## DATA ON SELECTED PROCESS SYSTEMS AND EQUIPMENT

| Taxonomy No. 3.3.4 | Equipment Description ROTATING EQUIPMENT-MOTOR-DRIVEN FANS |
|---|---|
| Operating Mode | Process Severity UNKNOWN |

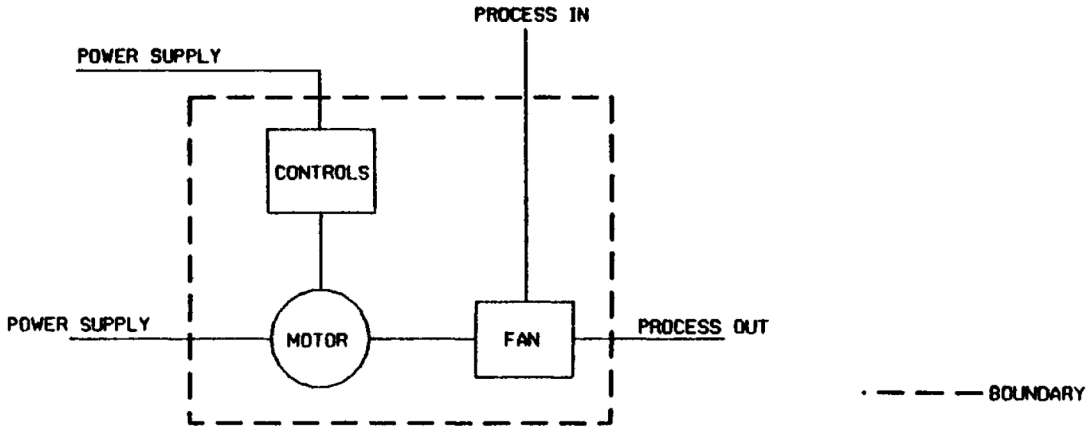
| Population | Samples | Aggregated time in service ($10^6$ hrs) | | No. of Demands |
|---|---|---|---|---|
| | | Calendar time | Operating time | |

| Failure mode | Failures (per $10^6$ hrs) | | | Failures (per $10^3$ demands) | | |
|---|---|---|---|---|---|---|
| | Lower | Mean | Upper | Lower | Mean | Upper |
| CATASTROPHIC | | | | | | |
| a. Fails while Running | 1.75 | 9.09 | 24.7 | | | |
| b. Spurious Start/Command Fault | | | | | | |
| c. Fails to Start on Demand | | | | 0.00944 | 0.208 | 0.769 |
| d. Fails to Stop on Demand | | | | | | |

**Use of rates higher than the mean are not warranted for ventilation service.**

**For fans in the presence of abrasives, corrosives or regular exposure to the elements a higher rate should be considered.**

**Equipment Boundary**




**Data Reference No. (Table 5.1):** 8.2, 8.4, 8.5, 8.15

## DATA ON SELECTED PROCESS SYSTEMS AND EQUIPMENT

| Taxonomy No. | 1.1.1.1 | Equipment Description | MOTORS - AC - INDUCTION |
|---|---|---|---|
| Operating Mode | | Process Severity | UNKNOWN |

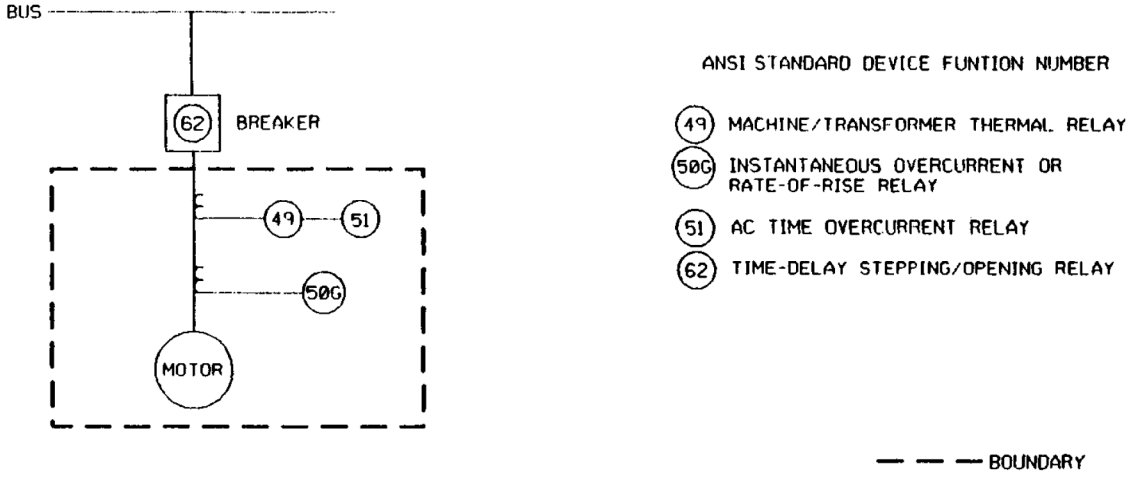
| Population | Samples | Aggregated time in service ( $10^6$ hrs) | | No. of Demands |
|---|---|---|---|---|
| | | Calendar time | Operating time | |

