

## **Annex Q**

# **Survey of Reliability and Availability Information for Power Distribution, Power Generation, and HVAC Components for Commercial, Industrial, and Utility Installations**

**By**

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**SURVEY OF RELIABILITY AND AVAILABILITY INFORMATION  
FOR POWER DISTRIBUTION, POWER GENERATION, AND  
HVAC COMPONENTS FOR COMMERCIAL, INDUSTRIAL,  
AND UTILITY INSTALLATIONS**

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**Abstract**

This paper presents the culmination of a 24,000 man-hour effort to collect operational and maintenance data on 204 power generation, power distribution and HVAC items, including gas turbine generators, diesel engine generators, electrical switchgear, cables, circuit breakers, boilers, piping, valves, pumps, motors and chillers. The data collection process and the resultant data are the subject of this paper.

The Power Reliability Enhancement Program established the data collection effort to determine the effects of "new technology" equipment, i.e., equipment installed after 1971, on reliability and availability. Previous data collection efforts were completed in the early 1970's using data collected in the 1950's and 1960's. The primary purpose of the data collection effort was to provide more current equipment reliability and availability data when performing a facility reliability/availability assessment. Information was obtained on a variety of commercial and industrial facility types (including office buildings, hospitals, water treatment facilities, prisons, utilities, manufacturing facilities, school universities and bank computer centers), with varying degrees of maintenance quality.

Data collection guidelines and goals were established to ensure that sufficient operational and maintenance data were collected for statistically valid analysis. Minimums of 3.5 million calendar hours were established for each component. Time-to-failure data, helpful in model development, were collected, when available, to determine device failure characteristics. A database system, with flexible output capabilities, was developed to track both the equipment information

(containing over 6,000 records of operational and maintenance data) and the contact information (containing over 3,500 records identifying information sources). The levels of data quality and maintenance quality were assessed during the analysis phase of the project.

The results indicated that the maintenance quality level was a major predictor of equipment availability, therefore, the availability values presented represent an average maintenance program across all the data sources. In addition, the information obtained can aid facility designers and engineers in evaluating different designs to minimize production/mission failure and to estimate the down times associated with various systems or sub-systems. Facility types that require more maintenance time and systems that may benefit from redundancy or replacement can also be identified.

The U.S. Army Corps of Engineers, Power Reliability Enhancement Program, located in Fort Belvoir, VA, sponsored this two-year program. The work was accomplished by the Reliability Analysis Center (RAC) in Rome, NY.

I. INTRODUCTION

The U.S. Army Corps of Engineers, Power Reliability Enhancement Program (PREP) sponsored a study of the reliability, availability and maintainability characteristics of 204-power generation, power distribution, and Heating Ventilation and Air Conditioning (HVAC) items. This paper describes the data collection and summarization of all 204 items. The Reliability Analysis Center (RAC), a DoD Information Analysis Center operated by IIT Research Institute, in Rome New York, began the work in October 1991 and delivered the final report in early 1994.

## II. BACKGROUND

The Power Reliability Enhancement Program established a utility system availability goal of 0.999999 (31.5 sec/yr. downtime) at Command, Control, Communication, Computers and Intelligence facilities worldwide. The methodology PREP used in calculating the system reliability and availability was a Boolean algebra based modeling technique using individual equipment reliability values to produce the system model.

Prior to this study, PREP based its predictions on component reliability and availability information developed in the early 1970's that had been compiled from multiple sources. However, PREP had discovered problems with using this information source since the information contradicted itself and contained some confusing data. In addition, the database did not fully address maintenance. Therefore, it became apparent that the data needed to be updated.

## III. DATABASE DEVELOPMENT

A computerized system named PREPIS (Power Reliability Enhancement Program Information System) was developed to assist technical staff in organizing, tracking, analyzing, and reporting all of the technical and contact information during the execution of this PREP program. The two major components in PREPIS are:

1. Contact records: contains site information; it is comprised of 6208 contact records.
2. Equipment records: contains performance and maintenance information; it includes 4043 equipment records.
3. This comprehensive database system was organized functionally to support the following tasks:
  - Record individual site information
  - Prioritize site visits
  - Collect and organize site data
  - Data input and verification
  - Data summarization and analysis
  - Report generation

The output record generator contains several "canned" reports designed for data summary and availability calculations. Some of the reports are designed to allow the user the flexibility to select a multitude of query topics. The format of the report generator allows easy construction of custom reports for individual needs.

This database, developed in 1991, was adequate for the task. As new, more efficient database tools were developed it became apparent that a more portable, user friendly database tool was needed. In addition several inquiries of the database resulted in a significant effort to recreate data reports to satisfy requests. A better method was sought to minimize this time.

RAC began the arduous task in 1998 of creating a common database and has transferred the data into Microsoft Office Access database allowing the user the ability to develop customized data extraction scenarios on a

PC. The database can now be placed on a CD and transferred to anyone with Microsoft Office Access.

### *Database Information*

In order to collect statistically valid data it was important that a stratified survey of different facility categories, applications and operating conditions be conducted. Guidelines were developed to assist in the selection of potential sites. These guidelines include:

1. Locations surveyed were required to have varying degrees of maintenance practices.
2. A number of sites for each facility category were predetermined; this was required to eliminate any skewing of the data caused by the influence of limited data.
3. Component size was also a basis of site selection to ensure that similar technologies were being compared.
4. Equipment age was also considered to ensure that data from both the newer high-efficiency generation of equipment and the older technology generation were included.

The first of these was included because it is known that maintenance policies and practices directly affect equipment availability. High levels of maintenance lower availability, but have the potential to increase reliability. Too little maintenance raises availability, but has the potential to decrease reliability. During a prolonged period of operation time with little maintenance, availability and reliability both decrease drastically. The amount of maintenance performed can drastically affect the performance parameters being collected.

A process of identification and certification of data was developed to ensure that each data collection trip was successful. Minimum requirements for data were established to ensure a sound statistical basis for the analysis:

- A minimum of five years of operational data was collected.
- A minimum sample size of 40 with a maximum site allocation of 10 items each was imposed.
- A minimum of 3.5 million calendar hours total for each component was established.

### *Data Contacts*

Contacts were the key to the success of this program. The cooperation and support of the people involved from the many facilities, even during times of budget and personnel reduction is demonstrated in the quality of data received to support the PREP.

A concerted effort was employed to develop an extensive contact database using manufacturers, facilities, societies, and locations of any potential data contributor utilizing PREP components. Manufacturers were contacted not only for contacts, but also for any warranty data that may be available. A total of 25 manufacturers participated, including Caterpillar, Westinghouse Electric, EMD, and MFG Systems Corporation. A total of 25 professional societies were contacted, including:

- American Gas Association
- National Association of Power Engineers
- American Society of Mechanical Engineers
- Association of Physical Plant Administrators
- Association of Energy Engineers

#### IV. DATA SUMMARIZATION AND CLASSIFICATION

##### *Data Completeness*

As with every data collection program, there are varying degrees of completeness in the data gathered. Some data sources had complete records and could give statistics on operational characteristics on every piece of equipment from installation date to that current moment of time. More often, the only items tracked were major items such as cooling towers and boilers. Data for items such as valves and filters were not usually recorded. Other problems included incomplete or non-current versions of the equipment's blue prints. Several RAC technicians manually developed parts lists, recording data from nameplates and relying on facility engineers for component descriptions.

