional information steps describing unit and environmental effects. |

| | |
|---|---|
| SCSS | Sequence Coding and Search System; a format for encoding LERs in a computer-readable, computer-searchable form developed by the Nuclear Regulatory Commission Office for Analysis and Evaluation of Operational Data. |
| Sequence | A series of occurrences and additional information that are related to each other by virtue of each occurrence contributing to the cause of subsequent occurrences. |
| Timing | A field in the SCSS step data indicating whether occurrences are instantaneous, preexisting, or potential. |
| Vendor | A field in the SCSS step data for component manufacturer. |

# EXPLORATORY TREND AND PATTERN ANALYSIS OF 1981 LICENSEE EVENT REPORT DATA

## INTRODUCTION

The United States Nuclear Regulatory Commission (USNRC), Office for Analysis and Evaluation of Operational Data (AEOD) in conjunction with EG&G Idaho, Inc. has developed computer software that uses contingency table techniques to perform trend and pattern analysis of operational data reported by nuclear utilities. The main source of such data is Licensee Event Reports[1,2] (LERs) submitted to the USNRC by reactor licensees when an incident at a plant meets reporting criteria incorporated in its operating license technical specifications. LERs filed since 1981 have been encoded and stored on a computer in a Sequence Coding and Search System (SCSS) format[3,4,5] developed by AEOD and maintained by Oak Ridge National Laboratory (ORNL), in order to support both ad hoc data retrieval and the broader form statistical analysis that may identify trends and patterns. This report documents the first application of the trend and pattern analysis techniques to a large block of LER data, namely, all the LER data from 1981.

Trend and pattern analysis based on contingency tables provides the capability to study broad segments of the operational data and thereby obtain an overview of the activities and problems reported by the licensees. This is the principal way in which the technique is demonstrated in this study. That is, the main product of this initial, exploratory trend and pattern analysis of 1981 LER data is an overview of that data. Another purpose of the trend and pattern analysis is to identify outliers and anomalous behavior within the data that would be good candidates for detailed engineering followup. By examining tables of event counts based on large segments of the LER data base, the technique is intended to identify whether there are situations that may have safety significance due to their high or widespread incidence. The recognition of incident recurrence, increasing rate of occurrence, or a pattern of occurrence is enhanced by the capability to define conditions of interest, then examine the pattern of LER reporting of these events among plants, over time, and/or over other factors.

The ability to identify selected events rests on how the LERs are encoded in the SCSS. The SCSS is a method for storing the operational data from LERs, including supplemental information, in a computer-readable, searchable form amenable to cross-classification. The main data for each LER in the SCSS is an event matrix, which is a systematic way of recording the various occurrences or single incidences of hardware fault or human error that took place during an event. An occurrence can be thought of as a single step in a sequence. A sequence is a chain of actions or states of components, personnel, etc., that are related to each other by virtue of each occurrence contributing to the cause of the subsequent occurrence. One or more sequences may be reported in a single LER. In the event matrix, each row is called a step. Special fields in the step records are used to describe how the various occurrences relate to each other, while the remaining fields are used to describe the characteristics (e.g. system, component, cause, effect) of each occurrence.[a] There are also step records in the SCSS data base that provide additional information about other records or about the sequence as a whole.

This study is based on a SCSS data base established at the Idaho National Engineering Laboratory (INEL) from a May 4, 1983 dump of the ORNL SCSS data base. Since the purpose of this study is to provide an overview of all the 1981 LERs as represented in the SCSS, all nuclear units or plants with records in the SCSS data base for 1981 comprise the list of plants considered for inclusion in the analysis. Table 1 provides a list of these plants and their codes. This study is based on counts of selected patterns or configurations in the data. An iterative process was used to identify and analyze profiles of the data showing, for example, plant/component failure relationships. The results of this study can be used in defining relationships between characteristics and in flagging atypical events.

The general approach for this study was as follows. Configurations for events deemed interesting were defined. A configuration is simply a set

a. The main characteristics are defined in the terminology section.

**Table 1. Plants and their codes**

| Facility | Code (FID) |
|---|---|
| BWR Plants | |
| Brunswick 1 | BEP1 |
| Brunswick 2 | BEP2 |
| Browns Ferry 1 | BRF1 |
| Browns Ferry 2 | BRF2 |
| Browns Ferry 3 | BRF3 |
| Big Rock Point | BRP1 |
| Cooper | CPR1 |
| Duane Arnold | DAC1 |
| Dresden 2 | DRS2 |
| Dresden 3 | DRS3 |
| Edwin I. Hatch 1 | EIH1 |
| Edwin I. Hatch 2 | EIH2 |
| Humboldt Bay | HMB1 |
| James A. FitzPatrick | JAF1 |
| La Crosse | LBR1 |
| Monticello | MNP1 |
| Millstone 1 | MNS1 |
| Nine Mile Point 1 | NMP1 |
| Oyster Creek | OCP1 |
| Peach Bottom 2 | PBS2 |
| Peach Bottom 3 | PBS3 |
| Pilgrim 1 | PPS1 |
| Quad Cities 1 | QAD1 |
| Quad Cities 2 | QAD2 |
| Vermont Yankee | VYS1 |
| PWR Plants | |
| Arkansas Nuclear One 1 | ANO1 |
| Arkansas Nuclear One 2 | ANO2 |
| Beaver Valley 1 | BVS1 |
| Calvert Cliffs 1 | CCN1 |
| Calvert Cliffs 2 | CCN2 |
| Crystal River 3 | CRP3 |
| Davis-Besse 1 | DBS1 |
| D. C. Cook 1 | DCC1 |
| D. C. Cook 2 | DCC2 |
| Diablo Canyon 1 | DCP1 |
| Ft. Calhoun | FCS1 |
| H. B. Robinson 2 | HBR2 |
| Haddam Neck (Conn. Yankee) | HNP1 |
| Indian Point 2 | IPS2 |
| Indian Point 3 | IPS3 |

Table 1. (continued)

| Facility | Code (FID) |
| --- | --- |
| PWR Plants (continued) | |
| Joseph M. Farley 1 | JMF1 |
| Joseph M. Farley 2 | JMF2 |
| Kewaunee | KNP1 |
| McGuire 1 | MGS1 |
| Millstone 2 | MNS2 |
| Maine Yankee | MYP1 |
| North Anna 1 | NAS1 |
| North Anna 2 | NAS2 |
| Oconee 1 | NEE1 |
| Oconee 2 | NEE2 |
| Oconee 3 | NEE3 |
| Palisades | PAL1 |
| Point Beach 1 | PBH1 |
| Point Beach 2 | PBH2 |
| Prairie Island 1 | PIN1 |
| Prairie Island 2 | PIN2 |
| Robert E. Ginna | REG1 |
| Rancho Seco | RSS1 |
| Salem 1 | SGS1 |
| Salem 2 | SGS2 |
| St. Lucie 1 | SLS1 |
| Sequoyah 1 | SNP1 |
| Sequoyah 2 | SNP2 |
| San Onofre 1 | SOS1 |
| Surry 1 | SPS1 |
| Surry 2 | SPS2 |
| Three Mile Island 1 | TMI1 |
| Three Mile Island 2 | TMI2 |
| Trojan | TNP1 |
| Turkey Point 3 | TPS3 |
| Turkey Point 4 | TPS4 |
| Yankee Rowe 1 | YKR1 |
| Zion 1 | ZIS1 |
| Zion 2 | ZIS2 |

of characteristics (or fields), and specified values for these characteristics, which are used to define a set of events of interest. Queries into the SCSS data base were then performed through use of the software packages CONTING[6] and CONTIN2[7]. The results of each run are counts related to the number of step records or sequences or LERs in each *cell* of the configuration (i.e., each set of values that the set of characteristics can take on). These counts were fed into the statistical program P4F contained in the statistical software package BMDP-81,[8] in order to produce multidimensional tables of the frequency counts. Finally, each table was analyzed and evaluated with the potential of followup runs being performed. For many of the cells having high numbers of counts, listings of all the SCSS information for the corresponding LERs were examined to identify causes for anomalous behavior.

In obtaining an overview of 1981 LER activity, this study focused on two general types of configurations:

1. Configurations giving an overview of the entire 1981 SCSS data base

2. Configurations giving an overview of occurrences related to specific hardware, personnel, subsystem, or system faults.

In these configurations, the column field or variable generally indicates the type of overview or occurrence being examined, with FID (the plant identifier from Table 1) as the row field. Since the tables of counts are computer-generated, the tables initially have headings corresponding to the SCSS data base codes for the various attributes under study. Where possible, the codes have been replaced by their expansions for this report. Column headings can be stacked; however, codes that are used as row headings are not expanded in this report due to the lack of space in the tables. Where needed, tables defining these codes are provided.[a]

The results of each of the analyses are described in the following sections. Although not all of the table titles mention 1981, the data described in this report is entirely based on SCSS records for LERs with event dates in 1981. In each case, data from pressurized water reactor (PWR) plants and boiling water reactor (BWR) plants are analyzed separately. Additional capabilities of the analysis method are described in an appendix.

It should be noted that, due to variations in LER reporting requirements among plants, one may not be able to infer that plants having higher incidences of LER reporting have more reliability/maintenance problems than other plants.

a. In particular, the FID codes are used in nearly all the tables so the reader will need to refer back to Table 1. Guidance is included in the terminology section to help the reader become familiar with these codes.

# LER AND SEQUENCE REPORTING

The tables in this section provide a broad survey of the 1981 SCSS data base. The subsections below describe the basic LER and sequence reporting patterns of the plants. The effect of the sequences on the plants (their initial states and whether a shutdown was involved) and on the environment (whether the sequence resulted in any radiation release or personnel exposure) is also addressed.

## LER Reporting Frequency

Examination of the overall LER reporting pattern is important from two perspectives:

1. It provides feedback on the reporting process itself

2. It provides a context for the interpretation of numerical results for selected subsets of the data (eg., component failures, personnel errors).

The number of LERs *per se* has little absolute meaning. LER counts are useful from a comparative perspective, eg., high or low compared with the majority of the population (plants) or compared over a series of time periods.

For the purpose of exploratory analysis, the plants filing LERs for 1981 were grouped by BWR and PWR reactor types. Figures 1 and 2 are histograms based on total plant counts for the year for BWRs and PWRs, respectively. These histograms include all plants that filed 1981 LERs (25 BWRs and 49 PWRs). However, a number of PWR plants received operating licenses after the start of the year. These plants are shown in the table below, along with their license date[9] and earliest event date for LERs filed by each plant. The question arises as to whether or not the counts for these plants should be considered as yearly totals comparable to those for plants licensed prior to the start of 1981. In the cases of Diablo Canyon 1, Farley 2, and Sequoyah 2, the proximity of the license date and the date of earliest LER supports treating their counts as partial and dropping them from further comparative analysis. On the other hand, McGuire 1 and Salem 2 appear to have been reporting for the entire year and thus will be retained. Because Diablo Canyon 1, Farley 2, and Sequoyah 2 do not have a full year of data, they are excluded from *all* further analysis in this report.

Figure 3 shows the BWR and PWR histograms together for comparison, with the PWR histogram adjusted by dropping Diablo Canyon 1, Farley 2, and Sequoyah 2. Notable features of Figure 3 are as follows:

1. Both the BWR and the PWR distributions are skewed to the left (to low counts), with the PWR distribution showing surprising regularity. The skew for BWRs is due to the number of plants falling in the 21 to 40 range. Some of the regularity shown by the PWR group in comparison with the BWR group can be ascribed to a larger number of data points, i.e., plants.

2. There appears to be an elevated threshold for BWR reporting versus PWR reporting. That is, very few BWRs filed fewer than 21 LERs, while a proportionately larger number of PWRs did so.

| Plant | License Date | Date of Earliest LER | 1981 LER Count |
|---|---|---|---|
| Diablo Canyon 1 | September 22, 1981 | September 22, 1981 | 9 |
| Farley 2 | March 31, 1981 | March 10, 1981 | 57 |
| McGuire 1 | June 29, 1981 | January 29, 1981 | 188 |
| Salem 2 | May 20, 1981 | January 4, 1981 | 124 |
| Sequoyah 2 | September 15, 1981 | August 3, 1981 | 27 |

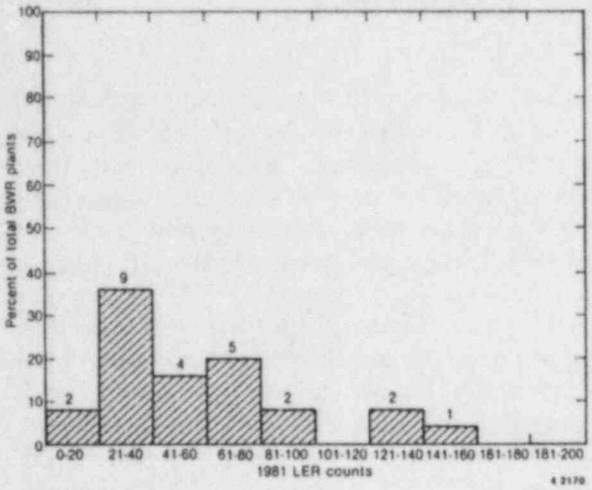


Figure 1. Histogram of LER counts—BWR.

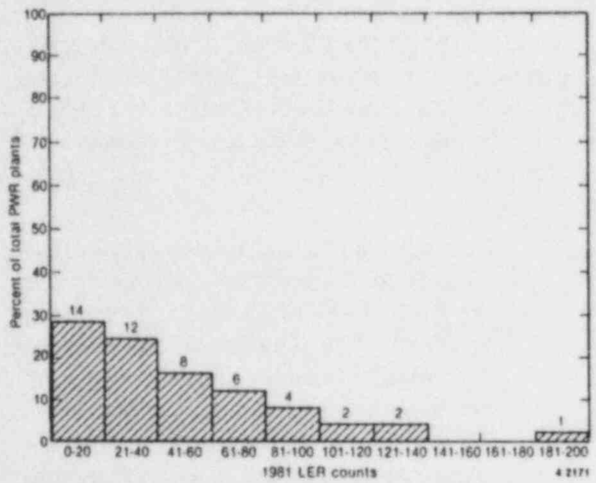


Figure 2. Histogram of LER counts—PWR.

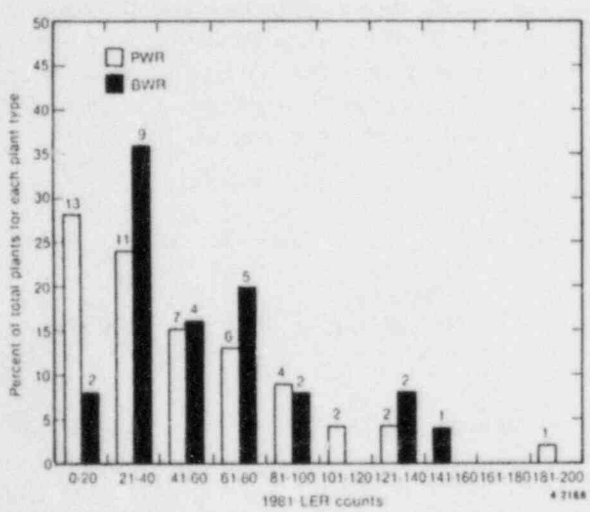


Figure 3. Histogram of LER counts—BWR and PWR (46 PWR plants).

3. The variance in annual LER reporting for both groups is quite large, even if the count for McGuire 1 is discounted. Listed in Table 2 are the five highest and five lowest reporting plants for each reactor type

The raw LER counts as a function of plant and event date month are shown for the BWR group in Table 3 and the PWR group in Table 4. The histograms in Figures 1 to 3 are based on plant totals from the last column of these tables. The other column headings describe the time interval start dates in a year, month, day format. Assignment to a time interval is based on LER event date. Figure 4 shows the monthly totals as a percent of total plant LER count for each plant type.

In order to look in more detail for any trends in LER reporting over the course of a year, the normalized cumulative differences of the counts from the monthly mean were plotted. That is, with

$X_i$ = Number of LERs reported in $i^{th}$ month of 1981

$$\bar{X} = \sum X_i / 12$$

$$s = \left[\sum (X_i - \bar{X})^2 / 11\right]^{1/2}$$

the quantities

$$C_j = \sum_{i=1}^{j} (X_i - \bar{X}) / 2s$$

were plotted as a function of j.[a] Figures 5, 6, and 7 show these plots for BWRs, PWRs, and all reactors, respectively. These plots tend to smooth out short term statistical fluctuations and emphasize the long term trend. The slope between two successive points is a measure of whether the number of LERs for the month indicated at the right endpoint is above or below the overall average monthly reporting level. Dividing by the 2s makes the scale of the plot such that successive differences from the mean that are >2s produce slopes that are greater than one.

The data do not show any clear trends (either increasing or decreasing) over the year for individual

a. Note: Since the deviations in the numerator of $C_j$ are measured from the sample mean instead of some hypothesized average level of monthly reporting, $C_{12}$ is always zero.

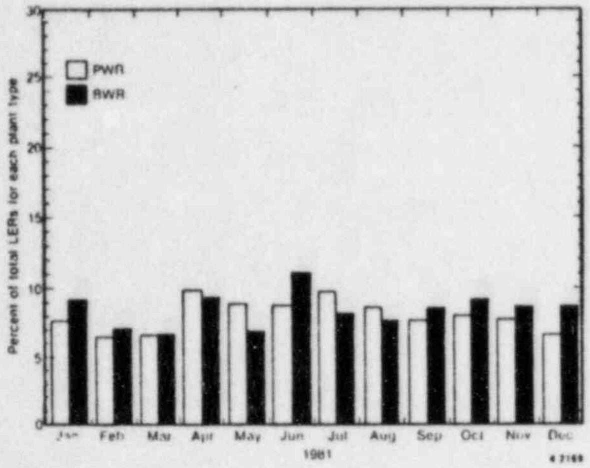


Figure 4. Percent of LER count by month for BWR and PWR plants.

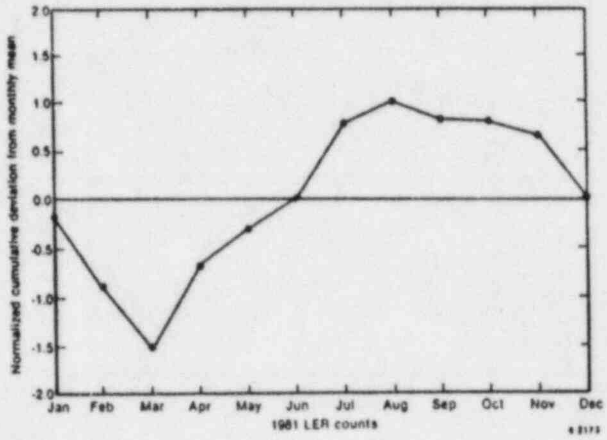


Figure 6. PWR monthly reporting cumulative sum.

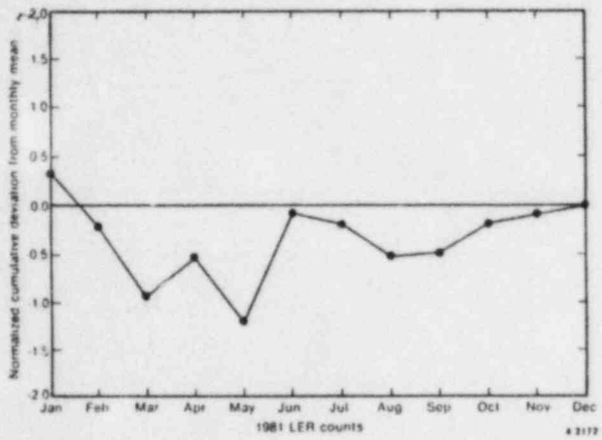


Figure 5. BWR monthly reporting cumulative sum.

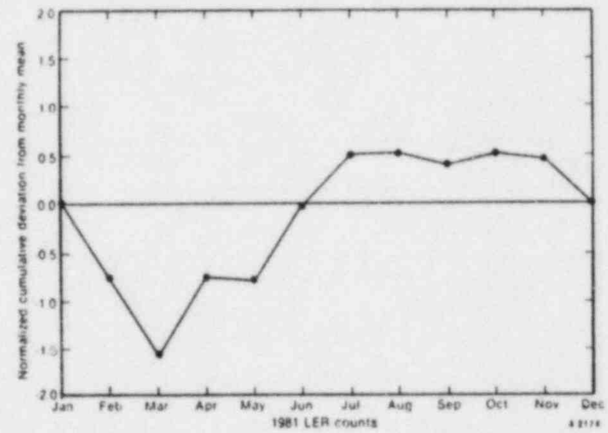


Figure 7. Overall monthly reporting cumulative sum.

**Table 2. Plants having high or low 1981 LER counts**

| BWR | | PWR | |
|---|---|---|---|
| Plant | LER Count | Plant | LER Count |
| Highest Reporting Plants | | | |
| Brunswick 2 | 145 | McGuire 1 | 188 |
| Hatch 1 | 140 | Sequoyah 1 | 133 |
| Hatch 2 | 133 | Salem 2 | 124 |
| Brunswick 1 | 94 | Salem 1 | 119 |
| Browns Ferry 1 | 83 | Beaver Valley 1 | 102 |
| Lowest Reporting Plants | | | |
| Humboldt Bay | 5 | Point Beach 2 | 8 |
| La Crosse | 15 | Indian Point 3 | 10 |
| Peach Bottom 3 | 21 | Fort Calhoun | 11 |
| Cooper 1, Monticello, Quad Cities 1 | 24 | Prairie Island 2, Three Mile Island 1 | 13 |
| Average | | | |
| For all BWR plants | 57 | For all PWR plants | 51 |

Table 3. 1981 LER reporting by plant and month—BWRs

| FID | Event Date | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 19810101 | 19810201 | 19810301 | 19810401 | 19810501 | 19810601 | 19810701 | 19810801 |
| BEP1 | 18 | 13 | 10 | 7 | 1 | 1 | 5 | 2 |
| BEP2 | 11 | 18 | 5 | 10 | 3 | 12 | 10 | 19 |
| BRF1 | 4 | 3 | 2 | 6 | 12 | 11 | 4 | 5 |
| BRF2 | 8 | 1 | 6 | 4 | 7 | 5 | 10 | 2 |
| BRF3 | 5 | 6 | 4 | 3 | 8 | 4 | 4 | 8 |
| BRP1 | 3 | 0 | 2 | 3 | 2 | 3 | 1 | 5 |
| CPR1 | 1 | 2 | 2 | 2 | 6 | 4 | 3 | 0 |
| DAC1 | 6 | 4 | 3 | 5 | 2 | 7 | 3 | 3 |
| DRS2 | 7 | 2 | 3 | 6 | 10 | 10 | 6 | 7 |
| DRS3 | 4 | 2 | 2 | 3 | 1 | 5 | 0 | 2 |
| EIH1 | 6 | 6 | 11 | 15 | 7 | 17 | 20 | 8 |
| EIH2 | 7 | 6 | 11 | 19 | 5 | 19 | 7 | 6 |
| HMB1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| JAF1 | 15 | 8 | 5 | 11 | 4 | 11 | 4 | 9 |
| LBR1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 0 |
| MNP1 | 1 | 0 | 2 | 8 | 3 | 4 | 1 | 0 |
| MNS1 | 0 | 1 | 0 | 7 | 2 | 6 | 3 | 4 |
| NMP1 | 1 | 4 | 2 | 4 | 4 | 11 | 7 | 4 |
| OCP1 | 6 | 4 | 5 | 4 | 3 | 6 | 8 | 7 |
| PBS2 | 9 | 5 | 7 | 5 | 3 | 2 | 0 | 5 |
| PBS3 | 4 | 5 | 1 | 1 | 0 | 0 | 0 | 1 |
| PPS1 | 2 | 3 | 3 | 5 | 4 | 10 | 10 | 5 |
| QAD1 | 4 | 1 | 2 | 3 | 0 | 2 | 3 | 0 |
| QAD2 | 2 | 3 | 3 | 0 | 3 | 1 | 2 | 1 |
| VYS1 | 5 | 2 | 3 | 0 | 5 | 2 | 3 | 3 |
| TOTAL | 130 | 101 | 95 | 132 | 97 | 156 | 115 | 108 |

| 19810901 | 19811001 | 19811101 | 19811201 | TOTAL |
|---|---|---|---|---|
| 7 | 9 | 12 | 9 | 94 |
| 13 | 17 | 11 | 16 | 145 |
| 6 | 6 | 15 | 9 | 63 |
| 5 | 11 | 4 | 3 | 66 |
| 9 | 11 | 4 | 4 | 69 |
| 5 | 1 | 0 | 2 | 27 |
| 1 | 1 | 0 | 2 | 24 |
| 3 | 2 | 6 | 5 | 49 |
| 4 | 5 | 5 | 9 | 74 |
| 8 | 7 | 4 | 1 | 39 |
| 15 | 8 | 12 | 14 | 140 |
| 14 | 7 | 14 | 16 | 135 |
| 1 | 1 | 0 | 0 | 5 |
| 1 | 6 | 3 | 2 | 79 |
| 2 | 1 | 2 | 2 | 15 |
| 0 | 3 | 2 | 0 | 24 |
| 7 | 2 | 4 | 3 | 39 |
| 1 | 2 | 2 | 1 | 43 |
| 3 | 10 | 6 | 11 | 73 |
| 3 | 1 | 1 | 2 | 43 |
| 1 | 2 | 3 | 3 | 21 |
| 4 | 6 | 2 | 3 | 57 |
| 1 | 4 | 3 | 1 | 24 |
| 5 | 2 | 2 | 1 | 25 |
| 1 | 4 | 5 | 3 | 36 |
| 120 | 129 | 122 | 122 | 1427 |

**Table 4. 1981 LER reporting by plant and month—PWRs**

| FID | 19810101 | 19810201 | 19810301 | 19810401 |
|---|---|---|---|---|
| ANJ1 | 2 | 1 | 1 | 3 |
| ANO2 | 3 | 7 | 3 | 3 |
| BVS1 | 12 | 15 | 3 | 10 |
| CCN1 | 7 | 8 | 8 | 7 |
| CCN2 | 7 | 1 | 7 | 9 |
| CRP3 | 6 | 4 | 8 | 7 |
| DBS1 | 9 | 6 | 6 | 5 |
| DCC1 | 1 | 2 | 6 | 4 |
| DCC2 | 2 | 1 | 5 | 10 |
| FCS1 | 1 | 0 | 0 | 4 |
| HBR2 | 6 | 2 | 1 | 3 |
| HNP1 | 0 | 1 | 2 | 2 |
| IPS2 | 5 | 0 | 2 | 2 |
| IPS3 | 2 | 1 | 2 | 0 |
| JMF1 | 1 | 3 | 7 | 13 |
| KNP1 | 3 | 3 | 3 | 3 |
| MGS1 | 4 | 16 | 11 | 40 |
| MNS2 | 7 | 4 | 3 | 3 |
| MYP1 | 0 | 0 | 1 | 2 |
| NAS1 | 7 | 3 | 6 | 15 |
| NAS2 | 13 | 10 | 5 | 5 |
| NEE1 | 3 | 2 | 1 | 1 |
| NEE2 | 1 | 2 | 3 | 3 |
| NEE3 | 1 | 2 | 4 | 1 |
| PAL1 | 9 | 1 | 3 | 3 |
| PBH1 | 2 | 0 | 1 | 1 |
| PBH2 | 0 | 0 | 1 | 1 |
| PIN1 | 1 | 0 | 1 | 0 |
| PIN2 | 0 | 0 | 1 | 2 |
| REG1 | 3 | 1 | 2 | 4 |
| RSS1 | 3 | 10 | 6 | 4 |
| SGS1 | 12 | 12 | 11 | 8 |
| SGS2 | 2 | 0 | 1 | 10 |
| SLS1 | 7 | 6 | 2 | 7 |
| SNP1 | 13 | 12 | 14 | 13 |
| SOS1 | 1 | 1 | 0 | 3 |
| SPS1 | 2 | 2 | 3 | 3 |
| SPS2 | 11 | 7 | 4 | 3 |
| TMI1 | 3 | 1 | 1 | 0 |
| TMI2 | 1 | 3 | 1 | 4 |
| TNP1 | 3 | 0 | 2 | 2 |
| TPS3 | 4 | 0 | 2 | 3 |
| TPS4 | 1 | 2 | 1 | 3 |
| YKR1 | 1 | 2 | 0 | 1 |
| ZIS1 | 4 | 3 | 6 | 8 |
| ZIS2 | 1 | 1 | 1 | 3 |
| TOTAL | 187 | 158 | 162 | 241 |

**Also Available On Aperture Card**

Event Date

| 9810501 | 19810601 | 19810701 | 19810801 | 19810901 | 19811001 | 19811101 | 19811201 | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 4 | 0 | 0 | 1 | 0 | 15 |
| 4 | 4 | 4 | 3 | 1 | 5 | 6 | 1 | 44 |
| 11 | 9 | 7 | 9 | 9 | 7 | 6 | 4 | 102 |
| 7 | 15 | 7 | 9 | 1 | 7 | 5 | 3 | 84 |
| 2 | 5 | 5 | 6 | 2 | 3 | 6 | 4 | 57 |
| 4 | 9 | 9 | 7 | 4 | 11 | 2 | 9 | 80 |
| 4 | 7 | 6 | 7 | 8 | 11 | 6 | 3 | 78 |
| 1 | 10 | 8 | 7 | 8 | 3 | 5 | 10 | 65 |
| 5 | 4 | 12 | 5 | 3 | 14 | 9 | 5 | 75 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 11 |
| 2 | 2 | 2 | 0 | 2 | 3 | 6 | 4 | 33 |
| 0 | 3 | 2 | 2 | 3 | 0 | 3 | 1 | 19 |
| 6 | 1 | 2 | 3 | 1 | 4 | 4 | 3 | 33 |
| 0 | 0 | 1 | 0 | 1 | 0 | 2 | 1 | 10 |
| 13 | 8 | 9 | 10 | 4 | 1 | 1 | 3 | 73 |
| 5 | 5 | 1 | 5 | 1 | 5 | 3 | 1 | 38 |
| 13 | 6 | 21 | 27 | 10 | 11 | 14 | 8 | 168 |
| 2 | 8 | 0 | 4 | 2 | 3 | 2 | 7 | 45 |
| 3 | 4 | 5 | 2 | 4 | 0 | 1 | 0 | 22 |
| 10 | 6 | 12 | 10 | 3 | 2 | 6 | 5 | 85 |
| 10 | 8 | 6 | 6 | 8 | 7 | 6 | 3 | 87 |
| 1 | 4 | 2 | 1 | 3 | 3 | 2 | 3 | 26 |
| 2 | 0 | 0 | 3 | 3 | 0 | 2 | 1 | 20 |
| 4 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 16 |
| 6 | 5 | 4 | 4 | 3 | 10 | 2 | 4 | 54 |
| 1 | 2 | 4 | 1 | 1 | 4 | 0 | 2 | 19 |
| 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 6 |
| 0 | 1 | 1 | 1 | 6 | 3 | 2 | 2 | 18 |
| 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 11 |
| 2 | 0 | 2 | 0 | 1 | 0 | 4 | 3 | 22 |
| 6 | 4 | 3 | 5 | 7 | 4 | 1 | 3 | 56 |
| 12 | 9 | 6 | 8 | 11 | 12 | 12 | 0 | 119 |
| 12 | 21 | 25 | 14 | 14 | 3 | 11 | 6 | 124 |
| 6 | 5 | 3 | 3 | 5 | 4 | 3 | 9 | 60 |
| 12 | 13 | 19 | 8 | 5 | 6 | 6 | 10 | 133 |
| 3 | 6 | 3 | 1 | 3 | 5 | 5 | 1 | 32 |
| 4 | 2 | 15 | 9 | 18 | 9 | 8 | 9 | 84 |
| 10 | 7 | 7 | 7 | 5 | 5 | 11 | 3 | 80 |
| 1 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 13 |
| 2 | 1 | 0 | 3 | 4 | 4 | 2 | 3 | 28 |
| 1 | 2 | 5 | 1 | 5 | 4 | 1 | 4 | 30 |
| 2 | 0 | 1 | 0 | 0 | 2 | 3 | 0 | 17 |
| 0 | 0 | 2 | 0 | 1 | 1 | 4 | 2 | 17 |
| 5 | 6 | 5 | 4 | 2 | 1 | 3 | 3 | 33 |
| 8 | 3 | 1 | 5 | 4 | 3 | 3 | 2 | 50 |
| 6 | 2 | 4 | 1 | 5 | 3 | 4 | 7 | 38 |
| 215 | 213 | 237 | 208 | 186 | 195 | 188 | 161 | 2352 |

plants, for the BWR and PWR classes, or for all plants combined. There is little regularity of any kind (e.g., cyclic monthly behavior) at the individual plant level over the course of a calendar year; virtually every month is a month of maximum LER reporting for some plant. Figures 5, 6, and 7 all exhibit negative slopes for February and March and positive slopes for April, reflecting the fact that for both plant types total reporting was below the 1981 monthly average in February and March and above it in April. However, the variety in average monthly reporting for the other nine months shown by these plots does not indicate an overall pattern or regularity. Additional years of data would be needed to assess whether there are seasonal patterns in LER reporting.

**In conclusion,** there is wide variation in reporting as a function of plant, to such an extent that it may not be possible to define subsets of the plants for which LER reporting behavior is similar. Preliminary statistical analysis indicates that grouping plants into BWR/PWR classes is not appropriate when considering monthly reporting patterns. Additional analysis and data are required.

## Sequence Counts

Each LER describes at least one sequence (interrelated set of occurrences) and some LERs describe more than one sequence. Tables 5 and 6 are like Tables 3 and 4 except that the sequences are tallied instead of the LERs themselves. In most cases, these numbers are just slightly higher than the LER profiles. For BWRs, the sequence count is 7.5% higher than the LER count, with an average of 61 coded sequences per plant. For PWRs, it is 8.1% higher with 55 per plant on the average. The same plants dominate the sequence counts as the LER counts.

Figures 8 and 9 are plots showing both LER and sequence counts for, respectively, BWRs and PWRs. The plants are sorted based on their LER count, so these plots summarize what has been observed about 1981 plant LER reporting frequencies. The solid part of each bar shows the additional counts obtained by adding the multiple sequences that are described in some LERs. The plots show that:

1. For most plants, the sequence counts either are identical to the LER counts or else differ by at least 10

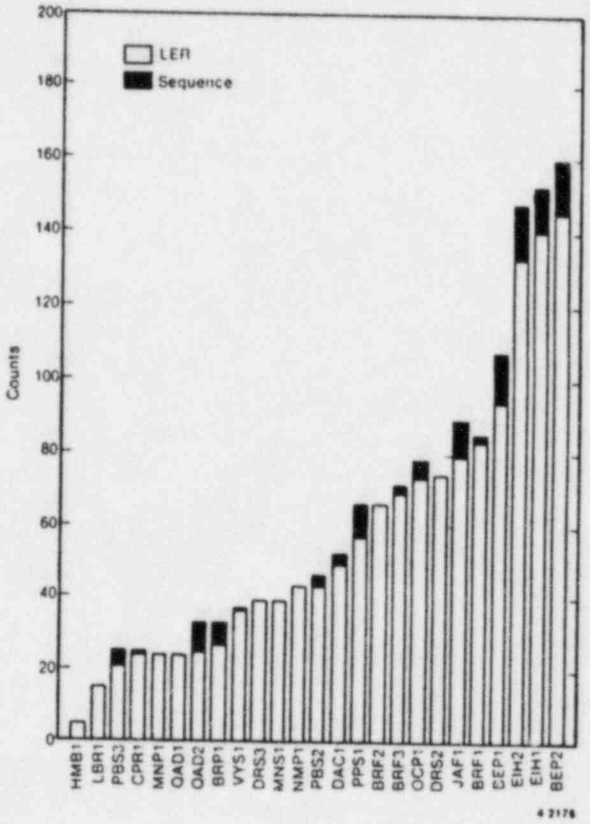


Figure 8. BWR LER and sequence counts.

2. With some exceptions, the plants that have a high reporting rate tend to be among those which have LERs with more than one sequence in the data base

3. Considering the sequence counts does not appreciably affect plant ranking based on LER count

4. The pattern for sequence counts as opposed to LER counts among BWR and PWR plants is similar.

**In conclusion,** plants generally include more than one sequence in less than ~8% of the LERs submitted. There is no significant pattern to these multiple-sequence LERs. Consequently, counts of either LERs or sequences may be used as the basis for trends and patterns analysis.

## Plant and Environmental Effects

Sequence attributes include information on the changes in plant status, environmental radiological releases, and personnel exposure associated with

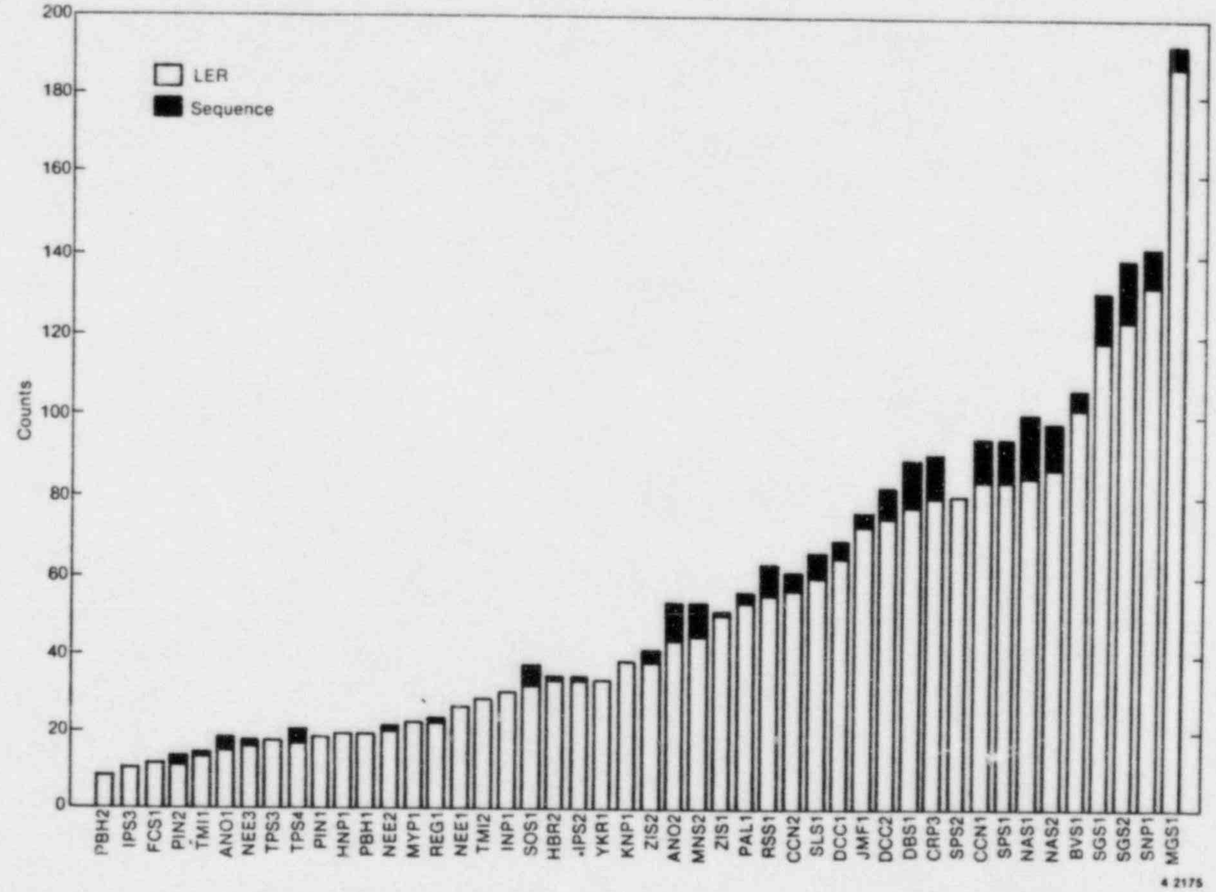


Figure 9. PWR LER and sequence counts.

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**Table 5. 1981 sequence counts by plant and month—BWRs**

| PID | Event Date | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 19810101 | 19810201 | 19810301 | 19810401 | 19810501 | 19810601 | 19810701 | 19810801 |
| BEP1 | 20 | 14 | 11 | 9 | 1 | 1 | 6 | 2 |
| BEP2 | 13 | 20 | 5 | 10 | 3 | 12 | 12 | 21 |
| BRF1 | 4 | 3 | 2 | 7 | 12 | 11 | 5 | 5 |
| BRF2 | 8 | 1 | 6 | 4 | 7 | 5 | 10 | 2 |
| BRF3 | 5 | 8 | 4 | 3 | 6 | 4 | 4 | 6 |
| BRP1 | 3 | 0 | 2 | 3 | 2 | 9 | 1 | 5 |
| CPR1 | 1 | 2 | 2 | 2 | 7 | 4 | 3 | 0 |
| DAC1 | 6 | 4 | 3 | 7 | 2 | 7 | 3 | 3 |
| DRS2 | 7 | 2 | 3 | 6 | 10 | 10 | 6 | 7 |
| DRS3 | 4 | 2 | 2 | 3 | 1 | 5 | 0 | 2 |
| EIH1 | 6 | 7 | 11 | 15 | 7 | 22 | 20 | 13 |
| EIH2 | 8 | 6 | 12 | 22 | 6 | 20 | 7 | 9 |
| HMB1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| JAF1 | 16 | 10 | 7 | 13 | 5 | 12 | 4 | 10 |
| LBR1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 0 |
| MNP1 | 1 | 0 | 2 | 8 | 3 | 4 | 1 | 0 |
| MNS1 | 0 | 1 | 0 | 7 | 2 | 6 | 3 | 4 |
| NMP1 | 1 | 4 | 2 | 4 | 4 | 11 | 7 | 4 |
| OCP1 | 6 | 4 | 5 | 4 | 3 | 7 | 8 | 8 |
| PBS2 | 9 | 5 | 8 | 5 | 3 | 2 | 0 | 7 |
| PBS3 | 4 | 9 | 1 | 1 | 3 | 0 | 0 | 1 |
| PPS1 | 3 | 4 | 3 | 5 | 5 | 14 | 10 | 5 |
| QAD1 | 4 | 1 | 2 | 3 | 0 | 2 | 3 | 0 |
| QAD2 | 2 | 3 | 3 | 0 | 3 | 1 | 2 | 1 |
| VYS1 | 5 | 2 | 3 | 0 | 3 | 2 | 3 | 4 |
| TOTAL | 137 | 114 | 100 | 142 | 101 | 174 | 119 | 121 |



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| 19810901 | 19811001 | 19811101 | 19811201 | TOTAL |
|---|---|---|---|---|
| 8 | 9 | 14 | 12 | 107 |
| 14 | 17 | 15 | 17 | 159 |
| 6 | 6 | 15 | 9 | 85 |
| 5 | 11 | 4 | 3 | 66 |
| 8 | 11 | 4 | 4 | 71 |
| 5 | 1 | 0 | 2 | 33 |
| 1 | 1 | 0 | 2 | 25 |
| 3 | 2 | 7 | 5 | 52 |
| 4 | 5 | 5 | 9 | 74 |
| 8 | 7 | 4 | 1 | 39 |
| 16 | 8 | 12 | 15 | 152 |
| 15 | 11 | 14 | 17 | 147 |
| 1 | 1 | 0 | 0 | 5 |
| 1 | 6 | 3 | 2 | 89 |
| 2 | 1 | 2 | 2 | 15 |
| 0 | 3 | 2 | 0 | 24 |
| 7 | 2 | 4 | 3 | 39 |
| 1 | 2 | 2 | 1 | 43 |
| 3 | 10 | 6 | 14 | 78 |
| 3 | 1 | 1 | 2 | 40 |
| 1 | 2 | 3 | 3 | 25 |
| 4 | 0 | 2 | 3 | 66 |
| 1 | 4 | 3 | 1 | 24 |
| 13 | 2 | 2 | 1 | 33 |
| 1 | 4 | 5 | 3 | 37 |
| 131 | 135 | 129 | 131 | 1534 |

## Table 6. 1981 sequence counts by plant and month—PWRs

| PID | 19810101 | 19810201 | 19810301 | 19810401 |
|---|---|---|---|---|
| ANO1 | 2 | 1 | 1 | 6 |
| ANO2 | 3 | 9 | 3 | 3 |
| BVS1 | 12 | 15 | 3 | 10 |
| CCN1 | 7 | 8 | 8 | 6 |
| CCN2 | 8 | 1 | 9 | 10 |
| CRP3 | 9 | 4 | 8 | 7 |
| DBS1 | 12 | 6 | 8 | 5 |
| DCC1 | 1 | 2 | 8 | 4 |
| DCC2 | 2 | 2 | 6 | 12 |
| FCS1 | 1 | 0 | 0 | 4 |
| HBR2 | 6 | 2 | 1 | 3 |
| MNP1 | 0 | 1 | 2 | 2 |
| IPS2 | 5 | 0 | 2 | 2 |
| IPS3 | 2 | 1 | 2 | 0 |
| JMF1 | 1 | 3 | 7 | 13 |
| KNP1 | 3 | 3 | 3 | 3 |
| MGS1 | 4 | 10 | 12 | 41 |
| MNS2 | 7 | 4 | 3 | 3 |
| MYP1 | 0 | 0 | 1 | 2 |
| NAS1 | 8 | 3 | 6 | 21 |
| NAS2 | 15 | 11 | 6 | 5 |
| NEC1 | 3 | 2 | 1 | 1 |
| NEC2 | 1 | 2 | 3 | 3 |
| NEC3 | 1 | 3 | 4 | 1 |
| PAL1 | 9 | 1 | 3 | 4 |
| PBM1 | 2 | 0 | 1 | 1 |
| PBM2 | 0 | 0 | 1 | 1 |
| PIN1 | 1 | 0 | 1 | 0 |
| PIN2 | 0 | 0 | 1 | 2 |
| REG1 | 3 | 1 | 3 | 4 |
| RSS1 | 3 | 11 | 6 | 5 |
| SGS1 | 14 | 12 | 11 | 9 |
| SGS2 | 2 | 0 | 1 | 10 |
| SLS1 | 7 | 10 | 2 | 7 |
| SNP1 | 14 | 13 | 16 | 13 |
| SOS1 | 1 | 1 | 0 | 4 |
| SPS1 | 2 | 2 | 3 | 4 |
| SPS2 | 11 | 7 | 4 | 3 |
| TMI1 | 4 | 1 | 1 | 0 |
| TMI2 | 1 | 3 | 1 | 4 |
| TNP1 | 3 | 0 | 2 | 2 |
| TPS3 | 4 | 0 | 2 | 3 |
| TPS4 | 1 | 3 | 2 | 3 |
| YKE1 | 1 | 2 | 0 | 1 |
| ZIS1 | 4 | 3 | 6 | 6 |
| ZIS2 | 1 | 1 | 1 | 3 |
| TOTAL | 201 | 170 | 175 | 260 |

Event Date

| 9810501 | 19810601 | 19810701 | 19810801 | 19810901 | 19811001 | 19811101 | 19811201 | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 4 | 0 | 0 | 1 | 0 | 18 |
| 4 | 4 | 5 | 6 | 1 | 7 | 7 | 1 | 53 |
| 11 | 9 | 10 | 9 | 9 | 8 | 8 | 4 | 106 |
| 7 | 18 | 8 | 11 | 1 | 9 | 5 | 4 | 94 |
| 2 | 5 | 5 | 6 | 2 | 3 | 6 | 4 | 61 |
| 5 | 11 | 9 | 7 | 4 | 15 | 2 | 9 | 90 |
| 4 | 7 | 6 | 7 | 10 | 15 | 6 | 3 | 89 |
| 1 | 10 | 8 | 9 | 3 | 3 | 5 | 10 | 69 |
| 5 | 4 | 14 | 6 | 3 | 14 | 9 | 5 | 82 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 11 |
| 2 | 3 | 2 | 0 | 2 | 3 | 6 | 4 | 34 |
| 0 | 3 | 2 | 2 | 3 | 0 | 3 | 1 | 19 |
| 8 | 2 | 2 | 3 | 1 | 4 | 4 | 3 | 34 |
| 0 | 0 | 1 | 0 | 1 | 0 | 2 | 1 | 10 |
| 13 | 8 | 11 | 10 | 4 | 1 | 1 | 4 | 76 |
| 5 | 5 | 1 | 5 | 1 | 5 | 3 | 1 | 36 |
| 15 | 8 | 21 | 30 | 10 | 11 | 14 | 8 | 193 |
| 2 | 16 | 0 | 4 | 2 | 3 | 2 | 7 | 53 |
| 3 | 4 | 5 | 2 | 4 | 0 | 1 | 0 | 22 |
| 14 | 7 | 13 | 10 | 3 | 3 | 6 | 8 | 100 |
| 10 | 10 | 7 | 7 | 9 | 9 | 6 | 3 | 98 |
| 1 | 4 | 2 | 1 | 3 | 3 | 2 | 3 | 26 |
| 2 | 0 | 0 | 4 | 3 | 0 | 2 | 1 | 21 |
| 4 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 17 |
| 6 | 6 | 4 | 4 | 3 | 10 | 2 | 4 | 56 |
| 1 | 2 | 4 | 1 | 1 | 4 | 0 | 2 | 19 |
| 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 8 |
| 0 | 1 | 1 | 1 | 6 | 3 | 2 | 2 | 18 |
| 1 | 0 | 2 | 1 | 2 | 1 | 2 | 1 | 13 |
| 2 | 0 | 2 | 0 | 1 | 0 | 4 | 3 | 23 |
| 8 | 4 | 3 | 5 | 10 | 4 | 1 | 3 | 63 |
| 12 | 10 | 6 | 10 | 14 | 13 | 14 | 8 | 131 |
| 12 | 23 | 27 | 16 | 14 | 9 | 16 | 9 | 139 |
| 6 | 5 | 3 | 3 | 5 | 4 | 3 | 11 | 66 |
| 13 | 14 | 20 | 8 | 5 | 9 | 6 | 11 | 142 |
| 3 | 7 | 3 | 2 | 3 | 7 | 5 | 1 | 37 |
| 4 | 2 | 15 | 12 | 22 | 10 | 9 | 9 | 94 |
| 10 | 7 | 7 | 7 | 5 | 5 | 11 | 3 | 80 |
| 1 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 14 |
| 2 | 1 | 0 | 3 | 4 | 4 | 2 | 3 | 28 |
| 1 | 2 | 5 | 1 | 5 | 4 | 1 | 4 | 30 |
| 2 | 0 | 1 | 0 | 0 | 2 | 3 | 0 | 17 |
| 0 | 0 | 2 | 0 | 1 | 1 | 5 | 2 | 20 |
| 5 | 6 | 5 | 4 | 2 | 1 | 3 | 3 | 33 |
| 8 | 3 | 1 | 6 | 4 | 3 | 3 | 2 | 51 |
| 6 | 2 | 6 | 1 | 5 | 3 | 4 | 8 | 41 |
| 224 | 237 | 254 | 230 | 199 | 217 | 199 | 171 | 2537 |





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reported sequences. The SCSS stores this information for each sequence. These data were examined and the results are discussed below.