| Failure mode | Failures (per $10^6$ hrs) | | | Failures (per $10^3$ demands) | | |
|---|---|---|---|---|---|---|
| | Lower | Mean | Upper | Lower | Mean | Upper |
| CATASTROPHIC<br>a. Fails to Run Once Started<br>b. Fails to Position Properly<br>c. Fails to Start on Demand | 0.311 | 3.20 | 10.5 | 0.00448 | 0.0247 | 0.0685 |
| DEGRADED<br>a. Shaft Fails to Run at Rated Speed<br>b. Fails to Position Correctly<br>c. "Hunts" for Correct Position | | | | | | |

**Reality check: An electric motor alone should have lower rates than a fan (motor, fan, controls).**

**The rates for just an electric motor are significantly lower.**

**Equipment Boundary**




**Data Reference No. (Table 5.1):** 8.2, 8.5

## DATA ON SELECTED PROCESS SYSTEMS AND EQUIPMENT

| Taxonomy No. 1.2.6 | Equipment Description FUSES |
|---|---|
| Operating Mode | Process Severity UNKNOWN |

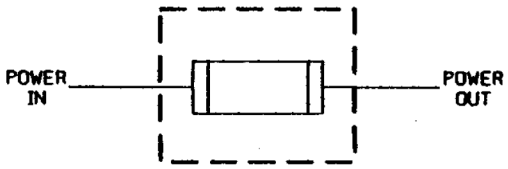
| Population | Samples | Aggregated time in service ( $10^6$ hrs) | | No. of Demands |
|---|---|---|---|---|
| | | Calendar time | Operating time | |

| Failure mode | Failures (per $10^6$ hrs) | | | Failures (per $10^3$ demands) | | |
|---|---|---|---|---|---|---|
| | Lower | Mean | Upper | Lower | Mean | Upper |
| CATASTROPHIC<br>a. Premature Open | 0.0265 | 0.634 | 2.36 | | | |

Also called fuse fatigue or fuse aging. Caused by cyclical current stresses that heat the fuse element.

Significant for element "in air" type fuses and less so for solid matrix fuses due to heat dissipation by the matrix.

Use of mean rate appropriate for fuses protecting sporadic motor operation at ambient temperture. Motor starts of more than 6 per hour are not sporadic.




· — — — BOUNDARY

Data Reference No. (Table 5.1): 8.2, 8.3, 8.5, 8.15

## DATA ON SELECTED PROCESS SYSTEMS AND EQUIPMENT

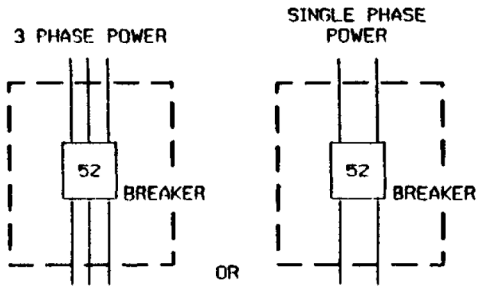
| Taxonomy No. 1.2.3.1 | Equipment Description CIRCUIT BREAKERS - AC |
|---|---|
| Operating Mode | Process Severity UNKNOWN |