It became important to categorize the different levels of data completeness to ensure that the final data collection included fair data representation for each component. To quantify this data completion (or quality) index, RAC identified these four levels:

1. Perfect Data: Data needed for a valid, complete reliability study, including a parts list, failure history data with time-to-failure statistics, parts description data, operational periods, and ten continuous years of recorded data. No engineering judgment or data extrapolation is required. The PREPIS equipment record database is comprised of 10% to 20% of this type of data.
2. Not Perfect Data: Data with no serious flaws, but the data collection process demanded additional time to ensure useful information was gathered. Examples include parts list determined by inspection, incomplete blueprints or less than ten years of data. The PREPIS equipment record database contains 35% to 40% of this type of data.
3. Verbal/Inspection Data: Data with serious gaps that required additional documentation and verification prior to its inclusion in the database. Items included were typically major items, such as generator sets and boilers. Senior maintenance personnel were interviewed to extract the necessary information to fill the data gaps. These interviews were used as support documentation to recorded data, not as data source information. About 25% of this type of data exist in the PREPIS equipment record database.
4. Soft Data: Data that relied on the memories of experienced maintenance personnel from the participating facility; it was often extracted from log books containing maintenance personnel entries, filing cabinets with work order forms, and repair records when outside repair support was needed. Engineering judgment was often used to

determine numerous performance parameters. This type of data was the most difficult and time consuming to summarize and was only used when no other data sources were available. The PREPIS equipment record database is comprised of 10% to 15% of this type of data.

##### *Maintenance Policy*

The major intent of the data collection effort was to minimize the effects of maintenance policies and procedures on the calculated availability values by collecting data from a variety of locations having various maintenance policies. RAC personnel developed a code to categorize each facility's maintenance policies and procedures into one of three levels:

Code "1": Above average maintenance policy. The facility not only followed a scheduled, preventative maintenance policy that was equivalent or similar to the manufacturer's suggested policy, but also went beyond it, such as using redundant units, specialized equipment tests (thermograph, vibration analysis, oil analysis), complete spare parts kits for equipment, and so on.

Code "2": Average maintenance policy. Facility used either in-house maintenance crews performing scheduled, preventative maintenance according to the equipment manufacturer's suggested PM schedule or a combination of in-house maintenance crews and outside contractors. In both cases, it was verified that they did actually follow a fairly rigid schedule.

Code "3": Below average maintenance policy. Facility's actual policy was less than average. It may have instituted a scheduled maintenance policy but not followed it or it may have had no maintenance policy. Symptoms such as leaky valves with rags tied around them, dirty air filters, squeaky bearings, lose belts, and general house keeping because of unavailable manpower were typical signs that maintenance at a facility was less than desirable.

Each location was then compared to each other and to the average maintenance policy. Overall, the facilities that RAC visited practiced an average level of maintenance; that is, they adhered to the manufacturers recommended maintenance policy. RAC looked at approximately the same number of facilities that had below average maintenance policies as those facilities that had an above average maintenance policy.

##### *Results*

Attached to this paper are the 204 components representing the PREP database. It is presented in a hierarchical structure to provide the analyst with numeric options if the exact component is not identified. As an example, the CATEGORY of Accumulator is comprised of two CLASSES (Pressurized and Unpressurized). Each of the CLASSES is comprised of individual data points. Reliability numeric is derived for each data point listed within a CLASS and displayed in columns in the database report.

The numeric is then rolled-up to the CLASS level to indicate a combination of information within each CLASS. Subsequently the data from the CLASS level is rolled-up

into the CATEGORY level. The reliability numeric becomes more generically applied to the item as the information is rolled-up to the next higher level. Where we had various sizes for example, transformer capacities, information was combined to create a general transformer number.

Table 1 is provided to help you understand and properly apply the data categories in your analysis. The summary information calculated from the individual equipment records is also included.

Definitions of each category are given below. These definitions are referenced in several reliability publications and the formulas can be verified in the RAC Toolkit for commercial practices, page 12, or MIL-STD-339, or in the IEEE standard definition publication. Definitions include the following:

- (MDT) = Mean Down Time is the average down time caused by scheduled and unscheduled maintenance, including any logistics time.
- (MTBM) = Mean Time Between Maintenance is the average time between scheduled and unscheduled maintenance, including logistics time.
- (Tp) = Total Period is the Calendar time over which data for the item was collected.
- (Rdt) = Repair Down Time is the Total Down Time for Repairs Due to failures (Unscheduled Maintenance).
- (Mdt) = Maintenance Down Time is the Total Down Time for scheduled maintenance (including logistics time).
- 8760 = Total Hours in a Year (non-leapyear).
- Ao = Operational Availability considers down time for Scheduled (repair due to failures) and Unscheduled maintenance, including Logistics

- Ai = Inherent Availability considers down time for repair to failures only, no logistics time. Reference RAC Toolkit, MIL-STD-338, and IEEE Dictionary.
- Rel = Reliability calculation based on the exponential distribution. Reference RAC Toolkit, MIL-STD-338, and IEEE Dictionary.  $\lambda$  represents the failure rate of the item and  $t$  represents the period of data collection in calendar time divided by 8760.
- Total\_Fails = Total number of failure occurrences during the Total Period.
- Total\_Maint = Total number of maintenance actions (Scheduled Maintenance) during the Total Period.
- MTBF = Mean Time Between Failures is the average time calculated between failure occurrences.
- MTTR = Mean Time To Repair is the average time to accomplish repairs on an item.
- MTTM = Mean Time To Maintain is the average time
- Hrdt/Yr. = (Mean Hours Down Time per Year) = Average hours the item is expected to be not functional based on a year.

The attached database identifies reliability and availability numeric for 204 components. Items with 0 failures, reliability statistics are calculated using the Chi Squared 60% confidence interval based on time truncated data. This common approach to data with no failures associated with the data collection time frame is explained in MIL-HDBK-338, section 8.3.2.5.2, Confidence Limits – Exponential Distribution. These items are identified by an asterisk (\*) in the database report.

TABLE 1

| Calculated Data                     | Formula for Calculation   |
|-------------------------------------|---|
| Ao, Operational Availability        | $Ao = (MTBF/MTBF+MDT)$  |
| Ai, Inherent Availability           | $Ai = (MTBF/MTBF+MTTR)$   |
| Rel, Reliability                    | $Rel = e^{-\lambda t}$  |
| FR, Failure Rate (per Year)         | $FR/Yr. = Total\ Failures / (Tp / 8760)$                        |
| MTBF, Mean Time Between Failures    | $MTBF = Tp / Total\_Fails$                                      |
| MTTR, Mean Time To Repair           | $MTTR = Rdt / Total\_Fails$                                     |
| MTTM, Mean Time To Maintain         | $MTTM = Mdt / Total\_Maint$                                     |
| MTBM, Mean Time Between Maintenance | $MTBM = Tp / All\ Actions,\ Maintenance\ and\ Repair$           |
| MDT, Mean Down Time                 | $MDT = (Rdt + Mdt) / All\ Actions,\ Maintenance\ and\ Repair$   |
| Hours Downtime per Year             | $Hrdt/Yr. = (rpt\_repair\_time + rpt\_maint\_time) / (Tp/8760)$ |

## V. CONCLUSIONS

Information collected in this study is useful in determining the site reliability or availability. The actual value that is predicted for a specific system may not be totally definitive, but the comparisons between systems is of greater value.

The data and procedure can be used in different manners to aid the facility designer and facility engineer. The designer can use the data to evaluate different designs. The designer can estimate the length of downtime by adding the failure time to the production or mission loss and can estimate the total length of time from line stop to line start as a result of failures. New designs or redesigns can be evaluated to minimize the production/mission failure with estimates on money saved by avoiding downtime. The engineer can estimate the down times associated with the systems or sub-systems and compare these results to the actual times. This could identify problem areas that may need more (or less) maintenance time and systems that may benefit from redundancy or replacement.