**Change in Plant Status.** Table 7 lists the categories used in the SCSS for describing plant initial states.

**Table 7. SCSS initial condition codes**

| Code | Initial Condition |
|---|---|
| B | Preoperational/start-up/power ascension tests |
| C | Routine start-up |
| D | Routine shutdown |
| E | Steady state operation |
| F | Load change during routine power operation |
| H | Refueling |
| I | Cold shutdown |
| K | Hot shutdown |
| L | Hot standby (PWRs only) |
| X | Other |
| Z | Unknown/not applicable |

Table 8 gives counts of the initial conditions of BWR plant sequences; Table 9 shows, for BWRs, the percent of each total plant count (row total) that falls in each initial condition category. The fact that Humboldt Bay was shutdown is reflected in its lack of a count for Condition E, steady state operation.

The last line of Table 9 shows the percentage distribution of initial conditions for BWRs as a class; slightly over half (55%) of the reported sequences fall into the steady state operation category, with the next highest concentration being ~15% in the refueling category. However, the rows of Table 8 show wide variation about this average BWR class behavior for the individual plants, demonstrating that it would be difficult to find a typical BWR from the initial condition perspective.

The PWR Tables 10 and 11 are analogous to the BWR Tables 8 and 9. The BWR and PWR data are similar. As was the case with the BWRs, it would be difficult to select a typical PWR plant, since there is such wide variation in the overall PWR initial condition distribution pattern. That general pattern as shown in Table 11 has 50% of the sequences in the steady state category, with the next highest concentration at 11% in the cold shutdown category.

The specific type of effect events had on the status of the plants is indicated by the plant effect categories in the SCSS. Tables 12 and 13 show plant effect counts, for, respectively, BWR and PWR plants. All SCSS categories showing plant status changes appear in these tables except unintentional manual scram and power reduction, which were not used in the 1981 SCSS data. Most of the counts are in the no significant effect column. For BWR plants, Dresden 3, and Hatch 1 experienced 3 and 4 reportable events causing manual shutdowns, respectively, while Brunswick 1 and La Crosse had, respectively, 3 and 4 reported events involving automatic scrams. Among PWR plants, 8 plant-effect cells had 3 or more events with some effect on the plants, as follows:

| Plant | Plant Effect | Number of Sequences |
|---|---|---|
| Beaver Valley 1 | Extension of Outage | 3 |
| Crystal River 3 | Automatic Scram | 3 |
| McGuire 1 | Unintentional ESF Actuation | 4 |
| North Anna 2 | Unintentional ESF Actuation | 3 |
| Salem 1 | Unintentional ESF Actuation | 3 |
| Salem 2 | Unintentional ESF Actuation | 5 |
| St. Lucie 1 | Automatic Scram | 4 |
| Zion 1 | Automatic Scram | 3 |

**Table 8. BWR initial condition counts**

| FID | B | C |
|---|---|---|
| BEP1 | 0 | 18 |
| BEP2 | 0 | 21 |
| BRF1 | 0 | 0 |
| BRF2 | 0 | 3 |
| BRF3 | 0 | 7 |
| BRP1 | 0 | 0 |
| CPR1 | 0 | 3 |
| DAC1 | 0 | 2 |
| DRS2 | 0 | 5 |
| DRS3 | 0 | 2 |
| EIH1 | 0 | 17 |
| EIH2 | 0 | 8 |
| HMB1 | 0 | 0 |
| JAF1 | 0 | 1 |
| LBR1 | 0 | 2 |
| MNP1 | 0 | 0 |
| MNS1 | 0 | 10 |
| NMP1 | 0 | 1 |
| OCP1 | 0 | 1 |
| PBS2 | 0 | 4 |
| PBS3 | 0 | 3 |
| PPS1 | 0 | 3 |
| QAD1 | 1 | 0 |
| QAD2 | 0 | 0 |
| VYS1 | 0 | 2 |
| TOTAL | 1 | 113 |

a. B, preoperational/start-up/power
E, steady-state operation; F, load c
K, hot shutdown; X, other; Z, unknow

Initial Conditions[a]

| D | E | F | H | I | K | X | Z | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 13 | 32 | 21 | 0 | 9 | 1 | 0 | 16 | 110 |
| 9 | 56 | 51 | 0 | 4 | 6 | 0 | 15 | 162 |
| 0 | 70 | 0 | 49 | 2 | 0 | 4 | 1 | 126 |
| 1 | 52 | 0 | 2 | 4 | 1 | 0 | 0 | 63 |
| 2 | 42 | 1 | 12 | 1 | 1 | 0 | 0 | 66 |
| 0 | 30 | 0 | 1 | 2 | 0 | 0 | 0 | 33 |
| 1 | 11 | 0 | 7 | 2 | 1 | 0 | 0 | 25 |
| 0 | 29 | 5 | 8 | 2 | 1 | 0 | 5 | 52 |
| 2 | 42 | 3 | 18 | 1 | 0 | 1 | 0 | 72 |
| 2 | 30 | 0 | 2 | 2 | 0 | 0 | 1 | 39 |
| 5 | 75 | 2 | 35 | 14 | 2 | 0 | 9 | 159 |
| 1 | 107 | 7 | 9 | 7 | 5 | 0 | 5 | 149 |
| 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 |
| 6 | 65 | 0 | 0 | 7 | 1 | 0 | 7 | 87 |
| 2 | 10 | 0 | 0 | 1 | 1 | 0 | 0 | 16 |
| 1 | 9 | 0 | 10 | 4 | 0 | 0 | 0 | 24 |
| 0 | 15 | 4 | 4 | 5 | 0 | 1 | 0 | 39 |
| 1 | 18 | 0 | 21 | 0 | 0 | 0 | 0 | 41 |
| 2 | 35 | 2 | 13 | 16 | 1 | 1 | 4 | 75 |
| 0 | 29 | 2 | 1 | 5 | 0 | 1 | 6 | 48 |
| 0 | 14 | 0 | 4 | 0 | 0 | 0 | 4 | 25 |
| 1 | 33 | 2 | 15 | 1 | 0 | 0 | 4 | 59 |
| 0 | 21 | 0 | 0 | 0 | 1 | 0 | 0 | 23 |
| 1 | 14 | 0 | 16 | 0 | 0 | 0 | 1 | 32 |
| 1 | 21 | 1 | 6 | 2 | 1 | 0 | 1 | 35 |
| 51 | 860 | 101 | 233 | 96 | 23 | 8 | 79 | 1565 |

ascension tests; C, routine start-up; D, routine shutdown;
hange during routine power operation; H, refueling; I, cold shutdown;
n/not applicable.

Table 9. BWR initial conditions as a percent of plant totals

| FID | Initial Conditions[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | C | D | E | F | H | I | K | X | Z | TOTAL |
| BEP1 | 0.0 | 16.4 | 11.8 | 29.1 | 19.1 | 0.0 | 8.2 | .9 | 0.0 | 14.5 | 100.0 |
| BEP2 | 0.0 | 13.0 | 5.6 | 34.6 | 31.5 | 0.0 | 2.5 | 3.7 | 0.0 | 9.3 | 100.0 |
| BRF1 | 0.0 | 0.0 | 0.0 | 55.6 | 0.0 | 38.9 | 1.6 | 0.0 | 3.2 | .8 | 100.0 |
| BRF2 | 0.0 | 4.8 | 1.6 | 82.5 | 0.0 | 3.2 | 6.3 | 1.6 | 0.0 | 0.0 | 100.0 |
| BRF3 | 0.0 | 10.6 | 3.0 | 63.6 | 1.5 | 18.2 | 1.5 | 1.5 | 0.0 | 0.0 | 100.0 |
| BRP1 | 0.0 | 0.0 | 0.0 | 90.9 | 0.0 | 3.0 | 6.1 | 0.0 | 0.0 | 0.0 | 100.0 |
| CPR1 | 0.0 | 12.0 | 4.0 | 44.0 | 0.0 | 28.0 | 8.0 | 4.0 | 0.0 | 0.0 | 100.0 |
| DAC1 | 0.0 | 3.8 | 0.0 | 55.8 | 9.6 | 15.4 | 3.8 | 1.9 | 0.0 | 9.6 | 100.0 |
| DRS2 | 0.0 | 6.9 | 2.8 | 58.3 | 4.2 | 25.0 | 1.4 | 0.0 | 1.4 | 0.0 | 100.0 |
| DRS3 | 0.0 | 5.1 | 5.1 | 76.9 | 0.0 | 5.1 | 5.1 | 0.0 | 0.0 | 2.6 | 100.0 |
| EIH1 | 0.0 | 10.7 | 3.1 | 47.2 | 1.3 | 22.0 | 8.8 | 1.3 | 0.0 | 5.7 | 100.0 |
| EIH2 | 0.0 | 5.4 | .7 | 71.8 | 4.7 | 6.0 | 4.7 | 3.4 | 0.0 | 3.4 | 100.0 |
| HMB1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| JAF1 | 0.0 | 1.1 | 6.9 | 74.7 | 0.0 | 0.0 | 8.0 | 1.1 | 0.0 | 8.0 | 100.0 |
| LBR1 | 0.0 | 12.5 | 12.5 | 62.5 | 0.0 | 0.0 | 6.3 | 6.3 | 0.0 | 0.0 | 100.0 |
| MNP1 | 0.0 | 0.0 | 4.2 | 37.5 | 0.0 | 41.7 | 16.7 | 0.0 | 0.0 | 0.0 | 100.0 |
| MNS1 | 0.0 | 25.6 | 0.0 | 38.5 | 10.3 | 10.3 | 12.8 | 0.0 | 2.6 | 0.0 | 100.0 |
| NMP1 | 0.0 | 2.4 | 2.4 | 43.9 | 0.0 | 51.2 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| OCP1 | 0.0 | 1.3 | 2.7 | 46.7 | 2.7 | 17.3 | 21.3 | 1.3 | 1.3 | 5.3 | 100.0 |
| PBS2 | 0.0 | 8.3 | 0.0 | 60.4 | 4.2 | 2.1 | 10.4 | 0.0 | 2.1 | 12.5 | 100.0 |
| PBS3 | 0.0 | 12.0 | 0.0 | 56.0 | 0.0 | 16.0 | 0.0 | 0.0 | 0.0 | 16.0 | 100.0 |
| PPS1 | 0.0 | 5.1 | 1.7 | 55.9 | 3.4 | 25.4 | 1.7 | 0.0 | 0.0 | 6.8 | 100.0 |
| QAD1 | 4.3 | 0.0 | 0.0 | 91.3 | 0.0 | 0.0 | 0.0 | 4.3 | 0.0 | 0.0 | 100.0 |
| QAD2 | 0.0 | 0.0 | 3.1 | 43.8 | 0.0 | 50.0 | 0.0 | 0.0 | 0.0 | 3.1 | 100.0 |
| VYS1 | 0.0 | 5.7 | 2.9 | 60.0 | 2.9 | 17.1 | 5.7 | 2.9 | 0.0 | 2.9 | 100.0 |
| TOTAL | .1 | 7.2 | 3.3 | 55.0 | 6.5 | 14.9 | 6.1 | 1.5 | .5 | 5.0 | 100.0 |

a. B, preoperational/start-up/power ascension tests; C, routine start-up; D, routine shutdown; E, steady-state operation; F, load change during routine power operation; H, refueling; I, cold shutdown; K, hot shutdown; X, other; Z, unknown/not applicable.

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Table 10. PWR initial condition counts

| FID | B | C | D |
|---|---|---|---|
| ANO1 | 0 | 0 | 2 |
| ANO2 | 0 | 5 | 1 |
| BVS1 | 0 | 7 | 2 |
| CCN1 | 0 | 10 | 3 |
| CCN2 | 0 | 3 | 3 |
| CRP3 | 0 | 1 | 3 |
| DBS1 | 0 | 7 | 1 |
| DCC1 | 0 | 1 | 3 |
| DCC2 | 0 | 7 | 3 |
| FCS1 | 0 | 1 | 0 |
| HBR2 | 0 | 3 | 1 |
| HNP1 | 0 | 0 | 1 |
| IPS2 | 0 | 0 | 4 |
| IPS3 | 0 | 0 | 0 |
| JMF1 | 3 | 2 | 0 |
| KNP1 | 0 | 3 | 0 |
| MGS1 | 23 | 19 | 1 |
| MNS2 | 0 | 0 | 1 |
| MYP1 | 0 | 1 | 0 |
| NAS1 | 0 | 2 | 1 |
| NAS2 | 0 | 8 | 0 |
| NEE1 | 1 | 1 | 3 |
| NEE2 | 0 | 1 | 1 |
| NEE3 | 0 | 0 | 0 |
| PAL1 | 0 | 1 | 0 |
| PBH1 | 0 | 1 | 0 |
| PBH2 | 0 | 0 | 1 |
| PIN1 | 0 | 1 | 0 |
| PIN2 | 0 | 0 | 1 |
| REG1 | 0 | 0 | 2 |
| RSS1 | 0 | 0 | 5 |
| SGS1 | 0 | 10 | 8 |
| SGS2 | 3 | 21 | 9 |
| SLS1 | 2 | 4 | 0 |
| SNP1 | 6 | 16 | 2 |
| SOS1 | 1 | 3 | 0 |
| SPS1 | 1 | 5 | 4 |
| SPS2 | 0 | 2 | 0 |
| TMI1 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 |
| TNP1 | 0 | 1 | 1 |
| TPS3 | 0 | 1 | 1 |
| TPS4 | 0 | 2 | 0 |
| YKR1 | 0 | 1 | 1 |
| ZIS1 | 0 | 1 | 0 |
| ZIS2 | 0 | 2 | 0 |
| TOTAL | 40 | 154 | 69 |

a. B, preoperational/start-up/power ascension
E, steady-state operation; F, load change durin
K, hot shutdown; L, hot standby; X, other; Z,

Initial Conditions[a]

| E | F | H | I | K | L | X | Z | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 6 | 0 | 4 | 1 | 0 | 0 | 1 | 4 | 18 |
| 22 | 1 | 6 | 6 | 0 | 6 | 0 | 4 | 51 |
| 76 | 6 | 1 | 5 | 4 | 1 | 0 | 4 | 106 |
| 64 | 1 | 1 | 1 | 3 | 0 | 1 | 6 | 90 |
| 38 | 1 | 2 | 5 | 3 | 2 | 0 | 3 | 60 |
| 41 | 2 | 12 | 13 | 10 | 4 | 0 | 2 | 88 |
| 54 | 0 | 0 | 11 | 2 | 6 | 1 | 6 | 88 |
| 37 | 1 | 15 | 5 | 1 | 1 | 0 | 7 | 71 |
| 40 | 4 | 17 | 2 | 1 | 1 | 0 | 4 | 79 |
| 7 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 11 |
| 20 | 1 | 0 | 3 | 6 | 0 | 0 | 0 | 34 |
| 16 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 18 |
| 14 | 0 | 8 | 4 | 3 | 0 | 0 | 1 | 34 |
| 2 | 0 | 0 | 2 | 3 | 1 | 0 | 0 | 8 |
| 53 | 1 | 2 | 16 | 1 | 2 | 0 | 16 | 96 |
| 28 | 0 | 6 | 0 | 2 | 0 | 0 | 0 | 39 |
| 9 | 0 | 11 | 47 | 19 | 53 | 7 | 10 | 199 |
| 32 | 0 | 4 | 3 | 3 | 2 | 0 | 8 | 53 |
| 10 | 0 | 9 | 0 | 0 | 1 | 0 | 0 | 21 |
| 61 | 3 | 8 | 15 | 2 | 5 | 0 | 13 | 110 |
| 64 | 4 | 0 | 5 | 5 | 9 | 1 | 2 | 98 |
| 14 | 0 | 8 | 5 | 0 | 1 | 1 | 1 | 35 |
| 13 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 17 |
| 11 | 0 | 3 | 0 | 1 | 0 | 0 | 2 | 17 |
| 32 | 0 | 10 | 10 | 1 | 0 | 0 | 0 | 54 |
| 10 | 0 | 4 | 2 | 1 | 0 | 0 | 5 | 23 |
| 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 8 |
| 10 | 1 | 7 | 1 | 0 | 0 | 0 | 1 | 21 |
| 9 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 13 |
| 17 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 22 |
| 17 | 0 | 23 | 10 | 1 | 1 | 0 | 6 | 63 |
| 69 | 0 | 0 | 13 | 3 | 6 | 0 | 10 | 139 |
| 76 | 0 | 0 | 14 | 4 | 15 | 0 | 4 | 146 |
| 35 | 2 | 11 | 5 | 1 | 0 | 0 | 5 | 65 |
| 64 | 1 | 1 | 19 | 10 | 19 | 0 | 12 | 150 |
| 8 | 0 | 3 | 13 | 5 | 0 | 3 | 3 | 39 |
| 46 | 1 | 11 | 16 | 4 | 0 | 5 | 6 | 99 |
| 59 | 0 | 8 | 6 | 0 | 0 | 0 | 2 | 77 |
| 0 | 0 | 0 | 1 | 0 | 0 | 12 | 2 | 15 |
| 0 | 0 | 0 | 3 | 0 | 0 | 24 | 1 | 28 |
| 24 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 30 |
| 3 | 0 | 2 | 8 | 2 | 0 | 2 | 2 | 21 |
| 9 | 0 | 6 | 1 | 4 | 0 | 0 | 0 | 22 |
| 16 | 0 | 13 | 2 | 0 | 0 | 0 | 0 | 33 |
| 42 | 0 | 5 | 1 | 4 | 0 | 0 | 3 | 56 |
| 20 | 0 | 3 | 3 | 12 | 0 | 0 | 4 | 44 |
| 1324 | 30 | 229 | 284 | 123 | 137 | 58 | 161 | 2609 |

tests; C, routine start-up; D, routine shutdown;
ng routine power operation; H, refueling; I, cold shutdown;
unknown/not applicable.

Table 11. PWR initial conditions as a percent of plant totals

| FID | Initial Conditions[a] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | C | D | E | F | H | I | K | L | X | Z | TOTAL |
| AN01 | 0.0 | 0.0 | 11.1 | 33.3 | 0.0 | 22.2 | 5.6 | 0.0 | 0.0 | 5.6 | 22.2 | 100.0 |
| AN02 | 0.0 | 9.8 | 2.0 | 43.1 | 2.3 | 11.8 | 11.8 | 0.0 | 11.8 | 0.0 | 7.8 | 100.0 |
| BVS1 | 0.0 | 6.6 | 1.9 | 71.7 | 5.7 | .9 | 4.7 | 3.8 | .9 | 0.0 | 3.8 | 100.0 |
| CCN1 | 0.0 | 11.1 | 3.3 | 71.1 | 1.1 | 1.1 | 1.1 | 3.3 | 0.0 | 1.1 | 6.7 | 100.0 |
| CCN2 | 0.0 | 5.0 | 5.0 | 63.3 | 1.7 | 3.3 | 8.3 | 5.0 | 3.3 | 0.0 | 5.0 | 100.0 |
| CRP3 | 0.0 | 1.1 | 3.4 | 40.6 | 2.3 | 13.6 | 14.8 | 11.4 | 4.5 | 0.0 | 2.3 | 100.0 |
| DBS1 | 0.0 | 8.0 | 1.1 | 61.4 | 0.0 | 0.0 | 12.5 | 2.3 | 6.8 | 1.1 | 6.8 | 100.0 |
| DCC1 | 0.0 | 1.4 | 4.2 | 52.1 | 1.4 | 21.1 | 7.0 | 1.4 | 1.4 | 0.0 | 9.9 | 100.0 |
| DCC2 | 0.0 | 3.9 | 3.6 | 50.6 | 5.1 | 21.5 | 2.5 | 1.3 | 1.3 | 0.0 | 5.1 | 100.0 |
| FCS1 | 0.0 | 4.1 | 0.0 | 63.6 | 0.0 | 18.2 | 9.1 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| HBR2 | 0.0 | 8.6 | 2.9 | 50.9 | 2.9 | 0.0 | 8.8 | 17.6 | 0.0 | 0.0 | 0.0 | 100.0 |
| HNP1 | 0.0 | 0.0 | 5.6 | 60.9 | 0.0 | 5.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| IPS2 | 0.0 | 0.0 | 11.8 | 41.2 | 0.0 | 23.5 | 11.8 | 8.8 | 0.0 | 0.0 | 2.9 | 100.0 |
| IPS3 | 0.0 | 0.0 | 0.0 | 25.0 | 0.0 | 0.0 | 25.0 | 37.5 | 12.5 | 0.0 | 0.0 | 100.0 |
| JMF1 | 3.1 | 2.1 | 0.0 | 55.2 | 1.0 | 2.1 | 16.7 | 1.0 | 2.1 | 0.0 | 16.7 | 100.0 |
| KNP1 | 0.0 | 7.7 | 0.0 | 71.8 | 0.0 | 15.4 | 0.0 | 5.1 | 0.0 | 0.0 | 0.0 | 100.0 |
| MGS1 | 11.6 | 9.5 | .5 | 4.5 | 0.0 | 5.5 | 23.6 | 9.5 | 26.6 | 3.5 | 5.0 | 100.0 |
| MNS2 | 0.0 | 0.0 | 1.9 | 63.4 | 0.0 | 7.5 | 5.7 | 5.7 | 3.8 | 0.0 | 15.1 | 100.0 |
| MYP1 | 0.0 | 4.6 | 0.0 | 47.6 | 0.0 | 42.9 | 0.0 | 0.0 | 4.8 | 0.0 | 0.0 | 100.0 |
| NAS1 | 0.0 | 1.6 | .9 | 55.5 | 2.7 | 7.3 | 13.0 | 1.6 | 4.5 | 0.0 | 11.8 | 100.0 |
| NAS2 | 0.0 | 8.2 | 0.0 | 65.3 | 4.1 | 0.0 | 5.1 | 5.1 | 9.2 | 1.0 | 2.0 | 100.0 |
| NEE1 | 2.9 | 2.4 | 5.6 | 40.0 | 0.0 | 22.9 | 14.3 | 0.0 | 2.9 | 2.9 | 2.9 | 100.0 |
| NEE2 | 0.0 | 5.9 | 5.9 | 70.5 | 0.0 | 0.0 | 11.4 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| NEE3 | 0.0 | 0.0 | 0.0 | 64.7 | 0.0 | 17.6 | 0.0 | 5.9 | 0.0 | 0.0 | 11.8 | 100.0 |
| PAL1 | 0.0 | 1.9 | 0.0 | 59.3 | 0.0 | 18.5 | 13.5 | 1.9 | 0.0 | 0.0 | 0.0 | 100.0 |
| PBH1 | 0.0 | 4.3 | 0.0 | 43.5 | 0.0 | 17.4 | 3.7 | 4.3 | 0.0 | 0.0 | 21.7 | 100.0 |
| PBH2 | 0.0 | 0.0 | 12.5 | 75.0 | 0.0 | 0.0 | 12.5 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| PIN1 | 0.0 | 4.8 | 0.0 | 47.6 | 4.8 | 33.3 | 4.8 | 0.0 | 0.0 | 0.0 | 4.8 | 100.0 |
| PIN2 | 0.0 | 0.6 | 7.7 | 64.2 | 0.0 | 7.7 | 0.0 | 7.7 | 0.0 | 0.0 | 7.7 | 100.0 |
| REG1 | 0.0 | 0.0 | 9.1 | 77.3 | 0.0 | 4.5 | 4.5 | 0.0 | 0.0 | 0.0 | 4.5 | 100.0 |
| RSS1 | 0.0 | 0.0 | 7.9 | 27.0 | 0.0 | 36.5 | 15.9 | 1.6 | 1.6 | 0.0 | 9.5 | 100.0 |
| SGS1 | 0.0 | 7.2 | 5.8 | 64.0 | 0.0 | 0.0 | 9.4 | 2.2 | 4.3 | 0.0 | 7.2 | 100.0 |
| SGS2 | 2.1 | 14.4 | 6.2 | 52.1 | 0.0 | 0.0 | 9.6 | 2.7 | 13.3 | 0.0 | 2.7 | 100.0 |
| SLS1 | 3.1 | 6.2 | 0.0 | 53.5 | 3.1 | 16.4 | 7.7 | 1.5 | 0.0 | 0.0 | 7.7 | 100.0 |
| SNP1 | 4.3 | 10.7 | 1.3 | 42.7 | .7 | .7 | 12.7 | 6.7 | 12.7 | 0.0 | 8.0 | 100.0 |
| SOS1 | 2.6 | 7.7 | 0.0 | 20.5 | 0.0 | 7.7 | 33.3 | 12.8 | 0.0 | 7.7 | 7.7 | 100.0 |
| SPS1 | 1.0 | 3.1 | 4.0 | 40.5 | 1.0 | 11.1 | 16.2 | 4.0 | 0.0 | 5.1 | 6.1 | 100.0 |
| SPS2 | 0.0 | 2.6 | 0.0 | 70.6 | 0.0 | 10.4 | 7.8 | 0.0 | 0.0 | 0.0 | 2.6 | 100.0 |
| TMI1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.7 | 0.0 | 0.0 | 30.0 | 13.3 | 100.0 |
| TMI2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.7 | 0.0 | 0.0 | 35.7 | 3.0 | 100.0 |
| TNP1 | 0.0 | 3.3 | 3.3 | 20.0 | 0.0 | 0.0 | 6.7 | 3.3 | 3.3 | 0.0 | 0.0 | 100.0 |
| TPS3 | 0.0 | 4.6 | 4.8 | 14.3 | 0.0 | 9.5 | 33.1 | 9.5 | 0.0 | 9.5 | 9.5 | 100.0 |
| TPS4 | 0.0 | 9.1 | 0.0 | 40.9 | 0.0 | 27.3 | 4.5 | 16.2 | 0.0 | 0.0 | 0.0 | 100.0 |
| YRS1 | 0.0 | 3.0 | 3.0 | 46.5 | 0.0 | 39.4 | 6.1 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| ZIS1 | 0.0 | 1.6 | 0.0 | 75.0 | 0.0 | 0.9 | 1.6 | 7.1 | 0.0 | 0.0 | 5.4 | 100.0 |
| ZIS2 | 0.0 | 4.5 | 0.0 | 45.5 | 0.0 | 6.0 | 6.8 | 27.3 | 0.0 | 0.0 | 9.1 | 100.0 |
| TOTAL | 1.5 | 5.9 | 2.6 | 50.7 | 1.1 | 8.5 | 10.9 | 4.7 | 5.3 | 2.2 | 6.2 | 100.0 |

a. B, preoperational/start-up/power ascension tests; C, routine start-up; D, routine shutdown; E, steady-state operation; F, load change during routine power operation; H, refueling; I, cold shutdown; K, hot shutdown; L, hot standby X, other; Z, unknown/not applicable.

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Table 12. BWR plant effect counts

| FID | Manual Shutdown | Manual Scram | Auto Scram |
|---|---|---|---|
| BEP1 | 0 | 0 | 3 |
| BEP2 | 6 | 2 | 2 |
| BRF1 | 0 | 0 | 0 |
| BRF2 | 0 | 0 | 1 |
| BRF3 | 0 | 2 | 0 |
| BRP1 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 0 |
| DAC1 | 1 | 0 | 0 |
| DRS2 | 1 | 0 | 0 |
| DRS3 | 3 | 0 | 1 |
| EIH1 | 4 | 0 | 0 |
| EIH2 | 1 | 0 | 0 |
| HMB1 | 0 | 0 | 0 |
| JAF1 | 1 | 1 | 1 |
| LBR1 | 0 | 0 | 4 |
| MNP1 | 0 | 0 | 0 |
| MNS1 | 1 | 0 | 1 |
| NMP1 | 0 | 0 | 1 |
| OCP1 | 2 | 0 | 0 |
| PBS2 | 0 | 0 | 0 |
| PBS3 | 1 | 0 | 0 |
| PPS1 | 2 | 1 | 0 |
| QAD1 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 |
| VYS1 | 0 | 0 | 0 |
| TOTAL | 23 | 6 | 14 |

| Plant Effect | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Unintentional Auto Scram | Extension of Preexisting Outage | Required ESF Actuation | Unintentional ESF Actuation | Forced Long Outage | Natural Circ. | No Signif. Effect | Not Stated/ Unknown | Total |
| 0 | 1 | 0 | 0 | 0 | 0 | 105 | 1 | 110 |
| 0 | 0 | 0 | 0 | 0 | 0 | 152 | 0 | 162 |
| 0 | 0 | 0 | 0 | 0 | 0 | 126 | 0 | 126 |
| 0 | 0 | 0 | 0 | 0 | 0 | 62 | 0 | 63 |
| 0 | 1 | 0 | 0 | 0 | 0 | 63 | 0 | 66 |
| 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 33 |
| 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 25 |
| 0 | 0 | 0 | 0 | 0 | 0 | 51 | 0 | 52 |
| 0 | 3 | 0 | 0 | 0 | 0 | 68 | 0 | 72 |
| 0 | 0 | 0 | 0 | 0 | 0 | 35 | 0 | 39 |
| 1 | 0 | 0 | 0 | 0 | 0 | 154 | 0 | 159 |
| 0 | 0 | 0 | 0 | 0 | 0 | 148 | 0 | 149 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 5 |
| 0 | 0 | 1 | 0 | 0 | 0 | 63 | 0 | 67 |
| 0 | 1 | 0 | 0 | 0 | 0 | 11 | 0 | 16 |
| 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 24 |
| 0 | 0 | 0 | 0 | 0 | 1 | 36 | 0 | 39 |
| 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 41 |
| 0 | 0 | 0 | 0 | 0 | 0 | 73 | 0 | 75 |
| 0 | 0 | 0 | 0 | 0 | 0 | 46 | 2 | 48 |
| 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 25 |
| 0 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 59 |
| 0 | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 23 |
| 0 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 32 |
| 0 | 0 | 0 | 0 | 0 | 0 | 35 | 0 | 35 |
| 1 | 6 | 1 | 0 | 0 | 1 | 1510 | 3 | 1565 |

**Table 13. PWR plant effect counts**

| FID | Plant Effect: Manual Shutdown | Manual Scram | Auto Scram | Unintentional Auto Scram | Extension of Preexisting Outage | Required ESF Actuation | Unintentional ESF Actuation | Forced Long Outage | Natural Circ. | No Signif. Effect | Not Stated/ Unknown | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANU1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 0 | 18 |
| ANU2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 0 | 51 |
| BVS1 | 1 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 100 | 0 | 106 |
| CCN1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 89 | 0 | 90 |
| CCN2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 58 | 0 | 60 |
| CRP3 | 0 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 83 | 0 | 88 |
| DBS1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 85 | 0 | 88 |
| DCC1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 68 | 1 | 71 |
| DCC2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 77 | 0 | 79 |
| FCS1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 11 |
| HBR2 | 3 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 27 | 0 | 34 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 18 |
| IPS2 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 31 | 0 | 34 |
| IPS3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 8 |
| JMF1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 95 | 0 | 96 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 39 |
| MGS1 | 2 | 2 | 1 | 0 | 1 | 1 | 4 | 0 | 2 | 186 | 0 | 199 |
| MNS2 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 50 | 0 | 53 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 21 |
| NAS1 | 1 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 105 | 0 | 110 |
| NAS2 | 1 | 1 | 2 | 1 | 0 | 0 | 3 | 0 | 0 | 90 | 0 | 98 |
| NEE1 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 32 | 0 | 35 |
| NEE2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 17 |
| NEE3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 17 |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 53 | 0 | 54 |
| PBH1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 23 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 8 |
| PIN1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 20 | 0 | 21 |
| PIN2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 9 | 0 | 13 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 22 |
| RSS1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 60 | 0 | 63 |
| SGS1 | 1 | 0 | 2 | 0 | 1 | 0 | 3 | 0 | 0 | 131 | 1 | 139 |
| SGS2 | 1 | 3 | 2 | 0 | 0 | 2 | 5 | 0 | 0 | 133 | 0 | 146 |
| SLS1 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 65 |
| SNP1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 149 | 0 | 150 |
| SOS1 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 34 | 0 | 39 |
| SPS1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 94 | 1 | 99 |
| SPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 77 | 0 | 77 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 1 | 15 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 | 28 |
| TNP1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 | 30 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 21 |
| TPS4 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 17 | 0 | 22 |
| YKR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 33 |
| ZIS1 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 52 | 0 | 56 |
| ZIS2 | 1 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 39 | 0 | 44 |
| TOTAL | 28 | 12 | 34 | 4 | 22 | 7 | 23 | 1 | 4 | 2470 | 4 | 2609 |

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All other cells outside the no significant effect column in Tables 12 and 13 had <3 counts.

Tables 12 and 13 provide ample evidence that the reportable occurrences covered by the LER system have little to do with mishaps that directly impact balance-of-plant operation. 1981 LER reporting requirements included coverage of "conditions leading to operation in a degraded mode permitted by a limiting condition for operation (LCO) or plant shutdown required by a LCO," [Reference 1, Section 2b(2)]. While many of the LERs indicate that described events led to system operation in degraded modes permitted by LCOs, Tables 12 and 13 show that <3% of the 1981 LERs indicate manual scrams or shutdowns or extensions of outages, and none of them indicate power reductions. Since such instances required by LCOs would be reportable, there were few situations in 1981 wherein compliance with a technical specification LCO has seriously impacted plant availability.

A similar observation is the rarity of LER reports involving unintentional scrams and unintentional ESF actuations. Out of over 4000 sequences only 31 fall into these categories, with 25 of the 31 being unintentional ESF actuations at PWRs. Normalizing by the number of PWR plant operating years in 1981, 44 (excluding Three Mile Island 1 and 2), yields a rate of 0.6 per year or 1 unintentional ESF actuation every 1.75 years. This is in comparison to an even much lower rate of 1 every 25 years for BWRs. However, as noted above, the 25 instances for PWRs are clustered at relatively few plants: McGuire, North Anna 2 and the two Salem plants account for 15 of the 25 instances.

Table 14 provides a final summary of the plant initial conditions and plant effects by presenting the percentages of sequences for each type of plant associated with each of the types of initial condition and each of the categories for plant resultant effects. Table 14 shows that PWR plants experienced a larger percentage of scrams and ESF actuations in the events reported through LERs, and BWR plants experienced a larger percentage of manual shutdowns in LER events.

Tables 15 and 16 are in a sense transition matrices for BWRs and PWRs, respectively (i.e., they reflect the frequency with which particular effects on plants result with the different initial states of the plants). The row variable is the initial condition and the column variable is the plant effect. Entries in these tables are percentages of the total table count. For BWRs and PWRs the dominant combination is steady state operation—no effect, which would be anticipated based on the separate findings for initial condition and plant effect.

**Table 14. Summary of initial conditions and plant effects**

| | Percentages of Sequences | |
|---|---|---|
| Initial Conditions | BWR | PWR |
| Preoperational | 0.1 | 1.5 |
| Start-up | 7.2 | 5.9 |
| Shutdown | 3.3 | 2.6 |
| Steady state | 55.0 | 50.7 |
| Load change | 6.5 | 1.1 |
| Refueling | 14.9 | 8.8 |
| Cold shutdown | 6.1 | 10.9 |
| Hot shutdown | 1.5 | 4.7 |
| Hot standby | — | 5.3 |
| Other | 0.5 | 2.2 |
| Unknown | 5.0 | 6.2 |
| | 100[a] | 100 |
| Plant Effects | BWR | PWR |
| Manual shutdown | 1.5 | 1.1 |
| Scrams | | |
| Manual | 0.4 | 0.5 |
| Automatic | 0.9 | 1.3 |
| Unintentional automatic | 0.1 | 0.2 |
| Extension of preexisting outage | 0.4 | 0.8 |
| ESF actuation | | |
| Required | 0.1 | 0.3 |
| Unintentional | 0 | 0.9 |
| Forced long outage | 0 | 0.0 |
| Natural circulation | 0.1 | 0.2 |
| No significant effect | 96.5 | 94.7 |
| Unknown | 0.2 | 0.2 |
| | 100 | 100 |

a. Sums of percentages are not exactly 100.0 due to roundoff.

Table 15. BWR plant effects as a function of initial conditions—percent of BWR sequences

| | Plant Effect | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| INITIAL CONDITIONS[a] | Manual Shutdown | Manual Scram | Auto Scram | Unintentional Auto Scram | Extension of Preexisting Outage | Required ESF Actuation | Unintentional ESF Actuation | Force Long Outag |
| B | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| C | .2 | .1 | .3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D | 0.0 | .1 | .1 | 0.0 | .2 | 0.0 | 0.0 | 0.0 |
| E | .8 | .2 | .5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| F | .4 | .1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| H | 0.0 | 0.0 | 0.0 | 0.0 | .2 | 0.0 | 0.0 | 0.0 |
| I | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| K | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .1 | 0.0 | 0.0 |
| X | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Z | .1 | 0.0 | 0.0 | .1 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 1.5 | .4 | .9 | .1 | .4 | .1 | 0.0 | 0.0 |

a. B, preoperational/start-up/power ascension tests; C, routine start-up; D, routine shutdown; E, steady-state operation; F, load change during routine power operation; H, refueling; I, cold K, hot shutdown; X, other; Z, unknown/not applicable.

Table 16. PWR plant effects as a function of initial conditions—percent of PWR sequences

| | Plant Effect | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| INITIAL CONDITIONS[a] | Manual Shutdown | Manual Scram | Auto Scram | Unintentional Auto Scram | Extension of Preexisting Outage | Required ESF Actuation | Unintentional ESF Actuation | Force Long Outag |
| B | 0.0 | .0 | .0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| C | .2 | .2 | .2 | 0.0 | .0 | 0.0 | 0.0 | 0.0 |
| D | 0.0 | .0 | 0.0 | 0.0 | .2 | .1 | .2 | .0 |
| E | .7 | .2 | 1.0 | .1 | 0.0 | 0.0 | .0 | 0.0 |
| F | .0 | 0.0 | .0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| H | 0.0 | 0.0 | 0.0 | 0.0 | .1 | 0.0 | 0.0 | 0.0 |
| I | 0.0 | 0.0 | 0.0 | 0.0 | .2 | .0 | .3 | 0.0 |
| K | .1 | 0.0 | 0.0 | .0 | .2 | .2 | .1 | 0.0 |
| L | .0 | .1 | 0.0 | 0.0 | .1 | 0.0 | .2 | 0.0 |
| X | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .0 | 0.0 |
| Z | .1 | 0.0 | .0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 1.1 | .5 | 1.3 | .2 | .5 | .3 | .9 | .0 |

a. B, preoperational/start-up/power ascension tests; C, routine start-up; D, routine shutdown; E, steady-state operation; F, load change during routine power operation; H, refueling; I, cold K, hot shutdown; L hot standby; X, other; Z, unknown/not applicable.

| Natural Circ. | No Signif. Effect | Not Stated/ Unknown | Total |
|---|---|---|---|
| 0.0 | .1 | 0.0 | .1 |
| .1 | 6.6 | 0.0 | 7.2 |
| 0.0 | 2.9 | .1 | 3.3 |
| 0.0 | 53.4 | 0.0 | 55.0 |
| 0.0 | 6.0 | 0.0 | 6.5 |
| 0.0 | 14.7 | 0.0 | 14.9 |
| 0.0 | 6.1 | 0.0 | 6.1 |
| 0.0 | 1.4 | 0.0 | 1.5 |
| 0.0 | .5 | 0.0 | .5 |
| 0.0 | 4.8 | .1 | 5.0 |
| .1 | 96.5 | .2 | 100.0 |

shutdown;

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| Natural Circ. | No Signif. Effect | Not Stated/ Unknown | Total |
|---|---|---|---|
| 0.0 | 1.5 | 0.0 | 1.5 |
| 0.0 | 5.4 | 0.0 | 5.9 |
| 0.0 | 2.1 | 0.0 | 2.6 |
| .0 | 48.6 | .0 | 50.7 |
| 0.0 | 1.1 | 0.0 | 1.1 |
| 0.0 | 8.7 | 0.0 | 8.8 |
| 0.0 | 10.3 | .0 | 10.9 |
| .1 | 4.1 | 0.0 | 4.7 |
| 0.0 | 4.6 | 0.0 | 5.3 |
| 0.0 | 2.1 | .0 | 2.2 |
| .0 | 6.0 | .0 | 6.2 |
| .2 | 94.7 | .2 | 100.0 |

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shutdown;

**Table 19. PWR en**

| FID |
|---|
| ANO1 |
| ANO2 |
| BVS1 |
| CCN1 |
| CCN2 |
| CRP3 |
| DBS1 |
| DCC1 |
| DCC2 |
| FCS1 |
| HBR2 |
| HNP1 |
| IPS2 |
| IPS3 |
| JMF1 |
| KNP1 |
| MGS1 |
| MNS2 |
| MYP1 |
| NAS1 |
| NAS2 |
| NEC1 |
| NEC2 |
| NEC3 |
| PAL1 |
| PBH1 |
| PBH2 |
| PIN1 |
| PIN2 |
| RGE1 |
| RSS1 |
| SGS1 |
| SGS2 |
| SLS1 |
| SNP1 |
| SOS1 |
| SPS1 |
| SPS2 |
| TMI1 |
| TMI2 |
| TNP1 |
| TPS3 |
| TPS4 |
| YRK1 |
| ZIS1 |
| ZIS2 |
| TOTAL |

a. N, no relea
T, radiological
environment > t
X, other; Y, th

ronmental release counts

| | Environmental Release[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| N | R | S | T | U | W | X | Y | TOTAL |
| 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1[illegible] |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 |
| 102 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 106 |
| 96 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 98 |
| 54 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 61 |
| 4[illegible] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 91 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 91 |
| 66 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 72 |
| 76 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | [illegible] |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| 32 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 34 |
| 1[illegible] | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 19 |
| 32 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 34 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1[illegible] |
| 95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9[illegible] |
| 37 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3[illegible] |
| 1[illegible]3 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 196 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 |
| 14 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 22 |
| 11[illegible] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11[illegible] |
| 1[illegible] | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| 22 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 23 |
| 1[illegible] | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1[illegible] |
| [illegible] | 0 | 0 | 1 | 0 | 0 | 0 | 0 | [illegible] |
| 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 |
| [illegible] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| 22 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 23 |
| 60 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 63 |
| 134 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 137 |
| 140 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 143 |
| 65 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 65 |
| 14[illegible] | 2 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 33 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 37 |
| 95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 81 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | [illegible] |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1[illegible] |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 |
| 2[illegible] | 0 | 1 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 17 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | [illegible] |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 41 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 577 | 1[illegible] | 7 | 27 | [illegible] | 1 | 6 | 0 | 263[illegible] |

se; R, radiological release to containment; S, radiological release within site boundary; release to environment ≤ technical specification limits; U, radiological release to echnical specification limits; W, radiological release to environment (quantity unknown); ermal release in excess of technical specification limits.

**Table 18. BWR environmental release counts**

| FID | Environmental Release[a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | R | S | T | U | W | X | Y | TOTAL |
| BEP1 | 111 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 111 |
| BEP2 | 162 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 163 |
| BRF1 | 126 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 127 |
| BRF2 | 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 69 |
| BRF3 | 70 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 71 |
| BRP1 | 32 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 33 |
| CPR1 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| DAC1 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 52 |
| DRS2 | 71 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 74 |
| DRS3 | 39 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 40 |
| EIH1 | 158 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 161 |
| EIH2 | 148 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 149 |
| HMB1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| JAF1 | 88 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 89 |
| LBR1 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| MNP1 | 23 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 24 |
| MNS1 | 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| NMP1 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 43 |
| OCP1 | 75 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 79 |
| PBS2 | 46 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 50 |
| PBS3 | 24 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 25 |
| PPS1 | 62 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 66 |
| QAD1 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 |
| QAD2 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| VYS1 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37 |
| TOTAL | 1577 | 6 | 6 | 12 | 2 | 1 | 0 | 1 | 1605 |

a. N, no release; R, radiological release to containment; S, radiological release within site boundary; T, radiological release to environment ≤ technical specification limits; U, radiological release to environment > technical specification limits; W, radiological release to environment (quantity unknown); X, other; Y, thermal release in excess of technical specification limits.

**Environmental Release**. Environmental release codes are defined in Table 17. These codes are used to indicate the rate or quantity of leaks or spills of radioactive material or releases of such effluents to the environment. Tables 18 and 19 show the distribution of counts for environmental release for BWR and PWR plants, respectively. Of all the BWR sequences 98% show no release, as do 98% of the PWR sequences. For both plant types the next largest category is an environmental release less than the technical specification limit, with 0.7 and 1.0%, respectively. The plants contributing at least 3 counts to these totals are: Oyster Creek 1 and Peach Bottom 2 (BWRs) and Cook 1 (5 occurrences), Cook 2, Oconee 1, and Surry 1 (PWRs). The third most reported category is radiological release to containment (0.4% of the BWR sequences and 0.7% of the PWR sequences). Pilgrim 1 had 4 such counts. The BWRs Brunswick 2, Peach Bottom 2, and the PWR Calvert Cliffs 1 each had one 1981 event with a radiological release to environment greater than technical specification limits.

**Table 17. SCSS environmental release codes**

| Code | Environmental Release |
|---|---|
| N | No release |
| R | Radiological release to containment |
| S | Radiological release within site boundary |
| T | Radiological release to environment ≤ tech spec limit |
| U | Radiological release to environment > tech spec limit |
| W | Radiological release to environment (quantity unknown) |
| X | Other |
| Y | Thermal release in excess of tech spec limit |

**Personnel Exposure**. Tables 20 and 21 describe personnel exposure associated with the 1981 LER sequences.[a] Tables 20 and 21 indicate few reported instances of personnel exposure. However, NUREG-0161, *Instructions for Preparation of Data Entry Sheets for Licensee Event Report (LER) File*,[2] contains in the descriptions for LER Items 37 and 39 the following guidance for reporting personnel exposure associated with an event reportable as an LER:

> ". . . [Report information] for each event which results in an exposure exceeding 5 man-rem as a result of the event (including exposures incurred in corrective action, clean-up, and following). Note that these items are *not* limited only to overexposures. . . . Describe magnitude of estimated maximum dose rate to which workers were exposed. Identify categories of workers exposed (e.g., maintenance, operational, engineering, etc.), how many exposed in each category, and estimated total man-rem dose received by each category."

Thus, the intent in the LER reporting system is to gather data both on overexposures that are the immediate result of an event and on total man-rem exposure associated with *corrective action* if that total exceeds 5 man-rem. The sparsity of data in Tables 20 and 21 outside the *no exposure* column raises serious doubt about consistent reporting of the corrective action type of personnel exposure.

Among reported incidents, there were two cases of external exposure for BWRs and 7 for PWRs. The two BWR external exposures were due to the repair of the reactor water cleanup heat exchanger piping at Monticello and a leaking waste container at FitzPatrick. The PWR external exposure events occurred at Indian Point 2, Millstone 2, Oconee 2, Salem 1, St. Lucie 1, and Yankee Rowe 1. Six of the seven PWR external exposures were due to steam generator tube leak repairs; the other PWR external exposure was due to reactor coolant pump repair. There was one instance of both internal (ingested or inhaled) and external exposure; it was due to a waste gas compressor's leaking diaphragm in the auxiliary building.

a. Note that internal exposure without external exposure does not appear in Tables 20 and 21 because it was not reported in the 1981 LER data.