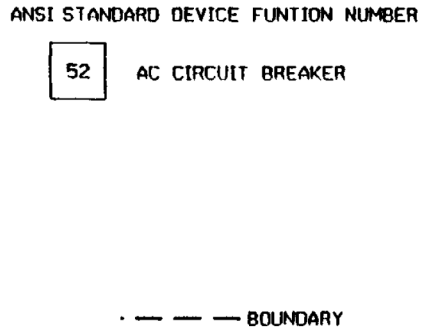
| Population | Samples | Aggregated time in service ( $10^6$ hrs) | | No. of Demands |
|---|---|---|---|---|
| | | Calendar time | Operating time | |

| Failure mode | Failures (per $10^6$ hrs) | | | Failures (per $10^3$ demands) | | |
|---|---|---|---|---|---|---|
| | Lower | Mean | Upper | Lower | Mean | Upper |
| CATASTROPHIC<br>a. Spurious Operation<br>b. Failed to Open on Demand<br>c. Failed to Close on Demand | 0.162 | 1.75 | 5.79 | 0.203 | 1.16 | 3.24 |
| DEGRADED | | | | | | |
| INCIPIENT<br>a. Contaminated | | | | | | |

**Use of breaker spurious operation appropriate when equipment is protected by breaker or plugged into circuit protected by a local breaker panel.**

**Large breakers protecting multiple fuse panels are electrical infrastructure and part of site power reliability.**




**Data Reference No. (Table 5.1):** 7, 8.1, 8.2, 8.3, 8.4, 8.6, 8.11, 8.12, 8.14, 8.15

TABLE 5.1
Resources Used for Data Tables

| Data Reference No. | | Data Resource Title | Chapter 4 Resource No. |
|---|---|---|---|
| 1. | | Development of an Improved Liquefied Natural Gas Plant Failure Rate Data Base. | 4.3-2 |
| 2. | | Pressure Vessel Reliability. | 4.4-1 |
| 3. | | Some Data on the Reliability of Pressure Equipment in the Chemical Plant Environment. | 4.4-3 |
| 4. | | Some Data on the Reliability of Instruments in the Chemical Plant Environment | 4.4-4 |
| 5. | | Failure and Maintenance Data Analysis at a Petrochemical Plant. | 4.4-5 |
| 6. | | Hazardous Waste Tank Failure. | 4.5-1 |
| 7. | | Reliability Data Book for Components in Swedish Nuclear Power Plants. | 4.6-6 |
| 8.* | | SAIC Proprietary Data Set containing data from: | 4.6-10 |
| | 8.1 | The In-Plant Reliability Data Base for Nuclear Power Plant Components. | 4.6-11 |
| | 8.2 | IEEE Standard 500-1984. | 4.6-12 |
| | 8.3 | Generic Data Base for Data and Models Chapter of the National Reliability Evaluation Program Guide (NREP). | 4.6-13 |
| | 8.4 | Offshore Reliability Data Handbook (OREDA). | 4.6-14 |
| | 8.5 | RADC Non-Electronic Reliability Notebook. | 4.6-15 |
| | 8.6 | Reliability Prediction of Electronic Equipment (Military Handbook 217E). | 4.6-16 |
| | 8.7 | Data Summaries of Licensee Event Reports at U.S. Commercial Nuclear Power Plants (Various Components). | 4.7-8 |
| | 8.8 | Reliability of Emergency Diesel Generators at U.S. Nuclear Power Plants. | 4.7-14 |
| | 8.9 | Big Rock Point Probabilistic Risk Assessment. | 4.8-1 |
| | 8.10 | Indian Point Units 2 and 3 Probabilistic Risk Assessment. | 4.8-3 |
| | 8.11 | Interim Reliability Evaluation Program: Analysis of the Millstone Point 1 Nuclear Power Plant Assessment. | 4.8-5 |
| | 8.12 | Oconee-3 PRA: A Probabilistic Risk Assessment of Oconee Unit 3. | 4.8-6 |
| | 8.13 | Yankee Nuclear Power Station Probabilistic Safety Study. | 4.8-7 |
| | 8.14 | Zion Probabilistic Safety Study. | 4.8-8 |
| | 8.15 | Reactor Safety Study: An Assessment of Accident Risk in U.S. Commercial Nuclear Power Plants (WASH-1400). | 4.8-9 |
| 9. | | An Analysis of Reportable Incidents for Natural Gas Transmission and Gathering Lines—1970 through June 1984. | 4.7-19 |
| 10. | | Pressure Vessel Failure Statistics and Probabilities. | 4.7-21 |

*Note: SAIC has selected some data from resources 8.1 through 8.15 to construct its proprietary data files for use in performing PRAs. Relevant data from these files was used to construct the CCPS Generic Failure Rate Data Base. Accordingly, all usable data points contained in the resources used by SAIC may not be in the Data Tables in this book.

GUIDELINES FOR

# PROCESS EQUIPMENT RELIABILITY DATA

## WITH DATA TABLES

**CENTER FOR CHEMICAL PROCESS SAFETY**
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