## VI. WHERE TO GET ADDITIONAL INFORMATION

Additional information including list of contacts and specific maintenance information may be obtained from:

U.S. Army Corps of Engineers  
Special Missions Office  
Power Reliability Enhancement Program (PREP)  
10115 Gridley Road  
Fort Belvoir, VA 22060-5859  
(703) 704-2777

Reliability Analysis Center  
201 Mill Street  
Rome, NY 13440-6916  
(315) 337-0900

## REFERENCES

- [1] GO, available from Electric Power Software Center, University Computing Company, 1930 Hi Line Drive, Dallas, TX 75207.
- [2] Design of Reliable Industrial and Commercial Power Systems, IEEE Standard 493-1990.
- [3] Dickinson, W.H., Gannon, P.E., Heising, C.R., Patton, A.D., and McWilliams, D.W., "Fundamentals of Reliability Techniques as Applied to Industrial Power Systems," Conference Record 1971, IEEE Industrial Commercial Power Systems Technical Conference, 71C18-IGA, p. 10-31.
- [4] Singh, C. and Billinton, R., *System Reliability Modeling and Evaluation*, Hutchinson Educational, London, England, 1977.
- [5] IEEE Standard 493-1980, IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems, Table 2. In general, failure duration is actual hours downtime per failure based on industry averages. Data from "All Equipment Failures" are used, as opposed to median plant averages, which use data of all plants that reported actual outage time on equipment failures.

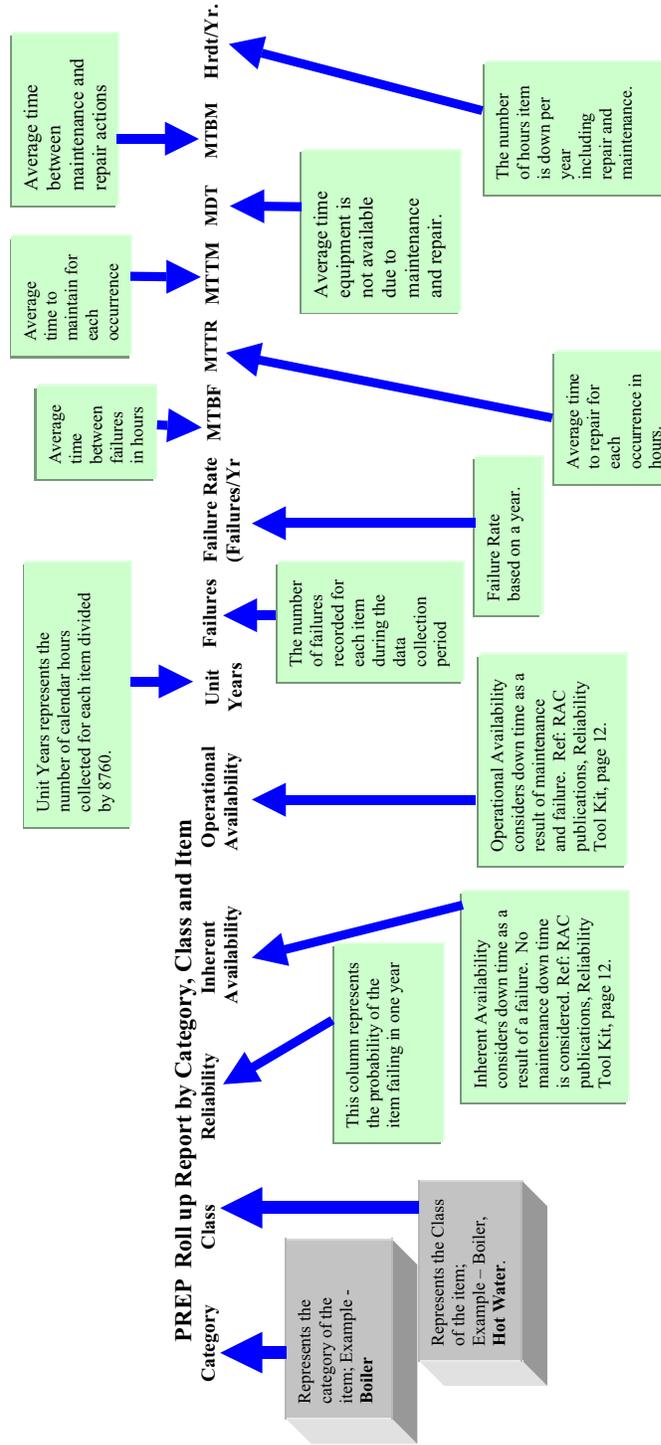
## BIOGRAPHIES

Peyton S. Hale, Jr. received his B.S. in Mechanical Engineering, from the University of Virginia in 1983. He received his Masters Degree in Engineering Management from George Washington University in 1993. His principal responsibilities include performing reliability/availability analyses, leading site field surveys and preparing recommended system improvement documents for electrical and mechanical systems for critical Command, Control, Communications and Intelligence (C3I) facilities.

Robert G. Arno received his B.S. in Electrical Engineering from State University of New York at Utica/Rome in 1982 and is currently a member of ASQC, Mohawk Valley Chapter. Mr. Arno has worked in the reliability field for 23 years, joining IIT Research Institute in Rome, NY in 1977. His principal responsibilities include program management, electrical and mechanical system analysis and modeling, and data collection and analysis. He managed the described data collection program.

PREP DATABASE / Version 4.2

The header below represents the header in the database. Each column heading is explained in the text boxes. The formulas, representing the column heading, are contained in the table in Section V above.