Table 20. BWR personnel exposure counts

| FID | Personnel Exposure: External Exposure | Internal and External Exposure | No Exposure | Total |
|---|---|---|---|---|
| BEP1 | 0 | 0 | 111 | 111 |
| BEP2 | 0 | 0 | 163 | 163 |
| BRF1 | 0 | 0 | 127 | 127 |
| BRF2 | 0 | 0 | 69 | 69 |
| BRF3 | 0 | 0 | 71 | 71 |
| BRP1 | 0 | 0 | 33 | 33 |
| CPR1 | 0 | 0 | 25 | 25 |
| DAC1 | 0 | 0 | 52 | 52 |
| DRS2 | 0 | 0 | 74 | 74 |
| DRS3 | 0 | 0 | 40 | 40 |
| EIH1 | 0 | 0 | 161 | 161 |
| EIH2 | 0 | 0 | 149 | 149 |
| HMB1 | 0 | 0 | 5 | 5 |
| JAF1 | 1 | 0 | 88 | 89 |
| LBR1 | 0 | 0 | 15 | 15 |
| MNP1 | 1 | 0 | 23 | 24 |
| MNS1 | 0 | 0 | 39 | 39 |
| NMP1 | 0 | 0 | 43 | 43 |
| OCP1 | 0 | 0 | 79 | 79 |
| PBS2 | 0 | 0 | 50 | 50 |
| PBS3 | 0 | 0 | 25 | 25 |
| PPS1 | 0 | 0 | 66 | 66 |
| QAD1 | 0 | 0 | 24 | 24 |
| QAD2 | 0 | 0 | 34 | 34 |
| VYS1 | 0 | 0 | 37 | 37 |
| TOTAL | 2 | 0 | 1603 | 1605 |

**Table 21. PWR personnel exposure counts**

| FI | Personnel Exposure: External Exposure | Personnel Exposure: Internal and External Exposure | Personnel Exposure: No Exposure | Total |
|---|---|---|---|---|
| ANO1 | 0 | 0 | 18 | 18 |
| ANO2 | 0 | 0 | 53 | 53 |
| BVS1 | 0 | 0 | 106 | 106 |
| CCN1 | 0 | 0 | 98 | 98 |
| CCN2 | 0 | 0 | 61 | 61 |
| CRP3 | 0 | 0 | 90 | 90 |
| DBS1 | 0 | 0 | 91 | 91 |
| DCC1 | 0 | 0 | 72 | 72 |
| DCC2 | 0 | 0 | 82 | 82 |
| FCS1 | 0 | 0 | 11 | 11 |
| HBR2 | 0 | 0 | 34 | 34 |
| HNP1 | 0 | 0 | 19 | 19 |
| IPS2 | 2 | 0 | 32 | 34 |
| IPS3 | 0 | 0 | 10 | 10 |
| JMF1 | 0 | 0 | 96 | 96 |
| KNP1 | 0 | 0 | 36 | 36 |
| MGS1 | 0 | 0 | 196 | 196 |
| MNS2 | 1 | 0 | 52 | 53 |
| MYP1 | 0 | 0 | 22 | 22 |
| NAS1 | 0 | 0 | 115 | 115 |
| NAS2 | 0 | 0 | 100 | 100 |
| NEC1 | 0 | 0 | 33 | 33 |
| NEC2 | 2 | 0 | 21 | 23 |
| NEC3 | 0 | 0 | 15 | 15 |
| PAL1 | 0 | 0 | 56 | 56 |
| PBH1 | 0 | 0 | 24 | 24 |
| PBH2 | 0 | 0 | 8 | 8 |
| PIN1 | 0 | 0 | 21 | 21 |
| PIN2 | 0 | 0 | 13 | 13 |
| REG1 | 0 | 0 | 23 | 23 |
| RSS1 | 0 | 0 | 63 | 63 |
| SGS1 | 0 | 1 | 136 | 137 |
| SGS2 | 0 | 0 | 143 | 143 |
| SLS1 | 1 | 0 | 65 | 66 |
| SNP1 | 0 | 0 | 150 | 150 |
| SOS1 | 0 | 0 | 37 | 37 |
| SPS1 | 0 | 0 | 98 | 98 |
| SPS2 | 0 | 0 | 82 | 82 |
| TMI1 | 0 | 0 | 15 | 15 |
| TMI2 | 0 | 0 | 28 | 28 |
| TNP1 | 0 | 0 | 30 | 30 |
| TPS3 | 0 | 0 | 21 | 21 |
| TPS4 | 0 | 0 | 20 | 20 |
| YKR1 | 1 | 0 | 32 | 33 |
| ZIS1 | 0 | 0 | 55 | 55 |
| ZIS2 | 0 | 0 | 42 | 42 |
| TOTAL | 7 | 1 | 2630 | 2638 |

Tables 22 and 23 permit one to examine associations, if any, between environmental release and personnel exposure. Ninety-eight percent of both the BWR and PWR sequences show no release and no exposure. Personnel exposure without environmental release is possible due to the existence of high radiation areas that personnel may potentially enter. Table 22 shows that the two BWR cases of personnel exposure also involved radiological release within the site boundary. Five of the PWR exposure events did not involve any environmental release. The other two involved a release to the environment less than the technical specification limit.

**Conclusions from Sequence Information**. The exploratory trend and pattern analysis of the additional information included for each sequence in the SCSS yielded the following observations:

1. In general, events reported in LERs have had little impact on plant availability

2. Unintentional ESF actuations and scrams are relatively rare in the 1981 reported experience; however, the concentration of unintentional ESF actuations at a few PWRs appears to warrant followup to determine if plant specific factors are involved

3. The vast majority of 1981 LER-reported sequences involved no releases, and no particular issues or problems are indicated by the data

4. The personnel exposure data contained in the LERs is probably less than that requested in reporting procedures.

**Table 22. BWR personnel exposure counts as a function of environmental release**

| ENVIRON-MENTAL RELEASE[a] | Personnel Exposure: External Exposure | Internal and External Exposure | No Exposure | Total |
|---|---|---|---|---|
| N | 0 | 0 | 1577 | 1577 |
| R | 0 | 0 | 6 | 6 |
| S | 2 | 0 | 4 | 6 |
| T | 0 | 0 | 12 | 12 |
| U | 0 | 0 | 2 | 2 |
| W | 0 | 0 | 1 | 1 |
| X | 0 | 0 | 0 | 0 |
| Y | 0 | 0 | 1 | 1 |
| TOTAL | 2 | 0 | 1603 | 1605 |

a. N, no release; R, radiological release to containment; S, radiological release within site boundary; T, radiological release to environment ≤ technical specification limits; U, radiological release to environment > technical specification limits; W, radiological release to environment (quantity unknown); X, other; Y, thermal release in excess of technical specification limits.

**Table 23. PWR personnel exposure counts as a function of environmental release**

| ENVIRON-MENTAL RELEASE[a] | Personnel Exposure: External Exposure | Internal and External Exposure | No Exposure | Total |
|---|---|---|---|---|
| N | 5 | 0 | 2572 | 2577 |
| R | 0 | 0 | 19 | 19 |
| S | 0 | 0 | 7 | 7 |
| T | 2 | 1 | 24 | 27 |
| U | 0 | 0 | 1 | 1 |
| W | 0 | 0 | 1 | 1 |
| X | 0 | 0 | 6 | 6 |
| Y | 0 | 0 | 0 | 0 |
| TOTAL | 7 | 1 | 2630 | 2638 |

a. N, no release; R, radiological release to containment; S, radiological release within site boundary; T, radiological release to environment ≤ technical specification limits; U, radiological release to environment > technical specification limits; W, radiological release to environment (quantity unknown); X, other; Y, thermal release in excess of technical specification limits.

# HARDWARE FAULTS

This section explores the 1981 LER data at the component hardware level. The intent is to provide an initial overview for reported faults of major active components. A component fault is defined as the inability of the component to perform its intended function. The component may be held accountable or it may be due to the failure of some other part of the system to give the component the proper inputs or leave it in the proper state. In the event of a fault the component may or may not require repair.

In the SCSS, there are 47 groups of component codes. For example, twelve types of pumps, including centrifugal pumps, diaphragm pumps, and unknown type pumps, are combined into a single grouping called pumps. In this report, 22 of these groups of hardware types are studied. In general, the groups with the most activity (i.e., the greatest number of reported faults) in the 1981 SCSS data base were selected. The exceptions to this principle are as follows:

1. The focus is on components rather than piece parts such as electrical/I&C function items, equipment interface items, mechanical function items, structural function items, and miscellaneous subcomponents

2. The focus is on active components rather than passive ones such as electrical conductors and pipes/fittings

3. Unless the activity is quite high, the focus is on end use items such as pumps and valves rather than drivers such as turbines.

In addition, control rod drives, control rods, batteries/chargers and fuel elements were included in the analysis although they have fewer references in the LERs.

Table 24 lists the component groups studied. In addition, it shows the results of a review of the SCSS categorization of individual components for the 22 component groupings. It was concluded that some components were dissimilar to the remaining components within their grouping and they consequently were excluded from their groups. One component was moved to a different component group.

**Table 24. Component groupings studies**

| Component Group | Notes |
|---|---|
| Accumulators/reservoirs | Excludes gas bottles and manifolds |
| Batteries/chargers | |
| Control rods | |
| Control rod drives | |
| Internal combustion engines | Includes diesels only |
| Non-I&C filters | Excludes transducers |
| Fuel elements | |
| Generators | |
| Heat exchangers | |
| I&C/circuit breakers | Excludes fuses |
| I&C/computation modules | |
| I&C/controllers | |
| I&C/indicators | |
| I&C/relays | |
| I&C/sensors | |
| I&C/switches | |
| I&C/transmitters | Includes transducers |
| Motors | Excludes exciters and motor starters |
| Penetrations | |
| Pumps | |
| Valves | Excludes damper/louver and vacuum breakers |
| Valve Operators | |

The component groups were examined, each separately for BWRs and PWRs. Tables providing counts for each selected group by component and plant for BWRs and for PWRs are in Appendix A. A quick glance at these tables shows that when plant and component type are considered simultaneously, the statistics are very sparse; i.e., the tables contain mostly zeros. Breaking already sparse tables into time segments, for example by month, would obviously make the situation worse. One conclusion then from this exploratory look is that one year of data is not enough to identify trends at the component level if plant is also specified. Since plant-to-plant variation can be large, and plants use varying numbers of each component type, dropping a plant

as an explanatory variable may not be possible. Trending at the component level will probably require collecting data for an extended period of time and employing fairly coarse time increments, e.g., six-months per cell.

An overview of the fault data for the 22 component groups by plant is provided in Table 25 for BWRs and in Table 26 for PWRs.[a] These tables show that, for most plants, most of the faults are associated with valves. Greater than 20% of the faults among the 22 component groups are valve faults for 15 of the 25 BWR plants and for 22 of the 46 PWR plants. The other largest category for BWRs is switches; nine of the 25 BWR plants have >25% of their faults associated with this group of components. For PWRs, the group second only to valves in activity is I&C indicators. Ten of the 46 plants have over 20% of their activity in this group.

Tables 27 and 28 show the percent each plant contributed to the total number of faults for each component grouping for BWRs and PWRs, respectively. As expected, each column of Tables 27 and 28 totals to 100%. If all plants had the same distribution of fault reporting among the 22 component groups, each row of Tables 27 and 28 would be constant and equal to the overall reporting percentages among plants given by the row totals. High percentages in Tables 27 and 28 show component groups for which the corresponding plants had a greater influence on the fault count than would be expected from the total plant fault counts.

Table 29 contains the component group and corresponding percentage that is the maximum for each row of Tables 27 and 28. That is, Table 29 indicates, for each BWR plant and for each PWR plant, the component group on which the plant had the greatest influence (as measured by percentage of the component group's total fault count for the type of plant). Based on overall fault reporting, no plant would be expected to have much more than 10% of the counts for any component grouping. However, the following BWR plants have >25% of the counts for the listed groups:

a. The counts in these tables are based on the SCSS component groupings and are not adjusted for the excluded components.

| Component Group | Dominant BWR Plant[a] |
|---|---|
| Control Rods | Brunswick 2 (29) |
| Control Rod Drives | Dresden 2 (30), Hatch 2 (30) |
| Fuel Elements | Hatch 1 (46) |
| I&C Computation Modules | Browns Ferry 1 (27), FitzPatrick (33) |
| I&C Transmitters | Brunswick 1 (25), Brunswick 2 (27) |

a. Each number in parentheses following a plant is that plant's percentage of the fault count for the indicated component group.

The following list shows PWR plants having greater than 20% of the count for certain component groups:

| Component Group | Dominant PWR Plants[a] |
|---|---|
| Batteries/Chargers | Salem 2 (22) |
| Control Rod Drives | H. B. Robinson 2 (35) |
| Fuel Elements | Surry 1 (42) |
| Heat Exchangers | Salem 1 (25) |
| I&C Sensors | McGuire 1 (81) |
| Motors | Palisades (23) |

a. Each number in parentheses following a plant is that plant's percentage of the fault count for the indicated component group.

These percentages should not be addressed without taking into consideration the overall number of fault counts for the specific component. For example, the 30% of BWR control rod drive faults for

**Table 25. BWR component group counts**

| FID | Accumulators and Reservoirs | Control Rod Drives | Internal Combustion Engines | Non-I&C Filters | Fuel Elements | Generators | Heat Exchangers | I&C Circuit Breakers |
|---|---|---|---|---|---|---|---|---|
| | Component Grouping | | | | | | | |
| BEP1 | 4 | 0 | 3 | 1 | 0 | 1 | 3 | 8 |
| BEP2 | 2 | 1 | 14 | 3 | 3 | 4 | 11 | 14 |
| BRF1 | 3 | 0 | 6 | 0 | 0 | 3 | 4 | 10 |
| BRF2 | 0 | 0 | 1 | 0 | 8 | 2 | 4 | 1 |
| BRF3 | 1 | 0 | 10 | 0 | 2 | 10 | 4 | 5 |
| BRP1 | 2 | 0 | 3 | 0 | 0 | 0 | 6 | 2 |
| CPR1 | 1 | 0 | 5 | 0 | 0 | 1 | 0 | 2 |
| DAC1 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 4 |
| DRS2 | 8 | 3 | 2 | 3 | 0 | 1 | 0 | 4 |
| DRS3 | 2 | 0 | 4 | 2 | 0 | 1 | 0 | 0 |
| EIH1 | 13 | 0 | 6 | 7 | 15 | 6 | 6 | 4 |
| EIH2 | 8 | 3 | 17 | 6 | 2 | 8 | 3 | 7 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 5 | 2 | 2 | 2 | 0 | 2 | 0 | 2 |
| LBR1 | 4 | 0 | 0 | 0 | 2 | 0 | 0 | 6 |
| MNP1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| MNS1 | 0 | 0 | 2 | 2 | 1 | 3 | 1 | 3 |
| NMP1 | 0 | 0 | 2 | 0 | 0 | 2 | 3 | 1 |
| OCP1 | 10 | 0 | 1 | 3 | 0 | 0 | 8 | 5 |
| PBS2 | 6 | 0 | 8 | 0 | 0 | 0 | 2 | 2 |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| PPS1 | 0 | 1 | 0 | 0 | 0 | 2 | 3 | 16 |
| QAD1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 4 |
| QAD2 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 3 |
| VYS1 | 1 | 0 | 1 | 3 | 0 | 0 | 0 | 11 |
| TOTAL - | 70 | 10 | 90 | 37 | 33 | 49 | 59 | 125 |

| FID | I&C Sensors | I&C Switches | I&C Transmitters | Motors | Penetrations | Pumps | Valves |
|---|---|---|---|---|---|---|---|
| | Component Grouping | | | | | | |
| BEP1 | 5 | 44 | 13 | 3 | 1 | 15 | 47 |
| BEP2 | 6 | 44 | 14 | 5 | 5 | 8 | 53 |
| BRF1 | 3 | 40 | 1 | 3 | 6 | 9 | 29 |
| BRF2 | 5 | 37 | 5 | 5 | 8 | 17 | 11 |
| BRF3 | 2 | 13 | 2 | 5 | 0 | 10 | 34 |
| BRP1 | 0 | 1 | 0 | 0 | 1 | 1 | 13 |
| CPR1 | 0 | 10 | 0 | 2 | 0 | 3 | 51 |
| DAC1 | 6 | 8 | 2 | 0 | 4 | 6 | 36 |
| DRS2 | 3 | 15 | 2 | 2 | 0 | 6 | 32 |
| DRS3 | 0 | 18 | 0 | 1 | 0 | 4 | 9 |
| EIH1 | 2 | 45 | 2 | 4 | 0 | 23 | 82 |
| EIH2 | 4 | 120 | 2 | 5 | 1 | 17 | 48 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| JAF1 | 1 | 26 | 2 | 1 | 0 | 8 | 13 |
| LBR1 | 0 | 5 | 0 | 0 | 2 | 3 | 2 |
| MNP1 | 0 | 9 | 0 | 0 | 0 | 1 | 23 |
| MNS1 | 1 | 20 | 0 | 1 | 0 | 2 | 13 |
| NMP1 | 5 | 8 | 0 | 1 | 0 | 5 | 30 |
| OCP1 | 2 | 39 | 0 | 1 | 6 | 14 | 29 |
| PBS2 | 0 | 5 | 4 | 1 | 0 | 0 | 37 |
| PBS3 | 0 | 5 | 2 | 0 | 0 | 1 | 42 |
| PPS1 | 1 | 8 | 1 | 2 | 0 | 19 | 55 |
| QAD1 | 0 | 11 | 0 | 1 | 0 | 2 | 6 |
| QAD2 | 0 | 19 | 0 | 0 | 6 | 1 | 21 |
| VYS1 | 0 | 4 | 0 | 8 | 0 | 11 | 25 |
| TOTAL | 46 | 554 | 52 | 57 | 40 | 188 | 743 |



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| it ers | I&C Computation Modules | I&C Controllers | I&C Indicators | I&C Relays |
|---|---|---|---|---|
| | 1 | 1 | 33 | 6 |
| | 2 | 1 | 71 | 8 |
| | 8 | 0 | 15 | 10 |
| | 4 | 1 | 20 | 13 |
| | 0 | 2 | 22 | 11 |
| | 0 | 2 | 6 | 0 |
| | 1 | 0 | 3 | 1 |
| | 0 | 3 | 7 | 0 |
| | 0 | 1 | 14 | 4 |
| | 1 | 3 | 8 | 1 |
| | 2 | 4 | 36 | 12 |
| | 0 | 8 | 24 | 13 |
| | 0 | 0 | 0 | 0 |
| | 10 | 5 | 29 | 3 |
| | 0 | 1 | 2 | 1 |
| | 0 | 0 | 1 | 3 |
| | 0 | 3 | 9 | 8 |
| | 0 | 4 | 21 | 5 |
| | 0 | 0 | 23 | 0 |
| | 0 | 1 | 16 | 0 |
| | 0 | 2 | 7 | 0 |
| | 1 | 2 | 4 | 2 |
| | 0 | 1 | 2 | 0 |
| | 0 | 2 | 0 | 1 |
| | 0 | 1 | 7 | 2 |
| | 30 | 48 | 380 | 104 |

| Valve Operators | Batteries and Chargers | Control Rods | Total |
|---|---|---|---|
| 7 | 0 | 4 | 200 |
| 17 | 0 | 7 | 293 |
| 0 | 1 | 0 | 156 |
| 2 | 0 | 1 | 146 |
| 8 | 0 | 1 | 142 |
| 2 | 4 | 0 | 43 |
| 5 | 6 | 0 | 91 |
| 11 | 1 | 1 | 94 |
| 16 | 1 | 2 | 119 |
| 3 | 0 | 1 | 58 |
| 28 | 0 | 0 | 297 |
| 19 | 6 | 4 | 325 |
| 0 | 0 | 0 | 4 |
| 3 | 3 | 0 | 119 |
| 0 | 0 | 0 | 28 |
| 3 | 2 | 0 | 44 |
| 4 | 0 | 0 | 73 |
| 9 | 0 | 2 | 98 |
| 11 | 0 | 1 | 153 |
| 13 | 0 | 0 | 95 |
| 2 | 0 | 0 | 71 |
| 6 | 0 | 0 | 123 |
| 3 | 0 | 0 | 32 |
| 3 | 0 | 0 | 60 |
| 13 | 1 | 0 | 88 |
| 188 | 25 | 24 | 2952 |

Table 26. PWR component group counts

| FID | Accumulators and Reservoirs | Control Rod Drives | Internal Combustion Engines | Non-I&C Filters | Fuel Elements | Generators | Heat Exchangers | I&C Circuit Breakers | I&C Computation Modules | I&C Controllers | I&C Indicators | I&C Relays |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Component Grouping | | | | | | | | | | | |
| AN01 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 13 |
| AN02 | 0 | 3 | 2 | 1 | 34 | 2 | 7 | 4 | 6 | 2 | 8 | 2 |
| BVS1 | 6 | 0 | 1 | 1 | 0 | 0 | 6 | 7 | 1 | 3 | 41 | 3 |
| CCN1 | 3 | 1 | 7 | 0 | 0 | 1 | 9 | 1 | 6 | 2 | 26 | 3 |
| CCN2 | 1 | 0 | 6 | 0 | 0 | 1 | 0 | 7 | 1 | 3 | 16 | 12 |
| CRP3 | 1 | 0 | 4 | 6 | 5 | 2 | 1 | 8 | 5 | 3 | 45 | 12 |
| DBS1 | 1 | 1 | 2 | 1 | 2 | 2 | 6 | 16 | 5 | 1 | 34 | 6 |
| DCC1 | 4 | 0 | 3 | 0 | 0 | 0 | 0 | 8 | 1 | 0 | 19 | 18 |
| DCC2 | 4 | 0 | 3 | 5 | 1 | 1 | 7 | 5 | 0 | 1 | 16 | 15 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 6 |
| HBR2 | 0 | 6 | 2 | 0 | 0 | 0 | 2 | 8 | 2 | 1 | 4 | 0 |
| HNP1 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 2 | 1 |
| IPS2 | 0 | 0 | 3 | 0 | 1 | 3 | 4 | 2 | 0 | 0 | 5 | 2 |
| IPS3 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 1 | 0 |
| JMF1 | 11 | 1 | 24 | 4 | 0 | 3 | 1 | 10 | 0 | 3 | 28 | 6 |
| KNP1 | 4 | 0 | 2 | 0 | 0 | 0 | 3 | 6 | 0 | 0 | 4 | 1 |
| MGS1 | 28 | 0 | 4 | 9 | 0 | 4 | 10 | 14 | 2 | 3 | 73 | 3 |
| MNS2 | 4 | 0 | 4 | 2 | 0 | 0 | 1 | 2 | 3 | 0 | 12 | 0 |
| MYP1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 5 | 2 | 4 | 0 |
| NAS1 | 19 | 0 | 4 | 3 | 3 | 0 | 16 | 9 | 1 | 2 | 25 | 2 |
| NAS2 | 33 | 0 | 3 | 0 | 2 | 0 | 1 | 4 | 4 | 2 | 24 | 1 |
| NEE1 | 0 | 0 | 0 | 2 | 0 | 5 | 1 | 13 | 8 | 0 | 7 | 1 |
| NEE2 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 2 | 1 | 8 | 1 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 3 | 0 |
| PAL1 | 6 | 1 | 5 | 0 | 5 | 3 | 1 | 4 | 2 | 2 | 1 | 7 |
| PBH1 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 6 | 0 | 1 | 4 | 3 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 8 | 0 | 0 | 0 | 16 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | [illegible] | 1 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 0 | 0 | 5 | 0 |
| RSS1 | 9 | 0 | 1 | 0 | 0 | 0 | 5 | 4 | 0 | 0 | 2 | 4 |
| SGS1 | 18 | 0 | 4 | 0 | 0 | 2 | 55 | 7 | 6 | 1 | 26 | 1 |
| SGS2 | 11 | 1 | 17 | 1 | 4 | 1 | 31 | 13 | 5 | 6 | 45 | 9 |
| SLS1 | 9 | 1 | 2 | 1 | 1 | 2 | 4 | 6 | 3 | 1 | 15 | 15 |
| SNP1 | 10 | 0 | 7 | 5 | 0 | 2 | 0 | 7 | 0 | 4 | 46 | 6 |
| SOS1 | 11 | 0 | 3 | 1 | 0 | 0 | 2 | 1 | 6 | 4 | 10 | 3 |
| SPS1 | 9 | 2 | 0 | 1 | 0 | 0 | 3 | [illegible] | 1 | 4 | 29 | 0 |
| SPS2 | 21 | 0 | 3 | 3 | 13 | 0 | 5 | 9 | 0 | 0 | 18 | 1 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 5 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 14 | 1 |
| TNP1 | 1 | 0 | 2 | 0 | 0 | 1 | 7 | 2 | 0 | 2 | 8 | 3 |
| TPS3 | 3 | 0 | 1 | 0 | 0 | 2 | 2 | 3 | 0 | 1 | 0 | 6 |
| TPS4 | 3 | 0 | 1 | 0 | 0 | 0 | 3 | 5 | 2 | 0 | 0 | 5 |
| YKR1 | 2 | 0 | 2 | 0 | 10 | 0 | 1 | 0 | 0 | 1 | 15 | 10 |
| ZIS1 | 2 | 0 | 1 | 3 | 0 | 3 | 0 | 7 | 0 | 0 | 24 | 2 |
| ZIS2 | 0 | 0 | 2 | 2 | 0 | 4 | 5 | 1 | 2 | 2 | 17 | 12 |
| TOTAL - | 238 | 17 | 136 | 55 | 82 | 48 | 223 | 219 | 81 | 63 | 691 | 213 |

TI APERTURE CARD

Also Available On Aperture Card



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Table 26. (continued)

| FID | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Component Grouping | | | | | | | |
| FID | I&C Sensors | I&C Switches | I&C Transmitters | Motors | Penetrations | Pumps | Valves | V Ope |
| ANO1 | 0 | 3 | 0 | 0 | 0 | 3 | 5 | |
| ANO2 | 31 | 2 | 0 | 3 | 0 | 11 | 13 | |
| BVS1 | 4 | 10 | 10 | 3 | 5 | 13 | 37 | |
| CCN1 | 5 | 6 | 10 | 2 | 0 | 11 | 38 | |
| CCN2 | 3 | 8 | 5 | 2 | 2 | 11 | 18 | |
| CRP3 | 1 | 8 | 22 | 0 | 0 | 7 | 26 | |
| DBS1 | 2 | 10 | 4 | 3 | 4 | 25 | 36 | |
| DCC1 | 2 | 6 | 3 | 1 | 4 | 5 | 42 | |
| DCC2 | 1 | 16 | 5 | 0 | 2 | 10 | 84 | |
| FCS1 | 1 | 4 | 1 | 0 | 2 | 0 | 0 | |
| HBR2 | 0 | 4 | 1 | 2 | 0 | 12 | 15 | |
| HNP1 | 0 | 0 | 0 | 1 | 2 | 5 | 10 | |
| IPS2 | 4 | 1 | 2 | 4 | 0 | 6 | 14 | |
| IPS3 | 0 | 2 | 0 | 0 | 0 | 1 | 2 | |
| JMF1 | 1 | 7 | 4 | 0 | 4 | 11 | 17 | |
| KNP1 | 0 | 5 | 7 | 3 | 0 | 10 | 14 | |
| MGS1 | 406 | 43 | 21 | 16 | 12 | 39 | 108 | |
| MNS2 | 5 | 7 | 2 | 0 | 0 | 9 | 26 | |
| MYP1 | 0 | 1 | 2 | 0 | 0 | 0 | 16 | |
| NAS1 | 2 | 7 | 7 | 1 | 18 | 8 | 63 | |
| NAS2 | 6 | 13 | 1 | 0 | 0 | 12 | 48 | |
| NEE1 | 0 | 2 | 0 | 1 | 0 | 3 | 8 | |
| NEE2 | 0 | 3 | 2 | 2 | 2 | 4 | 8 | |
| NEF3 | 0 | 3 | 1 | 1 | 1 | 2 | 16 | |
| PAL1 | 1 | 1 | 0 | 22 | 4 | 3 | 39 | |
| PBH1 | 0 | 4 | 1 | 0 | 0 | 1 | 40 | |
| PBH2 | 0 | 2 | 0 | 0 | 0 | 1 | 6 | |
| PIN1 | 0 | 4 | 0 | 0 | 2 | 7 | 3 | |
| PIN2 | 0 | 5 | 0 | 1 | 2 | 6 | 4 | |
| REG1 | 0 | 0 | 1 | 0 | 0 | 6 | 4 | |
| RSS1 | 0 | 6 | 3 | 0 | 3 | 7 | 21 | |
| SGS1 | 2 | 5 | 16 | 2 | 2 | 20 | 28 | |
| SGS2 | 7 | 6 | 21 | 3 | 6 | 15 | 46 | |
| SLS1 | 3 | 7 | 3 | 3 | 0 | 5 | 20 | |
| SNP1 | 8 | 16 | 25 | 5 | 11 | 20 | 33 | |
| SOS1 | 1 | 4 | 6 | 0 | 6 | 1 | 27 | |
| SPS1 | 3 | 0 | 6 | 1 | 1 | 20 | 16 | |
| SPS2 | 0 | 2 | 2 | 5 | 9 | 23 | 39 | |
| TMI1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| TMI2 | 2 | 2 | 1 | 1 | 0 | 4 | 17 | |
| TNP1 | 0 | 2 | 0 | 3 | 0 | 6 | 24 | |
| TPS3 | 0 | 2 | 0 | 1 | 0 | 4 | 1 | |
| TPS4 | 0 | 2 | 2 | 0 | 2 | 7 | 13 | |
| YKR1 | 2 | 2 | 1 | 3 | 10 | 3 | 8 | |
| ZIS1 | 0 | 12 | 0 | 0 | 0 | 3 | 13 | |
| ZIS2 | 1 | 19 | 7 | 1 | 0 | 19 | 17 | |
| TOTAL | 504 | 275 | 205 | 96 | 116 | 399 | 1083 | 2 |



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| …alve …rators | Batteries and Chargers | Control Rods | Total |
|---|---|---|---|
| 4 | 2 | 0 | 37 |
| 6 | 0 | 3 | 140 |
| 2 | 5 | 2 | 170 |
| 9 | 1 | 3 | 144 |
| 9 | 0 | 1 | 106 |
| 8 | 2 | 2 | 168 |
| 4 | 0 | 1 | 171 |
| 0 | 0 | 0 | 126 |
| 2 | 1 | 0 | 179 |
| 0 | 0 | 0 | 16 |
| 3 | 0 | 5 | 67 |
| 0 | 0 | 1 | 29 |
| 2 | 0 | 2 | 55 |
| 0 | 3 | 0 | 15 |
| 3 | 0 | 0 | 138 |
| 7 | 0 | 0 | 66 |
| 16 | 7 | 1 | 819 |
| 15 | 0 | 1 | 93 |
| 3 | 0 | 0 | 37 |
| 5 | 3 | 7 | 205 |
| 13 | 2 | 2 | 171 |
| 1 | 0 | 0 | 49 |
| 2 | 0 | 0 | 41 |
| 2 | 0 | 0 | 32 |
| 3 | 2 | 0 | 112 |
| 32 | 0 | 0 | 97 |
| 3 | 0 | 0 | 14 |
| 2 | 0 | 0 | 45 |
| 0 | 0 | 0 | 22 |
| 0 | 0 | 2 | 25 |
| 9 | 0 | 0 | 74 |
| 2 | 0 | 0 | 197 |
| 5 | 12 | 1 | 266 |
| 5 | 2 | 4 | 112 |
| 9 | 0 | 0 | 214 |
| 9 | 0 | 2 | 97 |
| 5 | 0 | 3 | 121 |
| 8 | 5 | 0 | 153 |
| 0 | 1 | 0 | 4 |
| 2 | 3 | 0 | 56 |
| 6 | 0 | 0 | 67 |
| 1 | 1 | 0 | 28 |
| 1 | 0 | 0 | 46 |
| 1 | 0 | 1 | 72 |
| 3 | 3 | 0 | 76 |
| 7 | 0 | 0 | 118 |
| 49 | 55 | 44 | 5092 |

**Table 27. BWR component group counts by plant as a percent of component group totals**

| FID | Accumulators and Reservoirs | Control Rod Drives | Internal Combustion Engines | Non-I&C Filters | Fuel Elements | Generators | Heat Exchangers | I&C Circuit Breakers | I&C Computation Modules | I&C Controllers | I&C Indicators | I&C Relays |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Component Grouping | | | | | | | | | | | |
| BEP1 | 5.7 | 0.0 | 3.3 | 2.7 | 0.0 | 2.0 | 5.1 | 6.4 | 3.3 | 2.1 | [illegible] | 5.8 |
| BEP2 | 2.9 | 10.0 | 15.6 | 8.1 | 9.1 | 8.2 | 18.6 | 11.2 | 6.7 | 2.1 | 16.7 | 7.7 |
| BRF1 | 4.3 | 0.0 | 6.7 | 0.0 | 0.0 | 6.1 | 6.8 | 8.0 | 26.7 | 0.0 | 3.9 | 9.6 |
| BRF2 | 0.0 | 0.0 | 1.1 | 0.0 | 24.2 | 4.1 | 6.8 | .8 | 13.3 | 2.1 | 5.3 | 12.5 |
| BRF3 | 1.4 | 0.0 | 11.1 | 0.0 | 6.1 | 20.4 | 6.8 | 4.0 | 0.0 | 4.2 | 5.8 | 10.6 |
| BRP1 | 2.9 | 0.0 | 3.3 | 0.0 | 0.0 | 0.0 | 10.2 | 1.6 | 0.0 | 4.2 | 1.6 | 0.0 |
| CPR1 | 1.4 | 0.0 | 5.6 | 0.0 | 0.0 | 2.0 | 0.0 | 1.6 | 3.3 | 0.0 | .8 | 1.0 |
| DAC1 | 0.0 | 0.0 | 0.0 | 10.8 | 0.0 | 0.0 | 1.7 | 3.2 | 0.0 | 6.3 | 1.8 | 0.0 |
| DRS2 | 11.4 | 30.0 | 2.2 | 8.1 | 0.0 | 2.0 | 0.0 | 3.2 | 0.0 | 2.1 | 3.7 | 3.8 |
| DRS3 | 2.9 | 0.0 | 4.4 | 5.4 | 0.0 | 2.0 | 0.0 | 0.0 | 3.3 | 6.3 | 2.1 | 1.0 |
| EIH1 | 14.6 | 0.0 | 6.7 | 18.9 | 45.5 | 12.2 | 10.2 | 3.2 | 6.7 | 8.3 | 9.5 | 11.5 |
| EIH2 | 11.4 | 30.0 | 18.9 | 16.2 | 6.1 | 16.3 | 5.1 | 5.6 | 0.0 | 16.7 | 6.3 | 12.5 |
| HMB1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| JAF1 | 7.1 | 20.0 | 2.2 | 5.4 | 0.0 | 4.1 | 0.0 | 1.6 | 33.3 | 10.4 | 7.6 | 2.9 |
| LBR1 | 5.7 | 0.0 | 0.0 | 0.0 | 6.1 | 0.0 | 0.0 | 4.8 | 0.0 | 2.1 | .5 | 1.0 |
| MNP1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | .8 | 0.0 | 0.0 | .3 | 2.9 |
| MNS1 | 0.0 | 0.0 | 2.2 | 5.4 | 3.0 | 6.1 | 1.7 | 2.4 | 0.0 | 6.3 | 2.4 | 7.7 |
| NMP1 | 0.0 | 0.0 | 2.2 | 0.0 | 0.0 | 4.1 | 5.1 | .8 | 0.0 | 8.3 | 5.5 | 4.8 |
| OCP1 | 14.3 | 0.0 | 1.1 | 8.1 | 0.0 | 0.0 | 13.6 | 4.0 | 0.0 | 0.0 | 6.1 | 0.0 |
| PBS2 | 8.6 | 0.0 | 8.9 | 0.0 | 0.0 | 0.0 | 3.4 | 1.6 | 0.0 | 2.1 | 4.2 | 0.0 |
| PBS3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 8.0 | 0.0 | 4.2 | 1.8 | 0.0 |
| PPS1 | 0.0 | 10.0 | 0.0 | 0.0 | 0.0 | 4.1 | 5.1 | 12.8 | 3.3 | 4.2 | 1.1 | 1.9 |
| QAD1 | 0.0 | 0.0 | 1.1 | 2.7 | 0.0 | 0.0 | 0.0 | 3.2 | 0.0 | 2.1 | .5 | 0.0 |
| QAD2 | 0.0 | 0.0 | 2.2 | 0.0 | 0.0 | 4.1 | 0.0 | 2.4 | 0.0 | 4.2 | 0.0 | 1.0 |
| VYS1 | 1.4 | 0.0 | 1.1 | 8.1 | 0.0 | 0.0 | 0.0 | 8.8 | 0.0 | 2.1 | 1.8 | 1.9 |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

| FID | I&C Sensors | I&C Switches | I&C Transmitters | Motors | Penetrations | Pumps | Valves | Valve Operators | Batteries and Chargers | Control Rods | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Component Grouping | | | | | | | | | | |
| BEP1 | 10.9 | 7.9 | 25.0 | 5.3 | 2.5 | 8.0 | 6.3 | 3.7 | 0.0 | 16.7 | 6.8 |
| BEP2 | 13.0 | 7.9 | 26.9 | 8.8 | 12.5 | 4.3 | 7.1 | 9.0 | 0.0 | 29.2 | 9.9 |
| BRF1 | 6.5 | 7.2 | 1.9 | 14.0 | 15.0 | 4.8 | 3.9 | 0.0 | 4.0 | 0.0 | 5.3 |
| BRF2 | 10.9 | 6.7 | 9.6 | 10.5 | 20.0 | 9.0 | 1.5 | 1.1 | 0.0 | 4.2 | 4.9 |
| BRF3 | 4.3 | 2.3 | 3.8 | 8.8 | 0.0 | 5.3 | 4.6 | 4.3 | 0.0 | 4.2 | 4.8 |
| BRP1 | 0.0 | .2 | 0.0 | 0.0 | 2.5 | .5 | 1.7 | 1.1 | 16.0 | 0.0 | 1.5 |
| CPR1 | 0.0 | 1.8 | 0.0 | 3.5 | 0.0 | 1.6 | 6.9 | 2.7 | 24.0 | 0.0 | 3.1 |
| DAC1 | 13.0 | 1.4 | 3.8 | 0.0 | 10.0 | 3.2 | 4.8 | 5.9 | 4.0 | 4.2 | 3.2 |
| DRS2 | 6.5 | 2.7 | 3.8 | 3.5 | 0.0 | 3.2 | 4.3 | 8.5 | 4.0 | 8.3 | 4.0 |
| DRS3 | 0.0 | 3.2 | 0.0 | 1.8 | 0.0 | 2.1 | 1.2 | 1.6 | 0.0 | 4.2 | 2.0 |
| EIH1 | 4.3 | 8.1 | 3.8 | 7.0 | 0.0 | 12.2 | 11.0 | 14.9 | 0.0 | 0.0 | 10.1 |
| EIH2 | 8.7 | 21.7 | 3.8 | 8.8 | 2.5 | 9.0 | 6.5 | 10.1 | 24.0 | 16.7 | 11.0 |
| HMB1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | .3 | 0.0 | 0.0 | 0.0 | .1 |
| JAF1 | 2.2 | 4.7 | 3.8 | 1.8 | 0.0 | 4.3 | 1.7 | 1.6 | 12.0 | 0.0 | 4.0 |
| LBR1 | 0.0 | .9 | 0.0 | 0.0 | 5.0 | 1.6 | .3 | 0.0 | 0.0 | 0.0 | .9 |
| MNP1 | 0.0 | 1.6 | 0.0 | 0.0 | 0.0 | .5 | 3.1 | 1.6 | 8.0 | 0.0 | 1.5 |
| MNS1 | 2.2 | 3.6 | 0.0 | 1.8 | 0.0 | 1.1 | 1.7 | 2.1 | 0.0 | 0.0 | 2.5 |
| NMP1 | 10.9 | 1.4 | 0.0 | 1.8 | 0.0 | 2.7 | 4.0 | 4.8 | 0.0 | 8.3 | 3.3 |
| OCP1 | 4.3 | 7.0 | 0.0 | 1.8 | 15.0 | 7.4 | 3.9 | 5.9 | 0.0 | 4.2 | 5.2 |
| PBS2 | 0.0 | .9 | 7.7 | 1.8 | 0.0 | 0.0 | 5.0 | 6.9 | 0.0 | 0.0 | 3.2 |
| PBS3 | 0.0 | .9 | 3.8 | 0.0 | 0.0 | .5 | 5.7 | 1.1 | 0.0 | 0.0 | 2.4 |
| PPS1 | 2.2 | 1.4 | 1.9 | 3.5 | 0.0 | 10.1 | 7.4 | 3.2 | 0.0 | 0.0 | 4.2 |
| QAD1 | 0.0 | 2.0 | 0.0 | 1.8 | 0.0 | 1.1 | .8 | 1.6 | 0.0 | 0.0 | 1.1 |
| QAD2 | 0.0 | 3.4 | 0.0 | 0.0 | 15.0 | .5 | 2.8 | 1.6 | 0.0 | 0.0 | 2.0 |
| VYS1 | 0.0 | .7 | 0.0 | 14.0 | 0.0 | 5.9 | 3.4 | 6.9 | 4.0 | 0.0 | 3.0 |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

**Table 28. PWR component group counts by plant as a percent of component group totals**

| | Component Grouping | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FID | Accumulators and Reservoirs | Control Rod Drives | Internal Combustion Engines | Non-I&C Filters | Fuel Elements | Generators | Heat Exchangers | I&C Circu[it] Break[ers] |
| ANO1 | .4 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 | .4 | [illegible] |
| ANO2 | 0.0 | 17.6 | 1.5 | 1.8 | 41.5 | 4.2 | 3.1 | 1. |
| BVS1 | 2.5 | 0.0 | .7 | 1.8 | 0.0 | 0.0 | 2.7 | 3. |
| CCN1 | 1.3 | 5.9 | 5.1 | 0.0 | 0.0 | 2.1 | 4.0 | [illegible] |
| CCN2 | .4 | 0.0 | 4.4 | 0.0 | 0.0 | 2.1 | 0.0 | 3. |
| CRP3 | .4 | 0.0 | 2.9 | 10.9 | 6.1 | 4.2 | .4 | 3. |
| DBS1 | .4 | 5.9 | 1.5 | 1.8 | 2.4 | .2 | 2.7 | 7. |
| DCC1 | 1.7 | 0.0 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 3. |
| DCC2 | 1.7 | 0.0 | 2.2 | 9.1 | 1.2 | 2.1 | 3.1 | 2. |
| FCS1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .9 | [illegible] |
| HBR2 | 0.0 | 35.3 | 1.5 | 0.0 | 0.0 | 0.0 | .9 | 3. |
| HNP1 | 0.0 | 0.0 | 2.2 | 0.0 | 0.0 | 0.0 | .4 | [illegible] |
| IPS2 | 0.0 | 0.0 | 2.2 | 0.0 | 1.2 | 6.3 | 1.8 | [illegible] |
| IPS3 | .4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 0. |
| JMF1 | 4.6 | 5.9 | 17.6 | 7.3 | 0.0 | 6.3 | .4 | 4. |
| KNP1 | 1.7 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 | 1.3 | 2. |
| MGS1 | 11.8 | 0.0 | 2.9 | 16.4 | 0.0 | 8.3 | 4.5 | 6. |
| MNS2 | 1.7 | 0.0 | 2.9 | 3.5 | 0.0 | 0.0 | .4 | [illegible] |
| MYP1 | 0.0 | 0.0 | 0.0 | 5.5 | 0.0 | 0.0 | 0.0 | [illegible] |
| NAS1 | 8.0 | 0.0 | 2.9 | 5.5 | 3.7 | 0.0 | 7.2 | 4. |
| NAS2 | 13.9 | 0.0 | 2.2 | 0.0 | 2.4 | 0.0 | .4 | 1. |
| NEE1 | 0.0 | 0.0 | 0.0 | 3.6 | 0.0 | 10.4 | .4 | 4. |
| NEE2 | .4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 0. |
| NEE3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .4 | [illegible] |
| PAL1 | 2.5 | 5.9 | 3.7 | 0.0 | 6.1 | 6.3 | .4 | 1. |
| PBH1 | .4 | 0.0 | 0.0 | 0.0 | 0.0 | 4.2 | .9 | 2. |
| PBH2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .9 | 0. |
| PIN1 | 0.0 | 0.0 | .7 | 0.0 | 1.2 | 2.1 | 0.0 | 3. |
| PIN2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .9 | 0. |
| REG1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .9 | 2. |
| RSS1 | 3.8 | 0.0 | .7 | 0.0 | 0.0 | 0.0 | 2.2 | 1. |
| SGS1 | 7.6 | 0.0 | 2.9 | 0.0 | 0.0 | 4.2 | 24.7 | 3. |
| SGS2 | 4.0 | 5.9 | 12.5 | 1.8 | 4.9 | 2.1 | 13.9 | 5. |
| SLS1 | 3.8 | 5.9 | 1.5 | 1.8 | 1.2 | 4.2 | 1.8 | 2. |
| SNP1 | 4.2 | 0.0 | 5.1 | 9.1 | 0.0 | 4.2 | 0.0 | 3. |
| SOS1 | 4.6 | 0.0 | 2.2 | 1.8 | 0.0 | 0.0 | .9 | [illegible] |
| SPS1 | 3.8 | 11.8 | 0.0 | 1.8 | 15.9 | 0.0 | 1.3 | 1. |
| SPS2 | 8.8 | 0.0 | 2.2 | 5.5 | 0.0 | 0.0 | 2.2 | 4. |
| TMI1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .9 | 0. |
| TMI2 | 0.0 | 0.0 | 3.7 | 1.8 | 0.0 | 2.1 | 0.0 | 0. |
| TNP1 | .4 | 0.0 | 1.5 | 0.0 | 0.0 | 2.1 | 3.1 | [illegible] |
| TPS3 | 1.3 | 0.0 | .7 | 0.0 | 0.0 | 4.2 | .9 | 1. |
| TPS4 | 1.3 | 0.0 | .7 | 0.0 | 0.0 | 0.0 | 1.3 | 2. |
| YKR1 | .8 | 0.0 | 1.5 | 0.0 | 12.2 | 0.0 | .4 | 0. |
| ZIS1 | .8 | 0.0 | .7 | 5.5 | 0.0 | 6.3 | 0.0 | 3. |
| ZIS2 | 0.0 | 0.0 | 1.5 | 3.6 | 0.0 | 8.3 | 2.2 | [illegible] |
| TOTAL - | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100[.0] |



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| it ers | I&C Computation Modules | I&C Controllers | I&C Indicators | I&C Relays |
|---|---|---|---|---|
| 9 | 1.2 | 0.0 | 0.0 | 6.1 |
| 8 | 7.4 | 3.2 | 1.2 | .9 |
| 2 | 1.2 | 4.8 | 5.9 | 1.4 |
| 5 | 7.4 | 3.2 | 3.8 | 1.4 |
| 2 | 1.2 | 4.8 | 2.3 | 5.6 |
| 7 | 6.2 | 4.8 | 6.5 | 5.6 |
| 3 | 6.2 | 1.6 | 5.6 | 2.8 |
| 7 | 1.2 | 0.0 | 2.7 | 8.5 |
| 3 | 0.0 | 1.6 | 2.3 | 7.0 |
| 5 | 0.0 | 0.0 | .1 | 2.8 |
| 7 | 2.5 | 1.6 | .6 | 0.0 |
| 5 | 0.0 | 3.2 | .3 | .5 |
| 9 | 0.0 | 0.0 | .7 | .9 |
| 0 | 0.0 | 1.6 | .1 | 0.0 |
| 6 | 0.0 | 4.8 | 4.1 | 2.8 |
| 7 | 0.0 | 0.0 | .6 | .5 |
| 4 | 2.5 | 4.8 | 10.6 | 1.4 |
| 9 | 3.7 | 0.0 | 1.7 | 0.0 |
| 5 | 6.2 | 3.2 | .6 | 0.0 |
| 1 | 1.2 | 3.2 | 3.6 | .9 |
| 8 | 4.9 | 3.2 | 3.5 | .5 |
| 6 | 9.9 | 0.0 | 1.0 | .5 |
| 0 | 2.5 | 1.6 | 1.2 | .5 |
| 5 | 1.2 | 0.0 | .4 | 0.0 |
| 8 | 2.5 | 3.2 | .1 | 3.3 |
| 7 | 0.0 | 1.6 | .6 | 1.4 |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 7.5 |
| 0 | 0.0 | 0.0 | .1 | .5 |
| 3 | 0.0 | 0.0 | .7 | 0.0 |
| 8 | 0.0 | 0.0 | .3 | 1.9 |
| 2 | 7.4 | 1.6 | 3.8 | .5 |
| 9 | 6.2 | 9.5 | 6.5 | 4.2 |
| 7 | 3.7 | 1.6 | 2.2 | 7.0 |
| 2 | 0.0 | 6.3 | 6.7 | 2.8 |
| 5 | 7.4 | 6.3 | 1.4 | 1.4 |
| 8 | 1.2 | 6.3 | 4.2 | 0.0 |
| 1 | 0.0 | 0.0 | 2.6 | .5 |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0 | 0.0 | 3.2 | 2.0 | .5 |
| 9 | 0.0 | 3.2 | 1.2 | 1.4 |
| 4 | 0.0 | 1.6 | 0.0 | 2.8 |
| 3 | 2.5 | 0.0 | 0.0 | 2.3 |
| 0 | 0.0 | 1.6 | 2.2 | 4.7 |
| 2 | 0.0 | 0.0 | 3.5 | .9 |
| 5 | 2.5 | 3.2 | 2.5 | 5.6 |
| 0 | 100.0 | 100.0 | 100.0 | 100.0 |