\*Time Truncated. Chi Squared. 60% Single Side Confidence Interval

| <i>PREP</i><br><b>CATEGORY</b> | <i>Roll Up Report by Category, Class and Item</i><br><b>CLASS</b> | <i>Reliability</i> | <i>Inherent Availability</i> | <i>Operational Availability</i> | <i>Unit Years</i> | <i>Failures</i> | <i>Failure Rate (Failures/Year)</i> | <b>MTBF</b> | <b>MTR</b> | <b>MTTM</b> | <b>MDT</b> | <b>MTBM</b> | <i>Frdt/Year</i> |
|--------------------------------|---|--------------------|------------------------------|---------------------------------|-------------------|-----------------|-------------------------------------|-------------|------------|-------------|------------|-------------|------------------|
| <b>Accumulator</b>             |   | 0.993467721        | 0.999993949                  | 0.999884828                     | 1373.3            | 9               | 0.00655                             | 1336648     | 8.22       | 0.8375      | 0.880      | 7638        | 1.0089           |
| <b>Pressurized</b>             |   | 0.993913727        | 0.999992102                  | 0.999841861                     | 982.8             | 6               | 0.00610                             | 1434920     | 11.33      | 0.8555      | 0.897      | 5672        | 1.3853           |
| Item: 1                        | Accumulator, Pressurized.   | 0.993913727        | 0.999992102                  | 0.999841861                     | 982.8             | 6               | 0.00610                             | 1434920     | 11.33      | 1.0000      | 0.897      | 5672        | 1.3853           |
| <b>Unpressurized</b>           |   | 0.992345933        | 0.999998246                  | 0.999992983                     | 390.4             | 3               | 0.00768                             | 1140104     | 2.00       | 0.3333      | 0.421      | 60005       | 0.0615           |
| Item: 2                        | Accumulator, Unpressurized.                                       | 0.992345933        | 0.999998246                  | 0.999992983                     | 390.4             | 3               | 0.00768                             | 1140104     | 2.00       | 0.0000      | 0.421      | 60005       | 0.0615           |
| <b>Air Compressor</b>          |   | 0.964395571        | 0.999966392                  | 0.999377084                     | 799.9             | 29              | 0.03625                             | 241630.3    | 8.12       | 0.3086      | 0.326      | 523         | 5.4567           |
| <b>Electric</b>                |   | 0.926805720        | 0.999919556                  | 0.999207149                     | 315.7             | 24              | 0.07601                             | 115246      | 9.27       | 0.1602      | 0.178      | 224         | 6.9454           |
| Item: 3                        | Air Compressor, Electric.   | 0.926805720        | 0.999919556                  | 0.999207149                     | 315.7             | 24              | 0.07601                             | 115246      | 9.27       | 0.0000      | 0.178      | 224         | 6.9454           |
| <b>Fuel</b>                    |   | 0.989726301        | 0.999996935                  | 0.999487902                     | 484.2             | 5               | 0.01033                             | 848275.2    | 2.60       | 2.0028      | 2.006      | 3916        | 4.4860           |
| Item: 4                        | Air Compressor, Fuel.   | 0.989726301        | 0.999996935                  | 0.999487902                     | 484.2             | 5               | 0.01033                             | 848275.2    | 2.60       | 2.0000      | 2.006      | 3916        | 4.4860           |
| <b>Air Dryer</b>               |   | 0.997716217        | 0.999986895                  | 0.99926162                      | 437.4             | 1               | 0.00229                             | 3831360     | 5.00       | 0.9326      | 0.946      | 12814       | 0.6468           |
| <b>All Types</b>               |   | 0.997716217        | 0.999986895                  | 0.99926162                      | 437.4             | 1               | 0.00229                             | 3831360     | 5.00       | 0.9326      | 0.946      | 12814       | 0.6468           |
| Item: 5                        | Air Dryer, All Types.   | 0.997716217        | 0.999986895                  | 0.99926162                      | 437.4             | 1               | 0.00229                             | 3831360     | 5.00       | 1.0000      | 0.946      | 12814       | 0.6468           |
| <b>Air Handling Unit</b>       |   | 0.989056337        | 0.999997032                  | 0.999875595                     | 1817.5            | 20              | 0.01100                             | 796075.2    | 2.36       | xxx         | 99.036     | 796075      | 1.0898           |
| <b>Non-humid wo/Drive</b>      |   | 0.989056337        | 0.999997032                  | 0.999875595                     | 1817.5            | 20              | 0.01100                             | 796075.2    | 2.36       | xxx         | 99.036     | 796075      | 1.0898           |
| Item: 6                        | Air Handling Unit, Non-humid wo/Drive.                            | 0.989056337        | 0.999997032                  | 0.999875595                     | 1817.5            | 20              | 0.01100                             | 796075.2    | 2.36       | 0.0000      | 99.036     | 796075      | 1.0898           |
| <b>Arrester</b>                |   | 0.998679474        | 0.999999397                  | 0.999999397                     | 1513.5            | 2               | 0.00132                             | 6629340     | 4.00       | xxx         | 4.000      | 6629340     | 0.0053           |
| <b>Lightning</b>               |   | 0.998679474        | 0.999999397                  | 0.999999397                     | 1513.5            | 2               | 0.00132                             | 6629340     | 4.00       | xxx         | 4.000      | 6629340     | 0.0053           |
| Item: 134                      | Arrester, Lightning.  | 0.998679474        | 0.999999397                  | 0.999999397                     | 1513.5            | 2               | 0.00132                             | 6629340     | 4.00       | 0.0000      | 4.000      | 6629340     | 0.0053           |
| <b>Battery</b>                 |   | 0.993006248        | 0.999990299                  | 0.999969547                     | 10543.8           | 74              | 0.00702                             | 1248161.    | 12.11      | 0.1490      | 0.217      | 7140        | 0.2668           |
| <b>Gel Cell-Sealed</b>         |   | 0.980061731        | 0.999995402                  | 0.999967422                     | 2333.7            | 47              | 0.02014                             | 434961.3    | 2.00       | 0.1318      | 0.152      | 4660        | 0.2854           |
| Item: 10                       | Battery, Gel Cell-Sealed, Strings.                                | 0.980061731        | 0.999995402                  | 0.999967422                     | 2333.7            | 47              | 0.02014                             | 434961.4    | 2.00       | 0.0000      | 0.152      | 4660        | 0.2854           |

| CATEGORY               | CLASS  | Reliability   | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF     | MTTR  | MTTM    | MDT     | MTBM     | Hr/d/Year |
|------------------------|--|---------------|-----------------------|--------------------------|------------|----------|------------------------------|----------|-------|---------|---------|----------|-----------|
| <b>Lead Acid</b>       |  | 0.992563514   | 0.999972627           | 0.999968207              | 3215.3     | 24       | 0.00746                      | 1173590. | 32.13 | 0.1463  | 1.023   | 32190    | 0.2785    |
| Item: 11               | Battery, Lead Acid, System.                              | 0.992563514   | 0.999972627           | 0.999968207              | 3215.3     | 24       | 0.00746                      | 1173590. | 32.13 | 0.0000  | 1.023   | 32190    | 0.2785    |
| <b>Nickel-Cadmium</b>  |  | 0.999399558   | 0.99999292            | 0.999971403              | 4994.8     | 3        | 0.00060                      | 14584865 | 10.33 | 0.1591  | 0.163   | 5701     | 0.2505    |
| Item: 246              | Battery, Nickel-Cadmium.                                 | 0.999399558   | 0.99999292            | 0.999971403              | 4994.8     | 3        | 0.00060                      | 14584865 | 10.33 | 0.0000  | 0.163   | 5701     | 0.2505    |
| <b>Blower</b>          |  | 0.999825378   | 1.000000000           | 0.999960812              | 2920.3     | 0        | 0.00017                      | 50160988 | xxx   | 0.0692  | 0.069   | 1765     | 0.3433    |
| wo/Drive               |  | 0.999825378   | 1.000000000           | 0.999960812              | 2920.3     | 0        | 0.00017                      | 50160988 | xxx   | 0.0692  | 0.069   | 1765     | 0.3433    |
| Item: 12               | Blower, wo/Drive.  | 0.999825378 * | 1.000000000           | 0.999960812              | 2920.3     | 0        | 0.00017 *                    | 50160988 | 0.00  | 0.0000  | 0.069   | 1765     | 0.3433    |
| <b>Boiler</b>          |  | 0.878642210   | 0.999360697           | 0.995132436              | 1113.0     | 144      | 0.12938                      | 67708.83 | 43.29 | 3.2844  | 3.738   | 768      | 42.639    |
| Hot Water              |  | 0.959008598   | 0.999985268           | 0.999501894              | 358.4      | 15       | 0.04186                      | 209292.8 | 3.08  | 0.9848  | 1.005   | 2018     | 4.3634    |
| Item: 13               | Boiler, Hot Water, Gravity and Circulated.               | 0.959008598   | 0.999985268           | 0.999501894              | 358.4      | 15       | 0.04186                      | 209292.8 | 3.08  | 1.0000  | 1.005   | 2018     | 4.3634    |
| <b>Steam</b>           |  | 0.842870823   | 0.999064090           | 0.993057393              | 754.6      | 129      | 0.17094                      | 51245.58 | 47.96 | 3.6062  | 4.120   | 593      | 60.817    |
| Item: 14               | Boiler, Steam, High Pressure.                            | 0.928028957   | 0.999619462           | 0.991482148              | 468.6      | 35       | 0.07469                      | 117277.7 | 44.63 | 3.0000  | 3.162   | 372      | 74.528    |
| Item: 15               | Boiler, Steam, Low Pressure.                             | 0.719936234   | 0.998154400           | 0.995621239              | 286.1      | 94       | 0.32859                      | 26659.1  | 49.20 | 0.0000  | 116.734 | 26659    | 38.357    |
| <b>Bus Duct</b>        |  | 0.999696290   | 1.000000000           | 1.000000000              | 1679.0     | 0        | 0.00030                      | 28838917 | xxx   | xxx     | xxx     | xxx      | 0.0000    |
| All types              |  | 0.999696290   | 1.000000000           | 1.000000000              | 1679.0     | 0        | 0.00030                      | 28838917 | xxx   | xxx     | xxx     | xxx      | 0.0000    |
| Item: 16               | Bus Duct, All types, (100').                             | 0.999696290 * | 1.000000000           | 1.000000000              | 1679.0     | 0        | 0.00030 *                    | 28838917 | 0.00  | 0.0000  | xxx     | xxx      | 0.0000    |
| <b>Cabinet Heaters</b> |  | 0.999897930   | 0.999999994           | 0.999978224              | 9796.7     | 1        | 0.00010                      | 85819128 | 0.50  | 1.6476  | 1.647   | 75612    | 0.1908    |
| Forced Air Flow        |  | 0.999897930   | 0.999999994           | 0.999978224              | 9796.7     | 1        | 0.00010                      | 85819128 | 0.50  | 1.6476  | 1.647   | 75612    | 0.1908    |
| Item: 17               | Cabinet Heaters, Forced Air Flow, Steam or Hot Water.    | 0.999897930   | 0.999999994           | 0.999978224              | 9796.7     | 1        | 0.00010                      | 85819128 | 0.50  | 2.0000  | 1.647   | 75612    | 0.1908    |
| <b>Cable</b>           |  | 0.998149212   | 0.99998818            | 0.999987869              | 736301.3   | 1364     | 0.00185                      | 4728738. | 5.59  | 4.2595  | 4.361   | 359452   | 0.1063    |
| Above Ground           |  | 0.999509398   | 0.999999527           | 0.999998357              | 589327.8   | 289      | 0.00049                      | 17851235 | 8.44  | 6.8680  | 7.256   | 4416958  | 0.0144    |
| Item: 18               | Cable, Above Ground, In Conduit, ≤600V, Per 1000ft.      | 0.999509398   | 0.999999527           | 0.999998357              | 589327.8   | 289      | 0.00049                      | 17851235 | 8.44  | 6.8680  | 7.256   | 4416958  | 0.0144    |
| Item: 19               | Cable, Above Ground, In Conduit, >600V ≤5kV, Per 1000ft. | 0.999463225   | 0.999999476           | 0.999998707              | 523356.6   | 281      | 0.00054                      | 16315315 | 8.56  | 41.0000 | 16.109  | 12458162 | 0.0113    |
| Item: 20               | Cable, Above Ground, No Conduit, ≤600V, Per 1000ft.      | 0.999879838   | 0.999999966           | 0.999999904              | 33286.3    | 4        | 0.00012                      | 72896904 | 2.50  | 0.0000  | 0.078   | 816772   | 0.0008    |
| Item: 21               | Cable, Above Ground, No Conduit, >600V ≤5kV, Per 1000ft. | 0.999244433   | 0.999999655           | 0.999999655              | 2648.0     | 2        | 0.00076                      | 11589564 | 4.00  | 0.0000  | 0.032   | 92717    | 0.0030    |