**Table 28. (continued)**

| FID | I&C Sensors | I Swi |
|---|---|---|
| ANO1 | 0.0 | 1 |
| ANO2 | 6.2 | |
| BVS1 | .8 | 3 |
| CCN1 | 1.0 | 2 |
| CCN2 | .6 | 2 |
| CRP3 | .2 | 2 |
| DBS1 | .4 | 3 |
| DCC1 | .4 | 2 |
| DCC2 | .2 | 5 |
| FCS1 | .2 | 1 |
| HBR2 | 0.0 | 1 |
| HNP1 | 0.0 | 0 |
| IPS2 | .8 | |
| IPS3 | 0.0 | |
| JMF1 | .2 | 2 |
| KNP1 | 0.0 | 1 |
| MGS1 | 80.6 | 15 |
| MNS2 | 1.0 | 2 |
| MYP1 | 0.0 | |
| NAS1 | .4 | 2 |
| NAS2 | 1.2 | 4 |
| NEE1 | 0.0 | |
| NEE2 | 0.0 | 1 |
| NEE3 | 0.0 | 1 |
| PAL1 | .2 | |
| PBH1 | 0.0 | 1 |
| PBH2 | 0.0 | |
| PIN1 | 0.0 | 1 |
| PIN2 | 0.0 | 1 |
| REG1 | 0.0 | 0 |
| RSS1 | 0.0 | 2 |
| SGS1 | .4 | 1 |
| SGS2 | 1.4 | 2 |
| SLS1 | .6 | 2 |
| SNP1 | 1.6 | 5 |
| SUS1 | .2 | 1 |
| SPS1 | .6 | 0 |
| SPS2 | 0.0 | |
| TMI1 | 0.0 | |
| TMI2 | .4 | |
| TNP1 | 0.0 | |
| TPS3 | 0.0 | |
| TPS4 | 0.0 | |
| YKR1 | .4 | |
| ZIS1 | 0.0 | 4 |
| ZIS2 | .2 | 6 |
| TOTAL | 100.0 | 100 |

Component Grouping

| &C tches | I&C Trans- mitters | Motors | Penetra- tions | Pumps | Valves | Valve Operators | Batteries and Chargers | Control Rods | Total |
|---|---|---|---|---|---|---|---|---|---|
| .1 | 0.0 | 0.0 | 0.0 | .8 | .5 | 1.6 | 3.6 | 0.0 | .7 |
| .7 | 0.0 | 3.1 | 0.0 | 2.8 | 1.2 | 2.4 | 0.0 | 6.8 | 2.7 |
| .6 | 4.9 | 3.1 | 4.3 | 3.3 | 3.4 | 4.8 | 9.1 | 4.5 | 3.3 |
| .2 | 4.9 | 2.1 | 0.0 | 2.8 | 3.5 | 3.6 | 1.8 | 6.8 | 2.8 |
| .9 | 2.4 | 2.1 | 1.7 | 2.8 | 1.7 | 3.6 | 0.0 | 2.3 | 2.1 |
| .9 | 10.7 | 0.0 | 0.0 | 1.8 | 2.4 | 3.2 | 3.6 | 4.5 | 3.3 |
| .6 | 2.0 | 3.1 | 3.4 | 6.3 | 3.3 | 1.6 | 0.0 | 2.3 | 3.4 |
| .2 | 1.5 | 1.0 | 3.4 | 1.3 | 3.9 | 4.0 | 0.0 | 0.0 | 2.5 |
| .8 | 2.4 | 0.0 | 1.7 | 2.5 | 7.8 | .8 | 1.8 | 0.0 | 3.5 |
| .5 | .5 | 0.0 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .4 |
| .5 | .5 | 2.1 | 0.0 | 3.0 | 1.4 | 1.2 | 0.0 | 11.4 | 1.3 |
| .0 | 0.0 | 1.0 | 1.7 | 1.3 | .9 | 0.0 | 0.0 | 2.3 | .6 |
| .4 | 1.0 | 4.2 | 0.0 | 1.5 | 1.3 | .8 | 0.0 | 4.5 | 1.1 |
| .7 | 0.0 | 0.0 | 0.0 | .3 | .2 | 0.0 | 5.5 | 0.0 | .3 |
| .5 | 2.0 | 0.0 | 3.4 | 2.8 | 1.6 | 1.2 | 0.0 | 0.0 | 2.7 |
| .8 | 3.4 | 3.1 | 0.0 | 2.5 | 1.3 | 2.8 | 0.0 | 0.0 | 1.3 |
| .6 | 10.2 | 16.7 | 10.3 | 9.8 | 10.0 | 6.4 | 12.7 | 2.3 | 16.1 |
| .5 | 1.0 | 0.0 | 0.0 | 2.3 | 2.4 | 6.0 | 0.0 | 2.3 | 1.8 |
| .4 | 1.0 | 0.0 | 0.0 | 0.0 | 1.5 | 1.2 | 0.0 | 0.0 | .7 |
| .5 | 3.4 | 1.0 | 15.5 | 2.0 | 5.8 | 2.0 | 5.5 | 15.9 | 4.0 |
| .7 | .5 | 0.0 | 0.0 | 3.0 | 4.4 | 5.2 | 3.6 | 4.5 | 3.4 |
| .7 | 0.0 | 1.0 | 0.0 | .8 | .7 | .4 | 0.0 | 0.0 | 1.0 |
| .1 | 1.0 | 2.1 | 1.7 | 1.0 | .7 | .8 | 0.0 | 0.0 | .8 |
| .1 | .5 | 1.0 | .9 | .5 | 1.5 | .8 | 0.0 | 0.0 | .6 |
| .4 | 0.0 | 22.9 | 3.4 | .8 | 3.6 | 1.2 | 3.6 | 0.0 | 2.2 |
| .5 | .5 | 0.0 | 0.0 | .3 | 3.7 | 12.9 | 0.0 | 0.0 | 1.9 |
| .7 | 0.0 | 0.0 | 0.0 | .3 | .6 | 1.2 | 0.0 | 0.0 | .3 |
| .5 | 0.0 | 0.0 | 1.7 | 1.8 | .3 | .8 | 0.0 | 0.0 | .9 |
| .8 | 0.0 | 1.0 | 1.7 | 1.5 | .4 | 0.0 | 0.0 | 0.0 | .4 |
| .0 | .5 | 0.0 | 0.0 | 1.5 | .4 | 0.0 | 0.0 | 4.5 | .5 |
| .2 | 1.5 | 0.0 | 2.6 | 1.8 | 1.9 | 3.6 | 0.0 | 0.0 | 1.5 |
| .8 | 7.8 | 2.1 | 1.7 | 5.0 | 2.6 | .8 | 0.0 | 0.0 | 3.9 |
| .2 | 10.2 | 3.1 | 5.2 | 3.8 | 4.2 | 2.0 | 21.8 | 2.3 | 5.2 |
| .5 | 1.5 | 3.1 | 0.0 | 1.3 | 1.8 | 2.0 | 3.6 | 9.1 | 2.2 |
| .8 | 12.2 | 5.2 | 9.5 | 5.0 | 3.0 | 3.6 | 0.0 | 0.0 | 4.2 |
| .5 | 2.9 | 0.0 | 5.2 | .3 | 2.5 | 3.6 | 0.0 | 4.5 | 1.9 |
| .0 | 2.9 | 1.0 | .9 | 5.0 | 1.5 | 2.0 | 0.0 | 6.8 | 2.4 |
| .7 | 1.0 | 5.2 | 7.8 | 5.8 | 3.6 | 3.2 | 9.1 | 0.0 | 3.0 |
| .4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | .1 |
| .7 | .5 | 1.0 | 0.0 | 1.0 | 1.6 | .8 | 5.5 | 0.0 | 1.1 |
| .7 | 0.0 | 3.1 | 0.0 | 1.5 | 2.2 | 2.4 | 0.0 | 0.0 | 1.3 |
| .7 | 0.0 | 1.0 | 0.0 | 1.0 | .1 | .4 | 1.8 | 0.0 | .5 |
| .7 | 1.0 | 0.0 | 1.7 | 1.8 | 1.2 | .4 | 0.0 | 0.0 | .9 |
| .7 | .5 | 3.1 | 8.6 | .8 | .7 | .4 | 0.0 | 2.3 | 1.4 |
| .4 | 0.0 | 0.0 | 0.0 | .8 | 1.2 | 1.2 | 5.5 | 0.0 | 1.5 |
| .9 | 3.4 | 1.0 | 0.0 | 4.8 | 1.6 | 2.8 | 0.0 | 0.0 | 2.3 |
| .0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Table 29. Plant influence on component groups

| | Plant | Component Group Most Influenced by the Plant | Influence (%) | Overall Plant Influence[a] (%) |
|---|---|---|---|---|
| BWRs | | | | |
| BEP1 | Brunswick 1 | I&C/Transmitters | 25.0 | 6.8 |
| BEP2 | Brunswick 2 | Control Rods | 29.2 | 9.9 |
| BRF1 | Browns Ferry 1 | I&C/Computation Modules | 26.7 | 5.3 |
| BRF2 | Browns Ferry 2 | Fuel Elements | 24.2 | 4.9 |
| BRF3 | Browns Ferry 3 | Generators | 20.4 | 4.8 |
| BRP1 | Big Rock Point | Batteries/Chargers | 16.0 | 1.5 |
| CPR1 | Cooper | Batteries/Chargers | 24.0 | 3.1 |
| DAC1 | Arnold | I&C/Sensors | 13.0 | 3.2 |
| DRS2 | Dresden 2 | Control Rod Drives | 30.0 | 4.0 |
| DRS3 | Dresden 3 | I&C/Controllers | 6.3 | 2.0 |
| EIH1 | Hatch 1 | Fuel Elements | 45.5 | 10.1 |
| EIH2 | Hatch 2 | Control Rod Drives | 30.0 | 11.0 |
| HMB1 | Humboldt Bay | Pumps | 1.1 | 0.1 |
| JAF1 | FitzPatrick | I&C/Computation Modules | 33.3 | 4.0 |
| LBR1 | La Crosse | Fuel Elements | 6.1 | 0.9 |
| MNP1 | Monticello | Batteries/Chargers | 8.0 | 1.5 |
| MNS1 | Millstone 1 | I&C/Relays | 7.7 | 2.5 |
| NMP1 | Nine Mile Point 1 | I&C/Sensors | 10.9 | 3.3 |
| OCP1 | Oyster Creek | Penetrations | 15.0 | 5.2 |
| PBS2 | Peach Bottom 2 | Diesels | 8.9 | 3.2 |
| PBS3 | Peach Bottom 3 | I&C/Circuit Breakers | 8.0 | 2.4 |
| PPS1 | Pilgrim 1 | I&C/Circuit Breakers | 12.8 | 4.2 |
| QAD1 | Quad Cities 1 | Non-I&C Filters | 2.7 | 1.1 |
| QAD2 | Quad Cities 2 | Penetrations | 15.0 | 2.0 |
| VYS1 | Vermont Yankee | I&C/Circuit Breakers | 8.8 | 3.0 |
| PWRs | | | | |
| ANO1 | Arkansas Nuclear 1 | I&C/Relays | 6.1 | 0.7 |
| ANO2 | Arkansas Nuclear 2 | Fuel Elements | 41.5 | 2.7 |
| BVS1 | Beaver Valley 1 | Batteries/Chargers | 9.1 | 3.3 |
| CCN1 | Calvert Cliffs 1 | I&C/Computation Modules | 7.4 | 2.8 |
| CCN2 | Calvert Cliffs 2 | I&C/Relays | 5.6 | 2.1 |
| CRP3 | Crystal River 3 | Non-I&C Filters | 10.9 | 3.3 |
| DBS1 | Davis-Besse 1 | I&C/Circuit Breakers | 7.3 | 3.4 |
| DCC1 | Cook 1 | I&C/Relays | 8.5 | 2.5 |
| DCC2 | Cook 2 | Non-I&C Filters | 9.1 | 3.5 |
| FCS1 | Ft. Calhoun | I&C/Relays | 2.6 | 0.4 |
| HBR2 | H. B. Robinson 2 | Control Rod Drives | 35.3 | 1.3 |
| HNP1 | Haddam Neck | I&C/Controllers | 3.2 | 0.6 |
| IPS2 | Indian Point 2 | Generators | 6.3 | 1.1 |
| IPS3 | Indian Point 3 | Batteries/Chargers | 5.5 | 0.3 |
| JMF1 | Joseph M. Farley 1 | Diesels | 17.6 | 2.7 |
| KNP1 | Kewaunee | I&C/Transmitters | 3.4 | 1.3 |

**Table 29. (continued)**

| | Plant | Component Group Most Influenced by the Plant | Influence (%) | Overall Plant Influence[a] (%) |
|---|---|---|---|---|
| MGS1 | McGuire 1 | I&C Sensors | 80.6 | 16.1 |
| MNS2 | Millstone 2 | Valve Operators | 6.0 | 1.8 |
| MYP1 | Maine Yankee | I&C Computation Modules | 6.2 | 0.7 |
| NAS1 | North Anna 1 | Control Rods | 15.9 | 4.0 |
| NAS2 | North Anna 2 | Accumulators/Reservoirs | 13.9 | 3.4 |
| NEE1 | Oconee 1 | Generators | 10.4 | 1.0 |
| NEE2 | Oconee 2 | I&C/Computation Modules | 2.5 | 0.8 |
| NEE3 | Oconee 3 | Valves | 1.5 | 0.6 |
| PAL1 | Palisades | Motors | 22.9 | 2.2 |
| PBH1 | Point Beach 1 | Valve Operators | 12.9 | 1.9 |
| PBH2 | Point Beach 2 | Valve Operators | 1.2 | 0.3 |
| PIN1 | Prairie Island 1 | I&C/Relays | 7.5 | 0.9 |
| PIN2 | Prairie Island 2 | I&C/Switches | 1.8 | 0.4 |
| REG1 | Ginna | Control Rods | 4.5 | 0.5 |
| RSS1 | Rancho Seco | Accumulators/Reservoirs | 3.8 | 1.5 |
| SGS1 | Salem 1 | Heat Exchangers | 24.7 | 3.9 |
| SGS2 | Salem 2 | Batteries/Chargers | 21.8 | 5.2 |
| SLS1 | St. Lucie 1 | Control Rods | 9.1 | 2.2 |
| SNP1 | Sequoyah 1 | I&C/Transmitters | 12.2 | 4.2 |
| SOS1 | San Onofre 1 | I&C/Computation Modules | 7.4 | 1.9 |
| SPS1 | Surry 1 | Fuel Elements | 15.9 | 2.4 |
| SPS2 | Surry 2 | Batteries/Chargers | 9.1 | 3.0 |
| TMI1 | Three Mile Island 1 | Batteries/Chargers | 1.8 | 0.1 |
| TMI2 | Three Mile Island 2 | Batteries/Chargers | 5.5 | 1.1 |
| TNP1 | Trojan | I&C/Controllers | 3.2 | 1.3 |
| TPS3 | Turkey Point 3 | Generators | 4.2 | 0.5 |
| TPS4 | Turkey Point 4 | I&C/Computation Modules | 2.5 | 0.9 |
| YKR1 | Yankee Rowe 1 | Fuel Elements | 12.2 | 1.4 |
| ZIS1 | Zion 1 | Generators | 6.3 | 1.5 |
| ZIS2 | Zion 2 | Generators | 8.3 | 2.3 |

a. Based on the total fault count from the plant for all 22 component groups.

Dresden 2 represents only 3 faults. Whether these high percentages indicate that the plants have unusual numbers of problems with these types of components or that other plants are not reporting the same kind of problems with these components is in most cases a subject for future study.

However, in some cases the causes for these patterns were identified from the SCSS LER information. In the remainder of this section the focus is on the individual component groupings. In the Appendix A tables, for the cell counts that stand out, the SCSS information on the associated LER was reviewed. The results are discussed below.

Four points need to be made prior to the discussions on the component tables. First, the term *outlier* will be used in referencing the tables. In this context *outlier* will be used to mean a cell frequency that is unusually high relative to the other cells in the table. No statistical inference is implied by the use of this term.

Secondly, the term *activity* is commonly used throughout the table discussions. The term is used as a qualitative indicator of relative number of counts. The Table below shows in general how this term is applied. Because there are roughly twice (46 versus 25) the number of PWR as BWR plants, two different sets of intervals are given for activity levels.

| | Number of faults | |
|---|---|---|
| Activity Level | BWR | PWR |
| Extremely low | 0 to 19 | 0 to 19 |
| Low | 20 to 29 | 20 to 39 |
| Moderate | 30 to 59 | 40 to 89 |
| Moderately high | 60 to 109 | 90 to 199 |
| High | 110 to 199 | 200 to 299 |
| Extremely high | over 199 | over 299 |

Thirdly, a factor that stands out in the component tables is that certain plants consistently have a larger number of occurrences. In particular, for the BWR plants Brunswick 1 and 2 and Hatch 1 and 2 and the PWR plants McGuire 1, Sequoyah 1, and Salem 1 and 2, a larger number of events are observed in the tables. These plants have an overall high LER reporting frequency (see Tables 3 and 4, as well as Tables 24 and 25). Consistently higher numbers of faults in the data base from certain plants should be kept in mind in evaluating all the SCSS data contingency tables. When large cell counts are observed for these facilities they are still explored but may not be discussed if nothing exceptional was associated with the events. All large cell counts that are observed and not addressed in the ensuing discussions fall into this category. Cells that are discussed are shown boxed in the Appendix A tables.

Finally, each of the component group tables are discussed in subsections below with the exception of batteries/chargers, control rod drives, and I&C/controllers. The first two groups are not discussed due to their nominal amount of activity. The latter table lacks any cell counts worthy of discussion for either BWRs or PWRs.

## Accumulators/Reservoirs

A moderately high level of activity was observed for these components. The reservoir and tank components experienced the majority of the faults reported with a much lesser number reported for accumulators. The majority of tank faults represented the levels of different types of tanks falling below minimum technical specification required levels. Commonly, these level fluctuations were due to leaking valves or the inadvertent release of liquid radioactive waste or gas by plant personnel. This behavior was similar for both BWRs and PWRs.

## Control Rods

For BWRs, a low amount of activity was observed. Brunswick 2 reported a total of 7 control rod element faults, all of which were reported in one LER. This event was described as a maladjustment of rods due to a miscalculation of the flux profile.

For PWRs, also a low level of activity was observed. North Anna 1's control rod element faulting was attributed to the same reason as the Brunswick 2 control rod element faults described above.

## Internal Combustion Engines

The term *diesel* generally represents what is actually a system composed of the diesel engine, the generator, the output circuit breaker, associated electronics, and four support systems (lube oil, fuel oil, starting, and cooling). Therefore, when diesels are reported as faulted, the component that is faulted may not be the actual diesel but any of the components within these subsystems. This observation, together with the required frequent testing of the diesel, helps explain the relatively high level of activity for diesels for both BWR and PWR plants.

Among BWRs, Browns Ferry 3 is an example illustrating this point. In eight of the ten faults the diesel engine system itself did not fail but the faulting of some auxiliary system caused the diesel to be faulted. These faults included two times when the start relay time delay exceeded technical specifications because the relay had drifted out of tolerance. Twice the air start valve caused diesel generator failure, once because the valve had an accumulation of dirt and grit, and the other due to loose bolts on the valve causing loss of pilot air pressure necessary for opening the main air supply

to the air starter. Other causes included a diode failure allowing the inadvertent start of the diesel generator, a mechanical remote speed control failing to function, and the diesel generator being made inoperable in order to calibrate a relay. Brunswick 2 also had a high number of faults (14). Brunswick 2's faults were attributed to varying causes among which were two instances of low control air pressure due to a misaligned valve disk in the control air header, two diesel trips caused by the jacket water temperature exceeding the trip set point, diesel tripping due to low lube oil pressure that was actually a clogged sensing line, the diesel's failure to attain rated speed within technical specification limits, personnel error, and two unexplained times when the diesel failed to start. Hatch 2 also had a high number of faults that included an array of typical generator problems including failure to start and various diesel subsystem problems.

Among PWRs, the cell count for Farley 1 is an outlier. However, review of this plant's LERs revealed that in early 1981 Farley 1 began reporting diesel faults for both Farley 1 and Farley 2 (these components were shared by the two plants). Salem 2 was another outlier for diesel engines. Examination of Salem 2's LERs showed:

1. There were four occurrences of one diesel failing while another diesel was down for maintenance
2. There were four cases where the starting time specification was not met due to an improper turbo boost
3. Other failures were a variety of diesel subsystem problems including low oil pump pressure and service water leakage.

## Noninstrumentation and Control (Non-I&C) Filters

For both BWRs and PWRs, filters had a moderate level of activity. Almost all of the faults were clogged filters that were subsequently cleaned or replaced. No case of a filter allowing the passage of too much material was reported in the 1981 LERs reviewed.

## Fuel Elements

Both BWR and PWR plants were characterized by moderate levels of activity. For Surry 1, an outlier among PWRs for fuel elements, all reported fuel element leaks were discovered during evaluation of postreactor trip specific activity samples of the reactor coolant system that exceeded technical specification limits. Hatch 1 reported a high number of fuel assembly faults. The fuel assembly faults for Hatch 1 represented leaks, cladding degradation, and personnel errors in loading.

Arkansas Nuclear 2 is a definite outlier for fuel element/rod. Of Arkansas Nuclear 2's 34 reported fuel rod element faults, 30 were discovered simultaneously. At the time the LER for this event was submitted the cause was still under investigation by the plant.

## Generators

BWR plants reported moderate activity. For BWRs inverter faulting is most commonly observed in the low pressure coolant injection system (LPCI) and the essential ac distribution system. However, some BWR plants have no inverters in either of these system. Browns Ferry 3 reported an above average number of motor generator faults. The majority of these faults were caused by coupling damage (generator to flywheel) that was due to misalignment and loss of lubricant in the coupling.

PWR plants also displayed moderate activity. While a high number of inverter faults were reported at PWRs, no faults were reported for motor generator sets. Motor generator sets and inverters are used in varying quantities at BWRs and PWRs. More specifically, on the average, PWR plants utilize a greater number of inverters.[10] Therefore because of their basic design differences PWRs have a much higher expected number of failures for inverters. The data is consistent with this relationship. However, the absence of any reported motor generator set faults for PWRs was unexpected.

## Heat Exchangers

For BWRs, moderately high activity was observed. Brunswick 2's faulting for heat exchangers was

relatively high. However, the events were mostly due to clogged filters that led to degradation of flow, which resulted in a reduction in the heat transfer rate. Note: The BWR table excludes the component steam generator since it is not part of a BWR design.

PWRs showed a high level of activity. Outlier cells included cooling coils for Salem 1 and fan cooling units for Salem 1 and 2. Cooling coil faults are commonly discovered as a result of investigating leakage from fan cooling units. This was in fact the case for the majority of Salem 1's cooling coil faults. Some of the cooling coil faults reported by Salem 1 were the result of erosion of the coil due to silt in the service water, a process that evolves over a substantial period of time. The fact that Salem 2 has only been operating since early 1981 may explain why it had not experienced similar faulting for cooling coils. The reasons for Salem 2's faulting for fan cooling units include an overcurrent protective relay being set wrong, a pipe cap on the fan cooling unit motor cooler vent not being tightened, and the set point on a containment fan coil unit set point generator being incorrectly adjusted. In all of these cases the cause for faulting was external to the actual unit. All the fan cooling unit faults for Salem 1 and 2 were for containment fan coil unit leakage.

## I&C/Circuit Breakers

Circuit breakers in general are widely used in instrumentation, and their function is such that their faults are likely to be reported. BWRs and PWRs each exhibited a moderately high level of activity for circuit breakers. There is an overwhelmingly greater number of ac circuit breaker faults than dc circuit breaker faults, which is consistent with the relative prevalence of these two components in nuclear plants.

## I&C/Computation Modules

Both BWR and PWR plants showed a moderate level of activity. For BWRs the events reported were concentrated in the amplifier and integrator component groups with Browns Ferry 1 and FitzPatrick representing outliers. Browns Ferry 1 had five cases where interlock faults were mistakenly coded as integrators. The remaining integrator fault was due to instrument drift. FitzPatrick's integrator faults represented instruments being out of technical specification due to drift. Reasons for the amplifier faults reported by FitzPatrick included an improper gain setting, a loose connector at the preamplifier, and two cases where the entire controller for the high pressure coolant injection system was replaced. In one of the latter cases faulty transistors in the amplifier were determined to be the cause of the fault.

For PWRs, faults occurred in the greatest quantity for amplifiers and computers.

## I&C/Indicators

An extremely high level of activity was characteristic of both BWR and PWR plants. Indicators exist in great quantity throughout a nuclear plant. Both Brunswick 1 and 2 reported a high number of indicator faults.

All of the Brunswick 1 analyzer indicator activity involved two containment air monitors. All of the Brunswick 2 analyzer indicator activity was also with two containment air monitors. For both of these plants many of the faults were attributed to the instruments being out of calibration or moisture buildup in the torus analyzer sample line. The Brunswick 2 level indicator activity represented reactor water level and suppression pool level instruments.

Beaver Valley 1's cell count for analyzer indicators was also high. All but one of these faults were due to the inability of the chlorine detectors to meet the minimum electrolyte drip rate criteria.

## I&C/Relays

For BWR and PWR plants a high level of activity was observed. Like indicators, there are a large number of relays in a plant.

Approximately half the faults of relays in BWR plants were categorized as *other unknown type*. This most likely can be attributed to nonspecific writing of LERs. Time delay relays were second in reporting of events. A large percentage of the time delay relay faults were due to drift requiring recalibration, a common occurrence.

For PWRs the largest number of faults were also reported for the other unknown type group.

However, in comparison to BWR plants, PWR reporting displayed relatively higher counts in the remaining relay component groups. More specific reporting for relay faulting appears to be the case for PWR plants.

The SCSS has the capability of storing information on what are called *potential* occurrences. These are faults that are not actually observed but would be observed at some future time based on a postulated sequence of events occurring. In most cases the inclusion of potential occurrences at the component level does not affect the statistics appreciably. However, in the case of the other unknown type relay faults reported for St. Lucie 1 it does, and therefore an additional table is included in Appendix A (Table A-14c). With the inclusion of potential events 102 faults are reported for St Lucie 1 other unknown type relays. However, only 3 of these faults actually occurred. The potential faults came from St. Lucie 1's response to General Electric's (GE's) Service Advisory Bulletin S.A. 721-PSL-152.2, which reported the potential failure of GE Type HFA auxiliary relays. In one LER St Lucie 1 had reported one actual fault and 99 potential faults for these relays.

Initially, Prairie Island 1 had a relatively high count for other unknown relays. However, LER 282/81-020 from Prairie Island 1 reported two faulted relays for Unit 1, and 5 faulted relays for Unit 2. With the five other unknown types of relay faults from Unit 2 attributed to the correct plant, neither unit exists as an outlier for these relays.

Cook 1 LER 315/81-017 and Cook 2 LER 316/81-015 reported similar faults for switchgear protective relaying (11 faults at Cook 1 and 10 faults at Cook 2). All Cook 1 and 2 faults were found during one test at each plant and all of the relays are the same make and model. All relays except one were out of specification on the high side.

## I&C/Sensors

BWRs showed a moderate level of activity overall, but the data is sparse. With the exception of McGuire 1 a moderate amount of activity was also the case for PWRs. McGuire 1 showed a count of 402 faults for fire/smoke primary element. This count was due to various portions of its fire detection system being inoperable over a two week period in early 1981. Arkansas Nuclear 2 showed a count of 29 faults for temperature primary element. These events were due to resistance temperature devices not meeting the technical specification requirement of a 6 s response time due to the thermowell couplant drying out.

## I&C/Switches

For BWRs, a very high level of activity was observed. About half of all reported switch faultings described pressure switches. The fact that pressure switches, like other switches, are mechanical devices and frequently experience set point drift influences this number. The other categories of switches with a high number of faults reported could be explained by the abundance of switches in plant systems as well as by the frequency with which they require adjustment.

Two issues stand out in these tables:

1. Pressure switch faulting represented about 50% of all switch faulting reported for BWRs, while only about one sixth of all switch faults for PWRs.

2. The level of activity for PWR switch faulting is considerably lower than for BWRs. This is perhaps explained by the greater use of digital channels (rather than analog) in the reactor protection system of BWR plants.[11]

## I&C/Transmitters

BWRs exhibited moderate reporting activity. Even though the number of level transmitter faults for Brunswick 1 and 2 represent outliers for these tables, the actual number (10 for each) is not unusually high. Further, the events were routine faulting of level transmitters. In fact, it is surprising that more level transmitter faults were not reported for the remaining BWR plants.

PWR transmitter faulting was high. Nine of the ten pressure transmitter faults at Crystal River 3 were due to set point drift, a common occurrence. Ft. Calhoun reported 16 potential pressure transmitter faults and zero actual (see Table A-17c). These potential faults were a result of the utility choosing to shutdown and check all transmitters of a certain type due to notification from the vendor

that they may be defective. Salem 1 and 2 are outliers for flow transmitter events. These occurrences were associated with the containment fan cooling unit, steam generator flow, and reactor coolant flow. The containment fan cooling unit problems were also discussed in conjunction with the cooling coil faults in the "Heat Exchanger" section above. Regarding Sequoyah 1's 19 level transmitter faults, 9 represented installation errors.

## Motors

For motors, BWRs displayed a moderate amount of activity, while PWRs activity was moderately high.

An outlier was observed for the PWR plant Palisades. Of Palisades' 22 reported faults, twenty were due to splices in low and medium voltage motors requiring repair because of questionable environmental qualification, a condition that resulted from a change in the standards for splicing that existed at the time of construction. Thus, these twenty faults represented preventive maintenance rather than actual faulting of the motors.

## Penetrations

A factor to consider in examining the A-19 tables showing penetration fault counts is the fact that these counts describe faults in individual sealing surfaces or barriers. Many instances of containment isolation system penetration faulting will give rise to pairs of counts in the tables, one for the inner seal and one for the outer seal.

BWRs displayed a moderate level of activity. Most events reported corresponded to personnel access penetrations, equipment access penetrations, and process piping penetrations. Many of these events occurred during normal plant operation; secondary containment entries during operation are common in BWR plants.

PWRs, like BWRs, reported the majority of their activity in personnel access penetration but in contrast to the BWRs reported no faults for equipment access penetrations and a relatively large number of electrical penetration faults.

## Pumps

BWRs showed a high level of activity. The majority of pump events have been coded as unknown type pumps, reflecting nonspecific LER reporting practices. Otherwise, only centrifugal pumps and vane type pumps have an appreciable number of reported occurrences. With the large number of centrifugal pumps in a plant, the number of faulted centrifugal pumps may actually be even greater with many hidden in the unknown type pump group.

PWRs paralleled BWRs with a high level of activity. Surry 2 reported a large number (15) of centrifugal pump faults while it reported a relatively low number (7) of unknown type pump faults. The LERs for Surry 2's centrifugal pump faults are characteristic of standard pump problems (e.g., clogged strainer, driver failure, etc.). Surry 2's high number of centrifugal pump faults may be reflective of its more specific reporting for pump faults.

## Valves

Extremely high levels of activity were observed for both BWR and PWR plants. Over half the activity reported for BWRs represented faults for some type of isolation valve.[a] Each of the remaining valve groups' reported activity represented <10% of the total. Among BWRs Peach Bottom 3 and Cooper both had high counts for isolation valves. Faulting reported for isolation valves in BWRs commonly involved the high pressure coolant injection system. Reasons for isolation valve faults for Peach Bottom 3 included damaged seating surfaces, pressure seal failure, debris buildup on seats, and blown fuses in valve motor circuits. Practically all Cooper's isolation valve faults were discovered while performing local leak rate tests. Almost all these faults were attributed to normal valve wear.

Among PWR plants not quite half of the activity was for isolation valves. McGuire 1 represents an outlier for these valves. Most of these valves were part of the containment isolation system and no single reason was observed for their faulting. Included in the reasons were the valves' failure to close, inadvertent closure, loose fittings, and personnel error. Cook 2's isolation valve faults were also attributed to a variety of reasons, including packing and seal leakage, sand deposits on seating surfaces, loose valve activators, and parts not meeting design specifications. North Anna 1,

a. SCSS categories are combined across material type for each valve type.

another isolation valve outlier, had faults with a variety of causes similar to those above.

Among other valve types in BWRs, Monticello reported a high number of check valve faults. These events all corresponded to leakage of the valves. A variety of causes for the leaks were reported; the most common was inadequate maintenance. The PWR plants had a relatively higher percentage of check valve faults in contrast to BWRs. The reported faulting for Davis-Besse 1 check valves all represented human error with no actual faulting of the valves themselves. All Cook 1 check valve faults were in the containment isolation system.

Davis-Besse 1 and Palisades were both outliers among PWR plants for relief valves. Eleven of Davis-Besse 1's 12 faults were a result of low set point problems. These problems are currently being reviewed with the vendor. Similar to Davis-Besse 1, the majority of Palisades faults were due to low set point problems.

Ten of the fourteen bypass valve faults reported for BWRs were for Brunswick 1. Eight of these faults resulted from upscale indications of a reactor level instrument. In each case a stem packing leak went undetected and resulted in a reoccurrence of the original problem. Upon discovery of the leak the valve packing was adjusted and normal service resumed.

For Big Rock Point, an outlier for vent valve faults, all faults were instances where exhaust valves failed to close within technical specification limits. The exact cause of the timing deficiency was not determined.

## Valve Operators

High levels of activity were observed for both plant types.

For Point Beach 1, a relatively large number of electric/servo valve operator faults was reported (32). However, there were only two LERs for these 32 faults. Thirty-one of these faults occurred when a motor control center supply breaker tripped.

## Conclusions on Hardware Faults

Although PWR and BWR plants have a wide range of numbers of reported component faults, overall, the groups of components with higher reporting rates are similar for the two plant types. Plants of both plant types, for example, report a large number of valve faults.

Trend analysis at the component level was not performed in this study. Breaking the cell counts down to compare reporting by months or quarters may not be meaningful due to the sparsity of data exacerbated by the need to leave the plant in the analysis to account for plant-to-plant variation in component populations.

The exploratory analysis demonstrated in a number of instances that details supplied by the licensee in a report can vary and affect the relative distribution of the statistics. For example, the lack of specific information with regard to pump type affects these counts. Absolute numbers of counts can also be influenced, as in McGuire 1's report of 400 faulted sensors due to the outage of portions of the fire detection system. Inclusion of potential faults in tables usually does not significantly impact the reported distribution of events. It appears that detailed review of high counts in new data may be the only statistical analysis warranted by the nature and the quality of the data. These descriptive statistics can serve as discussion points with individual licensees.

# EXPLORATORY ANALYSIS OF PERSONNEL ERRORS

Personnel are focused on in this section. The following SCSS categories are used to indicate the type of personnel involved in an incident:

| | |
|---|---|
| Plant Contractor Personnel: | Consultants and/or contractors hired by the utility |
| Licensed Operator: | Licensed reactor operator or senior reactor operator |
| Nonlicensed Operator: | Nonlicensed, auxiliary, or assistant operations personnel |
| Other Utility Personnel: | Personnel known to be a utility employee |
| Other: | Personnel type known, but does not fit any of the defined codes |
| Unknown: | Personnel type neither given nor implied. |

Tables 30 and 31 show the two way distribution of personnel errors by type of personnel and plant for BWRs and PWRs, respectively. The frequency with which the LERs report that different types of persons committed errors at the different plants is reflected in these tables.

Of all the LERs for 1981, 36% contained at least one step record that represented a personnel error. *Other utility personnel* is the most common personnel type reported for both BWRs and PWRs. *Other utility personnel* were reported in 45% and 40% of the errors for BWRs and PWRs, respectively. *Unknown personnel* was the second most commonly used personnel type encoded. In fact for all categories of personnel types the percentage distribution for BWRs and PWRs were remarkably similar; see Table 32. For both plant types in about one out of every four personnel errors reported the type of personnel could not be determined from the LER. Very rarely could a person be classified into one of the well defined personnel type groupings (e.g., licensed operator). This general reporting pattern for the two types of plants typified the reporting patterns for most of the individual plants. Mostly all of the individual plants' reporting was for the other utility and unknown personnel groups. Exceptions to the general pattern represent one area for detailed follow up on reporting of personnel errors.

Hatch 1 reported at least three times more errors for plant contractor personnel than any other BWR plant. Most of the occurrences involving Hatch 1 plant contractor personnel were attributable to design faults or deviations from design that led to inadequate pipe supports that did not meet the code requirements in the event of a design basis or seismic event.

FitzPatrick is an outlier for utility licensed operators. These occurrences represented either checks required by technical specifications not being done on schedule or technical specification limits being exceeded.

For PWR plants McGuire 1 had relatively heavy reporting in all the personnel categories. McGuire 1's reporting represented 13% of the total number of personnel errors for PWRs.

Tables 30 and 31 are limited to providing descriptions of the type of personnel involved in the personnel steps. With the addition of other SCSS fields a more descriptive characterization of personnel actions can be achieved. The idea of analyzing more of the factors in the SCSS data base simultaneously is currently being pursued. Appendix B presents the details of a more complete investigation of these options and an example of how they can be used specifically with regard to personnel errors.

The modeling of personnel error has only reached its preliminary stage. However, the work done in Appendix B shows how this technique can be used to determine the significance of factors individually as well as collectively. For example, the modeling revealed that for the limited data used, the classification of data by time is independent of the activities personnel are engaged in, whereas there is some indication of a dependency between the activities and the plant type. In the future, the options of using more or a different set of variables included in the SCSS data base might be employed in the exploratory modeling efforts.

**In conclusion,** the data indicate that in a large number of cases LERs do not provide an adequate description of the personnel involved. This impacts the meaning of a particular licensee as being high or low in a particular category of personnel, such as FitzPatrick in the utility licensed operator category.

**Table 30. BWR personnel error counts by personnel type**

| FID | Plant Contractor Personnel | Licensed Operator | Non-Licensed Operator | Other Utility Personnel | Other | Unknown | Total |
|---|---|---|---|---|---|---|---|
| | Personnel Type | | | | | | |
| BEP1 | 2 | 6 | 3 | 16 | 0 | 10 | 39 |
| BEP2 | 3 | 3 | 1 | 22 | 0 | 16 | 47 |
| BRF1 | 0 | 2 | 0 | 15 | 0 | 9 | 26 |
| BRF2 | 0 | 6 | 0 | 11 | 0 | 4 | 21 |
| BRF3 | 1 | 4 | 0 | 3 | 0 | 3 | 11 |
| BRP1 | 0 | 0 | 2 | 0 | 0 | 3 | 5 |
| CPR1 | 0 | 1 | 0 | 10 | 0 | 2 | 13 |
| DAC1 | 0 | 3 | 1 | 12 | 0 | 2 | 18 |
| DRS2 | 2 | 3 | 1 | 13 | 0 | 6 | 25 |
| DRS3 | 0 | 2 | 0 | 1 | 0 | 4 | 7 |
| EIH1 | 12 | 4 | 1 | 22 | 0 | 11 | 50 |
| EIH2 | 4 | 6 | 1 | 19 | 0 | 6 | 36 |
| HMB1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| JAF1 | 2 | 12 | 1 | 11 | 0 | 3 | 29 |
| LBR1 | 0 | 1 | 1 | 3 | 0 | 1 | 6 |
| MNP1 | 1 | 1 | 1 | 5 | 0 | 2 | 10 |
| MLS1 | 0 | 1 | 0 | 3 | 0 | 0 | 4 |
| NMP1 | 0 | 4 | 2 | 2 | 0 | 1 | 9 |
| OCP1 | 4 | 3 | 2 | 12 | 0 | 14 | 35 |
| PBS2 | 2 | 2 | 3 | 0 | 0 | 15 | 22 |
| PBS3 | 0 | 2 | 1 | 1 | 0 | 2 | 6 |
| PPL1 | 3 | 4 | 1 | 14 | 0 | 5 | 27 |
| QAD1 | 0 | 0 | 0 | 5 | 0 | 1 | 6 |
| QAD2 | 1 | 1 | 0 | 1 | 0 | 2 | 5 |
| VYS1 | 0 | 0 | 2 | 1 | 0 | 1 | 4 |
| TOTAL | 37 | 73 | 23 | 212 | 1 | 123 | 469 |

Table 31. PWR personnel error counts by personnel type

| PID | Plant Contractor Personnel | Licensed Operator | Non-Licensed Operator | Other Utility Personnel | Other | Unk |
|---|---|---|---|---|---|---|
| | Personnel Type | | | | | |
| ANO1 | 2 | 0 | 0 | 3 | 0 | |
| ANO2 | 2 | 0 | 0 | 9 | 1 | |
| BVS1 | 4 | 3 | 1 | 17 | 0 | 2 |
| CCN1 | 1 | 3 | 1 | 12 | 0 | 1 |
| CCN2 | 7 | 1 | 0 | 5 | 0 | |
| CRP3 | 3 | 0 | 1 | 10 | 0 | |
| DBS1 | 7 | 7 | 0 | 23 | 0 | 1 |
| DCC1 | 4 | 5 | 2 | 9 | 0 | 1 |
| DCC2 | 3 | 3 | 1 | 7 | 0 | 1 |
| FCS1 | 0 | 0 | 0 | 2 | 1 | |
| HBR2 | 4 | 4 | 0 | 10 | 0 | |
| HNP1 | 1 | 2 | 0 | 1 | 0 | |
| IPS2 | 0 | 0 | 0 | 2 | 0 | |
| IPS3 | 0 | 1 | 0 | 1 | 0 | |
| JMF1 | 1 | [illegible] | 2 | 14 | 0 | |
| KNP1 | 0 | 3 | 0 | 0 | 0 | |
| MGS1 | 11 | 19 | 7 | 67 | 1 | 3 |
| MNS2 | 0 | 3 | 1 | 5 | 0 | |
| MYP1 | 2 | 2 | 1 | 4 | 0 | |
| NAS1 | 3 | 7 | 1 | 11 | 1 | |
| NAS2 | 2 | 14 | 1 | 14 | 1 | |
| NEE1 | 1 | 3 | 0 | 4 | 1 | |
| NEE2 | 0 | 5 | 0 | 0 | 0 | |
| NEE3 | 2 | 1 | 0 | 2 | 0 | |
| PAL1 | 0 | 5 | 0 | 4 | 0 | |
| PBN1 | 2 | 2 | 2 | 2 | 0 | |
| PBN2 | 1 | 1 | 0 | 0 | 0 | |
| PIN1 | 2 | 3 | 0 | 6 | 0 | |
| PIN2 | 2 | 0 | 0 | 2 | 0 | |
| REG1 | 2 | 2 | 0 | 3 | 0 | |
| RSS1 | 3 | 2 | 1 | 6 | 0 | 1 |
| SGS1 | 2 | 11 | 4 | 6 | 0 | 1 |
| SGS2 | 4 | 12 | 3 | 6 | 0 | |
| SLS1 | | 3 | 0 | 6 | 0 | |
| SMP1 | 1 | 3 | 3 | 33 | 1 | 2 |
| SOS1 | 0 | 0 | 1 | 13 | 0 | 1 |
| SPS1 | 4 | 3 | 0 | 10 | 0 | |
| SPS2 | 4 | 4 | 3 | 16 | 0 | |
| TMI1 | 5 | 2 | 0 | 1 | 0 | |
| TMI2 | 1 | 2 | 1 | 11 | 0 | |
| TKP1 | 3 | 1 | 3 | 7 | 0 | |
| TPS3 | 2 | 0 | 3 | 1 | 0 | |
| TPS4 | 3 | 1 | 0 | 1 | 0 | |
| YKR1 | 0 | 0 | 1 | 4 | 1 | |
| ZIS1 | 1 | 3 | 0 | 11 | 0 | |
| ZIS2 | 1 | 0 | 2 | 4 | 0 | |
| TOTAL | 12? | 156 | 52 | 464? | [illegible] | 2? |

Also Avail
Apertur



8505280415-20

| nown | Total |
|---|---|
| | 4 |
| | 20 |
| | 45 |
| | 27 |
| | 17 |
| | 22 |
| | 24 |
| | 32 |
| | 24 |
| | 4 |
| | 13 |
| | 5 |
| | 7 |
| | 3 |
| | 30 |
| | 14 |
| | 140 |
| | 23 |
| | 11 |
| | 28 |
| | 37 |
| | 13 |
| | 7 |
| | 7 |
| | 23 |
| | 10 |
| | 2 |
| | 12 |
| | 3 |
| | 0 |
| | 23 |
| | 34 |
| | 33 |
| | 19 |
| | 67 |
| | 24 |
| | 30 |
| | 30 |
| | 10 |
| | 17 |
| | 14 |
| | 10 |
| | 6 |
| | 6 |
| | 20 |
| | 12 |
| 4 | 1034 |

**Table 32. Percentage distribution of personnel error by personnel type for BWR and PWR plants**

| Plant Type | Personnel Type: Plant Contractor Personnel | Licensed Operator | Non-licensed Operator | Other Utility Personnel | Other | Unknown | Total |
|---|---|---|---|---|---|---|---|
| BWR | 7.9 | 15.6 | 4.9 | 45.2 | 0.2 | 26.2 | 100.0 |
| PWR | 11.3 | 15.7 | 5.0 | 39.7 | 0.7 | 27.6 | 100.0 |

# SUBSYSTEM LEVEL OCCURRENCES

The SCSS can identify faults that propagate to the subsystem level. There are two interpretations of what a subsystem occurrence generally entails. The first is that it involves a loss of a train, instrument channel, or part of a system that has 100% capability of performing the system function. The second interpretation focuses on the train and channel aspect without regard to whether the subsystem alone can perform the system function. Both concepts convey the idea of a loss of redundancy; the second case includes all such losses rather than just the ones involving 100% capability. It is beyond the scope of this study to identify exactly which interpretation has more commonly been used in the SCSS for each system; overall, it appears that the first interpretation has been the most widely used in encoding the LERs. This area will be the subject of a detailed followup.

Table 33 lists the groups of system codes used in the SCSS to describe hardware systems. Tables 34 and 35 provide counts for subsystem records for BWRs and PWRs, respectively, by system. The records describe instances of subsystem faulting; these counts do not indicate the number of a particular type of subsystem involved in each instance. Systems not included in the tables had no subsystem records among the 1981 data for their type of plant. There are 457 BWR subsystem fault records in the 1981 SCSS data base and 926 such records for PWRs; or a per plant average of 18 and 20, respectively.

The most noticeable feature of Tables 34 and 35 is their sparsity, illustrating that for such a large number of possible categories (both plants and systems), one year's accumulation of data is not very informative. Of course, since the LER reporting requirements are biased toward safety systems in general, with additional variations in reporting requirements among the safety systems themselves, a wide variation in counts as a function of system would be expected. Certain balance of plant systems may never accumulate significant numbers. However, as in other areas of the data, the interest primarily lies in the pattern of reporting as a function of the plant for a given system, and in any possible interaction between plant and system. Determination of such a pattern using SCSS system groupings analogous to the component groupings is a possible followup activity. By combining all primary reactor systems, all essential reactor auxiliary systems, etc., the sparsity problem will be lessened in looking at subsystem occurrences.

Electrical subsystem faults were common for both plant types, representing 26.5% of the BWR subsystem faults and 22.7% of PWR faults. The majority of these are associated with diesel generators, which are regarded as subsystems of the emergency power generator system (diesel problems were discussed in the "Hardware Faults" section). The other largest groupings of systems with subsystem faults encoded were essential reactor auxiliary systems and instrumentation and control systems. Essential reactor auxiliary system faults accounted for 14.1% of the BWR subsystem faulting and 23.3% of the PWR subsystem faulting, while instrumentation and control systems accounted for 28% of the BWR subsystem faulting and 25% of such PWR faulting. Table 36 includes ordered lists of all of the specific systems that account for ≥3% of the reported instances of subsystem faulting for BWRs and PWRs.

To provide some indication about occurrences involving multiple subsystem faults, counts of subsystem faults as a function of system and affected redundancy are provided for each plant type in Tables 37 and 38. In these tables, the column headings are of the form **AXB**, which denotes **A** channels/trains faulted out of **B** possible faulted channels/trains.[a] The most striking feature of these tables is the prominence of the **1XZ** (unknown) category, indicating that many LERs do not contain information on the installed system redundancy, although such information has always been requested. This finding confirms the need for better detail in event descriptions as emphasized in the LER rule (10 CFR 50.73). Compilation of plant design feature data to allow SCSS coders to add the needed but missing information is underway to aid in remedying this reporting deficiency.

a. In the **AXB** notation, the use of **M** for **A** or **B** means "multiple" and **Z** means "unknown."

**In conclusion,** the most common subsystem level occurrences described in the 1981 SCSS data involve three groups of systems with high safety related significance; namely, diesel generators, essential reactor auxiliary systems, and instrumentation and control systems. A detailed investigation of these incidents and the extent to which they involve a 100% loss of system function is a subject for future study.