| CATEGORY                      | CLASS  | Reliability   | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTRR  | MTTM     | MDT    | MTBM     | Hrdb/Year |
|-------------------------------|--|---------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|-------|----------|--------|----------|-----------|
| Item: 22                      | Cable, Above Ground, Trays, ≤ 600V, Per 1000ft.          | 0.968468243 * | 1.000000000           | 1.000000000              | 15.9       | 0        | 0.03204 *                    | 273411.8 * | 0.00  | 0.0000   | xxx    | xxx      | 0.0000    |
| Item: 23                      | Cable, Above Ground, Trays, >600V ≤ 5kV, Per 1000ft.     | 0.997171966 * | 1.000000000           | 1.000000000              | 180.1      | 0        | 0.00283 *                    | 3093176. * | 0.00  | 0.0000   | xxx    | xxx      | 0.0000    |
| <b>Aerial</b>                 |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 32                      | Cable, Aerial, ≤ 15kV, Per Mile.                         | 0.988381339   | 0.999997295           | 0.999997259              | 37478.5    | 438      | 0.01169                      | 749570.9   | 2.03  | xxx      | 1.907  | 695576   | 0.0240    |
| Item: 33                      | Cable, Aerial, >15kV, Per Mile.                          | 0.953928762   | 0.999990218           | 0.999990218              | 6593.7     | 311      | 0.04717                      | 185725.9   | 1.82  | 0.0000   | 1.817  | 185726   | 0.0857    |
| <b>Below Ground</b>           |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 35                      | Cable, Below Ground, Duct, ≤ 600V, Per 1000ft.           | 0.994225869   | 0.999995527           | 0.999928197              | 109482.8   | 634      | 0.00579                      | 1512727.   | 6.77  | 4.1354   | 4.238  | 59023    | 0.6290    |
| Item: 36                      | Cable, Below Ground, Duct, >600V ≤ 5kV, Per 1000ft.      | 0.999875009   | 0.99999766            | 0.999999697              | 40000.4    | 5        | 0.00012                      | 70080729   | 16.40 | 1.0000   | 2.789  | 9221149  | 0.0026    |
| Item: 47                      | Cable, Below Ground, In Conduit, ≤ 600V, Per 1000ft.     | 0.987125021 * | 1.000000000           | 1.000000000              | 39.4       | 0        | 0.01296 *                    | 676000 *   | 0.00  | 0.0000   | xxx    | xxx      | 0.0000    |
| Item: 48                      | Cable, Below Ground, In Conduit >600V ≤ 5kV, per 1000ft. | 0.997994901   | 0.999997428           | 0.999991686              | 24413.2    | 49       | 0.00201                      | 4364479.   | 11.22 | 88.0000  | 28.222 | 3394595  | 0.0728    |
| Item: 46                      | Cable, Below Ground, Insulated, >5kV, Per 1000ft.        | 0.997646877   | 0.999995779           | 0.999987126              | 19525.5    | 46       | 0.00236                      | 3718331    | 15.70 | 211.0000 | 41.547 | 3227231  | 0.1128    |
| Item: 38                      | Cable, Below Ground, Insulated, ≤ 600V, Per 1000ft.      | 0.960031515   | 0.999988193           | 0.999674546              | 22508.1    | 454      | 0.02017                      | 434296.5   | 5.13  | 4.0000   | 4.007  | 12312    | 2.8510    |
| <b>Insulated</b>              |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 49                      | Cable, Insulated, DC, Per 100ft.                         | 0.973653295   | 0.999976836           | 0.999976836              | 2996.3     | 80       | 0.02870                      | 328089.9   | 7.60  | 0.0000   | 7.600  | 328090   | 0.2029    |
| <b>Cable Connection</b>       |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 29                      | Cable Connection   | 0.992748496   | 0.999998338           | 0.999998338              | 412.2      | 3        | 0.00728                      | 1203640    | 2.00  | 0.0000   | 0.109  | 65653    | 0.0146    |
| <b>Capacitor Bank</b>         |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 54                      | Capacitor Bank, Power Factor Corrector, (in kVAR).       | 0.992748496   | 0.999998338           | 0.999998338              | 412.2      | 3        | 0.00728                      | 1203640    | 2.00  | 0.0000   | 0.109  | 65653    | 0.0146    |
| <b>Power Factor Corrector</b> |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 54                      | Capacitor Bank, Power Factor Corrector, (in kVAR).       | 0.999629261   | 0.999999968           | 0.999999968              | 21574.5    | 8        | 0.00037                      | 23624073   | 0.75  | xxx      | 0.750  | 23624073 | 0.0003    |
| <b>Capacitor Bank</b>         |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 29                      | Cable Connection   | 0.999629261   | 0.999999968           | 0.999999968              | 21574.5    | 8        | 0.00037                      | 23624073   | 0.75  | 0.0000   | 0.750  | 23624073 | 0.0003    |
| <b>Power Factor Corrector</b> |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 54                      | Capacitor Bank, Power Factor Corrector, (in kVAR).       | 0.839937440   | 0.999954142           | 0.999942075              | 567.6      | 99       | 0.17443                      | 50221.33   | 2.30  | 10.0000  | 2.743  | 47352    | 0.5074    |
| <b>Power Factor Corrector</b> |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 54                      | Capacitor Bank, Power Factor Corrector, (in kVAR).       | 0.839937440   | 0.999954142           | 0.999942075              | 567.6      | 99       | 0.17443                      | 50221.33   | 2.30  | 10.0000  | 2.743  | 47352    | 0.5074    |
| <b>Power Factor Corrector</b> |  |               |                       |                          |            |          |                              |            |       |          |        |          |           |
| Item: 54                      | Capacitor Bank, Power Factor Corrector, (in kVAR).       | 0.839937440   | 0.999954142           | 0.999942075              | 567.6      | 99       | 0.17443                      | 50221.33   | 2.30  | 10.0000  | 2.743  | 47352    | 0.5074    |