The future study of subsystem faulting will be enhanced by having more years of data for analysis. With many plants and systems, the 1981 data is too sparse for a detailed statistical analysis of between-plant differences.

Subsystem level SCSS information is designed to permit study of losses of redundancy. However, more information from licensees on plant subsystem, train, and channel populations is needed in order to accurately count and evaluate these events in the broad context associated with trend and pattern analysis.

**Table 33. SCSS hardware system codes**

| | Codes |
|---|---|
| Primary Reactor Systems | |
| Reactor Core | AA |
| Control Rod Drive (PWR) | AB |
| Control Rod Drive (BWR) | AC |
| Reactor Vessel | AD |
| Primary Coolant (PWR) | AE |
| Pressurizer (PWR) | AF |
| Steam Generator (PWR) | AH |
| Recirculating Water (BWR) | AI |
| Essential Reactor Auxiliary Systems | |
| Auxiliary Feedwater (PWR) | BA |
| Isolation Condenser (BWR) | BB |
| Reactor Core Isolation Cooling (BWR) | BC |
| Emergency Boration (PWR) | BD |
| Standby Liquid Control (BWR) | BE |
| Residual Heat Removal (PWR) | BF |
| Residual Heat Removal (BWR) | BH |
| Low Pressure Coolant Injection (BWR) | BI |
| Chemical and Volume Control (PWR) | BK |
| Intermediate Pressure Injection (PWR) | BL |
| High Pressure Coolant Injection (BWR) | BN |
| Steam Generator Pressure Relief (PWR) | BP |
| Nuclear Boiler Overpressure Protection (BWR) | BR |
| Core Flooding Accumulator (PWR) | BS |
| Upper Head Injection (PWR) | BT |
| High Pressure Core Spray (BWR) | BW |
| Low Pressure Core Spray (BWR) | BX |
| Essential Service Systems | |
| Component Cooling Water | CA |
| Essential Raw Cooling/Service Water | CB |
| Essential Compressed Air | CC |

**Table 33. (continued)**

| | Codes |
|---|---|
| Essential Service Systems (continued) | |
| Borated/Refueling Water Storage (PWR) | CD |
| Reactor Water Storage (BWR) | CE |
| Condensate Storage | CF |
| Emergency Generator Lube Oil | CH |
| Emergency Generator Fuel | CI |
| Emergency Generator Starting | CK |
| Emergency Generator Cooling | CL |
| Essential Auxiliary Systems | |
| Spend Fuel Pool/Refueling Pool Cooling and Cleanup | DA |
| Containment Isolation | DB |
| Main Steam Isolation Valve Leakage Control | DC |
| Containment Isolation Leakage Control (BWR) | DD |
| Containment Spray | DE |
| Containment Pressure Suppression Make-Up (BWR) | DF |
| Containment Combustible Gas Control | DH |
| Containment Ice Condenser (PWR) | DI |
| Electrical Systems | |
| High Voltage AC (greater than 35KV) | EA |
| Medium Voltage AC (35KV to 600 V) | EB |
| Low Voltage AC (less than 600V) | EC |
| Vital Instrument, Control and Computer AC | ED |
| DC | EE |
| Electrical Heat Tracing | EF |
| Emergency Power Generation | EH |
| Lighting and Taxed Motive Power | EI |
| Security | EK |
| Communication | EL |
| Conduit and Cable Tray | EN |
| Grounding and Cathodic Protection | EP |
| Feedwater, Steam, and Power Conversion Systems | |
| Main Steam | FA |
| Turbogenerator | FB |
| Turbogenerator Turbine Steam Sealing | FC |
| Main Condenser | FD |
| Noncondensable Gases Extraction | FE |
| Turbine Bypass | FF |
| Steam Extraction | FH |
| Condensate and Feedwater | FI |
| Moisture Separators, Reheaters | FK |
| Various Thermal Cycle Drains and Vents | FL |
| Feedwater Chemistry Control | FN |
| Condensate Demineralizer | FP |
| Circulating Water (open cycle) | FR |
| Circulating Water (closed cycle) | FS |
| Seal Water | FT |

**Table 33. (continued)**

| | Codes |
|---|---|
| Heating, Ventilation, and Air Conditioning Systems | |
| Reactor Building HVAC (PWR) | HA |
| Reactor Building HVAC (BWR) | HB |
| Primary Containment Vacuum Relief | HC |
| Secondary Containment Recirculation and Exhaust | HD |
| Drywell/Torus HVAC and Purge (BWR) | HE |
| Reactor Auxiliary Building HVAC | HF |
| Control Building HVAC | HH |
| Emergency Generator Building HVAC | HI |
| Fuel Building HVAC | HK |
| Turbine Building HVAC (PWR) | HL |
| Turbine Building HVAC (BWR) | HN |
| Waste Management Building HVAC | HP |
| Pumping Stations HVAC | HR |
| Miscellaneous Structures HVAC | HS |
| Chilled Water | HT |
| Plant Stack | HW |
| Instrumentation and Controls Systems | |
| Alarm/Annunciator | IA |
| Computer | IB |
| Control Room Panels | IC |
| Auxiliary (backup) Control Area Panels | ID |
| Local Control Panels | IE |
| Fire Detection | IF |
| Environmental Monitoring | IG |
| Emergency Generator Instrumentation and Controls | IH |
| Turbogenerator Instrumentation and Control | II |
| Plant Monitoring | IJ |
| In-Core and Ex-Core Neutron Monitoring | IK |
| Leak Monitoring | IL |
| Radiation Monitoring | IN |
| Reactor Power Control (PWR) | IP |
| Reactor Power Control (BWR) | IR |
| Recirculation Flow Control (BWR) | IS |
| Feedwater Control | IT |
| Reactor Protection | IU |
| Engineered Safety Features Actuation | IW |
| Solid State Protection/Control | IX |
| Anticipated Transient Without Scram | IY |
| Nonnuclear Instrumentation | IZ |
| Service Auxiliary Systems | |
| Auxiliary Steam | KA |
| Sampling | KB |
| Control and Service Air | KC |
| Demineralized Water | KD |
| Material and Equipment Handling | KE |
| Fire Protection | KF |
| Compressed Gas | KH |
| Potable and Sanitary Water | KI |
| Insulating Oil | KK |
| Fuel Storage | KL |

Table 33. (continued)

| | Codes |
|---|---|
| Service Auxiliary Systems (continued) | |
| Steam Generator Startup | KN |
| Lube Oil Storage | KP |
| Boron Recovery | KR |
| Control Rod Drive Cooling Water | KS |
| Raw Cooling Water | KT |
| Raw Service Water | KW |
| Chemical Additive Injection | KX |
| Structural Systems | |
| Primary Reactor Containment (PWR) | SA |
| Secondary Reactor Containment (PWR) | SB |
| Reactor Drywell (BWR) | SC |
| Reactor Torus/Suppression Pool (BWR) | SD |
| Secondary Reactor Containment (BWR) | SE |
| Reactor Auxiliary Building | SF |
| Control Building | SH |
| Emergency Generator Building | SI |
| Fuel Building | SK |
| Turbine Building | SL |
| Waste Management Building | SN |
| Pumping Stations | SP |
| Cooling Towers | SR |
| Spray Pond | SS |
| Switchyard | ST |
| Miscellaneous Structures | SW |
| Environment (external to any structure) | SY |
| Waste Management Systems | |
| Liquid Radwaste | WA |
| Solid Radwaste | WB |
| Gaseous Radwaste (PWR) | WC |
| Gaseous Radwaste (BWR) | WD |
| Nonradioactive Waste (liquid, solid, and gaseous) | WE |
| Steam Generator Blowdown (PWR) | WF |
| Cooling Tower Blowdown | WH |
| Plant Drainage | WI |
| Equipment Drainage (including vents) | WK |
| Roof Drainage | WL |
| Suppression Pool Cleanup (BWR) | WN |
| Reactor Water Cleanup (BWR) | WP |
| Miscellaneous Systems | |
| Other | ZX |
| Multiple Known | ZY |
| Unknown | ZZ |

Table 34. BWR subsystem fault record counts by plant and system

| FID | | System | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AA | AC | AI | BB | BC | BE | BH | BI | BV | BP | BX | CA | CB |
| BEP1 | | 0 | 1 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| BEP2 | | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 4 |
| BRF1 | | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 |
| BRF2 | | 0 | 0 | 3 | 0 | 1 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRF3 | | 0 | 0 | 3 | 0 | 0 | 0 | 4 | 2 | 1 | 0 | 0 | 0 | 0 |
| BRP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| CPR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 3 | 0 | 0 |
| DRS2 | | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| DRS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 |
| EIH2 | | 0 | 1 | 1 | 0 | 0 | 2 | 7 | 0 | 0 | 0 | 0 | 0 | 2 |
| HMB1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| JAF1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| LBR1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 |
| MNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NMP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| OCP1 | | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| PPS1 | | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| QAD1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| QAD2 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TOTAL | - | 1 | 2 | 16 | 1 | 1 | 3 | 36 | 6 | 1 | 6 | [illegible] | 4 | 29 |

| FID | | System | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CH | CL | DB | DE | DH | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| BEP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 |
| BEP2 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46 | 1 | 0 |
| BRF1 | | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| BRF2 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| BRF3 | | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| BRP1 | | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| DAC1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 |
| DRS2 | | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DRS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH2 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HMB1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 |
| JAF1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LBR1 | | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| MNP1 | | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| NMP1 | | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 |
| OCP1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| PBS2 | | 0 | 0 | 0 | 0 | 0 | 7 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| PBS3 | | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| QAD2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| VYS1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| TOTAL | - | 1 | 4 | 15 | 3 | 3 | [illegible] | 7 | 0 | 1 | 5 | 100 | 2 | 2 |

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8505280415-21

Table 34. (continued)

| FID | | System | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | HB | HC | HD | HE | HF | HH | HK |
| BEP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BEP2 | | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| BRF1 | | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| BRF2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRF3 | | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| BRP1 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| DRS2 | | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| DRS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | | 0 | 1 | 3 | 0 | 0 | 0 | 0 |
| FIH2 | | 0 | 0 | 4 | 1 | 0 | 0 | 1 |
| HMB1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| LBR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNP1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| MNS1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NMP1 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| OCP1 | | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| PBS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| QAD2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | - | 2 | 2 | 18 | 4 | 1 | 4 | 1 |





8505280415-22

| [illegible] | IF | IK | IL | IN | IR |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 9 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 3 |
| 1 | 0 | 0 | 4 | 4 | 0 |
| 0 | 0 | 3 | 0 | 8 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 5 | 3 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 7 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 6 | 21 | 24 | 6 |

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Table 34. (continued)

| FID | System | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IU | IW | IY | IZ | KF | KM | KW | SF | SN | SW | WA | WU | WK |
| BEP1 | 2 | 1 | 0 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| BEP2 | 3 | 3 | 0 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRF1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| BRF2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRF3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRP1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| DRS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DRS3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | 2 | 0 | 0 | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| EIH2 | 1 | 1 | 0 | 4 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LBK1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| MNP1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NMP1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OCP1 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | 0 | 6 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 16 | 17 | 1 | 36 | 14 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |

| FID | System | | | |
|---|---|---|---|---|
| | WP | ZY | ZZ | TOTAL |
| BEP1 | 0 | 0 | 0 | 22 |
| BEP2 | 0 | 0 | 0 | 46 |
| BRF1 | 0 | 0 | 1 | 24 |
| BRF2 | 0 | 0 | 0 | 17 |
| BRF3 | 0 | 0 | 0 | 27 |
| BRP1 | 0 | 0 | 0 | 16 |
| CPR1 | 0 | 0 | 0 | 7 |
| DAC1 | 0 | 0 | 0 | 16 |
| DRS2 | 0 | 0 | 0 | 17 |
| DRS3 | 1 | 0 | 0 | 11 |
| EIH1 | 0 | 0 | 0 | 46 |
| EIH2 | 0 | 0 | 0 | 60 |
| HMB1 | 0 | 0 | 0 | 2 |
| JAF1 | 0 | 0 | 0 | 27 |
| LBK1 | 0 | 0 | 0 | 6 |
| MNP1 | 0 | 0 | 0 | 6 |
| MNS1 | 0 | 0 | 0 | 12 |
| NMP1 | 0 | 0 | 0 | 12 |
| OCP1 | 0 | 0 | 0 | 26 |
| PBS2 | 0 | 0 | 0 | 9 |
| PBS3 | 0 | 0 | 0 | 9 |
| PPS1 | 0 | 0 | 0 | 15 |
| QAD1 | 0 | 0 | 0 | 5 |
| QAD2 | 0 | 0 | 0 | 5 |
| VYS1 | 0 | 0 | 0 | 5 |
| TOTAL | 1 | 0 | 1 | 457 |

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**Table 35. PWR subsystem fault record counts by plant and system**

| FID | | System | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | AA | AD | AE | AF | AH | BA | BD | BF |
| AN01 | | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| AN02 | | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 1 |
| BVS1 | | 1 | 0 | 1 | 0 | 0 | 2 | 1 | 1 |
| CCN1 | | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| CCN2 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CRP3 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| DBS1 | | 0 | 0 | 4 | 0 | 0 | 2 | 0 | 4 |
| DCC1 | | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 |
| DCC2 | | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| FCS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | | 0 | 0 | 0 | 0 | 1 | 9 | 0 | 0 |
| HNP1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| IPS2 | | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| IPS3 | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| JMF1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| KNP1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| MGS1 | | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 8 |
| MNS2 | | 0 | 0 | 0 | 1 | 0 | 5 | 0 | 0 |
| MYP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| NAS2 | | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 |
| NEE1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| NEE2 | | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| NEE3 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| PAL1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 |
| PIN1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 |
| REG1 | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| RSS1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| SGS1 | | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 4 |
| SGS2 | | 0 | 1 | 1 | 5 | 0 | 2 | 0 | 0 |
| SLS1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| SNP1 | | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 3 |
| SOS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| SPS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| TMI1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| TPS3 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TPS4 | | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| YKR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 1 |
| TOTAL | - | 1 | 1 | 12 | 9 | 5 | 84 | 7 | 35 |

| BK | BL | BP | BS | BT |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 2 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 4 | 2 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 4 | 0 |
| 0 | 0 | 0 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 3 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 7 | 1 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 2 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 68 | 5 | 1 | 20 | 2 |

Table 35. (continued)

| FID | | System | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CA | CB | CC | CD | CI | CK | CL | DB | DE | DH | DI | EA | EB |
| ANO1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BVS1 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 1 | 0 |
| CCN1 | | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| DBS1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| DCC1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| DCC2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| FCS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| HNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| MGS1 | | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| MNS2 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| NAS2 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | 3 | 0 | 1 | 0 |
| NEE1 | | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| NEE2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| NEE3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| PBH1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| PIN2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| SGS1 | | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| SGS2 | | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SLS1 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| SNP1 | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| SOS1 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | | 0 | 4 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| TPS3 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| YKR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | - | 14 | 29 | 3 | 1 | 2 | 3 | 1 | 9 | 20 | 6 | 1 | 10 | 5 |

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**Table 35. (continued)**

| FID | System | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | EC | ED | EE | EF | EH | EK | FA | FF |
| AN01 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| AN02 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| BVS1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| CCN1 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| CCN2 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 |
| CRP3 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| DBS1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| DCC1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 |
| DCC2 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 2 | 0 | 3 | 1 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| NAS2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| NEE1 | 0 | 3 | 3 | 0 | 1 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| SGS1 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 |
| SGS2 | 0 | 0 | 1 | 2 | 20 | 0 | 0 | 0 |
| SLS1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| SNP1 | 0 | 1 | 0 | 0 | 8 | 0 | 0 | 0 |
| SOS1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| SPS2 | 0 | 0 | 0 | 1 | 3 | 0 | 1 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| TNP1 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| YKR1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| ZIS1 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 |
| ZIS2 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| TOTAL - | 1 | 10 | 9 | 11 | 156 | 1 | 3 | 1 |



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| FI | FR | HA | HD | HF |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 2 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 2 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 15 | 0 | 0 |
| 1 | 0 | 8 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 5 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 8 | 1 | 34 | 3 | 12 |

Table 35. (continued)

| FIC | HH | HK | HT | IA | IB | IC | ID | IF | IG | IH | IJ | IK | IL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | System | | | | | | | | | | | | |
| ANO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 1 | 0 | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| BVS1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 1 |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| CRP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | [illegible] | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 3 |
| NAS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| NAS2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| SNP1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 2 |
| SOS1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 23 | 3 | 8 | 3 | 1 | 0 | 2 | 8 | 3 | 1 | 0 | 19 | 19 |

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Table 35. (continued)

| FID | System | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | IN | IP | IT | IU | IW | IX | IZ | KB |
| AN01 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| AN02 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| BVS1 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 0 |
| CCN1 | 0 | 0 | 0 | 7 | 1 | 0 | 1 | 0 |
| CCN2 | 0 | 1 | 0 | 10 | 1 | 0 | 0 | 0 |
| CRP3 | 0 | 0 | 0 | 1 | 4 | 0 | 2 | 0 |
| DBS1 | 0 | 0 | 0 | 5 | 2 | 0 | 3 | 0 |
| DCC1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| DCC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 3 | 0 | 0 | 5 | 4 | 2 | 3 | 0 |
| MNS2 | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 1 | 0 | 7 | 1 | 0 | 0 | 0 |
| NAS2 | 0 | 2 | 0 | 4 | 1 | 1 | 0 | 0 |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| NEE2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 1 | 1 | 4 | 0 | 0 | 0 |
| SGS2 | 0 | 0 | 0 | 8 | 0 | 2 | 4 | 0 |
| SLS1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| SNP1 | 1 | 0 | 0 | 10 | 0 | 0 | 1 | 0 |
| SOS1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 0 |
| SPS2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 2 | 0 | 0 | 2 | 1 | 0 | 1 | 0 |
| ZIS1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 8 | 1 | 0 | 0 | 1 |
| TOTAL - | 13 | 7 | 1 | 93 | 30 | 7 | 28 | 1 |

| KC | KF | KH | KW | KX |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 2 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 2 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 10 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 4 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 7 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 2 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 1 | 34 | 4 | 2 | 2 |

**Table 35. (continued)**

| FID | SA | SB | SF |
|---|---|---|---|
| ANU1 | 1 | 0 | 0 |
| ANU2 | 0 | 0 | 0 |
| BVS1 | 0 | 0 | 0 |
| CCN1 | 0 | 0 | 0 |
| CCN2 | 0 | 0 | 0 |
| CRP3 | 0 | 0 | 0 |
| DBS1 | 0 | 1 | 1 |
| DCC1 | 0 | 0 | 2 |
| DCC2 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 0 |
| NAS2 | 0 | 0 | 0 |
| NEE1 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 |
| SGS2 | 0 | 0 | 0 |
| SLS1 | 0 | 0 | 0 |
| SNP1 | 0 | 0 | 0 |
| SOS1 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 |
| SPS2 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 1 |
| TPS4 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 |
| TOTAL | 1 | 1 | 4 |

| System | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SH | SK | WC | WE | WF | WI | WK | ZZ | TOTAL |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 29 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 37 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 19 |
| 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 14 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 17 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 82 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 11 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 59 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 64 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 49 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 11 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| 1 | 1 | 4 | 2 | 2 | 1 | 1 | 1 | 936 |

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**Table 36. Dominant subsystem faulting[a]**

| System | Type of System (System Grouping) | Total Subsystem Faulting For Plant Type (%) |
|---|---|---|
| BWR Subsystems | | |
| Emergency Power Generation (EH) | Electrical | 21.9 |
| Residual Heat Removal (BH) | Essential Reactor Auxiliary | 7.9 |
| Nonnuclear Instrumentation (IZ) | I&C[b] | 7.9 |
| Essential Raw Cooling/Service Water (CB) | Essential Service | 6.3 |
| Radiation Monitoring (IN) | I&C | 5.3 |
| Leak Monitoring (IL) | I&C | 4.6 |
| Secondary Containment Recirculation and Exhaust (HD) | HVAC[b] | 3.9 |
| Engineered Safety Feature Actuation (IW) | I&C | 3.7 |
| Reactor Protection (IU) | I&C | 3.5 |
| Recirculating Water (AI) | Primary Reactor | 3.5 |
| Containment Isolation (DB) | Essential Auxiliary | 3.3 |
| Fire Protection (KF) | Service Auxiliary | 3.1 |
| PWR Subsystems | | |
| Emergency Power Generation (EH) | Electrical | 16.8 |
| Reactor Protection (IU) | I&C | 10.0 |
| Auxiliary Feedwater (BA) | Essential Reactor Auxiliary | 9.0 |
| Chemical and Volume Control (BK) | Essential Reactor Auxiliary | 7.3 |
| Residual Heat Removal (BF) | Essential Reactor Auxiliary | 3.8 |
| Reactor Building HVAC (HA) | HVAC | 3.6 |
| Fire Protection (KF) | Service Auxiliary | 3.6 |
| Engineered Safety Feature Actuation (IW) | I&C | 3.2 |
| Essential Raw Cooling/Service Water (CB) | Essential Service | 3.1 |
| Nonnuclear Instrumentation (IZ) | I&C | 3.0 |

a. Only systems that account for at least 3% of the total subsystem faulting for each plant type are listed.

b. I&C: Instrumentation and Control.
HVAC: Heating, ventilation and air conditioning.

Table 37. BWR subsystem fault record counts by system and affected redundancy

| System | 1X2 | 1X3 | 1X4 | 1X5 | 1X6 | TOTAL |
|---|---|---|---|---|---|---|
| AA | 0 | 0 | 0 | 0 | 0 | 1 |
| AC | 0 | 0 | 0 | 0 | 0 | 2 |
| AI | 7 | 0 | 0 | 0 | 0 | 16 |
| BB | 1 | 0 | 0 | 0 | 0 | 1 |
| BC | 0 | 0 | 0 | 0 | 0 | 1 |
| BE | 2 | 0 | 0 | 0 | 0 | 3 |
| BH | [illegible] | 0 | 0 | 0 | 0 | 36 |
| BI | 1 | 0 | 0 | 0 | 0 | [illegible] |
| BN | 0 | 0 | 0 | 0 | 0 | 1 |
| BK | [illegible] | 0 | 2 | 0 | 0 | 8 |
| BA | [illegible] | 0 | 0 | 0 | 0 | [illegible] |
| CA | 1 | 0 | 0 | 0 | 0 | 4 |
| CB | [illegible] | 0 | 0 | 0 | 0 | 29 |
| CH | [illegible] | 0 | 1 | 0 | 0 | 1 |
| CL | [illegible] | 0 | 0 | 0 | 0 | 4 |
| DA | [illegible] | 0 | 0 | 0 | 0 | [illegible] |
| DE | 3 | 0 | 0 | 0 | 0 | 3 |
| DH | 3 | 0 | 0 | 0 | 0 | 3 |
| EA | 2 | 0 | 0 | 0 | 0 | 8 |
| EB | 1 | 0 | 0 | 0 | 0 | 7 |
| EC | 0 | 0 | 0 | 0 | 0 | 0 |
| EE | 0 | 1 | 0 | 0 | 0 | 1 |
| FE | 0 | 0 | 0 | 0 | 0 | 5 |
| EH | 13 | 0 | 8 | 0 | 0 | 10[illegible] |
| FA | 0 | 0 | 0 | 0 | 0 | 2 |
| FI | 1 | 0 | 0 | 0 | 0 | 2 |
| HB | 0 | 0 | 0 | 0 | 0 | 2 |
| HC | 1 | 0 | 0 | 0 | 0 | 18 |
| HD | [illegible] | 0 | 0 | 0 | 0 | 4 |
| HE | 0 | 0 | 0 | 0 | 0 | 1 |
| HF | 0 | 0 | 0 | 0 | 0 | 4 |
| HM | 0 | 0 | 0 | 0 | 0 | 1 |
| HX | 0 | 0 | 0 | 0 | 0 | 1 |
| HR | 0 | 0 | 0 | 0 | 0 | 1 |
| IF | [illegible] | 0 | 0 | 0 | 0 | 6 |
| IK | 1 | 3 | 0 | 0 | 0 | 21 |
| IL | 4 | 0 | 0 | 0 | 0 | 24 |
| IN | 4 | 0 | 2 | 0 | 0 | 6 |
| IK | 1 | 0 | 0 | 0 | 0 | 16 |
| IU | [illegible] | 0 | 0 | 0 | 0 | 17 |
| IW | 1 | 0 | 1 | 0 | 0 | 1 |
| IY | 1 | 0 | 0 | 0 | 0 | 36 |
| IZ | 11 | 0 | 0 | 0 | 0 | 14 |
| KE | [illegible] | 1 | 0 | 0 | 0 | 2 |
| KH | 0 | 0 | 0 | 0 | 0 | 1 |
| KW | 0 | 0 | 0 | 0 | 0 | 2 |
| SF | 0 | 0 | 0 | 0 | 0 | 1 |
| SN | 0 | 0 | 0 | 0 | 0 | 2 |
| SW | 0 | 0 | 0 | 0 | 0 | 2 |
| WA | 0 | 0 | 0 | 0 | 0 | 1 |
| WD | 0 | 1 | 0 | 0 | 0 | 2 |
| WK | 0 | 0 | 0 | 0 | 0 | 1 |
| WP | 0 | 0 | 0 | 0 | 0 | 0 |
| ZY | 0 | 0 | 0 | 0 | 0 | 1 |
| ZZ | 0 | 0 | 0 | 0 | 0 | [illegible] |
| TOTAL - | 100 | 19 | 14 | 2 | 1 | 457 |

| | 2X2 | 2X3 | 2X4 | 3X2 | 3X4 | 3X? | 3X? | 1X? |
|---|---|---|---|---|---|---|---|---|
| TOTAL | 256 | 3 | 3 | 37 | 3 | [illegible] | [illegible] | 12 |

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**Table 38. PWR subsystem fault record counts by system and affected redundancy**

| System | Affected Redundancy | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1X2 | 1X3 | 1X4 | 1X8 | 1XZ | 2X3 | 2X4 | 2XZ | 3X4 |
| AA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AD | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AE | 0 | 0 | 5 | 0 | 2 | 0 | 1 | 2 | 1 |
| AF | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 |
| AH | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| BA | 16 | 28 | 0 | 0 | 29 | 9 | 0 | 2 | 0 |
| BD | 3 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| BF | 16 | 0 | 0 | 0 | 19 | 0 | 0 | 0 | 0 |
| BK | 11 | 15 | 0 | 0 | 29 | 8 | 0 | 2 | 0 |
| BL | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| BP | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| BS | 0 | 5 | 2 | 0 | 11 | 0 | 0 | 2 | 0 |
| BT | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CA | 3 | 2 | 0 | 0 | 7 | 0 | 0 | 1 | 0 |
| CB | 11 | 2 | 1 | 0 | 10 | 1 | 0 | 2 | 0 |
| CC | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| CD | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CI | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CK | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| CL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| DB | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 1 | 0 |
| DE | 7 | 0 | 2 | 0 | 11 | 0 | 0 | 0 | 0 |
| DH | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| DI | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| EA | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 |
| EB | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 |
| EC | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| ED | 2 | 0 | 0 | 1 | 7 | 0 | 0 | 0 | 0 |
| EE | 3 | 1 | 0 | 0 | 3 | 0 | 0 | 2 | 0 |
| EF | 2 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 |
| EH | 26 | 14 | 0 | 0 | 104 | 1 | 0 | 11 | 0 |
| EK | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FA | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 |
| FF | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| FI | 2 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 |
| FR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| HA | 0 | 2 | 2 | 0 | 22 | 0 | 0 | 7 | 0 |
| HD | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| HF | 4 | 1 | 0 | 0 | 6 | 0 | 0 | 0 | 0 |
| HH | 8 | 2 | 0 | 0 | 10 | 1 | 0 | 2 | 0 |
| HK | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| HT | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 3 | 0 |
| IA | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| IB | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| IC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ID | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| IF | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 |
| IG | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| IH | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| IJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IK | 1 | 0 | 6 | 0 | 4 | 0 | 0 | 2 | 0 |
| IL | 0 | 0 | 1 | 0 | 12 | 0 | 0 | 2 | 0 |
| IN | 1 | 0 | 0 | 0 | 9 | 0 | 0 | 1 | 0 |
| IP | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 |
| IT | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IU | 5 | 3 | 18 | 0 | 57 | 0 | 1 | 5 | 0 |
| IW | 4 | 0 | 2 | 0 | 23 | 0 | 0 | 1 | 0 |
| IX | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 |
| IZ | 2 | 0 | 1 | 0 | 20 | 0 | 0 | 3 | 0 |
| KB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| KC | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| KF | 4 | 1 | 0 | 0 | 23 | 1 | 0 | 1 | 0 |
| KH | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| KW | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| KX | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| SA | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| SB | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| SF | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| SH | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| SK | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| WC | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| WE | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| WF | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| WI | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| WK | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| ZZ | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| TOTAL - | 155 | 78 | 41 | 1 | 531 | 22 | 2 | 60 | 1 |



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| 3XZ | 4XZ | MXZ | ZXZ | TOTAL |
|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 12 |
| 0 | 0 | 0 | 0 | 9 |
| 0 | 0 | 0 | 0 | 5 |
| 0 | 0 | 0 | 0 | 84 |
| 0 | 0 | 0 | 0 | 7 |
| 0 | 0 | 0 | 0 | 35 |
| 0 | 0 | 2 | 1 | 68 |
| 0 | 0 | 0 | 0 | 5 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 20 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 1 | 0 | 14 |
| 0 | 0 | 2 | 0 | 29 |
| 0 | 0 | 1 | 0 | 3 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 9 |
| 0 | 0 | 0 | 0 | 20 |
| 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 10 |
| 0 | 0 | 0 | 0 | 5 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 10 |
| 0 | 0 | 0 | 0 | 9 |
| 1 | 0 | 0 | 0 | 11 |
| 0 | 0 | 0 | 0 | 156 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 8 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 34 |
| 0 | 0 | 1 | 0 | 3 |
| 0 | 0 | 1 | 0 | 12 |
| 0 | 0 | 0 | 0 | 23 |
| 0 | 0 | 1 | 0 | 3 |
| 0 | 0 | 1 | 0 | 8 |
| 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 3 | 0 | 8 |
| 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 6 | 0 | 19 |
| 1 | 0 | 3 | 0 | 19 |
| 0 | 0 | 2 | 0 | 13 |
| 0 | 1 | 0 | 0 | 7 |
| 0 | 0 | 0 | 0 | 1 |
| 3 | 0 | 1 | 0 | 93 |
| 0 | 0 | 0 | 0 | 30 |
| 0 | 0 | 0 | 0 | 7 |
| 0 | 0 | 2 | 0 | 28 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 3 | 0 | 34 |
| 0 | 0 | 1 | 0 | 4 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 4 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 |
| 7 | 1 | 36 | 1 | 936 |

# SYSTEM LEVEL OCCURRENCES

System faults are also encoded in the SCSS. Tables 39 and 40 show the distribution of counts of total system faults among systems and plants for the 1981 SCSS data. As in the subsystem statistics, the data are quite sparse when all SCSS systems referenced in the 1981 data are used.

The SCSS coding flags situations in which an entire system is affected in some way. This can occur in two ways: there may be an actual system fault that prevents the system from being able to perform its function or makes it unavailable, or there may be an impact that cannot easily be assigned to some entity smaller than the system. Particularly in the latter case, these situations do not necessarily mean that an entire system failed to perform a design function. The paragraphs below contain system specific examples of the usage of the term *system fault* to describe events having only a general impact on a system.

Table 39 shows that BWR recirculation, reactor core isolation cooling (RCIC), and high pressure coolant injection (HPCI) systems had a relatively high incidence of events. An examination of SCSS information for recirculation system-level events associated with Brunswick 1 and 2 and Hatch 1 shows that 90% of these events deal with problems such as high conductivity, high chlorine concentration, or high activity in the recirculating water rather than recirculation problems. In one case both recirculation pumps tripped on high pressure caused by an operator error.

BWR RCIC events were more hardware-oriented. SCSS information for Brunswick 2 and Hatch 2 showed electrical faults to be a common cause of problems with the RCIC turbine speed control, including an overspeed trip during a test, a stop/throttle valve operator problem during RCIC operation, flow control problems in the *auto* position, and a problem in the turbine ramp generator that caused flow controller faults on two occasions. The turbine exhaust diaphragm was also a source of problems; in one case it ruptured due to a blocked line caused by a diaphragm check valve problem and on two other occasions faults in its pressure switches resulted in the RCIC system being unavailable. The other two RCIC hardware problems at Brunswick 2 and Hatch 2 were caused by switch faults; in one case RCIC was isolated on high temperature due to a fault in the RCIC steam line area ambient temperature switch and in the other case a mispositioned limit switch failed to activate the turbine ramp generator as soon as the steam inlet valve lifted off of its seat.

Over one-fifth of the HPCI events were reported by Hatch 1. Most of these faults were hardware problems, such as a stuck governor valve, an oil line break, a pressure switch failure that caused the HPCI system to be isolated, a stop valve failing to open to restart the HPCI system, a failure of the trip solenoid of the HPCI turbine, dirty contacts in the auxiliary oil pump seal-in relay, and repeated problems with oil leaks in the control valve diaphragm. The Hatch 1 faults also included events indirectly related to the HPCI system, such as operation of HPCI in conjunction with other systems that caused high temperatures in the torus and a postulated need for a design change. HPCI events at other facilities similarly reflected a variety of different problems. Several plants reported problems with gland seal condenser gaskets; but due to the variety of problems no one problem stands out as having a large number of occurrences.

Occurrences associated with the drywell and suppression pool as well as the containment isolation system each accounted for about 5% of the BWR system faults. All the drywell events involved either high oxygen concentrations or pressure differences between the drywell and the suppression pool. Suppression pool events involved high or low water levels, high water temperatures, and high oxygen concentrations. Leaks in personnel and equipment penetrations as well as valves were responsible for most of the containment isolation system events; there were also cases of an open pipe at each of Quad Cities 1 and Peach Bottom 3.

Twenty-seven BWR system faults described the environment, with ten of these at Peach Bottom 2. The majority of these system events described postulated earthquakes. Most other environmental system occurrences described either inadvertent radioactive contamination of the atmosphere or cases where an environmental condition (such as heat, high ground water, or high barometric pressure) had an impact on a plant.

For PWRs, the following systems each had 20 or more occurrences: reactor core, containment isolation, primary coolant, residual heat removal

**Table 39. BWR total system fault counts by plant and system**

| FID | AA | AC | AD | AI | BB | BC | B[illegible] |
|---|---|---|---|---|---|---|---|
| BEP1 | 0 | 0 | 0 | 3 | 0 | 4 | 0 |
| BEP2 | 2 | 0 | 1 | 6 | 0 | 7 | 0 |
| BRF1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| BRF2 | 1 | 0 | 0 | 2 | 0 | 0 | 1 |
| BRF3 | 4 | 0 | 0 | 0 | 0 | 2 | 0 |
| BRP1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| CPR1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| DAC1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| DRS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| DRS3 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| EIH1 | 0 | 0 | 0 | 4 | 0 | 3 | 0 |
| EIH2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 1 | 1 | 0 | 2 | 0 | 3 | 0 |
| LBR1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| MNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 |
| NMP1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| OCP1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS2 | 0 | 0 | 0 | 1 | 0 | 2 | 0 |
| PBS3 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| PPS1 | 0 | 0 | 0 | 2 | 0 | 1 | 0 |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| TOTAL - | 13 | 2 | 3 | 26 | 2 | 41 | 2 |

| FID | CC | DA | DB | DH | EA | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|
| BEP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BEP2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRF1 | 0 | 0 | 3 | 0 | 2 | 0 | 0 |
| BRF2 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| BRF3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| BRP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| DAC1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| DRS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DRS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| EIH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LBR1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| MNP1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| NMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OCP1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |
| PBS2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 1 | 1 | 17 | 3 | 5 | [illegible] | [illegible] |

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Table 39. (continued)

| FID | | System | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HB | H0 | HE | H1 | H4 | IK | IL | IN | IX | I0 | I* | IT | IZ |
| BEP1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | 1 | [illegible] | [illegible] | [illegible] |
| BEP2 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| BRF1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| BRF2 | | 2 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| BRF3 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| CPR1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DAC1 | | 0 | 0 | 1 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DRS2 | | 1 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DRS3 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| EIH1 | | 0 | 1 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| EIH2 | | 0 | 1 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| HMR1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JAF1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| LGR1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| MNP1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| MNS1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| NMP1 | | 1 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| OCP1 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| PBS2 | | 1 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| PBS3 | | 0 | 0 | 0 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| PPS1 | | 2 | 2 | 1 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| QAD1 | | 0 | 1 | 0 | 1 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| QAD2 | | 0 | 0 | 1 | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| VYS1 | | 0 | 1 | 0 | 0 | 1 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TOTAL | - | 7 | 6 | 3 | 1 | 1 | [illegible] | 4 | 4 | 1 | 2 | [illegible] | 1 | [illegible] |

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Table 39. (continued)

| FID | | System | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | KF | KL | KW | KX | SC | SD | S[illegible] | [illegible] |
| BEP1 | | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 |
| BEP2 | | 0 | 0 | 0 | 1 | 5 | 6 | 0 | 0 |
| BRF1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRF2 | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| BRF3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| DRS2 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| DRS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | | 2 | 0 | 0 | 0 | 3 | 4 | 0 | 0 |
| EIH2 | | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| HMB1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| LBR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| NMP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OCP1 | | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 |
| PBS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| PBS3 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| PPS1 | | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| QAD1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| QAD2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | - | 3 | 1 | 0 | 2 | 15 | 22 | 3 | [illegible] |

| FID | System | | |
|---|---|---|---|
| | ZY | ZZ | TOTAL |
| BEP1 | 0 | 0 | 16 |
| BEP2 | 0 | 0 | 44 |
| BRF1 | 0 | 1 | 11 |
| BRF2 | 0 | 0 | 16 |
| BRF3 | 0 | 0 | 12 |
| BRP1 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 5 |
| DAC1 | 0 | 0 | 10 |
| DRS2 | 0 | 0 | 9 |
| DRS3 | 0 | 0 | 8 |
| EIH1 | 0 | 0 | 46 |
| EIH2 | 0 | 0 | 20 |
| HMB1 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 13 |
| LBR1 | 0 | 0 | 6 |
| MNP1 | 0 | 0 | 2 |
| MNS1 | 0 | 0 | 7 |
| NMP1 | 0 | 0 | 7 |
| OCP1 | 0 | 0 | 13 |
| PBS2 | 1 | 0 | 23 |
| PBS3 | 0 | 0 | 9 |
| PPS1 | 0 | 0 | 19 |
| QAD1 | 0 | 0 | 8 |
| QAD2 | 0 | 0 | 5 |
| VYS1 | 0 | 0 | 9 |
| TOTAL | 1 | 1 | 318 |





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| SY | WA | WS | WR | WP |
|---|---|---|---|---|
| 0 | 1 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 7 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 |
| 27 | 2 | 1 | 1 | [illegible] |

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Table 40. PWR total system fault counts by plant and system

| FID | | System AA | AB | AD | AE | AF | AH | BA | BD | BF | BK | BL | BP | BS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AN01 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AN02 | | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BVS1 | | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| CCN1 | | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 0 |
| CCN2 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| CRP3 | | 1 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | | 1 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| DCC1 | | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | | 0 | 0 | 0 | 5 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| FCS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| JMF1 | | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| KNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 1 | 0 | 0 | 0 |
| MGS1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| MNS2 | | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| MYP1 | | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | | 7 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS2 | | 6 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| NEE1 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NEE2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| PAL1 | | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| SGS1 | | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | | 2 | 0 | 0 | 5 | 3 | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 |
| SLS1 | | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| SOS1 | | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | | 0 | 1 | 0 | 9 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 |
| SPS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| TPS3 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | - | 29 | 1 | 2 | 83 | 14 | 3 | 3 | 2 | 23 | 14 | 2 | 2 | 2 |

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Table 40. (continued)

| FID | | System | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | BT | CA | CB | CC | CD | CF | CH |
| AN01 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AN02 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| BVS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CCN2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| MGS1 | | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS2 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NAS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| SGS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SLS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| TMI1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | - | 8 | 3 | 4 | 2 | 1 | 1 | 0 |

| CI | DA | DB | DE | DH | DI |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 1 | 0 | 1 |
| 0 | 0 | 3 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 2 | 27 | 3 | 1 | 1 |

Table 40. (continued)

| FID | System | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EA | EB | EC | ED | EF | EH | FA | FB | FC | FD | FI | FK | HA |
| ANO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| BVS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 0 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| DBS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 2 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| NAS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| SLS1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOS1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| SPS2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TMI1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TFS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 10 | 0 | 0 | 1 | 1 | 2 | 15 | 3 | 1 | 4 | 11 | 1 | 11 |

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Table 40. (continued)

| FID | System | | | | | | |
|---|---|---|---|---|---|---|---|
| | HD | HF | HH | HK | HS | HT | HW |
| ANO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BVS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| DCC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| NAS1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| NAS2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NEE1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SLS1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| SNP1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| SOS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 3 | 1 | 2 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 1 | 9 | 8 | 2 | 1 | 4 | 2 |



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| A | IB | IF | IG | II | IK |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 2 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 2 | 2 | 1 | 0 | 4 |

Table 40. (continued)

| FID | | System IL | IN | IP | IT | IU | IW | IX | KA | KB | KF | KH | KX | SA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANO1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| BVS1 | | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CCN1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| DBS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| HNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| JMF1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| KNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| MNS2 | | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| MYP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NAS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 9 |
| NAS2 | | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE1 | | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| PBH1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SLS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| SNP1 | | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| SOS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| SPS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | – | 2 | 6 | 2 | 2 | 6 | 13 | 1 | 1 | 1 | 3 | 2 | 2 | 27 |

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Table 40. (continued)

| FID | System | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SF | SH | SI | SK | SL | SP | ST | S |
| ANO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BVS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOS1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 1 | 2 | 1 | 1 | 1 | 0 | 2 | 0 |

| SY | WA | WC | WE | WF |
|---|---|---|---|---|
| 2 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 3 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 4 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 2 | 5 | 0 | 4 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 42 | 11 | 2 | 4 | 2 |

**Table 40. (continue**

| FID |
|---|
| ANO1 |
| ANO2 |
| BVS1 |
| CCN1 |
| CCN2 |
| CRP3 |
| DBS1 |
| DCC1 |
| DCC2 |
| FCS1 |
| HBR2 |
| HNP1 |
| IPS2 |
| IPS3 |
| JMF1 |
| KNP1 |
| MGS1 |
| MNS2 |
| MYP1 |
| NAS1 |
| NAS2 |
| NEE1 |
| NEE2 |
| NEE3 |
| PAL1 |
| PBH1 |
| PBH2 |
| PIN1 |
| PIN2 |
| REG1 |
| RSS1 |
| SGS1 |
| SGS2 |
| SLS1 |
| SNP1 |
| SOS1 |
| SPS1 |
| SPS2 |
| TMI1 |
| TMI2 |
| TNP1 |
| TPS3 |
| TPS4 |
| YKR1 |
| ZIS1 |
| ZIS2 |
| TOTAL |

d)

| | | System | | | | |
|---|---|---|---|---|---|---|
| WH | WI | WL | ZX | ZY | ZZ | TOTAL |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| 2 | 0 | 0 | 0 | 0 | 0 | 26 |
| 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 0 | 0 | 0 | 0 | 0 | 0 | 19 |
| 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 0 | 0 | 0 | 0 | 0 | 2 | 36 |
| 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| 0 | 0 | 0 | 0 | 0 | 0 | 23 |
| 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 1 | 0 | 0 | 0 | 22 |
| 0 | 0 | 0 | 0 | 1 | 0 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 22 |
| 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| 0 | 0 | 0 | 2 | 0 | 0 | 28 |
| 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 0 | 1 | 0 | 0 | 0 | 0 | 8 |
| 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 2 | 1 | 1 | 2 | 1 | 2 | 477 |

RHR), primary reactor containment, and environment. The largest number is associated with the primary coolant system. These faults involved the reactor coolant being in some way out of specification, such as radioactive contamination from leaking fuel (I-131) (34%), thermal transients or high or low temperatures (29%), low boron or high chloride concentrations, and low or high pressures. None of these faults were failures of the system to remove heat from the primary system.

System faults related to the PWR reactor core were similar to the primary coolant faults. The majority involved flux abnormality. PWR containment isolation system faults represented penetration and valve leaks, as with BWRs; however, most of the penetration events were related to personnel penetrations rather than equipment penetrations. For RHR, system faults flagged a variety of events including relief valve problems, a relay closing a suction valve on two occasions, several cases of a residual heat removal train being secured while another one was inoperable, and other personnel errors.

Like BWR drywell events, the PWR primary reactor containment events involved high temperature and/or high pressure. Environment events for both facility types were also similar. For most of the other systems, events were spread evenly across the PWR plants. Neither plant type has a high incidence of instrumentation system faults.

For both BWRs and PWRs, the number of system faults is roughly proportional to the number of LERs. Plants whose percentage of the total system faults for the plant type differs by ≥2 from the percentage of LERs for the plant type are listed below. No system faults were associated with Humboldt Bay.

| BWR Plants | BWR LERs (%) | BWR System Faults (%) |
|---|---|---|
| Brunswick 2 | 10.2 | 13.8 |
| Browns Ferry 1 | 5.8 | 3.5 |
| Dresden 2 | 5.2 | 2.8 |
| Hatch 1 | 9.8 | 14.5 |
| Hatch 2 | 9.3 | 6.3 |
| Peach Bottom 2 | 3.0 | 7.2 |
| Pilgrim 1 | 4.0 | 6.0 |

| PWR Plants | PWR LERs (%) | PWR System Faults (%) |
|---|---|---|
| North Anna 1 | 3.6 | 7.1 |
| Ranch Seco 1 | 2.4 | 4.6 |
| Salem 1 | 5.1 | 2.1 |

**In conclusion**, the exploratory trend and pattern analysis of system occurrences in the 1981 LER data shows many areas for further study. In most cases, system level problems with primary reactor systems and with structural systems show events with system-level impacts rather than losses of function, while events flagged for such systems as HPCI and RHR indicate hardware problems. However, this is not true in all cases and more detailed followup efforts to separate system events involving a loss of function from those showing system level impacts is needed. Also, cases of certain plants having unusually high or low numbers of system faults are candidates for further investigation.

# CONCLUSIONS

An ability to perform trend and pattern analysis based on contingency tables has been developed. Through the contingency tables produced by the CONTING/CONTIN2/BMDP methodology, the LER information in the SCSS data base can easily be manipulated and profiled. These table displays provide the capability to study both narrow and broad segments of the operational data.

In this study, these tables have been used to obtain an overview of the activities and problems reported in 1981 by the licensees. That is, the main product of this initial, exploratory trend and pattern analysis of 1981 LER data is an overview of that data showing what events have taken place and their frequency. Each of the preceding *In conclusion* paragraphs has presented this type of information. A summary of these findings follows, in the next few paragraphs.

BWRs filed an average of 57 LER reports per plant, while PWRs filed 51 on the average. However, individual plant reporting varied widely, with BWR plant report counts ranging from 5 to 145 for 1981 and PWR plant LER counts ranging from 8 to 189. The LER reporting distributions are skewed, with more plants filing fewer LERs during 1981 and fewer plants filing large numbers of LERs. Although this behavior exists for both plant types, it is more pronounced for PWRs. There are relatively few BWR plants with fewer than 20 LERs from 1981. The variations in the total number of LERs filed by each plant in 1981 emphasize the need to distinguish between plants in reporting LER data.

There is similar variation in the distribution of LER reporting over time in 1981. Although both plant types (on average) were below their annual average number of reports per month in February and March, and above it in April, this trend does not hold for individual plants nor for the rest of the year. Thus, no seasonal patterns in reporting were observed in the 1981 data. More years of data are needed in order to examine this issue and determine causes for seasonal patterns if they exist.

A variety of events are described in the LERs. Most LERs describe single related sets of occurrences. LER counts would increase by ~8% overall if each separate event (sequence) were reported in a separate LER. Most of the events occur during normal operation; refueling is the second most prevalent initial condition for the events for BWRs and cold shutdown for PWRs. As with LER reporting, there is much plant-to-plant variation in the reported initial conditions. For nearly 95% of the events, no significant effect on the status of the plant was observed; radiological release and personnel exposure were not present in 98% of the events.

Events that did impact the status of the plant involved mostly automatic scrams and manual shutdowns. There were few instances of engineered safety feature actuation, especially at BWRs. There were no instances of forced power reductions in the reported LER events, and <1% involved extensions of preexisting outages. Reductions in plant availability associated with compliance with limiting conditions for operation are reportable to the LER system. Since the combined effect of manual shutdowns, manual scrams, and extensions of preexisting outages averages <1 1/2 events per plant in 1981, such reductions in availability in 1981 were not extensive.

The LERs reporting radiological release in most cases indicated an amount less than technical specification limits. In three cases, the release exceeded those limits. All cases of personnel exposure exceeding five rems are reportable, including repair and cleanup activities associated with events; two BWR and eight PWR events indicate such exposure.

The events reported in the 1981 LERs involved a variety of hardware. For both plant types, the most common faults were associated with valves. Leakage of containment isolation valves occurred frequently for both plant types. Check valve faulting was also prevalent for both plant types. Some BWRs experienced bypass valve problems, while relief valves were the next most common valve problem area for PWRs.