| CATEGORY                                    | CLASS   | Reliability | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTRR   | MTTM    | MDT    | MTBM    | Hrd/Year |
|---|---|-------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|--------|---------|--------|---------|----------|
| <b>Charger</b>                              |   | 0.992621004 | 0.999999577           | 0.9999986472             | 270.0      | 2        | 0.00741                      | 1182768    | 0.50   | 0.1297  | 0.133  | 9816    | 0.1185   |
| <b>Battery</b>                              |   | 0.992621004 | 0.999999577           | 0.9999986472             | 270.0      | 2        | 0.00741                      | 1182768    | 0.50   | 0.1297  | 0.133  | 9816    | 0.1185   |
| Item: 9                                     | Charger, Battery.   | 0.992621004 | 0.999999577           | 0.9999986472             | 270.0      | 2        | 0.00741                      | 1182768    | 0.50   | 0.0000  | 0.133  | 9816    | 0.1185   |
| <b>Chiller</b>                              |   | 0.888515818 | 0.999829779           | 0.997620632              | 2021.9     | 239      | 0.11820                      | 74109.90   | 12.62  | 1.0881  | 1.164  | 489     | 20.843   |
| <b>Absorption</b>                           |   | 0.841986658 | 0.999769437           | 0.995132437              | 430.3      | 74       | 0.17199                      | 50932.86   | 11.74  | 0.6240  | 0.653  | 134     | 42.639   |
| Item: 244                                   | Chiller, Absorption.  | 0.841986658 | 0.999769437           | 0.995132437              | 430.3      | 74       | 0.17199                      | 50932.9    | 11.74  | 1.0000  | 0.653  | 134     | 42.639   |
| <b>Centrifugal</b>                          |   | 0.955142622 | 0.999923928           | 0.997604888              | 544.7      | 25       | 0.04589                      | 190872.1   | 14.52  | 5.2247  | 5.333  | 2227    | 20.981   |
| Item: 55                                    | Chiller, Centrifugal, 600 - 1000 Tons.  | 0.955142622 | 0.999923928           | 0.997604888              | 544.7      | 25       | 0.04589                      | 190872.1   | 14.52  | 5.0000  | 5.333  | 2227    | 20.981   |
| <b>Reciprocating</b>                        |   | 0.864557699 | 0.999799791           | 0.99898189               | 948.2      | 138      | 0.14554                      | 60190.78   | 12.05  | 1.5457  | 1.837  | 1667    | 9.6519   |
| Item: 56                                    | Chiller, Reciprocating, Closed, w/Drive, 50 - 200 Tons.   | 0.879941865 | 0.999809524           | 0.998734968              | 680.2      | 87       | 0.12790                      | 68491.3    | 13.05  | 1.0000  | 1.662  | 1314    | 11.081   |
| Item: 57                                    | Chiller, Reciprocating, Open, wo/Drive, 50 - 200 Tons.  | 0.826705884 | 0.999775088           | 0.998312485              | 268.0      | 51       | 0.19031                      | 46031.1    | 10.35  | 3.0000  | 3.611  | 5252    | 6.0226   |
| <b>Rotary</b>                               |   | 0.986993503 | 0.999964132           | 0.996197991              | 76.4       | 1        | 0.01309                      | 669120     | 24.00  | 6.0723  | 6.115  | 1608    | 33.305   |
| Item: 58                                    | Chiller, Rotary, 600 - 1000 Tons.   | 0.986993503 | 0.999964132           | 0.996197991              | 76.4       | 1        | 0.01309                      | 669120     | 24.00  | 6.0000  | 6.115  | 1608    | 33.305   |
| <b>Screw</b>                                |   | 0.956286690 | 0.999510164           | 0.996566046              | 22.4       | 1        | 0.04470                      | 195984     | 96.00  | 1.0000  | 1.164  | 339     | 30.081   |
| Item: 59                                    | Chiller, Screw, >300 Tons.  | 0.956286690 | 0.999510164           | 0.996566046              | 22.4       | 1        | 0.04470                      | 195984     | 96.00  | 1.0000  | 1.164  | 339     | 30.081   |
| <b>Circuit Breaker, 600V 3 Phase, Fixed</b> |   | 0.999996752 | 0.999999582           | 0.99993888               | 157040.9   | 52       | 0.00000                      | 26974078   | xxx    | 1.9167  | 1.959  | 121569  | 0.1411   |
| Item: 61                                    | Circuit Breaker, 600V, 3 Phase, Fixed, including molded case, ≤600 amp, Normally Closed, Trip. Ckt. Incl. | 0.999996551 | 0.999999989           | 0.99992732               | 147880.0   | 5        | 0.00000                      | 25400557   | xxx    | 8.2967  | 8.376  | 1152516 | 0.0637   |
| Item: 60                                    | Circuit Breaker, 600V, 3 Phase, Fixed, including molded case, ≤600 amp, Normally Open, Trip. Ckt. Incl.   | 0.999984307 | * 1.000000000         | 0.999997443              | 32498.7    | 0        | 0.00002                      | * 55821363 | * 0.00 | 3.0000  | 3.098  | 1211442 | 0.0224   |
| Item: 63                                    | Circuit Breaker, 600V, 3 Phase, Fixed, including molded case, >600 amp, Normally Closed, Trip. Ckt. Incl. | 0.999887215 | 0.999999760           | 0.999990187              | 26597.8    | 3        | 0.00011                      | 77665552   | 18.67  | 9.0000  | 8.727  | 889300  | 0.0860   |
| Item: 62                                    | Circuit Breaker, 600V, 3 Phase, Fixed, including molded case >600V ≤5kV                                   | 0.999994218 | * 1.000000000         | 0.999992509              | 88200.2    | 0        | 0.00001                      | * 15149685 | * 0.00 | 14.0000 | 13.618 | 1817962 | 0.0656   |
| Item: 62                                    | Circuit Breaker, 600V, 3 Phase, Fixed, including molded case >600V ≤5kV                                   | 0.996576534 | 0.999985320           | 0.999880051              | 583.2      | 2        | 0.00343                      | 2554428    | 37.50  | 3.0000  | 3.034  | 25291   | 1.0507   |