Instrumentation and control (I&C) components are the second major area of faulting in the hardware. The combined effect of the I&C component faults exceeds that of valves. Set point drift/out of calibration problems were common. Moisture and loose connections were each factors in several of the events. BWR I&C faults were dominated by problems with switches, while PWR problems were dominated by indicator faulting.

Faulting in many other component types was also reported in the 1981 LERs. Tanks had low level problems, primarily caused by valve leakage or personnel errors. Diesels had many mechanical problems in their support systems. Slightly over 100 fuel element leaks were reported. BWRs had problems with personnel, equipment and piping penetrations, while personnel and electrical penetrations dominated the penetration problems in PWRs. Valve operator problems were dominated by electro-servo operators for both plant types; followed by solenoid operators in BWRs and by pneumatic operators in PWRs. Pump faulting was associated with many of the events.

Faulting at the subsystem or train level affected the diesels and the residual heat removal system for both plant types. PWRs also had auxiliary feedwater and chemical and volume control system train level occurrences. Instrumentation faults affecting channels occurred at both plant types. Hardware problems affecting the overall operation of the reactor core isolation cooling and high pressure coolant injection BWR systems and the residual heat removal and containment isolation PWR systems were also reported.

Of all the events, 36% involved personnel errors. The largest grouping of these was associated with nonoperator utility personnel.

In addition to providing an overview of LER activity, another capability of the trend and pattern analysis is to identify outliers and anomalous behavior within the data that would be good candidates for detailed engineering followup. By examining tables of event counts based on large segments of the LER data base, the technique is intended to identify whether there are situations that may have safety significance due to their high or wide-spread incidence. The recognition of incident recurrence, increasing rate of occurrence, or a pattern of occurrence is enhanced by the capability to define conditions of interest, then examine the pattern of LER reporting of these events among plants, over time, and/or over other factors.

In this study, outliers were investigated and issues that might deserve further discussion and resolution with the licensees were raised. Some examples of apparent outlier situations are the following:

- Unintentional engineered safety feature actuation at a few PWR plants (McGuire 1, North Anna 2, Salem 1, and Salem 2)
- Repairs of steam generator tubes involving personnel exposure at 5 PWRs (Indian Point 2, Millstone 2, Oconee 2, St. Lucie 1, and Yankee Rowe 1)
- Control rods mispositioned at 1 PWR (North Anna 1) and 1 BWR (Brunswick 2)
- Diesel subsystem problems at 3 BWRs (Browns Ferry 3, Brunswick 2, and Hatch 2) and 2 PWRs (Farley 1 and Salem 2)
- Fuel assembly leaks at 1 BWR (Hatch 1) and 2 PWRs (Surry 1, Arkansas Nuclear 2)
- Clogged filters in a heat exchanger at a BWR (Brunswick 2)
- Fan cooling unit tube leaks and command faults at 2 PWRs (Salem 1 and 2)
- Resistance temperature device faults at a PWR (Arkansas Nuclear 2)
- Fire detection instrumentation problems over a two-week period at a PWR (McGuire 1)
- Level transmitter faults at a PWR (Sequoyah 1) involving installation errors
- Over 35 isolation valve occurrences at each of two BWRs (Peach Bottom 3 and Cooper); over 60 each at two PWRs (McGuire 1 and Cook 2)
- A breaker trip involving 31 valve operators at a PWR (Point Beach 1)
- Residual heat removal train-level faults at 3 BWR plants (Browns Ferry 2, Hatch 1, and Oyster Creek)
- Auxiliary feedwater train-level faults at 4 PWR plants (Zion 2, Robinson 2, Sequoyah 1, and Arkansas Nuclear 2)
- Reactor core isolation cooling events at 2 BWRs (Brunswick 2 and Hatch 2)
- Plant contractor personnel faulting at a BWR (Hatch 1).

The scope of this study did not permit a detailed examination of all of these and similar outliers. Where possible, SCSS LER records were examined and particularly for hardware faulting the LER abstracts were studied. However, for the most part no firm conclusions were produced from these investigations. The major reasons for this include the following:

- A limited amount of data
- Variations in LER reporting practices, including variations in the frequency of reporting, the selection of what is reportable, and the detail provided in reporting similar occurrences
- Variations in representing the events in the SCSS data base.

Despite these factors, this study does serve as a preface for more detailed engineering studies of the outlying cells. The identification and examination of such outliers in this study leads to two recommendations. One is that the higher counts observed in the data for certain plants in comparison to other plants in many cases provide discussion points for the NRC and individual licensees. Secondly, many incidences of high counts, including those not explained in this study, should be subjects for future investigation. Having these counts in a form where they can be identified provides direction for such future studies.

An observation about most of the overview tables is that the data are sparse. That is, there are many zeros in the tables. The tables, being counts, are aggregates that weigh all items in a single cell equally. Unfortunately, as more SCSS variables are added to produce tables with comparable and homogeneous entries, the tables increase in dimension, automatically becoming larger and more sparse. For the SCSS data, the necessity of including plants in the tables to maintain a minimal level of resolution is a major contributor to this sparsity. One year of data is not adequate to overcome this problem. This is the reason for the limited amount of trend analysis (using tables with counts broken down by event date) in this report. As more LER data becomes available for trend analysis, this problem will be overcome.

Another problem that will be overcome as more complete data becomes available is the lack of specific reporting for some types of events. Types of pumps and relays, for example, are often not specified. Piping materials are generally unknown. Often the type of person involved in human errors is not clear. Train and channel population counts permitting assessment of losses of redundancy are often not available. As this information becomes a part of the SCSS data base, trend and pattern analysis will be improved.

A further feature of the trend and pattern analysis is the ability to formally study the quantitative relationships among factors in contingency tables through log-linear modeling. The potential for this capability has been demonstrated through an application to personnel errors. Through modeling, one can study the structure of the data and perhaps obtain simplified representations of it. The effect estimates associated with models that fit the data describe the relative contributions that levels of the various factors make to the observed cell counts. Furthermore, the approach provides a useful tool for systematically identifying cells as well as levels of factors that are outliers. Log-linear modeling applications for SCSS LER data can be further enhanced when: the concern about the sparsity of the data is remedied; greater insight into meaningful data comparisons and configurations in spite of reporting and other variations is gained; the licensees report subsystem, train, and channel populations; and the software is further refined to facilitate normalizing the counts by such factors as the size of populations at different facilities.

In summary, this exploratory trend and pattern analysis has provided insights into the information reported in the 1981 LERs, pointed out areas for future investigations, and also demonstrated areas having few events where no special concern or followup is warranted at this time.

# MAJOR SUBJECTS FOR FUTURE ANALYSIS

Currently, future exploration and analysis of the SCSS data are envisioned to encompass four general areas.

The first area is a continuation of the current 1981 trend and pattern analysis activity. This preliminary look at the 1981 LER data could not cover everything. The possibility exists for studying additional component groupings and other areas of the data base. In addition, further depth in this analysis could be pursued. For example, more of the SCSS LER information could be read to identify which subsystem incidents involve loss of system capability and which incidents involve loss of redundancy at a lower level. Similarly, system faults events could be studied on an individual LER basis to distinguish which ones indicate an impact on a system rather than a system loss of function.

Another topic is the defining of factors that impact and/or facilitate the characterization of the data and its underlying distribution. A host of factors exist whose significance in understanding the observed counts simply is not known at this time. Included among these are:

1. The efficacy of maintenance and testing
2. The possibility of correlating incidents and plant status
3. The relationship between the occurrence of events and the number of critical hours for plants
4. The time when events are discovered and how this relates to the plants initial hours and the amount of activity for the plant
5. The age of the plant and its correlation with the frequency and types of events reported.

The third area for future efforts is best referred to as *Special Topics*. Here, specific phenomena deemed interesting will be treated. The exploratory nature of these efforts leaves them loosely defined. The general topics being postulated for further analysis include:

1. Leak events, which would entail a study of the systems that are leaking, the systems receiving the leaks, BWR and PWR comparisons, and size distribution.
2. Containment isolation system leaks, which would be evaluated as in Item 1, but specific to the containment isolation system. Further, this analysis would be contrasted to the general findings.
3. Valve faulting by system.
4. Plant grouping, which would involve the idea of generating a set of factors that can be used to group plants into homogeneous groups based on reporting activity or other criteria.

The last area is statistical modeling. Modeling is not distinct from the topics above. In contrast it represents a very practical tool which would likely be used in the preceding areas. However, the modeling of specific events, e.g., personnel errors, exists as a stand alone category for future efforts. Appendix B presents an example of a typical modeling possibility.

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# APPENDIX A
# HARDWARE FAULT TABLES

# APPENDIX A
# HARDWARE FAULT TABLES

This appendix contains contingency tables with fault counts by plant and component for each of the 22 component groupings. The tables are for the most part in pairs, with each BWR table followed by a PWR table. The two exceptions are PWR tables included under I&C/relays and I&C/transmitters that contain potential faults in addition to actual faults. Counts that are specifically addressed in the "Hardware Faults" section of the text are shown boxed in these appendix tables.

**Table A-1a. Fault counts for accumulators/reservoirs—BWRs**

| FID | Component | | | |
|---|---|---|---|---|
| | Accumulator | Reservoir | Tank | Total |
| BFP1 | 3 | 0 | 1 | 4 |
| BFP2 | 0 | 0 | 2 | 2 |
| BRF1 | 0 | 2 | 1 | 3 |
| BRF2 | 0 | 0 | 0 | 0 |
| BRF3 | 0 | 1 | 0 | 1 |
| BRP1 | 0 | 0 | 2 | 2 |
| CPR1 | 0 | 1 | 0 | 1 |
| CAC1 | 0 | 0 | 0 | 0 |
| DRS2 | 0 | 5 | 3 | 8 |
| DRS3 | 0 | 2 | 0 | 2 |
| EIH1 | 0 | 5 | 8 | 13 |
| EIH2 | 5 | 2 | 1 | 8 |
| HAB1 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 5 | 5 |
| LBR1 | 0 | 0 | 4 | 4 |
| MNP1 | 0 | 0 | 0 | 0 |
| MNS1 | 0 | 0 | 0 | 0 |
| NMP1 | 0 | 0 | 0 | 0 |
| OCP1 | 0 | 6 | 4 | 10 |
| PBS2 | 0 | 4 | 2 | 6 |
| PBS3 | 0 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 | 0 |
| QAD1 | 0 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 | 0 |
| VYS1 | 0 | 1 | 0 | 1 |
| TOTAL | 8 | 29 | 33 | 70 |

**Table A-1b. Fault counts for accumulators/reservoirs—PWRs**

| FID | Component | | | |
|---|---|---|---|---|
| | Accumulator | Reservoir | Tank | Total |
| ANO1 | 0 | 0 | 1 | 1 |
| ANO2 | 0 | 0 | 0 | 0 |
| BVS1 | 2 | 1 | 3 | 6 |
| CCN1 | 1 | 1 | 1 | 3 |
| CCN2 | 0 | 0 | 1 | 1 |
| CRP3 | 0 | 0 | 1 | 1 |
| DBS1 | 0 | 0 | 1 | 1 |
| DCC1 | 0 | 0 | 4 | 4 |
| DCC2 | 0 | 1 | 3 | 4 |
| FCS1 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 1 | 0 | 1 |
| JMF1 | 1 | 1 | 9 | 11 |
| KNP1 | 0 | 0 | 4 | 4 |
| MGS1 | 10 | 1 | 17 | 28 |
| MNS2 | 0 | 1 | 3 | 4 |
| MYP1 | 0 | 0 | 0 | 0 |
| NAS1 | 9 | 2 | 5 | 16 |
| NAS2 | 6 | 2 | 17 | 25 |
| NEC1 | 0 | 0 | 0 | 0 |
| NEC2 | 0 | 1 | 0 | 1 |
| NEC3 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 6 | [illegible] |
| PBH1 | 0 | 0 | 1 | 1 |
| PBH2 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 |
| RSS1 | 2 | 7 | 0 | 9 |
| SGS1 | 0 | 1 | 14 | 15 |
| SGS2 | 0 | 1 | 10 | 11 |
| SLS1 | 0 | 8 | 1 | 9 |
| SNP1 | 1 | 3 | 6 | 10 |
| SUS1 | 0 | 6 | 5 | 11 |
| SPS1 | 1 | 0 | 8 | 9 |
| SPS2 | 2 | 9 | 10 | 21 |
| TMI1 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 1 | 1 |
| TPS3 | 0 | 0 | 3 | 3 |
| TPS4 | 0 | 0 | 3 | 3 |
| YKR1 | 0 | 0 | 1 | 1 |
| ZIS1 | 0 | 0 | 2 | 2 |
| ZIS2 | 0 | 0 | 0 | 0 |
| TOTAL | 35 | 47 | 141 | 223 |

**Table A-2a. Fault counts for batteries/chargers—BWRs**

| FID | Component: Battery | Component: Battery Charger | Total |
|---|---|---|---|
| BFP1 | 0 | 0 | 0 |
| BFP2 | 0 | 0 | 0 |
| BRF1 | 1 | 0 | 1 |
| BRF2 | 0 | 0 | 0 |
| BRF3 | 0 | 0 | 0 |
| BRP1 | 4 | 0 | 4 |
| CPR1 | 6 | 0 | 6 |
| DAC1 | 0 | 1 | 1 |
| DRS2 | 1 | 0 | 1 |
| DRS3 | 0 | 0 | 0 |
| EIH1 | 0 | 0 | 0 |
| EIH2 | 5 | 1 | 6 |
| HMB1 | 0 | 0 | 0 |
| JAF1 | 2 | 1 | 3 |
| LBR1 | 0 | 0 | 0 |
| MNP1 | 1 | 1 | 2 |
| MNS1 | 0 | 0 | 0 |
| NMP1 | 0 | 0 | 0 |
| OCP1 | 0 | 0 | 0 |
| PBS2 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 |
| QAD1 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 |
| VYS1 | 0 | 1 | 1 |
| TOTAL | 20 | 5 | 25 |

**Table A-2b. Fault counts for batteries/chargers—PWRs**

| FID | Component: Battery | Battery Charger | Total |
|---|---|---|---|
| ANO1 | 2 | 0 | 2 |
| ANO2 | 0 | 0 | 0 |
| BVS1 | 2 | 3 | 5 |
| CCN1 | 1 | 0 | 1 |
| CCN2 | 0 | 0 | 0 |
| CRP3 | 1 | 1 | 2 |
| DBS1 | 0 | 0 | 0 |
| DCC1 | 0 | 0 | 0 |
| DCC2 | 1 | 0 | 1 |
| FCS1 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 |
| IPS3 | 0 | 3 | 3 |
| JMF1 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 |
| MGS1 | 7 | 0 | 7 |
| MNS2 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 |
| NAS1 | 3 | 0 | 3 |
| NAS2 | 2 | 0 | 2 |
| NEE1 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 |
| PAL1 | 2 | 0 | 2 |
| PBH1 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 |
| SGS2 | 9 | 3 | 12 |
| SLS1 | 0 | 2 | 2 |
| SNP1 | 0 | 0 | 0 |
| SOS1 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 |
| SPS2 | 3 | 2 | 5 |
| TMI1 | 1 | 0 | 1 |
| TMI2 | 3 | 0 | 3 |
| TNP1 | 0 | 0 | 0 |
| TPS3 | 1 | 0 | 1 |
| TPS4 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 |
| ZIS1 | 2 | 1 | 3 |
| ZIS2 | 0 | 0 | 0 |
| TOTAL | 40 | 15 | 55 |

Table A-3a. Fault counts for control rods—BWRs

| FID | Component | | |
|---|---|---|---|
| | Control Rod Assembly | Control Rod | Total |
| BEP1 | 0 | 4 | 4 |
| BEP2 | 0 | 7 | 7 |
| BRF1 | 0 | 0 | 0 |
| BRF2 | 0 | 1 | 1 |
| BRF3 | 0 | 1 | 1 |
| BRP1 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 0 |
| DAC1 | 0 | 1 | 1 |
| DRS2 | 1 | 1 | 2 |
| DRS3 | 0 | 1 | 1 |
| EIH1 | 0 | 0 | 0 |
| EIH2 | 2 | 2 | 4 |
| HMB1 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 0 |
| LBR1 | 0 | 0 | 0 |
| MNP1 | 0 | 0 | 0 |
| MNS1 | 0 | 0 | 0 |
| NMP1 | 0 | 2 | 2 |
| OCP1 | 0 | 1 | 1 |
| PBS2 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 |
| QAD1 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 |
| VYS1 | 0 | 0 | 0 |
| TOTAL | 3 | 21 | 24 |

**Table A-3b. Fault counts for control rods—PWRs**

| FID | Component: Control Rod Assembly | Component: Control Rod | Total |
|---|---|---|---|
| ANO1 | 0 | 0 | 0 |
| ANO2 | 3 | 0 | 3 |
| BVS1 | 0 | 2 | 2 |
| CCN1 | 3 | 0 | 3 |
| CCN2 | 1 | 0 | 1 |
| CRP3 | 2 | 0 | 2 |
| DBS1 | 0 | 1 | 1 |
| DCC1 | 0 | 0 | 0 |
| DCC2 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 |
| HBR2 | 4 | 1 | 5 |
| HNP1 | 1 | 0 | 1 |
| IPS2 | 1 | 1 | 2 |
| IPS3 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 |
| MGS1 | 0 | 1 | 1 |
| MNS2 | 1 | 0 | 1 |
| MYP1 | 0 | 0 | 0 |
| NAS1 | 0 | 7 | 7 |
| NAS2 | 2 | 0 | 2 |
| NEC1 | 0 | 0 | 0 |
| NEC2 | 0 | 0 | 0 |
| NEC3 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 |
| REG1 | 0 | 2 | 2 |
| RSS1 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 |
| SGS2 | 0 | 1 | 1 |
| SLS1 | 3 | 1 | 4 |
| SNP1 | 0 | 0 | 0 |
| SOS1 | 2 | 0 | 2 |
| SPS1 | 0 | 3 | 3 |
| SPS2 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 |
| YKR1 | 0 | 1 | 1 |
| ZIS1 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 |
| TOTAL | 23 | 21 | 44 |

**Table A-4a. Fault counts for control rod drives—BWRs**

| FID | Component: Control Rod Drive | Total |
|---|---|---|
| BFP1 | 0 | 0 |
| BFP2 | 1 | 1 |
| BRF1 | 0 | 0 |
| BRF2 | 0 | 0 |
| BRF3 | 0 | 0 |
| BRP1 | 0 | 0 |
| CPR1 | 0 | 0 |
| DAC1 | 0 | 0 |
| DRS2 | 3 | 3 |
| DRS3 | 0 | 0 |
| EIH1 | 0 | 0 |
| EIH2 | 3 | 3 |
| HMB1 | 0 | 0 |
| JAF1 | 2 | 2 |
| LBR1 | 0 | 0 |
| MNP1 | 0 | 0 |
| MNS1 | 0 | 0 |
| NMP1 | 0 | 0 |
| OCP1 | 0 | 0 |
| PBS2 | 0 | 0 |
| PBS3 | 0 | 0 |
| PPS1 | 1 | 1 |
| QAD1 | 0 | 0 |
| QAD2 | 0 | 0 |
| VYS1 | 0 | 0 |
| TOTAL | 10 | 10 |

**Table A-4b. Fault counts for control rod drives—PWRs**

| FID | Component: Control Rod Drive | Total |
|---|---|---|
| ANO1 | 0 | 0 |
| ANO2 | 3 | 3 |
| BVS1 | 0 | 0 |
| CCN1 | 1 | 1 |
| CCN2 | 0 | 0 |
| CRP3 | 0 | 0 |
| DBS1 | 1 | 1 |
| DCC1 | 0 | 0 |
| DCC2 | 0 | 0 |
| FCS1 | 0 | 0 |
| HBR2 | 6 | 6 |
| HNP1 | 0 | 0 |
| IPS2 | 0 | 0 |
| IPS3 | 0 | 0 |
| JMF1 | 1 | 1 |
| KNP1 | 0 | 0 |
| MGS1 | 0 | 0 |
| MNS2 | 0 | 0 |
| MYP1 | 0 | 0 |
| NAS1 | 0 | 0 |
| NAS2 | 0 | 0 |
| NEE1 | 0 | 0 |
| NEE2 | 0 | 0 |
| NEE3 | 0 | 0 |
| PAL1 | 1 | 1 |
| PBH1 | 0 | 0 |
| PBH2 | 0 | 0 |
| PIN1 | 0 | 0 |
| PIN2 | 0 | 0 |
| REG1 | 0 | 0 |
| RSS1 | 0 | 0 |
| SGS1 | 0 | 0 |
| SGS2 | 1 | 1 |
| SLS1 | 1 | 1 |
| SNP1 | 0 | 0 |
| SUS1 | 0 | 0 |
| SPS1 | 2 | 2 |
| SPS2 | 0 | 0 |
| TMI1 | 0 | 0 |
| TMI2 | 0 | 0 |
| TNP1 | 0 | 0 |
| TPS3 | 0 | 0 |
| TPS4 | 0 | 0 |
| YKR1 | 0 | 0 |
| ZIS1 | 0 | 0 |
| ZIS2 | 0 | 0 |
| TOTAL | 17 | 17 |

**Table A-5a. Fault counts for internal combustion engines—BWRs**

| FID | Component: Diesel Engine | Total |
|---|---|---|
| BEP1 | 3 | 3 |
| BEP2 | 14 | 14 |
| BRF1 | 6 | 6 |
| BRF2 | 1 | 1 |
| BRF3 | 10 | 10 |
| BRP1 | 3 | 3 |
| CPR1 | 5 | 5 |
| DAC1 | 0 | 0 |
| DRS2 | 2 | 2 |
| DRS3 | 4 | 4 |
| EIH1 | 6 | 6 |
| EIH2 | 17 | 17 |
| HMB1 | 0 | 0 |
| JAF1 | 2 | 2 |
| LBR1 | 0 | 0 |
| MNP1 | 0 | 0 |
| MNS1 | 2 | 2 |
| NMP1 | 2 | 2 |
| OCP1 | 1 | 1 |
| PBS2 | 8 | 8 |
| PBS3 | 0 | 0 |
| PPS1 | 0 | 0 |
| QAD1 | 1 | 1 |
| QAD2 | 2 | 2 |
| VYS1 | 1 | 1 |
| TOTAL | 90 | 90 |

**Table A-5b. Fault counts for internal combustion engines—PWRs**

| FID | Component: Diesel Engine | Total |
|---|---|---|
| ANO1 | 2 | 2 |
| ANO2 | 2 | 2 |
| BVS1 | 1 | 1 |
| CCN1 | 7 | 7 |
| CCN2 | 6 | 6 |
| CRP3 | 4 | 4 |
| DBS1 | 2 | 2 |
| DCC1 | 3 | 3 |
| DCC2 | 3 | 3 |
| FCS1 | 0 | 0 |
| HBR2 | 2 | 2 |
| HNP1 | 3 | 3 |
| IPS2 | 3 | 3 |
| IPS3 | 0 | 0 |
| JMF1 | 24 | 24 |
| KNP1 | 2 | 2 |
| MGS1 | 4 | 4 |
| MNS2 | 4 | 4 |
| MYP1 | 0 | 0 |
| NAS1 | 4 | 4 |
| NAS2 | 3 | 3 |
| NEE1 | 0 | 0 |
| NEE2 | 0 | 0 |
| NEE3 | 0 | 0 |
| PAL1 | 5 | 5 |
| PBH1 | 0 | 0 |
| PBH2 | 0 | 0 |
| PIN1 | 1 | 1 |
| PIN2 | 0 | 0 |
| REG1 | 0 | 0 |
| RSS1 | 1 | 1 |
| SGS1 | 4 | 4 |
| SGS2 | 17 | 17 |
| SLS1 | 2 | 2 |
| SNP1 | 7 | 7 |
| SOS1 | 3 | 3 |
| SPS1 | 0 | 0 |
| SPS2 | 3 | 3 |
| TMI1 | 0 | 0 |
| TMI2 | 5 | 5 |
| TNP1 | 2 | 2 |
| TPS3 | 1 | 1 |
| TPS4 | 1 | 1 |
| YKR1 | 2 | 2 |
| ZIS1 | 1 | 1 |
| ZIS2 | 2 | 2 |
| TOTAL | 136 | 136 |

**Table A-6a. Fault counts for noninstrumentation and control filters—BWRs**

| FID | Component | | | | |
|---|---|---|---|---|---|
| | Process Filter | Screen | Separator | Strainer | Total |
| BEP1 | 0 | 1 | 0 | 0 | 1 |
| BEP2 | 3 | 0 | 0 | 0 | 3 |
| BRF1 | 0 | 0 | 0 | 0 | 0 |
| BRF2 | 0 | 0 | 0 | 0 | 0 |
| BRF3 | 0 | 0 | 0 | 0 | 0 |
| BRP1 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | 3 | 0 | 0 | 1 | 4 |
| DRS2 | 1 | 0 | 0 | 0 | 1 |
| DRS3 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | 3 | 0 | 0 | 4 | 7 |
| EIH2 | 2 | 3 | 0 | 1 | 6 |
| HTB1 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 2 | 0 | 0 | 0 | 2 |
| LAX1 | 0 | 0 | 0 | 0 | 0 |
| MXP1 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 2 | 0 | 0 | 0 | 2 |
| NMP1 | 0 | 0 | 0 | 0 | 0 |
| OCP1 | 0 | 2 | 0 | 1 | 3 |
| PBS2 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 | 0 | 0 |
| QAD1 | 0 | 0 | 0 | 1 | 1 |
| QAD2 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | 3 | 0 | 0 | 0 | 3 |
| TOTAL | 19 | 6 | 0 | 8 | 33 |

Table A-6b. Fault counts for noninstrumentation and control filters—PWRs

| FID | Component | | | | |
|---|---|---|---|---|---|
| | Process Filter | Screen | Separator | Strainer | Total |
| AN01 | 0 | 0 | 0 | 0 | 0 |
| AN02 | 1 | 0 | 0 | 0 | 1 |
| BVS1 | 1 | 0 | 0 | 0 | 1 |
| CCN1 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | 5 | 0 | 1 | 0 | 6 |
| DBS1 | 1 | 0 | 0 | 0 | 1 |
| DCC1 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 0 | 1 | 0 | 4 | 5 |
| FCS1 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 1 | 0 | 0 | 3 | 4 |
| KNP1 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 6 | 0 | 1 | 2 | 9 |
| MNS2 | 2 | 0 | 0 | 0 | 2 |
| MYP1 | 3 | 0 | 0 | 0 | 3 |
| NAS1 | 3 | 0 | 0 | 0 | 3 |
| NAS2 | 0 | 0 | 0 | 0 | 0 |
| NEE1 | 2 | 0 | 0 | 0 | 2 |
| NEE2 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | 1 | 0 | 0 | 0 | 1 |
| SLS1 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | 5 | 0 | 0 | 0 | 5 |
| SOS1 | 1 | 0 | 0 | 0 | 1 |
| SPS1 | 1 | 0 | 0 | 0 | 1 |
| SPS2 | 0 | 0 | 0 | 3 | 3 |
| TMI1 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 1 | 0 | 0 | 0 | 1 |
| TNP1 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 3 | 0 | 0 | 0 | 3 |
| ZIS2 | 2 | 0 | 0 | 0 | 2 |
| TOTAL | 39 | 1 | 2 | 12 | 54 |

**Table A-7a. Fault counts for fuel elements—BWRs**

| FID | Component: Fuel Assembly | Component: Fuel Element/Rod | Total |
|---|---|---|---|
| BFP1 | 0 | 0 | 0 |
| BFP2 | 0 | 3 | 3 |
| BRF1 | 0 | 0 | 0 |
| BRF2 | 8 | 0 | 8 |
| BRF3 | 2 | 0 | 2 |
| BRP1 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 0 |
| DAC1 | 0 | 0 | 0 |
| DRS2 | 0 | 0 | 0 |
| DRS3 | 0 | 0 | 0 |
| EIH1 | 13 | 2 | 15 |
| EIH2 | 2 | 0 | 2 |
| HMS1 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 0 |
| LBR1 | 0 | 2 | 2 |
| MNP1 | 0 | 0 | 0 |
| MNS1 | 1 | 0 | 1 |
| NMP1 | 0 | 0 | 0 |
| OCP1 | 0 | 0 | 0 |
| PBS2 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 |
| QAD1 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 |
| VYS1 | 0 | 0 | 0 |
| TOTAL | 26 | 7 | 33 |

**Table A-7b. Fault counts for fuel elements—PWRs**

| FID | Component: Fuel Assembly | Fuel Element/Rod | Total |
|---|---|---|---|
| ANO1 | 0 | 0 | 0 |
| ANO2 | 0 | 34 | 34 |
| BVS1 | 0 | 0 | 0 |
| CCN1 | 0 | 0 | 0 |
| CCN2 | 0 | 0 | 0 |
| CRP3 | 1 | 4 | 5 |
| DBS1 | 0 | 2 | 2 |
| DCC1 | 0 | 0 | 0 |
| DCC2 | 0 | 1 | 1 |
| FCS1 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 |
| IPS2 | 0 | 1 | 1 |
| IPS3 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 |
| NAS1 | 0 | 3 | 3 |
| NAS2 | 2 | 0 | 2 |
| NEE1 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 |
| PAL1 | 0 | 5 | 5 |
| PBH1 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 |
| PIN1 | 1 | 0 | 1 |
| PIN2 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 |
| SGS2 | 4 | 0 | 4 |
| SLS1 | 0 | 1 | 1 |
| SNP1 | 0 | 0 | 0 |
| SOS1 | 0 | 0 | 0 |
| SPS1 | 1 | 12 | 13 |
| SPS2 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 |
| YKR1 | 1 | 9 | 10 |
| ZIS1 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 |
| TOTAL | 10 | 72 | 82 |

**Table A-8a. Fault counts for generators—BWRs**

| FID | Component: Converter | Generator | Inverter | Motor Generator | Total |
|---|---|---|---|---|---|
| BEP1 | 0 | 0 | 0 | 1 | 1 |
| BEP2 | 2 | 1 | 0 | 1 | 4 |
| BRF1 | 0 | 0 | 0 | 3 | 3 |
| BRF2 | 0 | 0 | 0 | 2 | 2 |
| BRF3 | 0 | 0 | 0 | 10 | 10 |
| BRP1 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 1 | 0 | 1 |
| DAC1 | 0 | 0 | 0 | 0 | 0 |
| DRS2 | 0 | 0 | 0 | 1 | 1 |
| DRS3 | 0 | 0 | 0 | 1 | 1 |
| EIH1 | 0 | 0 | 6 | 0 | 6 |
| EIH2 | 1 | 3 | 3 | 1 | 8 |
| HMB1 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 1 | 1 | 0 | 2 |
| LBR1 | 0 | 0 | 0 | 0 | 0 |
| MNP1 | 0 | 1 | 0 | 0 | 1 |
| MNS1 | 1 | 2 | 0 | 0 | 3 |
| NMP1 | 1 | 0 | 0 | 1 | 2 |
| OCP1 | 0 | 0 | 0 | 0 | 0 |
| PBS2 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 1 | 1 | 2 |
| QAD1 | 0 | 0 | 0 | 0 | 0 |
| QAD2 | 0 | 2 | 0 | 0 | 2 |
| VYS1 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 5 | 10 | 12 | 22 | 49 |

**Table A-8b. Fault counts for generators—PWRs**

| FID | Component | | | | |
|---|---|---|---|---|---|
| | Converter | Generator | Inverter | Motor Generator | Total |
| ANO1 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 1 | 1 | 0 | 0 | 2 |
| BVS1 | 0 | 0 | 0 | 0 | 0 |
| CCN1 | 1 | 0 | 0 | 0 | 1 |
| CCN2 | 1 | 0 | 0 | 0 | 1 |
| CRP3 | 0 | 0 | 2 | 0 | 2 |
| DBS1 | 0 | 0 | 2 | 0 | 2 |
| DCC1 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 0 | 0 | 1 | 0 | 1 |
| FCS1 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 3 | 0 | 0 | 3 |
| IPS3 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 3 | 0 | 0 | 3 |
| KNP1 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 3 | 1 | 0 | 4 |
| MNS2 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 0 | 0 | 0 |
| NAS2 | 0 | 0 | 0 | 0 | 0 |
| NEE1 | 0 | 2 | 3 | 0 | 5 |
| NEE2 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 1 | 2 | 0 | 0 | 3 |
| PBH1 | 0 | 1 | 1 | 0 | 2 |
| PBH2 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 1 | 0 | 0 | 1 |
| PIN2 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 2 | 0 | 2 |
| SGS2 | 0 | 1 | 0 | 0 | 1 |
| SLS1 | 0 | 1 | 1 | 0 | 2 |
| SNP1 | 0 | 0 | 2 | 0 | 2 |
| SOS1 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 1 | 0 | 0 | 1 |
| TNP1 | 0 | 0 | 1 | 0 | 1 |
| TPS3 | 0 | 2 | 0 | 0 | 2 |
| TPS4 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 1 | 2 | 0 | 3 |
| ZIS2 | 0 | 2 | 2 | 0 | 4 |
| TOTAL | 4 | 24 | 20 | 0 | 4[illegible] |

**Table A-9a. Fault counts for heat exchangers—BWRs**

| FID | Air Unit (Heat & Vent) | Boiler | Cooling Coil | Cooler | Condenser | Fan Cooler | Heating Coil | Other Heater | Heat Exchanger | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | | |
| BEP1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 3 |
| BEP2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | [illegible] | 11 |
| BRF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | [illegible] | 4 |
| BRF2 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 4 |
| BRF3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 4 |
| BRP1 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 6 |
| CPR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| DRS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DRS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 2 | 1 | 6 |
| EIH2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 3 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LBR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| NMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| OCP1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 4 | [illegible] |
| PBS2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 1 | 7 | 3 | 7 | 2 | 3 | [illegible] | 27 | 54 |

**Table A-9b. Fault counts for heat exchangers—PWRs**

| FID | Air Unit (Heat & Vent) | Boiler | Cooling Coil | Cooler | Condenser | Fan Cooler | Heating Coil |
|---|---|---|---|---|---|---|---|
| | Component | | | | | | |
| AN01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AN02 | 0 | 0 | 1 | 2 | 0 | 0 | 0 |
| BVS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | 0 | 0 | 2 | 0 | 1 | 2 | 0 |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 1 | 0 | 0 | 2 | 2 | 0 | 0 |
| FCS1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| HBR2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| JMF1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| MGS1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 0 | 5 | 1 | 0 | 0 |
| NAS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| NEE2 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| RSS1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 17 | 2 | 0 | 34 | 0 |
| SGS2 | 0 | 0 | 4 | 0 | 0 | 17 | 0 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| SNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| SPS2 | 1 | 0 | 0 | 3 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 1 | 0 | 0 | 0 | 0 | 2 | 1 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| YKR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| TOTAL | 8 | 0 | 31 | 32 | 5 | 63 | 1 |

TI APERTURE CARD

Also Available On Aperture Card



8505280415-42

| Other Heater | Heat Exchanger | Steam Generator | Total |
|---|---|---|---|
| 0 | 0 | 1 | 1 |
| 0 | 4 | 0 | 7 |
| 1 | 2 | 3 | 6 |
| 0 | 2 | 0 | 7 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 7 |
| 0 | 0 | 0 | 2 |
| 0 | 0 | 1 | 2 |
| 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 4 |
| 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 1 |
| 0 | 2 | 0 | 3 |
| 2 | 1 | 3 | 10 |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 18 |
| 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 2 | [illegible] |
| 0 | 0 | 1 | 1 |
| 0 | 0 | 2 | 1 |
| 0 | 0 | 2 | 2 |
| 0 | 0 | 2 | 2 |
| 0 | 0 | 0 | 0 |
| 0 | 1 | 2 | 2 |
| 0 | 1 | 0 | 2 |
| 0 | 1 | 2 | [illegible] |
| 1 | 1 | 0 | [illegible] |
| 3 | 0 | 7 | [illegible] |
| 0 | 0 | 3 | 4 |
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 2 |
| 0 | 2 | 0 | 3 |
| 0 | 1 | 0 | 5 |
| 0 | 0 | 2 | 2 |
| 1 | 0 | 0 | 0 |
| 0 | 0 | 2 | 7 |
| 0 | 2 | 2 | 2 |
| 0 | 1 | 0 | 3 |
| 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 0 |
| 0 | 1 | 2 | 5 |
| 4 | 30 | 44 | 223 |

**Table A-10a. Fault counts for I&C/circuit breakers—BWRs**

| FID | Component | | | |
|---|---|---|---|---|
| | AC Circuit Breaker | DC Circuit Breaker | Unknown Type CB | Total |
| BFP1 | 4 | 0 | 0 | 4 |
| BFP2 | 6 | 0 | 0 | 6 |
| BRF1 | 6 | 1 | 0 | 7 |
| BRF2 | 1 | 0 | 0 | 1 |
| BRF3 | 4 | 1 | 0 | 5 |
| BRP1 | 2 | 0 | 0 | 2 |
| CPR1 | 0 | 0 | 0 | 0 |
| DAC1 | 2 | 0 | 0 | 2 |
| DRS2 | 2 | 0 | 0 | 2 |
| DRS3 | 0 | 0 | 0 | 0 |
| EIH1 | 3 | 0 | 0 | 3 |
| EIH2 | 3 | 1 | 1 | 5 |
| HMB1 | 0 | 0 | 0 | 0 |
| JAF1 | 1 | 0 | 0 | 1 |
| LBR1 | 6 | 0 | 0 | 6 |
| MNP1 | 1 | 0 | 0 | 1 |
| MNS1 | 2 | 0 | 0 | 2 |
| NMP1 | 0 | 0 | 1 | 1 |
| OCP1 | 1 | 0 | 0 | 1 |
| PBS2 | 1 | 0 | 0 | 1 |
| PBS3 | 2 | 0 | 0 | 2 |
| PPS1 | [illegible] | 0 | 0 | [illegible] |
| QAD1 | 3 | 0 | 0 | 3 |
| QAD2 | 2 | 0 | 0 | 2 |
| VYS1 | 11 | 0 | 0 | 11 |
| TOTAL | 71 | 3 | 2 | 76 |

**Table A-10b. Fault counts for I&C/circuit breakers—PWRs**

| FID | AC Circuit Breaker | DC Circuit Breaker | Unknown Type CB | Total |
|---|---|---|---|---|
| | Component | | | |
| ANO1 | 0 | 1 | 0 | 1 |
| ANO2 | 0 | 2 | 0 | 2 |
| BVS1 | 3 | 3 | 0 | 6 |
| CCN1 | 0 | 0 | 0 | 0 |
| CCN2 | 7 | 0 | 0 | 7 |
| CRP3 | 4 | 0 | 0 | 4 |
| DBS1 | 12 | 0 | 0 | 12 |
| DCC1 | 8 | 0 | 0 | 8 |
| DCC2 | 4 | 0 | 0 | 4 |
| FCS1 | 0 | 1 | 0 | 1 |
| HBR2 | 4 | 0 | 4 | 8 |
| HNP1 | 1 | 0 | 0 | 1 |
| IPS2 | 2 | 0 | 0 | 2 |
| IPS3 | 0 | 0 | 0 | 0 |
| JMF1 | 4 | 0 | 0 | 4 |
| KNP1 | 5 | 0 | 1 | 6 |
| MGS1 | 10 | 0 | 1 | 11 |
| MNS2 | 2 | 0 | 0 | 2 |
| MYP1 | 1 | 0 | 0 | 1 |
| NAS1 | 6 | 1 | 0 | 7 |
| NAS2 | 3 | 0 | 1 | 4 |
| NEE1 | 6 | 1 | 0 | 7 |
| NEE2 | 0 | 0 | 0 | 0 |
| NEE3 | 1 | 0 | 0 | 1 |
| PAL1 | 1 | 2 | 0 | 3 |
| PBH1 | 2 | 2 | 0 | 4 |
| PBH2 | 0 | 0 | 0 | 0 |
| PIN1 | 5 | 0 | 0 | 5 |
| PIN2 | 0 | 0 | 0 | 0 |
| REG1 | 5 | 0 | 0 | 5 |
| RSS1 | 3 | 0 | 1 | 4 |
| SGS1 | 3 | 0 | 0 | 3 |
| SGS2 | 10 | 2 | 0 | 12 |
| SLS1 | 3 | 2 | 0 | 5 |
| SNP1 | 3 | 0 | 0 | 3 |
| SOS1 | 0 | 0 | 0 | 0 |
| SPS1 | 2 | 0 | 0 | 2 |
| SPS2 | 7 | 0 | 0 | 7 |
| TMI1 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 1 | 1 |
| TPS3 | 1 | 0 | 0 | 1 |
| TPS4 | 5 | 0 | 0 | 5 |
| YKR1 | 0 | 0 | 0 | 0 |
| ZIS1 | 6 | 1 | 0 | 7 |
| ZIS2 | 1 | 0 | 0 | 1 |
| TOTAL | 140 | 16 | 9 | 167 |

**Table A-11a. Fault counts for I&C/computation modules—BWRs**

| FID | Amplifier | Computer | Integrator | Modifier | Summer | Totalizer/ Integrator | Total |
|---|---|---|---|---|---|---|---|
| BEP1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| BEP2 | 1 | 0 | 1 | 0 | 0 | 0 | 2 |
| BRF1 | 2 | 0 | 6 | 0 | 0 | 0 | 8 |
| BRF2 | 0 | 1 | 1 | 0 | 0 | 2 | 4 |
| BRF3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| DAC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DRS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DRS3 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| EIH1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| EIH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 4 | 3 | 3 | 0 | 0 | 0 | 10 |
| LBF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OCP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 10 | 5 | 13 | 0 | 0 | 2 | 30 |

**Table A-11b. Fault counts for I&C/computation modules—PWRs**

| FID | Component: Amplifier | Computer | Integrator | Modifier | Summer | Totalizer/ Integrator | Total |
|---|---|---|---|---|---|---|---|
| AND1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| AND2 | 0 | 6 | 0 | 0 | 0 | 0 | 6 |
| BVS1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| CCN1 | 0 | 6 | 0 | 0 | 0 | 0 | 6 |
| CCN2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| CRP3 | 4 | 1 | 0 | 0 | 0 | 0 | 5 |
| DBS1 | 5 | 0 | 0 | 0 | 0 | 0 | 5 |
| DCC1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| DCC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 1 | 0 | 0 | 0 | 0 | 1 | 2 |
| MNS2 | 2 | 1 | 0 | 0 | 0 | 0 | 3 |
| MYP1 | 3 | 1 | 0 | 0 | 1 | 0 | 5 |
| NAS1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| NAS2 | 0 | 1 | 0 | 1 | 2 | 0 | 4 |
| NEE1 | 1 | 7 | 0 | 0 | 0 | 0 | 8 |
| NEE2 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| NEE3 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| PAL1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 2 | 4 | 0 | 0 | 0 | 0 | 6 |
| SGS2 | 2 | 0 | 0 | 2 | 1 | 0 | 3 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SUS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| SPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| THI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| THI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| YKN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| TOTAL | 27 | 40 | 2 | 3 | 8 | 1 | 81 |

Table A-12a. Fault counts for I&C/controllers—BWRs

| FID | Analyzer | Control Operator | Voltage | Flow | Power | Level | Moisture/Humidity | Motor Control Center | Pressure | Controller | Speed/Freq. | Temp. | Other | Position | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| BEP2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| BRF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRF2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| BRF3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| BRP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| CPP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 |
| DRS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| DRS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 3 |
| EIH1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 4 |
| EIH2 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 5 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 5 |
| LAR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| MNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PNS1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| NMP1 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| OCP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| PPS1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| QAD2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| TOTAL - | 0 | 1 | 9 | 11 | 1 | 0 | 0 | 6 | 3 | 4 | 5 | 4 | 1 | 3 | 45 |

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**Table A-12b. Fault counts for I&C/controllers—PWRs**

| FID | | Compon | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Analyzer | Control Operator | Voltage | Flow | Power | Level | Moisture/ Humidity | Mot Cont Cent |
| ANO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| BVS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| CRP3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| DBS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| NAS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| SGS2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| SOS1 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| SPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| TPS3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 1 | 1 | 5 | 8 | 2 | 9 | 0 | 7 |



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| or rol er | Pressure | Controller | Speed/ Freq. | Temp. | Other | Position | Total |
|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 1 | 0 | 1 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 1 | 3 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | 1 | 0 | 0 | 0 | 0 | 0 | 4 |
| | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | [illegible] | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| | 5 | 11 | 6 | 3 | 2 | 1 | 63 |

Table A-13a. Fault counts for I&C/indicators—BWRs

| FID | | Component | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Analyzer | Cndctvty | Voltage | Flow | Current | Power | Level | Multi-Variable | Flux/Neutron | Pressure | Radiation | Speed/Freq. | Temp. | Vibration | Other Type | Position | Total |
| BFP1 | | 16 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 10 | 33 |
| BFP2 | | 23 | 0 | 0 | 3 | 0 | 0 | [illegible] | 0 | 6 | 0 | 1 | 0 | 7 | 0 | 0 | 5 | 71 |
| BRF1 | | 7 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 15 |
| BRF2 | | 5 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 20 |
| BRF3 | | 6 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 4 | 3 | 0 | 4 | 0 | 0 | 1 | 22 |
| BRP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 6 |
| CPR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| DAC1 | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 7 |
| DRS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 6 | 0 | 1 | 0 | 3 | 1 | 14 |
| DRS3 | | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 8 |
| EIH1 | | 14 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 2 | 3 | 13 | 0 | 0 | 0 | 0 | 0 | 36 |
| EIH2 | | 2 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 8 | 3 | 4 | 0 | 0 | 0 | 0 | 3 | 24 |
| HMB1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | | 2 | 1 | 0 | 7 | 0 | 0 | 2 | 0 | 4 | 2 | 6 | 0 | 0 | 0 | 0 | 3 | 29 |
| LGR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| MNP1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| MNS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| NMP1 | | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 13 | 0 | 1 | 0 | 5 | 0 | 21 |
| OCP1 | | 1 | 0 | 0 | 7 | 2 | 0 | 2 | 0 | 2 | 3 | 5 | 0 | 0 | 0 | 0 | 1 | 23 |
| PBS2 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 5 | 0 | 0 | 0 | 0 | 7 | 16 |
| PBS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 5 | 0 | 7 |
| PPS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 4 |
| QAD1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| QAD2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VYS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 1 | 7 |
| TOTAL | - | 82 | 1 | 0 | 27 | 2 | 2 | 50 | 0 | 33 | 23 | 100 | 1 | 11 | 0 | 13 | 35 | 380 |

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**Table A-13b. Fault counts for I&C/indicators—PWRs**

| FID | Component | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Analyzer | Cndc'tvty | Voltage | Flow | Current | Power | Level | Multi-Variable | Flux/Neutron | Pressure | Ra |
| AND1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| AND2 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | |
| BVS1 | 19 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 1 | |
| CCN1 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 8 | 3 | |
| CCN2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | |
| CRP3 | 1 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 9 | 3 | |
| DBS1 | 8 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 2 | |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | |
| DCC2 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 1 | 2 | |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| HNP1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| JMF1 | 3 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 1 | 2 | |
| KNP1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| MGS1 | 1 | 0 | 0 | 14 | 0 | 0 | 10 | 0 | 2 | 2 | |
| MNS2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | |
| MYP1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | |
| NAS1 | 6 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 1 | 0 | |
| NAS2 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 7 | 2 | |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PBH1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SGS1 | 1 | 0 | 0 | 6 | 0 | 0 | 5 | 0 | 2 | 0 | |
| SGS2 | 0 | 0 | 0 | 10 | 0 | 0 | 3 | 0 | 4 | 1 | |
| SLS1 | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| SHP1 | 5 | 0 | 0 | 1 | 0 | 0 | 9 | 0 | 2 | 1 | |
| SOS1 | 1 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 1 | |
| SPS1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | |
| SPS2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TMI2 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 2 | |
| TNP1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 4 | |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| YRK1 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| ZIS2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | |
| TOTAL | 59 | 0 | 0 | 71 | 0 | 1 | 55 | 0 | 51 | 39 | 2 |



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| iation | Speed/ Freq. | Temp. | Vibration | Other Type | Position | Total |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 1 | 0 | 0 | 0 | 8 |
| 5 | 0 | 1 | 0 | 4 | 5 | 41 |
| 5 | 0 | 1 | 0 | 1 | 2 | 26 |
| 2 | 0 | 4 | 0 | 1 | 3 | 16 |
| 5 | 2 | 3 | 0 | 3 | 2 | 45 |
| 6 | 1 | 2 | 0 | 2 | 4 | 39 |
| 6 | 0 | 6 | 0 | 0 | 1 | 19 |
| 4 | 0 | 4 | 0 | 0 | 0 | 16 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 2 | 4 |
| 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| 2 | 0 | 2 | 0 | 0 | 0 | 5 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 4 | 0 | 2 | 0 | 1 | 1 | 28 |
| 3 | 0 | 0 | 0 | 0 | 0 | 4 |
| 3 | 0 | 4 | 0 | 5 | 2 | 73 |
| 3 | 0 | 0 | 0 | 2 | 4 | 12 |
| 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 7 | 0 | 0 | 7 | 25 |
| 0 | 0 | 3 | 0 | 1 | 8 | 24 |
| 2 | 0 | 0 | 0 | 2 | 1 | 7 |
| 3 | 0 | 4 | 0 | 0 | 0 | 8 |
| 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 1 | 5 |
| 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| 1 | 0 | 0 | 0 | 0 | 11 | 26 |
| 7 | 0 | 0 | 0 | 0 | 20 | 45 |
| 4 | 0 | 0 | 0 | 1 | 2 | 15 |
| 5 | 0 | 0 | 0 | 0 | 3 | 46 |
| 0 | 0 | 0 | 0 | 0 | 1 | 10 |
| 3 | 0 | 0 | 2 | 0 | 1 | 29 |
| 5 | 0 | 0 | 0 | 0 | 0 | 18 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 | 0 | 14 |
| 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 15 |
| 1 | 0 | 2 | 0 | 0 | 0 | 24 |
| 1 | 0 | 2 | 0 | 0 | 0 | 17 |
| 61 | 4 | 49 | 2 | 25 | 83 | 691 |

Table A-14a. Fault counts for I&C/relays—BWRs

| FID | Over-Speed | Under-Voltage | Undercurrent/ Underpower | Thermal Overload | Over-Voltage | Freq. | Alarm/ Annunc. | Field Exciter | Lockout/ Tripping | Over-Current | Phase | Other Type | Sequencer | Synchro. | Time Delay | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | | | | | | | | |
| BEP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| BEP2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 0 | 0 | 0 | [illegible] |
| BRF1 | 0 | [illegible] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 10 |
| BRF2 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 6 | 0 | 0 | 1 | 13 |
| BRF3 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 11 |
| BRP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CPX1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 |
| CAC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DRS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 4 |
| DRS3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| EIH1 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 12 |
| EIH2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 13 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| LBR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| MNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 3 |
| MNS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| NMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 |
| OCP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| PBS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| TOTAL – | 1 | 6 | 0 | 5 | 3 | 0 | 0 | 3 | [illegible] | 4 | 1 | 30 | 0 | 0 | 20 | 104 |

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**Table A-14b. Fault counts for I&C/relays—PWRs**

| FID | Component | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Over-Speed | Under-Voltage | Undercurrent/ Underpower | Thermal Overload | Over-Voltage | Freq. | Alarm/ Annunc. | Field Exciter |
| ANO1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ANO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BVS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| CRP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC1 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 |
| DCC2 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 6 | 30 | 5 | 4 | 11 | 0 | 1 | 4 |



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| ockout/ ripping | Over-Current | Phase | Other Type | Sequencer | Synchro. | Time Delay | Total |
|---|---|---|---|---|---|---|---|
| 3 | 0 | 0 | 3 | 1 | 0 | 0 | 13 |
| 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 1 | 0 | 0 | 2 | 3 |
| 0 | 0 | 0 | 2 | 0 | 0 | 1 | 3 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 12 |
| 0 | 0 | 0 | 11 | 0 | 0 | 1 | 12 |
| 2 | 0 | 0 | 3 | 0 | 0 | 1 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 18 |
| 0 | 0 | 0 | 0 | 1 | 0 | 4 | 15 |
| 2 | 0 | 0 | 0 | 4 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 5 | 0 | 0 | 6 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 2 | 5 | 0 | 0 | 7 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 16 | 0 | 0 | 0 | 16 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 2 | 0 | 0 | 1 | 4 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 4 | 0 | 3 | 0 | 0 | 0 | 9 |
| 0 | 0 | 0 | 3 | 12 | 0 | 0 | 15 |
| 0 | 2 | 0 | 4 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 2 | 1 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 6 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 3 | 0 | 0 | 2 | 5 |
| 0 | 0 | 0 | 3 | 0 | 0 | 2 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 6 | 12 |
| 10 | 4 | 0 | 74 | 36 | 0 | 23 | 213 |

Table A-14c. Fault counts for I&C/relays—PWRs
(potential faults included)

| FID | Over-Speed | Under-Voltage | Undercurrent/Underpower | Thermal Overload | Over-Voltage | Freq. | Alarm/Annunc. | Field Exciter | Lockout/Tripping | Over-Current | Phase | Other/Unknown Type | Sequencer | Synchro. | Time Delay | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | | | | | | | | |
| ANO1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 4 | 1 | 0 | 0 | 15 |
| ANO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| BVS1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 5 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 3 |
| CCN2 | 0 | 8 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 12 |
| CRP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 1 | 12 |
| DBS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 0 | 1 | 6 |
| DCC1 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 1 | 18 |
| DCC2 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 15 |
| DCP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 4 | 0 | 0 | 6 |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 6 |
| JMF2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| MGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 5 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| NAS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| NEE1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 7 |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 16 |
| PIN2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 4 |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| SGS2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 3 | 0 | 0 | 0 | 9 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 102 | 12 | 0 | 0 | 114 |
| SNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 6 |
| SNP2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| SOS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 5 |
| SPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| TNP1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 8 |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 5 |
| YKR1 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 10 |
| ZIS1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 | 12 |
| TOTAL – | 6 | 31 | 5 | 4 | 11 | 1 | 1 | 4 | 11 | 9 | 0 | 180 | 41 | 0 | 23 | 327 |

Tab'': A-15a. Fault counts for I&C/sensors—BWRs

| FID | | Analyzer | Flow | Fire/ Smoke | Level | Moisture/ Humidity | Flux/ Neutron | Pressure | Radia |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Component | |
| BEP1 | | 2 | 0 | 0 | 0 | 0 | 2 | 0 | |
| BEP2 | | 5 | 0 | 0 | 0 | 0 | 1 | 0 | |
| BRF1 | | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| BRF2 | | 0 | 0 | 4 | 0 | 0 | 0 | 0 | |
| BRF3 | | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| BRP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| CPR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| DAC1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| DRS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| DRS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| EIH1 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| EIH2 | | 2 | 0 | 0 | 0 | 1 | 1 | 0 | |
| HMB1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| JAF1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| LBR1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| MNP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| MNS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NMP1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| OCP1 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| PBS2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PBS3 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PPS1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| QAD1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| QAD2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| VYS1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | - | 10 | 0 | 9 | 1 | 1 | 4 | 0 | 1 |



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| tion | Speed/ Freq. | Temp. | Vibration | Other Type | Position | Total |
|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 5 |
| | 0 | 0 | 0 | 0 | 0 | 6 |
| | 0 | 1 | 0 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 0 | 0 | [illegible] |
| | 0 | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 1 | 0 | 1 | 0 | 6 |
| | 0 | 0 | 0 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 4 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 1 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 3 | 0 | 0 | 0 | 5 |
| | 0 | 0 | 0 | 1 | 0 | 2 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 6 | 0 | 2 | 0 | 46 |

Table A-15b. Fault counts for I&C/sensors—PWRs

| FID | Analyzer | Flow | Fire/ Smoke | Level | Moisture/ Humidity | Flux/ Neutron | Pressure | Radiation | Speed/ Freq. | Temp. | Vibration | Other Type | Position | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Component | | | | | | | | |
| ANO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 29 | 0 | 0 | 0 | 31 |
| BVS1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 |
| CCN1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 5 |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 |
| CRP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| DBS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 2 |
| DCC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IND1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IP2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| IP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 502 | 0 | 0 | 0 | 0 | 4 | 0 | 2 | 0 | 0 | 0 | 406 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PTP1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| NAS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEC2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEC3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| POH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RGG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| SGS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 7 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 |
| SNP1 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 8 |
| SOS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| SPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| SPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YRR1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| TOTAL – | 6 | 4 | 404 | 2 | 0 | 15 | 4 | 13 | 2 | 52 | 1 | 4 | 0 | 504 |

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Table A-16a. Fault counts for I&C/switches—BWRs

| FID | Bistable | Cndctvty | Control | Disconnect | Voltage | Flow | Hand | Curr |
|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | |
| BEP1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | |
| BEP2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | |
| BRF1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | |
| BRF2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| BRF3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| BRP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| CPR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| DAC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| DRS2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| DRS3 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | |
| EIH1 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | |
| EIH2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| JAF1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | |
| LBR1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | |
| MNP1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | |
| MNS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NMP1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| OCP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PBS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| PPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| TOTAL - | 1 | 1 | 7 | 1 | 2 | 16 | 5 | |

| FID | Push Button | Pressure | Radiation | Speed/ Freq. | Temp. | Test | Vibration | Tor Fo |
|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | |
| BEP1 | 0 | 19 | 0 | 0 | 0 | 0 | 0 | |
| BEP2 | 0 | 20 | 0 | 0 | 6 | 0 | 0 | |
| BRF1 | 1 | 20 | 0 | 0 | 1 | 0 | 2 | |
| BRF2 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | |
| BRF3 | 0 | 4 | 0 | 0 | 2 | 0 | 0 | |
| BRP1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| CPR1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | |
| DAC1 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | |
| DRS2 | 0 | 11 | 1 | 0 | 1 | 0 | 0 | |
| DRS3 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | |
| EIH1 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | |
| EIH2 | 0 | 107 | 1 | 1 | 1 | 0 | 0 | |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| JAF1 | 0 | 9 | 2 | 0 | 0 | 1 | 0 | |
| LBR1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| MNP1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | |
| MNS1 | 0 | 13 | 0 | 0 | 2 | 0 | 0 | |
| NMP1 | 0 | 4 | 3 | 0 | 0 | 0 | 0 | |
| OCP1 | 0 | 29 | 0 | 0 | 0 | 0 | 0 | |
| PBS2 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | |
| PBS3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | |
| PPS1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | |
| QAD1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | |
| QAD2 | 0 | 8 | 0 | 0 | 4 | 0 | 0 | |
| VYS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | 1 | 313 | 7 | 1 | 24 | 1 | 2 | 1 |

| ...ent | Power | Time | Level | Moisture/ Humidity | Flux/ Neutron |
|---|---|---|---|---|---|
| [illegible] | 0 | 0 | 5 | 0 | 0 |
| [illegible] | 0 | 0 | 6 | 0 | 0 |
| [illegible] | 0 | 0 | 14 | 0 | 0 |
| [illegible] | 0 | 0 | 21 | 0 | 0 |
| [illegible] | 0 | 0 | 7 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 0 | 4 | 0 | 0 |
| [illegible] | 0 | 0 | 3 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 3 | 4 | 0 | 3 |
| [illegible] | 0 | 0 | 4 | 0 | 0 |
| [illegible] | 0 | 0 | 1 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 0 | 6 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 0 | 2 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 0 | 1 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 0 | 2 | 0 | 0 |
| [illegible] | 0 | 0 | 2 | 0 | 0 |
| [illegible] | 0 | 0 | 1 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 3 | 83 | 0 | 3 |

| ...que/ ...rce | Other Type | Position | Unknown Type | Total |
|---|---|---|---|---|
| [illegible] | 1 | 15 | 0 | 44 |
| [illegible] | 1 | 5 | 0 | 44 |
| [illegible] | 0 | 0 | 0 | 40 |
| [illegible] | 0 | 2 | 0 | 37 |
| [illegible] | 0 | 0 | 0 | 13 |
| [illegible] | 0 | 0 | 0 | 1 |
| [illegible] | 0 | 0 | 2 | 10 |
| [illegible] | 0 | 0 | 0 | [illegible] |
| [illegible] | 0 | 1 | 0 | 15 |
| [illegible] | 0 | 0 | 0 | 18 |
| [illegible] | 1 | 0 | 1 | 45 |
| [illegible] | 1 | 3 | 0 | 120 |
| [illegible] | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 2 | 2 | 20 |
| [illegible] | 1 | 0 | 0 | 5 |
| [illegible] | 1 | 3 | 0 | 4 |
| [illegible] | 0 | 3 | 0 | 20 |
| [illegible] | 0 | 0 | 0 | 3 |
| [illegible] | 1 | 0 | 0 | 34 |
| [illegible] | 1 | 0 | 0 | 5 |
| [illegible] | [illegible] | 0 | 0 | 5 |
| [illegible] | [illegible] | 0 | 0 | 0 |
| [illegible] | [illegible] | 1 | 0 | 11 |
| [illegible] | [illegible] | 4 | 0 | 17 |
| [illegible] | [illegible] | 1 | 0 | 4 |
| 4 | 14 | 45 | 5 | [illegible] |

Table A-16b. Fault counts for I&C/switches—PWRs

| FID | | Component | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bistable | Cndctvty | Control | Disconnect | Voltage | Flow | Hand | Current | Power | Time | Level | Moisture/ Humidity | Flux/ Neutron |
| ANJ1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANJ2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BVS1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | 2 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRP3 | 1 | 0 | 2 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 |
| DCC1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| [illegible] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| [illegible] | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 2 | 0 | 1 | 0 | 0 | 2 | 14 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 4 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEC3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH1 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| PBH2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RGE1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOS1 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SOS2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SLE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| SNP1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SQS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| YNR1 | 4 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 4 | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| TOTAL | 52 | 0 | 18 | 1 | 2 | 15 | 36 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

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Table A-16b. (continued)

| FID | Component: Push Button | Pressure | Radiation | Speed/ Freq. | Temp. | Test | Vibration | Tor Fo |
|---|---|---|---|---|---|---|---|---|
| ANO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ANO2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | |
| BVS1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| CCN1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| CRP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| DBS1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| DCC2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| JMF1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | |
| KNP1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| MGS1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | |
| MNS2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NAS1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | |
| NAS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NES1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NES2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NES3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PBH1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PIN1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| RSS1 | 0 | 4 | 0 | 0 | 0 | 1 | 0 | |
| SGS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SGS2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| SLS1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | |
| SNP1 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | |
| SUS1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | |
| SPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| YKR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ZIS2 | 0 | 9 | 0 | 0 | [illegible] | 0 | 0 | |
| TOTAL | 0 | 34 | 3 | 1 | 10 | 3 | 1 | 2 |

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| ...que/ ...rce | Other Type | Position | Unknown Type | Total |
| --- | --- | --- | --- | --- |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 22 | 26 | 7 | 275 |

Table A-17a. Fault counts for I&C/transmitters—BWRs

| FIL | Analyzer | Flow | Current | Level | Flux/ Neutron | Pressure | Radiation | Speed/ Freq. | Transducer | Temp. | Other Type | Position | Unknown Type | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | | | | | | |
| BFP1 | [illegible] | 2 | [illegible] | [illegible] | [illegible] | 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 13 |
| BFP2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 14 |
| BKP1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| BRF2 | [illegible] | 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| BRF3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| BRP1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| CPR1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DAC1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DRE2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DRS3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| HMB1 | [illegible] | [illegible] | [illegible] | 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JAF1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| LSR1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| PNP1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| PRD1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| NMP1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| OCP1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| PBS2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| PBS3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| FPS1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| GAD1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1 |
| GAD2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| VYS1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TOTAL – | [illegible] | 7 | 1 | 24 | 2 | [illegible] | [illegible] | 0 | 4 | 3 | [illegible] | [illegible] | [illegible] | 56 |

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**Table A-17b. Fault counts for I&C/transmitters—PWRs**

| FID | | | | Component | | | | |
|---|---|---|---|---|---|---|---|---|
| | Analyzer | Flow | Current | Level | Flux/ Neutron | Pressure | Radiation | S Fr |
| AN01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| AN02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| BVS1 | 0 | 4 | 0 | 5 | 0 | 1 | 0 | |
| CCN1 | 0 | 1 | 0 | 2 | 4 | 2 | 0 | |
| CCN2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| CRP3 | 0 | 1 | 0 | 5 | 0 | 10 | 0 | |
| DBS1 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | |
| DCC1 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | |
| DCC2 | 0 | 1 | 0 | 1 | 0 | 3 | 0 | |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| IPS2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| JMF1 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | |
| KNP1 | 0 | 3 | 0 | 1 | 0 | 3 | 0 | |
| MGS1 | 0 | 8 | 0 | 8 | 0 | 5 | 0 | |
| MNS2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | |
| MYP1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| NAS1 | 0 | 1 | 0 | 3 | 0 | 3 | 0 | |
| NAS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NEE2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | |
| NEE3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| PAL1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| REG1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| RSS1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | |
| SGS1 | 0 | 10 | 0 | 5 | 0 | 1 | 0 | |
| SGS2 | 0 | 17 | 0 | 3 | 0 | 1 | 0 | |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | |
| SNP1 | 0 | 3 | 0 | 19 | 0 | 3 | 0 | |
| SOS1 | 0 | 4 | 0 | 2 | 0 | 0 | 0 | |
| SPS1 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | |
| SPS2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TMI2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TPS4 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | |
| YKR1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ZIS2 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | |
| TOTAL – | 0 | 64 | 0 | 75 | 4 | 48 | 0 | |



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| eed/ eq. | Transducer | Temp. | Other Type | Position | Unknown Type | Total |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 0 | 0 | 1 | 0 | 0 | 0 | 10 |
| 0 | 0 | 3 | 1 | 0 | 0 | 5 |
| 0 | 0 | 0 | 0 | 0 | 6 | 22 |
| 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 1 | 0 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 0 | 1 | 1 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 0 | 1 | 6 | 1 | 1 | 6 | 206 |

**Table A-17c. Fault counts for I&C/transmitters—PWRs (potential faults included)**

| FID | | Analyzer | Flow | Current | Level | Flux/ Neutron |
|---|---|---|---|---|---|---|
| AN01 | | 0 | 0 | 0 | 0 | 0 |
| AN02 | | 0 | 0 | 0 | 0 | 0 |
| BVS1 | | 0 | 4 | 0 | 5 | 0 |
| CCN1 | | 0 | 1 | 0 | 2 | 4 |
| CCN2 | | 0 | 0 | 0 | 0 | 0 |
| CRP3 | | 0 | 1 | 0 | 5 | 0 |
| DBS1 | | 0 | 1 | 0 | 3 | 0 |
| DCC1 | | 0 | 0 | 0 | 1 | 0 |
| DCC2 | | 0 | 1 | 0 | 1 | 0 |
| FCS1 | | 0 | 5 | 0 | 5 | 0 |
| HBR2 | | 0 | 0 | 0 | 0 | 0 |
| HNP1 | | 0 | 0 | 0 | 0 | 0 |
| IPS2 | | 0 | 0 | 0 | 2 | 0 |
| IPS3 | | 0 | 0 | 0 | 0 | 0 |
| JMF1 | | 0 | 2 | 0 | 2 | 0 |
| KNP1 | | 0 | 3 | 0 | 1 | 0 |
| MGS1 | | 0 | 8 | 0 | 8 | 0 |
| MNS2 | | 0 | 0 | 0 | 2 | 0 |
| MYP1 | | 0 | 0 | 0 | 1 | 0 |
| NAS1 | | 0 | 1 | 0 | 3 | 0 |
| NAS2 | | 0 | 0 | 0 | 1 | 0 |
| NEE1 | | 0 | 0 | 0 | 0 | 0 |
| NEE2 | | 0 | 1 | 0 | 1 | 0 |
| NEE3 | | 0 | 0 | 0 | 0 | 0 |
| PAL1 | | 0 | 0 | 0 | 0 | 0 |
| PBH1 | | 0 | 0 | 0 | 0 | 0 |
| PBH2 | | 0 | 0 | 0 | 0 | 0 |
| PIN1 | | 0 | 0 | 0 | 0 | 0 |
| PIN2 | | 0 | 0 | 0 | 0 | 0 |
| REG1 | | 0 | 0 | 0 | 0 | 0 |
| RSS1 | | 0 | 0 | 0 | 0 | 0 |
| SGS1 | | 0 | 10 | 0 | 5 | 0 |
| SGS2 | | 0 | 17 | 0 | 3 | 0 |
| SLS1 | | 0 | 0 | 0 | 0 | 0 |
| SNP1 | | 0 | 3 | 0 | 27 | 0 |
| SOS1 | | 0 | 4 | 0 | 2 | 0 |
| SPS1 | | 0 | 3 | 0 | 3 | 0 |
| SPS2 | | 0 | 2 | 0 | 0 | 0 |
| TMI1 | | 0 | 0 | 0 | 0 | 0 |
| TMI2 | | 0 | 0 | 0 | 1 | 0 |
| TNP1 | | 0 | 0 | 0 | 0 | 0 |
| TPS3 | | 0 | 0 | 0 | 0 | 0 |
| TPS4 | | 0 | 0 | 0 | 0 | 0 |
| YKR1 | | 0 | 0 | 0 | 1 | 0 |
| ZIS1 | | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | | 0 | 2 | 0 | 3 | 0 |
| TOTAL | - | 0 | 69 | 0 | 88 | 4 |

Component

| Pressure | Radiation | Speed/ Freq. | Transducer | Temp. | Other Type | Position | Unknown Type | Total |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 11 |
| 1 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 5 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 22 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 16 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 27 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 4 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 65 | 0 | 0 | 1 | 6 | 1 | 1 | 6 | 241 |

**Table A-18a. Fault counts for motors—BWRs**

| FID | Component: Motor | Total |
|---|---|---|
| BEP1 | 2 | 2 |
| BEP2 | 5 | 5 |
| BRF1 | 5 | 5 |
| BRF2 | 5 | 5 |
| BRF3 | 5 | 5 |
| BRP1 | 0 | 0 |
| CPR1 | 1 | 1 |
| CAC1 | 0 | 0 |
| DRS2 | 2 | 2 |
| DRS3 | 1 | 1 |
| EIH1 | 4 | 4 |
| EIH2 | 4 | 4 |
| HMB1 | 0 | 0 |
| JAF1 | 1 | 1 |
| LBK1 | 0 | 0 |
| MNP1 | 0 | 0 |
| MNS1 | 1 | 1 |
| NMP1 | 1 | 1 |
| OCP1 | 1 | 1 |
| PBS2 | 1 | 1 |
| PHS3 | 0 | 0 |
| PPS1 | 2 | 2 |
| QAC1 | 1 | 1 |
| QAC2 | 0 | 0 |
| VYS1 | 8 | 8 |
| TOTAL | 53 | 53 |

Table A-18b. Fault counts for motors—PWRs

| FID | Component: Motor | Total |
|---|---|---|
| ANO1 | 0 | 0 |
| ANO2 | 3 | 3 |
| BVS1 | 3 | 3 |
| CCN1 | 1 | 1 |
| CCN2 | 2 | 2 |
| CRP3 | 0 | 0 |
| DBS1 | 3 | 3 |
| DCC1 | 1 | 1 |
| DCC2 | 0 | 0 |
| FCS1 | 0 | 0 |
| HBR2 | 2 | 2 |
| HNP1 | 1 | 1 |
| IPS2 | 4 | 4 |
| IPS3 | 0 | 0 |
| JMF1 | 0 | 0 |
| KNP1 | 3 | 3 |
| MGS1 | 16 | 16 |
| MNS2 | 0 | 0 |
| MYP1 | 0 | 0 |
| NAS1 | 1 | 1 |
| NAS2 | 0 | 0 |
| NEE1 | 0 | 0 |
| NEE2 | 2 | 2 |
| NEE3 | 1 | 1 |
| PAL1 | 22 | 22 |
| PBH1 | 0 | 0 |
| PBH2 | 0 | 0 |
| PIN1 | 0 | 0 |
| PIN2 | 1 | 1 |
| REG1 | 0 | 0 |
| RSS1 | 0 | 0 |
| SGS1 | 2 | 2 |
| SGS2 | 3 | 3 |
| SLS1 | 3 | 3 |
| SNP1 | 5 | 5 |
| SOS1 | 0 | 0 |
| SPS1 | 1 | 1 |
| SPS2 | 5 | 5 |
| TMI1 | 0 | 0 |
| TMI2 | 1 | 1 |
| TNP1 | 3 | 3 |
| TPS3 | 1 | 1 |
| TPS4 | 0 | 0 |
| YRK1 | 3 | 3 |
| ZIS1 | 0 | 0 |
| ZIS2 | 1 | 1 |
| TOTAL | 94 | 94 |

**Table A-19a. Fault counts for penetrations—BWRs**

| FID | Component | | | | | | |
|---|---|---|---|---|---|---|---|
| | Other/ Unknown Type | Personnel Access | Equip. Access | Electrical | Instr. Line | Process Piping | Total |
| BFP1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| BFP2 | 0 | 0 | 0 | 5 | 0 | 0 | 5 |
| BRF1 | 0 | 4 | 2 | 0 | 0 | 0 | 6 |
| BRF2 | 0 | 0 | 8 | 0 | 0 | 0 | 8 |
| BRF3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRP1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| CPR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | 0 | 2 | 0 | 0 | 0 | 2 | 4 |
| DRS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DRS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EIH2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LGR1 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| MNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OCP1 | 0 | 2 | 4 | 0 | 0 | 0 | 6 |
| PBS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 6 | 6 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 1 | 10 | 15 | 5 | 0 | 9 | 40 |

**Table A-19b. Fault counts for penetrations—PWRs**

| FID | Component | | | | | | |
|---|---|---|---|---|---|---|---|
| | Other/ Unknown Type | Personnel Access | Equip. Access | Electrical | Instr. Line | Process Piping | Total |
| ANO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BVS1 | 1 | 3 | 0 | 0 | 1 | 0 | 5 |
| CCN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CCN2 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| CRP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DBS1 | 0 | 2 | 0 | 2 | 0 | 0 | 4 |
| DCC1 | 0 | 2 | 0 | 2 | 0 | 0 | 4 |
| DCC2 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| FCS1 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| HBR2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| IPS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 4 | 0 | 0 | 0 | 0 | 4 |
| KNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 12 | 0 | 0 | 0 | 0 | 12 |
| MNS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 0 | 14 | 0 | 4 | 18 |
| NAS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| NEE3 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| PAL1 | 0 | 2 | 0 | 0 | 0 | 2 | 4 |
| PBN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| PIN2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 2 | 0 | 0 | 0 | 1 | 3 |
| SGS1 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| SGS2 | 0 | 6 | 0 | 0 | 0 | 0 | 6 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | 3 | 8 | 0 | 0 | 0 | 0 | 11 |
| SOS1 | 0 | 6 | 0 | 0 | 0 | 0 | 6 |
| SPS1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| SPS2 | 0 | 0 | 0 | 7 | 0 | 2 | 9 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TPS4 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| YKR1 | 0 | 0 | 0 | 10 | 0 | 0 | 10 |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 9 | 59 | 0 | 38 | 1 | 9 | 116 |

**Table A-20a. Fault counts for pumps—BWRs**

| FID | Component | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Axial | Centrifugal | Diaphragm | Gear | Reciprocating | Radial | Rotary | Van Typ |
| BEP1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| BEP2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| BRF1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | |
| BRF2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| BRF3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| BRP1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| CPR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| DAC1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | |
| DRS2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| DRS3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| EIH1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | |
| EIH2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| JAF1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| LAR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| MNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| MNS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| OCP1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | |
| PBS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PPS1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| QAD1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| VYS1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | |
| TOTAL | 0 | 25 | 8 | 0 | 0 | 0 | 0 | 1 |

| e | Jet | Other Type | Unknown Type | Total |
|---|---|---|---|---|
| 0 | 0 | 0 | 14 | 15 |
| 0 | 0 | 0 | 8 | 9 |
| 0 | 0 | 1 | 6 | 9 |
| 0 | 1 | 0 | 14 | 17 |
| 0 | 0 | 1 | 7 | 10 |
| 0 | 0 | 0 | 3 | 1 |
| 0 | 0 | 0 | 3 | 3 |
| 0 | 0 | 0 | 4 | 6 |
| 0 | 0 | 0 | 5 | 6 |
| 0 | 0 | 0 | 3 | 4 |
| 1 | 0 | 0 | 14 | 23 |
| 2 | 0 | 0 | 12 | 17 |
| 0 | 0 | 0 | 2 | 2 |
| 0 | 0 | 0 | 7 | 8 |
| 0 | 0 | 0 | 3 | 3 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 2 | 2 |
| 0 | 0 | 0 | 5 | 5 |
| 4 | 0 | 0 | 5 | 14 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 3 | 0 | 0 | 10 | 19 |
| 0 | 0 | 0 | 0 | 2 |
| 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 7 | 11 |
| 6 | 1 | 2 | 135 | 148 |

Also Available On
Aperture Card

Table A-20b. Fault counts for pumps—PWRs

| FID | Axial | Centrifugal | D |
|---|---|---|---|
| AN01 | 0 | 0 | |
| ANO2 | 0 | 1 | |
| BVS1 | 0 | 0 | |
| CCN1 | 0 | 0 | |
| CCN2 | 0 | 1 | |
| CRP3 | 1 | 2 | |
| DBS1 | 0 | 0 | |
| DCC1 | 0 | 0 | |
| DCC2 | 0 | 0 | |
| FCS1 | 0 | 0 | |
| HBR2 | 0 | 5 | |
| HNP1 | 0 | 1 | |
| IPS2 | 0 | 3 | |
| IPS3 | 0 | 1 | |
| JMF1 | 0 | 1 | |
| KNP1 | 0 | 4 | |
| MGS1 | 0 | 3 | |
| MNS2 | 0 | 4 | |
| MYP1 | 0 | 0 | |
| NAS1 | 0 | 0 | |
| NAS2 | 0 | 0 | |
| NEE1 | 0 | 0 | |
| NEE2 | 0 | 1 | |
| NEE3 | 0 | 0 | |
| PAL1 | 0 | 0 | |
| PBH1 | 0 | 0 | |
| PBH2 | 0 | 0 | |
| PIN1 | 0 | 0 | |
| PIN2 | 0 | 2 | |
| REG1 | 1 | 0 | |
| RSS1 | 0 | 2 | |
| SGS1 | 0 | 5 | |
| SGS2 | 0 | 0 | |
| SLS1 | 0 | 0 | |
| SNP1 | 0 | 7 | |
| SOS1 | 0 | 0 | |
| SPS1 | 0 | 7 | |
| SPS2 | 0 | [illegible] | |
| TMI1 | 0 | 0 | |
| TMI2 | 0 | 2 | |
| TNP1 | 0 | 1 | |
| TPS3 | 0 | 0 | |
| TPS4 | 0 | 2 | |
| YKR1 | 0 | 0 | |
| ZIS1 | 0 | 0 | |
| ZIS2 | 0 | 3 | |
| TOTAL | 2 | 79 | |

| | | | | Component | | | | |
|---|---|---|---|---|---|---|---|---|
| iaphragm | Gear | Reciprocating | Radial | Rotary | Vane Type | Other Type | Unknown Type | Total |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| 0 | 0 | 4 | 0 | 0 | 0 | 0 | 6 | 11 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 12 | 13 |
| 2 | 0 | 0 | 0 | 2 | 0 | 0 | 7 | 11 |
| 0 | 0 | 0 | 0 | 2 | 0 | 0 | 6 | 11 |
| 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 7 |
| 0 | 0 | 0 | 0 | 0 | [illegible] | 1 | 13 | 25 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 12 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | [illegible] |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 11 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 10 |
| 1 | 0 | 0 | 0 | 0 | 2 | 0 | 33 | 39 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 12 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 20 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 5 | 15 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 20 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 4 | 0 | 5 | 20 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | 23 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 7 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 19 |
| 4 | 2 | [illegible] | 0 | 5 | 14 | 1 | 276 | 39[illegible] |





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Table A-21a. Fault counts for valves—BWRs

| FID | Balancing Valve | Bypass Valve | Check Valve | Drain Valve | Flow Control Valve | Flush/ Purge Valve | Injection Valve | Isolation/ Shutoff Valve | Level Control Valve | Leakoff Valve | Relief Valve and Operator | Pressure Control Valve | Pressure Reducing Valve |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEP1 | 0 | 10 | 1 | 0 | 1 | 0 | 0 | 21 | 0 | 0 | 2 | 0 | 0 |
| BEP2 | 0 | 1 | 0 | 1 | 6 | 0 | 1 | 22 | [illegible] | 0 | 2 | 0 | 0 |
| BRF1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 3 | 0 | 0 |
| BRF2 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| BRF3 | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 19 | 0 | 0 | 0 | 0 | 0 |
| BRP1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| CPR1 | 0 | 0 | 4 | 0 | 2 | 0 | 0 | 43 | 0 | 0 | 0 | 0 | 0 |
| DAC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 1 | 4 | 0 | 0 |
| DRS2 | 0 | 0 | 3 | 0 | 1 | 0 | 1 | 21 | 0 | 0 | 1 | 0 | 0 |
| DRS3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 1 | 1 | 0 |
| EIH1 | 0 | 0 | 2 | 0 | 6 | 0 | 0 | 27 | 0 | 0 | 1 | 0 | 0 |
| EIH2 | 0 | 0 | 1 | 0 | 4 | 0 | 5 | 15 | 0 | 0 | 0 | 1 | 0 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| JAF1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 8 | 0 | 0 | 1 | 0 | 0 |
| LBR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] | 0 | 0 | 0 | 0 | 0 |
| MNP1 | 0 | 0 | 11 | 0 | 1 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 2 | 0 | 0 |
| NMP1 | 0 | 0 | 3 | 1 | 2 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 |
| OCP1 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 13 | 0 | 0 | 1 | 0 | 0 |
| PBS2 | 0 | 0 | 0 | 3 | 1 | 1 | 0 | 22 | 0 | 0 | 0 | 0 | 0 |
| PBS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 0 | 0 | 0 |
| PPS1 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 2 | 0 |
| QAD1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| QAD2 | 0 | 0 | 6 | 2 | 5 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 0 |
| VYS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 0 | 14 | 45 | 8 | 36 | 1 | 8 | 389 | 0 | 1 | 19 | 4 | 0 |

| FID | Recirculation Valve | Root Valve | Relief Valve | Speed/ Frequency Control Valve | Sample Valve | Temperature Control Valve | Telltale Valve | Vent Valve | Other Control Valve | Other Valve | Unknown Valve | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEP1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 42 |
| BEP2 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 5 | 44 |
| BRF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 26 |
| BRF2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 9 |
| BRF3 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 34 |
| BRP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 1 | 0 | 13 |
| CPR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 50 |
| DAC1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 30 |
| DRS2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 31 |
| DRS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| EIH1 | 0 | 2 | 9 | 1 | 0 | 0 | 0 | 2 | 1 | 3 | 23 | 77 |
| EIH2 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 6 | 4 | 40 |
| HMB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| JAF1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 13 |
| LBR1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] | 0 | 0 | 1 | 2 |
| MNP1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| MNS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 13 |
| NMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 28 |
| OCP1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 27 |
| PBS2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 36 |
| PBS3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 42 |
| PPS1 | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 47 |
| QAD1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| QAD2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 20 |
| VYS1 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | 1 | 25 |
| TOTAL | 4 | 7 | 31 | 5 | 0 | 0 | 3 | 12 | 4 | 37 | 57 | 665 |

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Table A-21b. Fault counts for valves—PWRs

| FID | Balancing Valve | Bypass Valve | Check Valve | Drain Valve | Flow Control Valve | Flush/ Purge Valve | Injection Valve | Isolation/ Shutoff Valve | Level Control Valve | Leakoff Valve | Relief Valve and Operator | Pressure Control Valve | Pressure Reducing Valve |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | | | | | |
| ANO1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 0 | 0 | 2 | 0 | 5 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| BVS1 | 0 | 2 | 0 | 1 | 3 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| CCN1 | 0 | 0 | 5 | 3 | 4 | 0 | 0 | 13 | 0 | 0 | 2 | 2 | 0 |
| CCN2 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 2 | 0 | 0 |
| CRP3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 17 | 0 | 0 | 1 | 0 | 0 |
| DBS1 | 0 | 1 | 10 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| DCC1 | 0 | 2 | 16 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 0 | 0 | 7 | 2 | 2 | 0 | 0 | 65 | 0 | 0 | 0 | 1 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 4 | 0 | 0 | 2 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 0 |
| IPS2 | 0 | 0 | 2 | 0 | 5 | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 8 | 0 | 0 | 0 | 1 | 0 |
| KNP1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 0 | 0 | 7 | 3 | 8 | 0 | 1 | 69 | 0 | 0 | 1 | 0 | 0 |
| MNS2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 10 | 0 | 0 | 1 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 0 | 8 | 0 | 1 | 0 | 0 | 12 | 0 | 0 | 6 | 0 | 0 |
| NAS2 | 0 | 0 | 7 | 2 | 2 | 0 | 0 | 11 | 0 | 0 | 12 | 0 | 0 |
| NEE1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| NEE2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| NEE3 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 |
| PAL1 | 0 | 0 | 5 | 1 | 1 | 0 | 0 | 16 | 0 | 0 | 0 | 1 | 0 |
| PBH1 | 0 | 0 | 4 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| PIN1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 0 | 2 | 1 | 7 | 0 | 0 | 9 | 0 | 0 | 1 | 0 | 0 |
| SGS2 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 7 | 0 | 0 | 8 | 0 | 0 |
| SLS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 |
| SNP1 | 0 | 0 | 5 | 0 | 4 | 0 | 0 | 8 | 3 | 0 | 1 | 2 | 0 |
| SOS1 | 0 | 0 | 1 | 0 | 7 | 0 | 2 | 10 | 0 | 0 | 1 | 1 | 0 |
| SPS1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 8 | 0 | 0 | 0 | 0 | 0 |
| SPS2 | 0 | 1 | 5 | 0 | 1 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| TNP1 | 0 | 0 | 1 | 3 | 2 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| TPS4 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 0 | 4 | 1 | 0 |
| YKR1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| ZIS2 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 |
| TOTAL - | 0 | 7 | 101 | 23 | 77 | 0 | 5 | 456 | 3 | 0 | 44 | 11 | 0 |

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**Table A-21b. (continued)**

| FID | Recirculation Valve | Root Valve | Relief Valve | Speed/ Frequency Control Valve | Sample Valve | Temperature Control Valve | Telltale Valve | Ve Va |
|---|---|---|---|---|---|---|---|---|
| AN01 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | |
| AN02 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| BVS1 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | |
| CCN1 | 0 | 2 | 5 | 0 | 0 | 0 | 0 | |
| CCN2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| CRP3 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | |
| DBS1 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | |
| DCC1 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | |
| DCC2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| HBR2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| HNP1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| IPS2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| JMF1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | |
| KNP1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | |
| MGS1 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | |
| MNS2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| MYP1 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | |
| NAS1 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | |
| NAS2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| NEE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NEE2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| NEE3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| PAL1 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | |
| PBH1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| PBH2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| PIN1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| REG1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| RSS1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | |
| SGS1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| SGS2 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | |
| SLS1 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | |
| SNP1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| SOS1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SPS1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | |
| SPS2 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TMI2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| TNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TPS4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| YKR1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | |
| ZIS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ZIS2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | 6 | 14 | 91 | 3 | 5 | 0 | 1 | 1 |

Component (spanning header over all valve columns)



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| Other Control Valve | Other Valve | Unknown Valve | Total |
|---|---|---|---|
| 0 | 1 | 0 | 5 |
| 0 | 1 | 0 | 13 |
| 0 | 7 | 2 | 32 |
| 0 | 1 | 0 | 37 |
| 0 | 0 | 0 | 15 |
| 0 | 0 | 1 | 26 |
| 0 | 0 | 9 | 34 |
| 0 | 1 | 2 | 42 |
| 0 | 0 | 4 | 82 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 5 | 15 |
| 2 | 0 | 0 | 9 |
| 0 | 0 | 0 | 14 |
| 0 | 0 | 0 | 2 |
| 0 | 1 | 1 | 17 |
| 0 | 2 | 0 | 12 |
| 0 | 6 | 1 | 108 |
| 0 | 0 | 12 | 26 |
| 0 | 0 | 1 | 15 |
| 0 | 0 | 6 | 58 |
| 0 | 9 | 3 | 48 |
| 0 | 0 | 2 | 8 |
| 0 | 1 | 3 | 8 |
| 0 | 0 | 1 | 16 |
| 0 | 0 | 1 | 39 |
| 0 | 0 | 31 | 38 |
| 0 | 0 | 0 | 6 |
| 0 | 0 | 1 | 3 |
| 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 4 |
| 0 | 2 | 4 | 21 |
| 0 | 3 | 1 | 27 |
| 0 | 4 | 14 | 45 |
| 1 | 0 | 0 | 18 |
| 0 | 2 | 4 | 31 |
| 0 | 0 | 4 | 27 |
| 0 | 1 | 1 | 16 |
| 0 | 2 | 6 | 38 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 11 |
| 0 | 0 | 6 | 22 |
| 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 13 |
| 0 | 0 | 0 | 8 |
| 0 | 0 | 0 | 9 |
| 0 | 0 | 4 | 16 |
| 4 | 44 | 130 | 1039 |

Table A-22a. Fault counts for valve operators—BWRs

| FID | Component | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Manual | Electric/ Servo | Hydraulic | Pneumatic | Solenoid | Float | Explosive/ Squib | Mechanical | Piston | Ball | Other Type | Unknown Type | Total |
| BFP1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 7 |
| BFP2 | 0 | 10 | 1 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 17 |
| BRF1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BRF2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| BRF3 | 0 | 7 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| BRP1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| CPR1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| DAC1 | 0 | 2 | 0 | 3 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 11 |
| DPR2 | 0 | 2 | 3 | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 16 |
| DPR3 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| EIH1 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| EIH2 | 0 | 4 | 3 | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 23 | 26 |
| HMB1 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 14 |
| JAF1 | 0 | 2 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LBR1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNP1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MNS1 | 0 | 2 | 0 | [illegible] | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| NMP1 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| OCP1 | 0 | 7 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 |
| PBS2 | 0 | 2 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 11 |
| PBS3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 13 |
| PPS1 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| QAD1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| QAD2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| VYS1 | 0 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 13 |
| TOTAL | 1 | 76 | 11 | 16 | 35 | 0 | 1 | 2 | 1 | 1 | 3 | 41 | 166 |

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Table A-22b. Fault counts for valve operators—PWRs

| FID | Component | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Manual | Electric/ Servo | Hydraulic | Pneumatic | Solenoid | Float | Explosive/ Squib | Mechan |
| AN01 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| ANO2 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 |
| BVS1 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 0 |
| CCN1 | 0 | 1 | 2 | 2 | 3 | 0 | 0 | 0 |
| CCN2 | 0 | 4 | 2 | 1 | 1 | 0 | 0 | 0 |
| CRP3 | 0 | 5 | 1 | 0 | 1 | 0 | 0 | 1 |
| CBS1 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 |
| DCC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCC2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| FCS1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HBR2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IPS2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| IPS3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMF1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| KNP1 | 0 | 5 | 2 | 0 | 0 | 0 | 0 | 0 |
| MGS1 | 1 | 8 | 0 | 4 | 1 | 0 | 0 | 0 |
| MNS2 | 0 | 13 | 0 | 0 | 1 | 0 | 0 | 0 |
| MYP1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| NAS1 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 0 |
| NAS2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEC1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEC2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| NEC3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| PAL1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| PBH1 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 0 |
| PBH2 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 |
| PIN1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| PIN2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REG1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RSS1 | 0 | 6 | 0 | 3 | 0 | 0 | 0 | 0 |
| SGS1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGS2 | 0 | 1 | 2 | 2 | 0 | 0 | 0 | 0 |
| SLS1 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 |
| SNP1 | 0 | 5 | 1 | 2 | 0 | 0 | 0 | 0 |
| SOS1 | 0 | 1 | 3 | 0 | 2 | 0 | 0 | 0 |
| SPS1 | 0 | 2 | 0 | 1 | 2 | 0 | 0 | 0 |
| SPS2 | 0 | 5 | 0 | 1 | 2 | 0 | 0 | 0 |
| TMI1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TMI2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| TNP1 | 1 | 4 | 0 | 0 | 1 | 0 | 0 | 0 |
| TPS3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| TPS4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| YKR1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZIS1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| ZIS2 | 0 | 1 | 1 | 3 | 2 | 0 | 0 | 0 |
| TOTAL | 4 | 130 | 16 | 38 | 23 | 0 | 0 | 3 |



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| ical | Piston | Ball | Other Type | Unknown Type | Total |
|---|---|---|---|---|---|
| | 0 | 0 | 0 | 1 | 4 |
| | 0 | 0 | 0 | 1 | 3 |
| | 0 | 0 | 0 | 7 | 12 |
| | 0 | 0 | 0 | 1 | 9 |
| | 0 | 0 | 0 | 1 | 9 |
| | 0 | 0 | 0 | 0 | 6 |
| | 0 | 0 | 0 | 0 | 4 |
| | 0 | 0 | 1 | 1 | 10 |
| | 0 | 0 | 0 | 1 | 2 |
| | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 1 | 1 |
| | 0 | 0 | 0 | 1 | 2 |
| | 0 | 0 | 0 | 1 | 0 |
| | 0 | 0 | 0 | 1 | 3 |
| | 0 | 0 | 0 | 0 | 7 |
| | 0 | 0 | 0 | 2 | 18 |
| | 0 | 0 | 0 | 1 | 15 |
| | 0 | 0 | 0 | 2 | 3 |
| | 0 | 0 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 11 | 13 |
| | 0 | 0 | 0 | 1 | 1 |
| | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 1 | 2 |
| | 0 | 0 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 0 | 32 |
| | 0 | 0 | 0 | 1 | 3 |
| | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 1 | 1 |
| | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 9 |
| | 0 | 0 | 0 | 0 | 2 |
| | 0 | 0 | 0 | 1 | 0 |
| | 0 | 0 | 0 | 1 | 3 |
| | 0 | 0 | 0 | 0 | 4 |
| | 0 | 0 | 0 | 1 | 4 |
| | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 1 | 2 |
| | 0 | 0 | 0 | 1 | 6 |
| | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 | 3 |
| | 0 | 0 | 0 | 0 | 7 |
| | 0 | 0 | 1 | 34 | 249 |

# APPENDIX B
# ADDITIONAL TREND AND PATTERN ANALYSIS CAPABILITIES

# APPENDIX B
# ADDITIONAL TREND AND PATTERN ANALYSIS CAPABILITIES

In this appendix multidimensional contingency tables represent the extent to which the SCSS data has been presented. The component tables in Appendix A and all other contingency tables appearing throughout the text were generated using input files prepared by CONTING[B-1] and CONTIN2[B-2] for Program P4F of the BMDP statistical package.[B-3]

The standard P4F input file prepared by these programs contains not only requests for table-formatted cell counts for all cells but also cell counts for all one- and two-way marginals and percent-of-total count figures for each cell. Additional table display options exist for BMDP-P4F; for example, the percent of column total option was used in the introductory material for the "Hardware Faults" section.

An even stronger additional feature of the trend and pattern analysis methodology is the capability to perform log-linear modeling and thus obtain a description of the relationships between the factors or variables in a multiway table. Although no requests for modeling are included in the standard file, the user may add P4F modeling commands on a case-by-case basis by editing the input file before submitting it for execution. In the remainder of this appendix, this capability will be explained further and an example involving selected SCSS personnel data will be presented.

## A Brief Description of Log Linear Modeling

In log-linear modeling the logarithm of the expected cell frequency is written as an additive function of main effects and interactions in a manner similar to the usual analysis of variance model. In the notation used in the BMDP documentation,[B-3] the log-linear model in three dimensions is written as

$$\ln F_{123} = \theta + \lambda_1 + \lambda_2 + \lambda_3 + \lambda_{12} + \lambda_{13} + \lambda_{23} + \lambda_{123} \qquad \text{(B-1)}$$

where

$F_{123}$ = expected cell counts in each cell of a three-dimensional array indexed by i = 1, I; j = 1, J; k = 1, K; for dimensions (variables, attributes) 1, 2 and 3, respectively (I is the number of categories or levels of the first attribute; J, the second; and K, the third)

$\theta$ = grand mean effect

$\lambda_1, \lambda_2, \lambda_3$ = main effects for the three dimensions

$\lambda_{12}, \lambda_{13}, \lambda_{23}$ = second order effects

$\lambda_{123}$ = third order effect.

The order of a term is synonymous with the number of different factors that in combination form a particular term; e.g., $\lambda_{12}$ is a second order term representing the first and second factors or dimensions in combination. In this notation, one may use further subscripts to denote effects for individual levels of the attributes; e.g., $\lambda_{12(ij)}$ is the second-order effect describing the interaction of the $i^{th}$ level of the first table dimension attribute with the $j^{th}$ level of the second attribute. When the additional subscripts are suppressed, the notation refers to the set of all such effects, over all the levels of the variables or attributes indexed by the subscripts. Standard log-linear modeling includes constraints that make the effects unique. The effects are a measure of the magnitude each term contributes to the expected cell frequency.

The model of Equation (B-1) is *saturated*; estimates for the λ's can be found so that the expected cell counts match the observed cell counts exactly. One may test the adequacy of log-linear models with selected sets of the effects assumed to

be zero and thus excluded. For example, one may test the hypothesis that the $\lambda_{123}$ are all zero. P4F finds maximum likelihood estimates of expected cell counts for hierarchical models; i.e., models for which the inclusion of an effect of a specified order implies the inclusion of all lower-order effect sets involving the same dimensions. The expected cell counts under assumed Poisson sampling are estimated using iterative proportional fitting (IPF).[B-4]

The IPF algorithm involves multiplying the rows and columns of an *initial fit matrix* by a series of factors that transform it into a matrix containing the expected cell counts for the model. This matrix generally starts as a matrix of all ones. However, P4F allows the user to override this default; one may for example declare certain cells to be structural zeros (empty cells; combinations of attributes that do not ever occur) by inputting zeros in the initial matrix for those cells.