| CATEGORY                    | CLASS   | Reliability               | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTR   | MTTM   | MDT   | MTBM   | Hr/Yr  |
|-----------------------------|---|---------------------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|-------|--------|-------|--------|--------|
| <b>Drawout (Metal Clad)</b> |   |                           |                       |                          |            |          |                              |            |       |        |       |        |        |
| Item: 67                    | Circuit Breaker, 600V, Drawout (Metal Clad), <600 amp, Normally Closed, Trp. Ckt. Incl. | 0.998892235               | 0.999999605           | 0.999837990              | 7217.8     | 8        | 0.00111                      | 7903437.   | 3.13  | 2.0569 | 2.059 | 12706  | 1.4192 |
| Item: 66                    | Circuit Breaker, 600V, Drawout (Metal Clad), <600 amp, Normally Open, Trp. Ckt. Incl.   | 0.999792091               | 0.999999858           | 0.999798004              | 4809.3     | 1        | 0.00021                      | 42129480   | 6.00  | 2.0000 | 2.019 | 9998   | 1.7695 |
| Item: 69                    | Circuit Breaker, 600V, Drawout (Metal Clad), >600 amp, Normally Closed, Trp. Ckt. Incl. | 0.997456731               | 0.999998256           | 0.999860901              | 785.4      | 2        | 0.00255                      | 3440004    | 6.00  | 3.0000 | 2.945 | 21169  | 1.2185 |
| Item: 68                    | Circuit Breaker, 600V, Drawout (Metal Clad), >600 amp, Normally Open, Trp. Ckt. Incl.   | 0.998150509               | 0.999999894           | 0.999954301              | 1080.4     | 2        | 0.00185                      | 4732057.   | 0.50  | 1.0000 | 1.481 | 32411  | 0.4003 |
| <b>Vacuum</b>               |   |                           |                       |                          |            |          |                              |            |       |        |       |        |        |
| Item: 78                    | Circuit Breaker, 5kV, Vacuum, <600 amp, Normally Closed, Trp. Ckt. Incl.                | 0.980129686               | 0.999975385           | 0.999852780              | 1943.2     | 39       | 0.02007                      | 436484     | 10.74 | 0.4031 | 0.480 | 3263   | 1.2897 |
| Item: 79                    | Circuit Breaker, 5kV, Vacuum, <600 amp, Normally Open, Trp. Ckt. Incl.                  | 0.997191564               | 0.999997432           | 0.999860511              | 355.6      | 1        | 0.00281                      | 3114792    | 8.00  | 0.0000 | 0.050 | 1257   | 0.3459 |
| Item: 80                    | Circuit Breaker, 5kV, Vacuum, >600 amp, Normally Closed, Trp. Ckt. Incl.                | 0.998887668 * 1.000000000 | 0.999983060           | 0.999983060              | 458.2      | 0        | 0.00111 *                    | 7870964. * | 0.00  | 2.0000 | 1.838 | 108492 | 0.1484 |
| Item: 81                    | Circuit Breaker, 5kV, Vacuum, >600 amp, Normally Open, Trp. Ckt. Incl.                  | 0.976752059               | 0.999960259           | 0.999619774              | 425.1      | 10       | 0.02352                      | 372410.4   | 14.80 | 1.0000 | 1.620 | 4261   | 3.3308 |
| <b>Compressor</b>           |   |                           |                       |                          |            |          |                              |            |       |        |       |        |        |
| Item: 84                    | Compressor, Refrigerant, >1 Ton.  | 0.961020019               | 0.999957368           | 0.999854272              | 704.2      | 28       | 0.03976                      | 220321.7   | 9.39  | 0.0000 | 0.492 | 3377   | 1.2766 |
| <b>Refrigerant</b>          |   |                           |                       |                          |            |          |                              |            |       |        |       |        |        |
| Item: 85                    | Compressor, Screw Type.   | 0.986548811               | 0.999986587           | 0.999865676              | 1255.3     | 17       | 0.01354                      | 648853.6   | 8.68  | 0.9208 | 1.011 | 7527   | 1.1767 |
| <b>Screw Type</b>           |   |                           |                       |                          |            |          |                              |            |       |        |       |        |        |
| Item: 85                    | Compressor, Screw Type.   | 0.995193627               | 0.999998075           | 0.999907183              | 1037.8     | 5        | 0.00482                      | 1818196.   | 3.50  | 0.9110 | 0.925 | 9968   | 0.8131 |
|                             |   | 0.995193627               | 0.999998075           | 0.999907183              | 1037.8     | 5        | 0.00482                      | 1818196.   | 3.50  | 1.0000 | 0.925 | 9968   | 0.8131 |
|                             |   | 0.946328222               | 0.999931777           | 0.999667651              | 217.5      | 12       | 0.05517                      | 158794     | 10.83 | 0.9372 | 1.154 | 3471   | 2.9114 |
|                             |   | 0.946328222               | 0.999931777           | 0.999667651              | 217.5      | 12       | 0.05517                      | 158794     | 10.83 | 1.0000 | 1.154 | 3471   | 2.9114 |

| CATEGORY                  | CLASS  | Reliability | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTTR   | MTTM   | MDT   | MTEB  | Hr/Yr  |
|---------------------------|--|-------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|--------|--------|-------|-------|--------|
| Condensers                | Double Tube<br>Item: 86<br>Condensers, Double Tube.  | 0.900083857 | 0.999913810           | 0.999583534              | 1102.0     | 116      | 0.10527                      | 83216.68   | 7.17   | 4.0979 | 4.497 | 10798 | 3.6482 |
|                           |  | 0.973573588 | 0.99992357            | 0.999758971              | 298.7      | 8        | 0.02678                      | 327087     | 2.50   | 2.6323 | 2.628 | 10903 | 2.1114 |
|                           |  | 0.973573588 | 0.99992357            | 0.999758971              | 298.7      | 8        | 0.02678                      | 327087     | 2.50   | 3.0000 | 2.628 | 10903 | 2.1114 |
| Propeller Type Fans/Coils | Item: 87<br>Condensers, Propeller Type Fans/Coils, DX.   | 0.733621551 | 0.999734138           | 0.999393134              | 348.7      | 108      | 0.30976                      | 28279.77   | 7.52   | 3.0905 | 4.165 | 6863  | 5.3161 |
|                           |  | 0.733621551 | 0.999734138           | 0.999393134              | 348.7      | 108      | 0.30976                      | 28279.8    | 7.52   | 3.0000 | 4.165 | 6863  | 5.3161 |
| Shell and Tube            | Item: 88<br>Condensers, Shell and Tube.  | 0.998878743 | 1.000000000           | 0.999614286              | 454.6      | 0        | 0.00112                      | 7808282.   | xxx    | 7.3493 | 7.349 | 19054 | 3.3789 |
|                           |  | 0.998878743 | * 1.000000000         | 0.999614286              | 454.6      | 0        | 0.00112                      | * 7808282. | * 0.00 | 7.0000 | 7.349 | 19054 | 3.3789 |
| Control Panel             | Generator<br>Item: 128<br>Control Panel, Generator, wo/<br>Switchgear.                                       | 0.994698171 | 0.999998908           | 0.999800624              | 5643.4     | 30       | 0.00532                      | 1647876.   | 1.80   | 4.4410 | 4.406 | 22119 | 1.7448 |
|                           |  | 0.988952766 | 0.99997330            | 0.99980962               | 1710.4     | 19       | 0.01111                      | 788570.5   | 2.11   | 0.5703 | 0.635 | 33369 | 0.1668 |
| HVAC/Chillers/AHUs        | Item: 129<br>Control Panel,<br>HVAC/Chillers/AHUs, wo/<br>Switchgear.  | 0.988952766 | 0.99997330            | 0.99980962               | 1710.4     | 19       | 0.01111                      | 788570.6   | 2.11   | 1.0000 | 0.635 | 33369 | 0.1668 |
|                           |  | 0.999848787 | 1.000000000           | 0.99982209               | 3372.5     | 0        | 0.00015                      | 57926964   | xxx    | 1.0449 | 1.045 | 58733 | 0.1559 |
| Switchgear controls       | Item: 130<br>Control Panel, Switchgear<br>controls.  | 0.999848787 | * 1.000000000         | 0.99982209               | 3372.5     | 0        | 0.00015                      | * 57926964 | * 0.00 | 1.0000 | 1.045 | 58733 | 0.1559 |
|                           |  | 0.980568763 | 0.99997149            | 0.988160003              | 560.6      | 11       | 0.01962                      | 446426.1   | 1.27   | 7.0925 | 7.043 | 3828  | 16.118 |
| Convectors                | Fin Tube Baseboard<br>Item: 89<br>Convectors, Fin Tube<br>Baseboard, Electric.                               | 0.980568763 | 0.99997149            | 0.988160003              | 560.6      | 11       | 0.01962                      | 446426.2   | 1.27   | 7.0000 | 7.043 | 3828  | 16.118 |
|                           |  | 0.999913016 | 1.000000000           | 0.999998481              | 5862.9     | 0        | 0.00009                      | 10070423   | xxx    | 0.0149 | 0.015 | 9830  | 0.0133 |
| Cooling Tower             | Atmospheric Type<br>Item: 94<br>Cooling Tower, Atmospheric<br>Type, wo/ fans, motors, pumps,<br>valves, etc. | 0.999913016 | 1.000000000           | 0.999998481              | 5862.9     | 0        | 0.00009                      | 10070423   | xxx    | 0.0149 | 0.015 | 9830  | 0.0133 |
|                           |  | 0.999582861 | * 1.000000000         | 0.999998626              | 1222.4     | 0        | 0.00042                      | * 20985611 | * 0.00 | 0.0000 | 0.005 | 12702 | 0.0033 |
| Evaporative Type          | Item: 95<br>Cooling Tower, Evaporative<br>Type, wo/ fans, motors, pumps,<br>valves, etc.                     | 0.999890105 | * 1.000000000         | 0.999998180              | 4640.6     | 0        | 0.00011                      | * 79708423 | * 0.00 | 0.0000 | 0.017 | 9277  | 0.0159 |
|                           |  | 0.968333522 | 0.999702865           | 0.997170520              | 839.1      | 27       | 0.03218                      | 272229.7   | 80.89  | 1.0681 | 1.192 | 421   | 24.786 |
| Evaporative Type          | Item: 95<br>Cooling Tower, Evaporative<br>Type, wo/ fans, motors, pumps,<br>valves, etc.                     | 0.928543791 | 0.999247479           | 0.994184363              | 323.7      | 24       | 0.07414                      | 118158.4   | 88.92  | 0.9918 | 1.137 | 196   | 50.945 |
|                           |  | 0.928543791 | 0.999247479           | 0.994184363              | 323.7      | 24       | 0.07414                      | 118158.5   | 88.92  | 1.0000 | 1.137 | 196   | 50.945 |
| Evaporative Type          | Item: 95<br>Cooling Tower, Evaporative<br>Type, wo/ fans, motors, pumps,<br>valves, etc.                     | 0.994195540 | 0.99988924            | 0.999046330              | 515.3      | 3        | 0.00582                      | 1504800    | 16.67  | 1.4429 | 1.458 | 1529  | 8.3542 |
|                           |  | 0.994195540 | 0.99988924            | 0.999046330              | 515.3      | 3        | 0.00582                      | 1504800    | 16.67  | 1.0000 | 1.458 | 1529  | 8.3542 |