An optional feature of the input files generated by CONTING and CONTING2, that has not been described in the main text other than in the terminology section, is an ability to include cell exposure times as an initial fit matrix for BMDP. These times are based on the plant identifiers and event date restriction (if any) associated with the cells, and may be measured in hours that the plants were critical or in ordinary calendar time. An area of the INEL SCSS data base containing critical hours for each plant for each month, based on the NRC Gray Books,[B-5] is used to calculate cell exposure times in critical hours for the initial fit matrix.

Specifying exposure times for each cell in a table as an initial fit matrix allows the user to apply log-linear models to occurrence (hazard) rates rather than counts. An example of such log-linear hazard modeling methodology was demonstrated by Laird and Olivier.[B-6] Laird and Olivier showed that if the exposure times are used as initial values and piecewise exponential sampling is assumed, then IPF yields cell estimates which, when divided by their respective exposure times, in turn yield a set of maximum likelihood estimates for occurrence or hazard rates. The given log-linear model in this case applies to these rates. Further, likelihood ratio tests based on the fitted counts are valid in making inferences about the hazard rates. With an initial fit matrix of exposure times, these rates are produced by P4F as expected values from the specified model.

Regardless of whether counts or rates are modeled, P4F uses either a weighted least squares method or mean removal to calculate parameter estimates (the $\lambda$'s in Equation B-1) and their standard errors if desired.

## A Trial Application Using Selected Personnel Data

The log-linear modeling approach to investigating the pattern or trend that may exist in a data set was applied to a contingency table for personnel errors in the SCSS data base. Personnel errors were used in this initial application of log-linear modeling techniques because they represent a unique and interesting subset of the SCSS database and they easily lend themselves to a configuration consisting of well defined categories. Also, one can readily form tables of manageable size that do not have overriding numbers of zeros with these data. The last reason stated is a significant factor that will be discussed later.

The original contingency table built through CONTING for this example consists of three SCSS fields, namely, **FID**, **PSYSTEM**, and **EVDATE**. For **FID** six plants were used. These six plants represented the three pressurized water reactor (PWR) and boiling water reactor (BWR) plants with the highest amount of LER reporting for 1981. The plants are listed below.

| BWRs | PWRs |
|---|---|
| **BEP2** - Brunswick Unit 2 | **MGS1** - McGuire Unit 1 |
| **EIH1** - Hatch Unit 1 | **SGS2** - Salem Unit 2 |
| **EIH2** - Hatch Unit 2 | **SNP1** - Sequoyah Unit 1 |

The SCSS **PSYSTEM** field for personnel step records reflects the activity engaged in when an incident occurs. Five activities were chosen for the modeling. The selection was based on their being deemed interesting from an engineering perspective and there being an appreciable number of records for each of these activities in the data base. The following activities were used:

| | |
|---|---|
| PD | Design Activity |
| PM | Maintenance/Repair Activity |
| PO | Operation Activity |
| PT | Test/Calibration Activity |
| PZ | Unknown Activity |

Finally, 1981 data were used in developing a model. The year was partitioned into four quarters. This partitioning was motivated by the interest in assessing whether or not the events being studied could be characterized by any underlying temporal trend or pattern. The four quarters of 1981 are labeled T1, T2, T3, and T4, respectively.

One other SCSS field was involved in this analysis. The SCSS EFFECT code when used in conjunction with personnel describes whether an omission or commission was involved. Some personnel records have the effect code **UF** (Desired Commission). These steps provide further information about reported events but are excluded from this study because they do not describe personnel errors.

With the basic structure of the table defined, the CONTING software package was then used. An initial run seeking the eleven personnel effect codes other than **UF** was used to form a set of step records describing personnel faults. A subsequent CONTING run using this set generated counts for a 6 x 5 x 4 table incorporating the plant (**FID**), activity (**PSYSTEM**), and **EVDATE** variables defined above. This run invoked the option for building a BMDP input deck for program P4F. The BMDP deck for this run, with the count data excluded, appears in Figure B-1. The deck was executed and an evaluation was made of the resulting contingency table. Figure B-2 shows the output, with percent of total and margin tables attached. The table has 120 cells and 295 observations, but 29 cells are zero. If the effect dimension were included for study, the same 295 observations would be spread among 1320 cells and the table would be extremely sparse.

Zero entries always pose some problem for log-linear modeling, since expected cell counts that follow a log model cannot be zero. The zeros in Figure B-2 are sampling zeros rather than structural zeros; given enough time for observation, eventually every cell would be nonzero. In the meantime, the data may not provide enough information to estimate all the parameters of specified log-linear models. The usual way of treating this situation is to assume that each effect whose cell counts are all zero is zero and make no attempt to estimate it. In essence the cells are treated as structural zeros and all the remaining effects with nonzero cell counts are estimated.

A number of additional alternatives for handling tables with sparse entries exist. Included are deletion of the rows and/or columns in the table whose sparsity inhibits the modeling, adding a small fraction to each cell in the table, and collapsing of categories into a lesser number of groups. The use of some of these alternatives is discussed below; References B-4, B-7, and B-8 provide further insights.

Returning to the particular model, after a number of iterations the decision was made to consolidate plants into the two groups, BWRs and PWRs. This change was made through a simple modification of the original BMDP deck produced by CONTING; adjacent columns or rows can be combined by the BMDP software by giving them a common name. Figure B-3 shows the modified BMDP deck with additional options specified for modeling. Commands in the deck which are new or modified are highlighted. The contingency table for this new configuration appears in Figure B-4.

In Figure B-3, the three fields **PSYSTEM**, **FID** and **EVDATE** are referenced, respectively, by the symbols **P**, **F**, and **T** (rather than the dimension numbers 1, 2, and 3 of Equation B-1). Also, a number of models for the data have been specified. Finding a good model is an exploratory process. The models specified in the figure represent only a small subset of those tested on the data. The ensuing discussion pertains only to the model ultimately chosen to characterize the data. However, there is no one model that can objectively be classified as the best model. Factors such as past knowledge of relationships between variables, physical constraints, and cost must be taken into consideration in development of any model.

The model selected to characterize the data is PF,T. That is, nonzero effects for the **PSYSTEM**-facility interaction and for event date will be included in the model. Since this is a hierarchical model, **P** and **F** are also terms whose main effects are included. The effect sets $\lambda_{PT}$, $\lambda_{FT}$, and $\lambda_{PFT}$ are assumed to be zero for this model.

Sections of the P4F output pertinent to this model are contained in Figure B-5. Figure B-5(b)[a] shows the expected cell frequencies generated.

a. Figure B-5 is marked with circled letters. These correspond to the letters in parentheses in the text figure references.

```
OVHBM,T37,P1,STANY.
ACCNT,ID=OVH,ORG=3540,BIN=TM3.
ATTACH,BMDP4F,ID=BMDP.
BMDP4F,W=50000.
*EOR
/ PROBLEM    TITLE IS
 'PERSONNEL MODELING 1981
/ INPUT      VARIABLES ARE 3.
             TABLE IS   5,  6,  4.
             FORMAT IS FREE.
/ VARIABLE   NAMES ARE PSYSTEM,FID      ,EVDATE .
/ TABLE      INDICES ARE PSYSTEM, FID      , EVDATE .
             SYMBOLS ARE A, B, C.
/ COMMENT '
          THE FOLLOWING TABLE SHOWS THE TIME CELLS
          AND CORRESPONDING EVENT DATE BOUNDARIES

   -----------------------------------------------------------
    CELL        BOUNDARY          CELL        BOUNDARY
   -----------------------------------------------------------
    T1      19810101-19810401     T3      19810701-19811001
    T2      19810401-19810701     T4      19811001-19820101
   -----------------------------------------------------------
          '.
/ CATEGORY
 CODES(3) ARE 1 TO   4
 NAMES(3) ARE
 'T1  ', 'T2  ', 'T3  ', 'T4  '.
 CODES(2) ARE 1 TO   6
 NAMES(2) ARE
 'BEP2', 'EIH1', 'EIH2', 'MGS1', 'SGS2', 'SNP1'.
 CODES(1) ARE 1 TO   5
 NAMES(1) ARE
 'PD  ', 'PM  ', 'PO  ', 'PT  ', 'PZ  '.
/ PRINT      OBS.PERC=TOT.MARGINALS=2.
/ COMMENT '
         SORT WAS PERFORMED ON SET  1 OF OLDSETS

         RECORD HITS WERE USED FOR FREQUENCY ACCUMULATION

         RECORDS PERTAINING TO BOTH FAILURES AND COMMAND
         FAULTS WERE SORTED


/ END
```

Figure B-1. Initial BMDP-P4F deck.

***** OBSERVED FREQUENCY TABLE 1

| EVDATE | FID | PSYSTEM PD | PM | PO | PI | PZ | TOTAL |
|---|---|---|---|---|---|---|---|
| T1 | BEP2 | 5 | 0 | 0 | 3 | 0 | 8 |
| | EIH1 | 2 | 0 | 0 | 0 | 1 | 3 |
| | EIH2 | 2 | 0 | 1 | 5 | 1 | 9 |
| | MGS1 | 6 | 4 | 3 | 1 | 1 | 15 |
| | SGS2 | 0 | 0 | 1 | 0 | 0 | 1 |
| | SNP1 | 5 | 2 | 4 | 6 | 2 | 19 |
| | TOTAL | 20 | 6 | 9 | 15 | 5 | 55 |
| T2 | BEP2 | 1 | 1 | 2 | 2 | 0 | 6 |
| | EIH1 | 7 | 1 | 0 | 2 | 2 | 12 |
| | EIH2 | 1 | 4 | 5 | 2 | 1 | 13 |
| | MGS1 | 6 | 15 | 15 | 5 | 2 | 43 |
| | SGS2 | 3 | 3 | 6 | 4 | 0 | 16 |
| | SNP1 | 6 | 2 | 1 | 1 | 1 | 11 |
| | TOTAL | 24 | 26 | 29 | 15 | 6 | 101 |
| T3 | BEP2 | 3 | 2 | 0 | 3 | 2 | 10 |
| | EIH1 | 1 | 5 | 2 | 1 | 1 | 10 |
| | EIH2 | 1 | 1 | 0 | 0 | 0 | 2 |
| | MGS1 | 11 | 14 | 13 | 2 | 1 | 41 |
| | SGS2 | 1 | 0 | 3 | 1 | 1 | 6 |
| | SNP1 | 4 | 2 | 0 | 6 | 3 | 15 |
| | TOTAL | 21 | 24 | 16 | 13 | 8 | 84 |
| T4 | BEP2 | 6 | 6 | 0 | 3 | 0 | 15 |
| | EIH1 | 2 | 0 | 3 | 1 | 0 | 6 |
| | EIH2 | 0 | 1 | 1 | 1 | 0 | 3 |
| | MGS1 | 4 | 2 | 3 | 5 | 2 | 17 |
| | SGS2 | 0 | 2 | 3 | 0 | 1 | 6 |
| | SNP1 | 2 | 2 | 3 | 0 | 1 | 8 |
| | TOTAL | 14 | 13 | 13 | 11 | 4 | 55 |

TOTAL OF THE OBSERVED FREQUENCY TABLE IS 295

Figure B-2. Output from initial BMDP-P4F run.

***** PERCENTS OF THE TABLE TOTAL -- TABLE 1

| EVDATE | FID | PD | PM | PO | PT | PZ | TOTAL |
|---|---|---|---|---|---|---|---|
| | | | | PSYSTEM | | | |
| T1 | BEP2 | 1.7 | 0.0 | 0.0 | 1.0 | 0.0 | 2.7 |
| | EIH1 | .7 | 0.0 | 0.0 | 0.0 | .3 | 1.0 |
| | EIH2 | .7 | 0.0 | .3 | 1.7 | .3 | 3.1 |
| | MGS1 | 2.0 | 1.4 | 1.0 | .3 | .3 | 5.1 |
| | SGS2 | 0.0 | 0.0 | .3 | 0.0 | 0.0 | .3 |
| | SNP1 | 1.7 | .7 | 1.4 | 2.0 | .7 | 5.4 |
| | TOTAL | 6.8 | 2.0 | 3.1 | 5.1 | 1.7 | 18.6 |
| T2 | BEP2 | .3 | .3 | .7 | .7 | 0.0 | 2.0 |
| | EIH1 | 2.4 | .3 | 0.0 | .7 | .7 | 4.1 |
| | EIH2 | .3 | 1.4 | 1.7 | .7 | .3 | 4.4 |
| | MGS1 | 2.0 | 5.1 | 5.1 | 1.7 | .7 | 14.6 |
| | SGS2 | 1.0 | 1.0 | 2.0 | 1.4 | 0.0 | 5.4 |
| | SNP1 | 2.0 | .7 | .3 | .3 | .3 | 3.7 |
| | TOTAL | 8.1 | 8.8 | 9.8 | 5.4 | 2.0 | 34.2 |
| T3 | BEP2 | 1.0 | .7 | 0.0 | 1.0 | .7 | 3.4 |
| | EIH1 | .3 | 1.7 | .7 | .3 | .3 | 3.4 |
| | EIH2 | .3 | .3 | 0.0 | 0.0 | 0.0 | .7 |
| | MGS1 | 3.7 | 4.7 | 4.4 | .7 | .3 | 13.9 |
| | SGS2 | .3 | 0.0 | 1.0 | .3 | .3 | 2.0 |
| | SNP1 | 1.4 | .7 | 0.0 | 2.0 | 1.0 | 5.1 |
| | TOTAL | 7.1 | 8.1 | 6.1 | 4.4 | 2.7 | 28.5 |
| T4 | BEP2 | 2.0 | 2.0 | 0.0 | 1.0 | 0.0 | 5.1 |
| | EIH1 | .7 | 0.0 | 1.0 | .3 | 0.0 | 2.0 |
| | EIH2 | 0.0 | .3 | .3 | .3 | 0.0 | 1.0 |
| | MGS1 | 1.4 | .7 | 1.0 | 2.0 | .7 | 5.8 |
| | SGS2 | 0.0 | .7 | 1.0 | 0.0 | .3 | 2.0 |
| | SNP1 | .7 | .7 | 1.0 | 0.0 | .3 | 2.7 |
| | TOTAL | 4.7 | 4.4 | 4.4 | 3.7 | 1.4 | 18.6 |

Figure B-2. (continued)

***** MARGINAL SUBTABLE -- TABLE 1

| PSYSTEM | | | | | |
|---|---|---|---|---|---|
| PD | PM | PJ | PT | PZ | TOTAL |
| 79 | 69 | 69 | 55 | 23 I | 295 |

***** MARGINAL SUBTABLE -- TABLE 1

| FID | | | | | | |
|---|---|---|---|---|---|---|
| BEP2 | EIH1 | EIH2 | MGS1 | SGS2 | SNP1 | TOTAL |
| 39 | 31 | 27 | 116 | 29 | 53 I | 295 |

***** MARGINAL SUBTABLE -- TABLE 1

| EVDATE | | | | |
|---|---|---|---|---|
| T1 | T2 | T3 | T4 | TOTAL |
| 55 | 101 | 84 | 55 I | 295 |

***** MARGINAL SUBTABLE -- TABLE 1

| FID | PSYSTEM | | | | | |
|---|---|---|---|---|---|---|
| | PD | PM | PJ | PT | PZ | TOTAL |
| BEP2 | 15 | 9 | 2 | 11 | 2 I | 39 |
| EIH1 | 12 | 6 | 5 | 4 | 4 I | 31 |
| EIH2 | 4 | 6 | 7 | 8 | 2 I | 27 |
| MGS1 | 27 | 35 | 34 | 14 | 6 I | 116 |
| SGS2 | 4 | 5 | 13 | 5 | 2 I | 29 |
| SNP1 | 17 | 8 | 8 | 13 | 7 I | 53 |
| TOTAL | 79 | 69 | 69 | 55 | 23 I | 295 |

Figure B-2. (continued)

***** MARGINAL SUBTABLE -- TABLE 1

| EVDATE | PSYSTEM | | | | | |
|---|---|---|---|---|---|---|
| | PD | PM | PO | PT | PZ | TOTAL |
| T1 | 20 | 6 | 9 | 15 | 5 | 55 |
| T2 | 24 | 26 | 29 | 16 | 6 | 101 |
| T3 | 21 | 24 | 18 | 13 | 8 | 84 |
| T4 | 14 | 13 | 13 | 11 | 4 | 55 |
| TOTAL | 79 | 69 | 69 | 55 | 23 | 295 |

***** MARGINAL SUBTABLE -- TABLE 1

| EVDATE | FID | | | | | | |
|---|---|---|---|---|---|---|---|
| | BEP2 | EIH1 | EIH2 | MGS1 | SGS2 | SNP1 | TOTAL |
| T1 | 8 | 3 | 9 | 15 | 1 | 19 | 55 |
| T2 | 6 | 12 | 13 | 43 | 15 | 11 | 101 |
| T3 | 10 | 10 | 2 | 41 | 6 | 15 | 84 |
| T4 | 15 | 6 | 3 | 17 | 6 | 8 | 55 |
| TOTAL | 39 | 31 | 27 | 116 | 29 | 53 | 295 |

Figure B-2. (continued)

```
    OVHBM,T37,P1,STANY.
    ACCNT,ID=OVH,ORG=3540,BIN=TM3.
    ATTACH,BMDP4F,ID=BMDP.
    BMDP4F,W=50000.
    *EOR
    / PROBLEM     TITLE IS
     'PERSONNEL MODELING 1981
    / INPUT       VARIABLES ARE 3.
                  TABLE IS   5,  6,  4.
                  FORMAT IS FREE.
    / VARIABLE    NAMES ARE PSYSTEM,FID    ,EVDATE .
    / TABLE       INDICES ARE PSYSTEM, FID    , EVDATE .
→     SYMBOLS ARE P,F,T.
→   /FIT MODEL IS PF,FT,PT.
→    CELL=STAN.STEP=8.PROB=.25.
→      ADD IS MULTIPLE.DELETE IS SIMPLE.STRATA IS PSYSTEM.
→   /FIT MODEL IS FP,T.
→    CELL=STAN.STEP=8.PROB=.25.
→     ADD IS MULTIPLE.DELETE IS SIMPLE.STRATA IS PSYSTEM.
→   /FIT MODEL IS F,PT.
→    CELL=STAN.STEP=8.PROB=.25.

→     ADD IS MULTIPLE .DELETE IS SIMPLE.STRATA IS PSYSTEM.
→   /FIT MODEL IS FT,P.
→    CELL=STAN.STEP=8.PROB=.25.
→     ADD IS MULTIPLE .DELETE IS SIMPLE .STRATA IS PSYSTEM.
→   /FIT MODEL IS  P,F,T.
→   CELL=STAN.STEP=8.PROB=.25.
→     ADD IS MULTIPLE.DELETE IS SIMPLE.STRATA IS PSYSTEM.
→   /PRINT  OBS.EXP.LAMBDA.BETA.PERC=TOT.
```

Figure B-3. Modified BMDP-P4F deck.

```
/ COMMENT '
        THE FOLLOWING TABLE SHOWS THE TIME CELLS
        AND CORRESPONDING EVENT DATE BOUNDARIES

     -------------------------------------------------------
      CELL        BOUNDARY          CELL        BOUNDARY
     -------------------------------------------------------
      T1     19810101-19810401      T3     19810701-19811001
      T2     19810401-19810701      T4     19811001-19820101
     -------------------------------------------------------
        '.
/ CATEGORY
 CODES(3) ARE 1 TO   4
 NAMES(3) ARE
 'T1  ', 'T2  ', 'T3  ', 'T4  '.
 CODES(2) ARE 1 TO   6
 NAMES(2) ARE
+'BWR', 'BWR', 'BWR', 'PWR', 'PWR', 'PWR'.
 CODES(1) ARE 1 TO   5
 NAMES(1) ARE
 'PD  ', 'PM  ', 'PO  ', 'PT  ', 'PZ  '.
/ COMMENT '
       SORT WAS PERFORMED ON SET  1 OF OLDSETS

       RECORD HITS WERE USED FOR FREQUENCY ACCUMULATION

       RECORDS PERTAINING TO BOTH FAILURES AND COMMAND
       FAULTS WERE SORTED

        '.
/ END
```

Figure B-3. (continued)

***** OBSERVED FREQUENCY TABLE 1

| EVDATE | FID | PSYSTEM PD | PM | PU | PT | PZ | TOTAL |
|---|---|---|---|---|---|---|---|
| T1 | BWR | 9 | 0 | 1 | 3 | 2 | 20 |
| | PWR | 11 | 6 | 8 | 7 | 3 | 35 |
| | TOTAL | 20 | 6 | 9 | 15 | 5 | 55 |
| T2 | BWR | 9 | 6 | 7 | 8 | 3 | 31 |
| | PWR | 15 | 20 | 22 | 10 | 3 | 70 |
| | TOTAL | 24 | 26 | 29 | [illegible] | [illegible] | [illegible] |
| T3 | BWR | 5 | 8 | 2 | 4 | 3 | 22 |
| | PWR | 16 | 16 | 16 | 9 | 5 | 62 |
| | TOTAL | 21 | 24 | 18 | 13 | 8 | 84 |
| T4 | BWR | 8 | 7 | 4 | 5 | 0 | 24 |
| | PWR | 6 | 6 | 9 | [illegible] | 4 | 31 |
| | TOTAL | 14 | 13 | 13 | 11 | 4 | 55 |

TOTAL OF THE OBSERVED FREQUENCY TABLE IS 295

Figure B-4. Observed frequency table from modified BMDP-P4F run.

| MODEL | D.F. | LIKELIHOOD-RATIO CHI-SQUARE | PROB | PEARSON CHI-SQUARE | PROB | ITER. |
|---|---|---|---|---|---|---|
| PF,T. | 27 | 35.31 | .1313 | 30.26 | .3015 | 2 |

(a)

***** EXPECTED VALUES USING ABOVE MODEL

(b)

| EVDATE | FID | PSYSTEM PD | PM | PO | PT | PZ | TOTAL |
|---|---|---|---|---|---|---|---|
| T1 | BWR | 5.8 | 3.9 | 2.6 | 4.3 | 1.5 | 18.1 |
| | PWR | 8.9 | 8.9 | 10.3 | 6.0 | 2.8 | 36.9 |
| | TOTAL | 14.7 | 12.9 | 12.9 | 10.3 | 4.3 | 55.0 |
| T2 | BWR | 10.6 | 7.2 | 4.8 | 7.9 | 2.7 | 33.2 |
| | PWR | 16.4 | 16.4 | 18.8 | 11.0 | 5.1 | 67.8 |
| | TOTAL | 27.0 | 23.6 | 23.6 | 18.9 | 7.9 | 101.0 |
| T3 | BWR | 8.8 | 6.0 | 4.0 | 6.5 | 2.3 | 27.6 |
| | PWR | 13.7 | 13.7 | 15.7 | 9.1 | 4.3 | 56.4 |
| | TOTAL | 22.5 | 19.6 | 19.6 | 15.7 | 6.5 | 84.0 |
| T4 | BWR | 5.8 | 3.9 | 2.6 | 4.3 | 1.5 | 18.1 |
| | PWR | 8.9 | 8.9 | 10.3 | 6.0 | 2.8 | 36.9 |
| | TOTAL | 14.7 | 12.9 | 12.9 | 10.3 | 4.3 | 55.0 |

Figure B-5. Modified BMDP-P4F-run output for selected model.

ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE (c)
THETA(MEAN) 1.8038

ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)
EXP(THETA) 6.0725

***** ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

| PSYSTEM | | | | |
|---|---|---|---|---|
| PD | PM | PO | PT | PZ |
| .427 | .232 | .098 | .075 | -.832 |

***** RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

| PSYSTEM | | | | |
|---|---|---|---|---|
| PD | PM | PO | PT | PZ |
| 3.783 | 1.894 | .723 | .593 | -4.543 |

***** ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

| PSYSTEM | | | | |
|---|---|---|---|---|
| PD | PM | PO | PT | PZ |
| 1.533 | 1.261 | 1.103 | 1.078 | .435 |

***** ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

| FID | |
|---|---|
| BWR | PWR |
| -.359 | .359 |

***** RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

| FID | |
|---|---|
| BWR | PWR |
| -5.196 | 5.196 |

***** ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

| FID | |
|---|---|
| BWR | PWR |
| .698 | 1.432 |

(d)

Figure B-5. (continued)

***** ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

| EVDATE | | | |
|---|---|---|---|
| T1 | T2 | T3 | T4 |
| -.258 | .350 | .166 | -.258 |

***** RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

| EVDATE | | | |
|---|---|---|---|
| T1 | T2 | T3 | T4 |
| -2.285 | 3.777 | 1.692 | -2.285 |

***** ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

| EVDATE | | | |
|---|---|---|---|
| T1 | T2 | T3 | T4 |
| .773 | 1.419 | 1.180 | .773 |

***** ESTIMATES OF THE LOG-LINEAR PARAMETERS (LAMBDA) IN THE MODEL ABOVE

| FID | PSYSTEM | | | | |
|---|---|---|---|---|---|
| | PD | PM | PO | PT | PZ |
| BWR | .140 | -.054 | -.325 | .194 | .045 |
| PWR | -.140 | .054 | .325 | -.194 | -.045 |

***** RATIO OF THE LOG-LINEAR PARAMETER ESTIMATES (LAMBDA) TO ITS STANDARD ERROR

| FID | PSYSTEM | | | | |
|---|---|---|---|---|---|
| | PD | PM | PO | PT | PZ |
| BWR | 1.245 | -.442 | -2.408 | 1.534 | .245 |
| PWR | -1.245 | .442 | 2.408 | -1.534 | -.245 |

***** ESTIMATES OF THE MULTIPLICATIVE PARAMETERS (BETA = EXP(LAMBDA)

| FID | PSYSTEM | | | | |
|---|---|---|---|---|---|
| | PD | PM | PO | PT | PZ |
| BWR | 1.151 | .947 | .723 | 1.214 | 1.046 |
| PWR | .869 | 1.056 | 1.384 | .824 | .956 |

(e)

Figure B-5. (continued)

MODELS FORMED BY ADDING TERMS TO MODEL -- PF,T.

| MODEL | | MULTIPLE EFFECT | D.F. | LIKELIHOOD-RATIO CHI-SQUARE | PROB | | PEARSON CHI-SQUARE | PROB |
|---|---|---|---|---|---|---|---|---|
| PT,PF. | | | 15 | 21.01 | .1367 | | 18.08 | .2586 |
| | DIFF. DUE TO ADDING | PT. | 12 | 14.30 | .2819 | | 12.21 | .4292 |
| FT,PF. | | | 24 | 30.26 | .1763 | (f) | 24.64 | .4256 |
| | DIFF. DUE TO ADDING | FT. | 3 | 5.05 | .1684 | | 5.65 | .1302 |
| PFT. | | | 0 | 0.00 | 1.0000 | | 0.00 | 1.0000 |
| | DIFF. DUE TO ADDING | PFT. | 27 | 35.31 | .1313 | | 30.28 | .3015 |

STEP 1. BEST MODEL FOUND IS -- PFT.

STEPPING STOPS DUE TO CRITERION PROBABILITY ( .250).

MODELS FORMED BY DELETING TERMS FROM MODEL -- PF,T.

| MODEL | | SIMPLE EFFECT | D.F. | LIKELIHOOD-RATIO CHI-SQUARE | PROB | | PEARSON CHI-SQUARE | PROB |
|---|---|---|---|---|---|---|---|---|
| PF. | | | 30 | 56.15 | .0026 | | 48.47 | .0178 |
| | DIFF. DUE TO DELETING | T. | 3 | 20.84 | .0001 | | 18.19 | .0004 |
| F,P,T. | | | 31 | 44.25 | .0581 | (g) | 39.29 | .1458 |
| | DIFF. DUE TO DELETING | PF. | 4 | 8.94 | .0625 | | 9.01 | .0609 |

STEP 1. BEST MODEL FOUND IS -- F,P,T.

STEPPING STOPS DUE TO CRITERION PROBABILITY ( .250).

*****DELETION OF STRATA

| VARIABLE | CATEGORY | CHISQUARE | D.F. | PROB. | |
|---|---|---|---|---|---|
| PSYSTEM | PD | 14.85 | 9 | .09521 | |
| PSYSTEM | PM | 8.28 | 9 | .50656 | (h) |
| PSYSTEM | PO | 14.83 | 9 | .09561 | |
| PSYSTEM | PT | 14.87 | 9 | .09450 | |
| PSYSTEM | PZ | 10.00 | 9 | .35076 | |

Figure B-5. (continued)

Estimates of the effects for the model are given in Figure B-5(c). Equation (B-1) together with the model implies that the (i,j,k) cell frequency can be estimated as

$$\exp(\theta) \cdot \exp[\lambda_{P(i)}] \cdot \exp[\lambda_{F(j)}] \cdot \exp[\lambda_{T(k)}] \cdot \exp[\lambda_{PF(ij)}] \qquad \text{(B-2)}$$

and the *multiplicative parameters* in the listing give these values. For example, the multiplicative *PWR* effect [see Figure B-5(d)] of 1.43 shows that counts for the PWR plant cells in the table are on the average roughly 43% higher than the overall average. Detailed interpretation of these effects and the model itself in general requires insight and knowledge on the part of the individual doing the analysis regarding the *real world* meaning of the factors being modeled in addition to an understanding of the mathematics involved in the modeling procedure itself.

A basic way of assessing how good the model fits the data is through evaluating the chi-square ($\chi^2$) statistic computed from the observed and expected data. The $\chi^2$ statistic can be computed either through the likelihood-ratio (LR) method or the Pearson method. In both cases the statistic is a measure of the overall amount of deviation between the expected and observed cell frequency counts. These statistics are presented in Figure B-5(a). The magnitude of the $\chi^2$ statistics must be evaluated relative to the specific configuration for a prescribed table and relative to the specified model. For this model the $\chi^2$ statistics and associated probability levels are (35.31, P = 0.13) and (30.28, P = 0.30), respectively for the LR and Pearson statistics. The probability level can be interpreted as the probability of getting a larger $\chi^2$ value under the hypothesis that the model is true. Low probability values imply that either the model is not acceptable or the observed data is rare for that model. The observed values for the PF,T model indicate a moderately good fit with this model; that is, the data give us no reason to suspect that the model is totally inadequate. However, it could be of interest and benefit to pursue trying to enhance the fit of the model to the data. Two common ways this is done are through addition or deletion of terms for the model and exclusion of selected cells from the data.

Figure B-5(f) shows the effect of including additional terms in the model. A better fit is obtained when the term FT is added. For the resulting model (FT,PF) the LR and Pearson $\chi^2$ statistics are 0.17 and 0.42, respectively. The significance of this observed change in the adequacy of the fit, again, is a subjective question that can only be answered specific to the particular application.

One might also try to enhance the model by deletion of terms. In particular, the term PF is of interest. The effects associated with the interaction between **PSYSTEM** and type of facility (PF) are shown in Figure 5(e). For example, the P4F output shows that, after adjusting for the main (overall) differences between the selected BWR and PWR plants, for design activities (**PD**) the BWR plant counts on the average remain about 15% higher than the average, while for operation activities (**PO**) PWR plant counts remain about 38% higher than the average. This indicates the relationship between **PSYSTEM** and **FID** may depend on the particular **PSYSTEM** and **FID** combination. The need to include this term in the model is reflected in the $\chi^2$ statistics obtained with the term deleted. Figure B-5(g) shows that the LR and Pearson $\chi^2$ statistics for the model (P, F, T) (without the interaction term) are 0.05 and 0.14, respectively; these in contrast to 0.13 and 0.30 with PF included.

The final section of the BMDP output, see Figure B-5(h), provides information about the level of PSYSTEM which has the greatest impact on the fit of the model. Maintenance is the type of activity which is least accommodated by the selected model.

The fact that the PF,T model provides a reasonable fit coupled with the fact that the $\chi^2$ statistics do not improve through adding PT to the model (Pearson $\chi^2$ actually decreases) indicates that the distribution of the personnel activities studied does not significantly change from one quarter to another in 1981 for the high-reporting plants.

In summary, with log-linear modeling a capability to statistically investigate the relationships present in the data exists. The application of this capability to SCSS data is in its preliminary stages; for example, the normalizing capability for studying hazard rates was not demonstrated in this trial application because its use in conjunction with collapsing categories to produce less sparse tables is still under development. However, log-linear hazard rate modeling is appropriate for this data and more insight about operational events will be gained through engineering analysis of events flagged by these methods as they evolve further.

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13. ABSTRACT (200 words or less)

This report presents an overview of the 1981 Sequence Coding and Search System (SCSS) data base that contains nuclear power plant operational data derived from Licensee Event Reports (LERs) submitted to the United States Nuclear Regulatory Commission. Both overall event reporting and events related to specific components, subsystems, systems, and personnel are discussed. At all of these levels of information, software is used to generate count data for contingency tables. Contingency table analysis is the main tool for the trend and pattern analysis.

The tables primarily focus on faults associated with various components and other items of interest across different plants. The abstracts and other SCSS information on the LERs accounting for unusual counts in the tables were examined to gain insights from the events.

14. DOCUMENT ANALYSIS – a. KEYWORDS/DESCRIPTORS

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EXPLORATORY TREND AND PATTERN ANALYSIS OF 1981 LICENSEE EVENT REPORT DATA

APRIL 1985

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## Draft Regulatory Analysis For Current Proposed Amendment

Revision of 10 CFR §50.55a
Codes and Standards

1. Statement of the Problem

The General Design Criteria (Appendix A of Part 50) of the NRC Regulations require that structures, systems, and components of light-water-reactors be designed, fabricated, erected, constructed, tested and inspected to quality standards commensurate with the importance of the safety function performed. Without a set of specific rules to implement these quality standards, it would be necessary for each applicant/licensee to develop its own program for submittal to the NRC. Each program would have to be reviewed by the staff on a case-by-case basis. This would increase significantly the licensing review time and would make inspections by the staff more difficult because of the nonstandard nature of each program.

To provide a consistent set of rules, which the industry has participated in developing, §50.55a mandates use of Section III of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for construction of Class 1, 2, 3 components, and Section XI of the ASME Code for inservice inspection of those components. Section III and Section XI are implemented by applicants/licensees of all light-water-cooled reactors. The NRC first endorsed the ASME Code by reference in 10 CFR §50.55a in 1971. The ASME publishes a new edition of the Code every three years and new addenda every 6 months. It has been a continuing policy of the Commission to update this section of the regulations to keep the references current. In those cases where an item in the ASME Code is inconsistent with NRC criteria, an exception may be taken to endorsing that portion of the Code, or supplementary criteria may be incorporated to make the item consistent with staff requirements.

Section 50.55a last endorsed the 1980 Edition and addenda through the Summer 1982 Addenda. Since then, the Winter 1982 Addenda, Summer 1983 Addenda, Winter 1983 Addenda, Summer 1984 Addenda, and 1983 Edition have been published by the ASME. The purpose of this proposed rule is to incorporate the new edition and addenda into the regulations.

The ASME Code is developed by the consensus process, which ensures that the various industry sectors (e.g., utility, NSSS suppliers, regulatory) are represented on the standards writing committees and that their viewpoints are considered in the standards writing process. Endorsement of the ASME Code by the NRC provides a method of incorporating rules into the regulatory process that are acceptable to the NRC and have received industry participation in their development.

If the NRC did not take action to endorse the ASME Code, the NRC position on the methods for construction and inservice inspection would have to be established on a case-by-case basis. If the NRC did not take action to update the ASME Code references, improved methods for construction and inservice inspection might not be implemented.

2. Objectives

The proposed rule would:

- Incorporate by reference into §50.55a of the NRC's regulations the Winter 1982 Addenda, Summer 1983 Addenda, Winter 1983 Addenda, Summer 1984 Addenda, and 1983 Edition of Section III, Division 1, and the Winter 1982 Addenda, Summer 1983 Addenda, and 1983 Edition of Section XI, Division 1, of the ASME Code.

- Incorporate revisions to correct certain existing footnote and paragraph references; to simplify the language of the rule; and to delete two obsolete provisions.

3. Alternatives

An alternative to incorporating by reference into NRC's regulations the latest requirements of Section III, Division 1, and Section XI, Division 1, and making certain editorial revisions would be to take no action. This would mean that the NRC position on the methods for construction and inservice inspection contained in the latest edition and addenda of the ASME Code would have to be provided on a case-by-case basis; certain incorrect footnote and paragraph references would remain in the present rule; and obsolete provisions would remain to clutter the rule.

A second alternative to incorporating by reference the latest requirements of Section III, Division 1, and Section XI, Division 1, is to incorporate the entire text of these sections of the ASME Code into the NRC regulations. Because of the volume of these sections, this approach is not practicable.

4. Consequences

Incorporating by reference the latest edition and addenda of the ASME Code will establish the NRC staff position on these Code rules on a generic basis for applicants/licensees thereby minimizing the need for case-by-case evaluations and reducing the time and effort required for submittal preparations and license reviews.

The cost/benefit of ASME Code revisions is balanced by the manner in which these revisions are achieved through the American National Standards Institute (ANSI) consensus process. The ANSI consensus process ensures that participation in ASME Code development is open to all persons and organizations that might reasonably be expected to be directly and materially affected by the activity, and ensures that such persons and organizations shall have the opportunity for fair and equitable participation without dominance by any single interest. Consensus is established when substantial agreement has been achieved by the interests involved. Consensus requires that all views and objectives be considered, and that a concerted effort be made toward resolution. ASME Code proposed revisions are published for public comment in the ASME Mechanical Engineering and ANSI Reporter publications prior to being submitted for final ASME and ANSI approval. Adverse public comments are referred to the appropriate technical committee for resolution.

The consensus process ensures a proper balance between utility, regulatory and other interests concerned with revisions to the ASME Code, and ensures that the cost of any Code revision is consistent with its benefit.

Implementation of the new ASME Code rules requires certain additional information collection requirements. The Supporting Statement for Information Collection Requirements in 10 CFR §50.55a is provided in Appendix A.

The proposed rule affects only the licensing and operation of nuclear power plants. The companies that own these plants do not fall within the scope of the definition of "small entities" set forth in the Regulatory Flexibility Act in the Small Business Size Standards set out in regulations issued by the Small Business Administration at 13 CFR Part 121. Since these companies are dominant in their serv'ce areas, this proposed rule does not fall in the province of this Act. The proposed rule will have no significant effect on a substantial number of small companies.

5. Decision Rationale

From the above analysis it is concluded that the proposed revision to incorporate the latest edition and addenda of the ASME Code will save applicants/licensees and the NRC staff both time and effort by providing uniform detailed criteria against which the staff can review any single submission. No significant additional cost to the applicants/licensees is expected as a result of NRC endorsement of the new ASME Code edition and addenda.

6. Implementation

No implementation problems are anticipated. The framework for implementation is already established in both the industry and the NRC.

## Appendix A

## Supporting Statement for Information Collection Requirements in 10 CFR §50.55a

1. Justification

a. Need for the Information Collection

NRC Regulations in 10 CFR §50.55a incorporate by reference Section III, Division 1, and Section XI, Division 1, of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). These sections of the ASME Code set forth the requirements to which nuclear power plant components are designed, constructed, tested and inspected. Inherent in these requirements are certain recordkeeping functions.

Incorporation of the Winter 1982 Addenda, Summer 1983 Addenda, Winter 1983 Addenda, Summer 1984 Addenda, and 1983 Edition for Section III, Division 1, of the ASME Code would add the following recordkeeping requirements.

Section III

- Winter 1982 Addenda
  NB-2125, Fabricated Hubbed Flanges - New provision for surface examination requires documentation of examination results.

- Summer 1983 Addenda
  No additional recordkeeping

- Winter 1983 Addenda

  NCA-3650, Design Documents for Appurtenances - Requires Design Document for each appurtenance that is to be attached to a component unless it is already included in the component Design Documents.

- Summer 1984 Addenda
  NB/NC-7240, Review of (Overpressure Protection) Report After Installation - Addendum to report required to document any modification of the installation from that used for preparation of the Overpressure Protection Report.

  ND-7200, Overpressure Protection Report - Requires overpressure protection report for Class 3 components to define the protected systems and the integrated overpressure protection provided, and (ND-7240) documentation of any modification of the installation from that used for preparation of the Overpressure Protection Report.

- 1983 Edition[1]
  All requirements, except those for Winter 1982 Addenda, previously incorporated in separate amendments to 10 CFR §50.55a.

[1] The 1983 Edition of Section III is equivalent to the 1980 Edition, as modified by the Summer 1980 Addenda, Winter 1980 Addenda, Summer 1981 Addenda, Winter 1981 Addenda, Summer 1982 Addenda, and the Winter 1982 Addenda.

Incorporation of the Winter 1982 Addenda, Summer 1983 Addenda, and the 1983 Edition of Section XI, Division 1, of the ASME Code would add the following recordkeeping requirements.

Section XI

- Winter 1982 Addenda
  IWA-6220(b), Preparation (of Records and Reports) - Requires preparation of Owner's Report for Repairs or Replacements (Form NIS-2).

- Summer 1983 Addenda
  No additional recordkeeping

- 1983 Edition[2]
  All requirements, except those for Winter 1982 Addenda, previously incorporated in separate amendments to 10 CFR §50.55a.

The Winter 1982 Addenda of the ASME Code references ANSI/ASME NQA-1-1979, "Quality Assurance Program Requirements for Nuclear Power Plants." NQA-1-1979 is based upon the contents of ANSI/ASME N45.2-1979, "Quality Assurance Program Requirements for Nuclear Facilities" and seven daughter standards. These standards are referenced in Regulatory Guides 1.28, 1.58, 1.64, 1.74, 1.88, 1.123, 1.144, and 1.146 as providing methods acceptable for implementing certain NRC quality assurance program requirements. NQA-1-1979 incorporates no recordkeeping beyond that originally required by the N45 standards upon which it is based. There is, therefore, no additional recordkeeping burden associated with the endorsement of NQA-1-1979.

b. Practical Utility of the Information Collection

These records are used by the licensees, National Board inspectors, insurance companies, and the NRC in the review of a variety of activities, many of which affect safety. The records are generally historical in nature and provide data on which future activities can be based. NRC Inspection and Enforcement personnel can spot check the records required by the ASME Code to determine, for example, if proper inservice examination test methods were utilized.

c. Duplication With Other Collections of Information

ASME requirements are incorporated to avoid the need for writing equivalent NRC requirements. The final rule will not duplicate the information collection requirements contained in any other generic regulatory requirement.

d. Consultations Outside the NRC

No consultations.

[2] The 1983 Edition of Section XI is equivalent to the 1980 Edition, as modified by the Winter 1980 Addenda, Winter 1981 Addenda, and the Winter 1982 Addenda.

e. Other Supporting Information

NRC applicants and licensees have been complying with the information collection requirements of the ASME Code since 1971. No problems with these information collection requirements have been identified to the NRC by the applicants or licensees.

2. Description of the Information Collection

a. Number and Type of Respondents

In general, the information collection requirements incurred by §50.55a through endorsement of the Code apply to the owners of the 34 nuclear power plants under construction and to the owners of the 93 nuclear power plants in operation. The actual number of plants that would implement the edition and addenda addressed by the proposed revision, and thereby be affected by their information collection requirements, is dependent on a variety of factors. These factors include whether the application is for Section III or Section XI, the class and type of components involved, the dates of the construction permit and construction permit application, the schedule of the inservice inspection program, and whether the plant voluntarily elects to implement updated editions and addenda of the ASME Code.

b. Reasonableness of the Schedule for Collecting Information

The information is generally not collected, but is retained by the licensee to be made available to the NRC in the event of an NRC inspection or audit.

c. Method of Collecting the Information

See Item 2(b).

d. Adequacy of the Description of the Information

The ASME Code provides listings of information required and specific forms to assist, where necessary, in documenting required information.

e. Record Retention Period

The retention period for information is in accordance with a schedule provided in Table NCA-4134.17-1 of the ASME Code. The retention periods for information keeping requirements specified in Item 1.a above are:

| Information | Retention Period[3] |
|---|---|
| Design document for appurtenances | Lifetime |
| Overpressure protection report | Lifetime |
| Reports for repair and replacement | Lifetime |
| Final nondestructive examination report | Lifetime |

Lifetime retention of the above records is necessary to ensure adequate historical information on the design and examination of components and systems to provide a basis for evaluating degradation of these components and systems at any time during their service lifetime.

3. Estimate of Burden

a. Estimated Hours

The information collection requirements inherent in incorporating by reference the latest edition and addenda of Section III, Division 1, and Section XI, Division 1, of the ASME Code are identified in Item 1.a above. These requirements may be categorized in terms of Section III requirements that document component/system design and the results of construction examinations, and Section XI requirements that document repairs and replacements.

The additional Section III requirements incur a one-time burden on plants under construction. The information collection requirements associated with the proposed edition and addenda are generation of the design documents for appurtenances and the overpressure protection report. Section 50.55a specifies that the Code Edition, Addenda, and optional Code Cases to be applied to reactor coolant pressure boundary, and Quality Group B and Quality Group C components must be determined by the provisions of paragraph NCA-1140 of Subsection NCA of Section III of the ASME Code. NCA-1140 specifies that the owner (or his designee) shall establish the ASME Code edition and addenda to be included in the Design Specifications, but that in no case shall the Code edition and addenda dates established in the Design Specifications be earlier than three years prior to the date that the nuclear power plant construction permit is docketed. NCA-1140 further states that later ASME Code editions and addenda may be used by mutual consent of the Owner (or his designee) and Certificate Holder. The earliest Section III addenda being addressed in the proposed rule is the Winter 1982 Addenda. Since the last plant to be docketed that is still under construction was docketed in October 1974 (Palo Verde Units 1, 2, 3), there is no plant under construction for which implementation of the Section III edition and addenda specified in the proposed rule is a requirement. Plants may implement these improved rules on a voluntary basis, but unless they make that choice, there is no additional paperwork burden associated with incorporating the proposed Section III edition and addenda.

[3] Service lifetime of the component or system.

The additional Section XI requirements incur a burden associated with the documentation of component repairs and replacements. To facilitate this documentation, Section XI provides Form NIS-2, "Owners' Report for Repairs or Replacements." Information required by this form relates to identifying the owner and facility; identifying the components repaired or replaced and replacement components; identifying the type of work, the repair organization and by whom the work was performed; and identifying the type of tests conducted. A portion of this information, such as that to identify the owner, facility and components is already required by Form NIS-1, "Owners' Data Report for Inservice Inspections," (Form NIS-1 was part of an addenda previously incorporated by reference into §50.55a). Most of the remaining information required by Form NIS-2 can be obtained from the previously prepared component work/repair order. It is estimated that the time required to complete the required documentation on Form NIS-2 is ten hours.

Nuclear power plants are required to update their inservice inspection programs by incorporating into their initial 120-month inspection interval requirements of the latest edition and addenda of Section XI, Division 1, that have been incorporated by reference into §50.55a as of 12 months prior to the date of issuance of the operating license; and by incorporating into successive 120-month inspection intervals requirements of the latest edition and addenda of Section XI that have been incorporated by reference as of 12 months prior to the start of a 120-month inspection interval. On this basis, many plants will at one time be required to implement the Section XI, Division 1, edition and addenda specified in the proposed rule. The number of plants that will be implementing the specified edition and addenda will grow gradually as each plant updates its inservice inspection program at the 10-year interval. Therefore, conservatively, the total number of plants that may ultimately be required to implement the specified edition and addenda is 127 (i.e., 93 operating plants and 34 plants under construction).

Inservice inspections are typically performed at the time of refueling (i.e., approximately every 18 months). The need to complete an NIS-2 form would occur as a result of a repair required by the results of an inservice inspection, or as a result of an unanticipated repair between refuelings. It is estimated that 2 NIS-2 forms are completed for repairs resulting from the inspection and 2 for repairs required during operation. Assuming applicability to 127 plants, and the completion of 4 NIS-2 forms by each plant every 18 months, with ten hours required to collect information and complete each form, it is estimated that the total time required by all utilities to complete the NIS-2 form is approximately 3400 hours/year (i.e., 4 forms x 127 plants = 508 forms per 18 months, 508 forms x 2 = 1016 forms per 3 years, 1016 forms / 3 = 339 forms per year, 339 forms x 10 hours per form = 3390 hours per year). The time required to maintain these repair and replacement records for

the period noted in Item 2.e is estimated to be 1 hour/year for each plant. Thus, the total time required by all utilities to complete and maintain the NIS-2 form is approximately 3517 hours/year.

b. Estimated Cost Required to Respond to the Collection

Based upon the hours specified in Item 3.a, it is estimated that the cost of responding to the information collection required by the Section III, Division 1, and Section XI, Division 1, edition and addenda specified in the proposed amendment to §50.55a is a total of $211,020/year (3517 hrs x $60/hr) for 127 plants.

c. Source of Burden Data and Method for Estimating Burden

Estimates of the number of NIS-2 forms that are completed during a year and the time required to collect the necessary information and to complete the forms, were obtained from utility staff inservice inspection specialists and NRC staff in the Office of Inspection and Enforcement (regional and headquarters) engaged in inservice inspection activities.

d. Reasonableness of Burden Estimate

The estimate of the burden is considered reasonable because of the reliable source of the burden data.

4. Estimate of Cost to the Federal Government

NRC inspection personnel who audit plant quality assurance records would include in their audit verification of the proper implementation of the NIS-2 form. The time associated with NRC inspectors verifying use of the NIS-2 form would be extremely small when the activity is performed as part of a normal quality assurance audit.