| CATEGORY                                | CLASS   | Reliability   | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTTR  | MTTM   | MDT   | MTBM   | Hrd/Year |
|---|---|---------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|-------|--------|-------|--------|----------|
| <b>Damper Assembly</b>                  |   | 0.999971953   | 0.999999975           | 0.999990131              | 18183.5    | 2        | 0.00003                      | 31232804   | xxx   | 0.0540 | 0.054 | 5486   | 0.0865   |
| <b>Motor</b>                            |   | 0.999966919   | 1.000000000           | 0.999989337              | 15416.3    | 0        | 0.00003                      | 26479769   | xxx   | 0.0497 | 0.050 | 4656   | 0.0934   |
| Item: 96                                | Damper Assembly, Motor.                                     | 0.999966919 * | 1.000000000           | 0.999989337              | 15416.3    | 0        | 0.00003 *                    | 26479769 * | 0.00  | 0.0000 | 0.050 | 4656   | 0.0934   |
| <b>Pneumatic</b>                        |   | 0.999277503   | 0.999999835           | 0.999994555              | 2767.2     | 2        | 0.00072                      | 12120240   | 2.00  | 4.0000 | 3.882 | 712955 | 0.0477   |
| Item: 97                                | Damper Assembly, Pneumatic.                                 | 0.999277503   | 0.999999835           | 0.999994555              | 2767.2     | 2        | 0.00072                      | 12120240   | 2.00  | 4.0000 | 3.882 | 712955 | 0.0477   |
| <b>Diesel Engine Generator Packaged</b> |   | 0.589772164   | 0.998540049           | 0.993985981              | 1354.1     | 715      | 0.52802                      | 16590.31   | 24.22 | 2.0554 | 2.642 | 439    | 52.682   |
| Item: 99                                | Diesel Engine Generator, Packaged, 250KW-1.5MW, Continuous. | 0.775917369   | 0.999329810           | 0.997272882              | 938.1      | 238      | 0.25371                      | 34527.71   | 23.14 | 1.1483 | 1.498 | 549    | 23.889   |
|   |   | 0.558396351   | 0.998287624           | 0.996927250              | 266.0      | 155      | 0.58269                      | 15033.8    | 25.74 | 1.0000 | 1.149 | 374    | 26.917   |
| Item: 98                                | Diesel Engine Generator, Packaged, 250KW-1.5MW, Standby.    | 0.883822868   | 0.999742312           | 0.997409685              | 672.1      | 83       | 0.12350                      | 70932      | 18.28 | 2.0000 | 1.748 | 675    | 22.681   |
| <b>Unpackaged</b>                       |   | 0.317735957   | 0.998759289           | 0.986574653              | 416.0      | 477      | 1.14653                      | 7640.415   | 24.76 | 3.2103 | 4.064 | 303    | 117.60   |
| Item: 101                               | Diesel Engine Generator, Unpackaged, 750KW-7MW, Continuous. | 0.162719469   | 0.994801087           | 0.980739869              | 180.6      | 328      | 1.81573                      | 4824.5     | 25.08 | 4.0000 | 4.997 | 259    | 168.71   |
| Item: 100                               | Diesel Engine Generator, Unpackaged, 750KW-7MW, Standby.    | 0.531004159   | 0.998262059           | 0.991052357              | 235.4      | 149      | 0.63299                      | 13839.2    | 24.05 | 3.0000 | 3.106 | 347    | 78.381   |
| <b>Drive</b>                            |   | 0.978172315   | 0.999958316           | 0.999925947              | 2990.6     | 66       | 0.02207                      | 396929.0   | 16.55 | 3.4472 | 6.218 | 83966  | 0.6487   |
| <b>Adjustable Speed</b>                 |   | 0.978172315   | 0.999958316           | 0.999925947              | 2990.6     | 66       | 0.02207                      | 396929.0   | 16.55 | 3.4472 | 6.218 | 83966  | 0.6487   |
| Item: 138                               | Drive, Adjustable Speed.                                    | 0.978172315   | 0.999958316           | 0.999925947              | 2990.6     | 66       | 0.02207                      | 396929.1   | 16.55 | 3.0000 | 6.218 | 83966  | 0.6487   |
| <b>Evaporator</b>                       |   | 0.995968933   | 0.999993228           | 0.999908962              | 7922.3     | 32       | 0.00404                      | 2168739    | 14.69 | 0.2565 | 0.277 | 3040   | 0.7975   |
| <b>Coil</b>                             |   | 0.995812835   | 0.999992633           | 0.999899263              | 6911.4     | 29       | 0.00420                      | 2087724.   | 15.38 | 0.2689 | 0.290 | 2876   | 0.8825   |
| Item: 82                                | Evaporator, Coil, Direct Expansion.                         | 0.995812835   | 0.999992633           | 0.999899263              | 6911.4     | 29       | 0.00420                      | 2087724.   | 15.38 | 0.0000 | 0.290 | 2876   | 0.8825   |
| <b>Shell Tube</b>                       |   | 0.997036799   | 0.999997290           | 0.999975270              | 1010.9     | 3        | 0.00297                      | 2951880    | 8.00  | 0.1097 | 0.123 | 4972   | 0.2166   |
| Item: 174                               | Evaporator, Shell Tube, Direct Expansion.                   | 0.997036799   | 0.999997290           | 0.999975270              | 1010.9     | 3        | 0.00297                      | 2951880    | 8.00  | 0.0000 | 0.123 | 4972   | 0.2166   |

| CATEGORY                     | CLASS   | Reliability | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF     | MTRR  | MTTM    | MDT    | MTBM    | Hrd/Year |
|------------------------------|---|-------------|-----------------------|--------------------------|------------|----------|------------------------------|----------|-------|---------|--------|---------|----------|
| <b>Fan</b>                   |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| <b>Centrifugal</b>           |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| Item: 106                    | Fan, Centrifugal.                                       | 0.987559807 | 0.999971610           | 0.999351118              | 2396.5     | 30       | 0.01252                      | 699780   | 19.87 | 4.2211  | 4.372  | 6737    | 5.6842   |
|                              |   | 0.981021428 | 0.999946483           | 0.999770440              | 782.8      | 15       | 0.01916                      | 457179.2 | 24.47 | 1.6118  | 2.061  | 8976    | 2.0109   |
|                              |   | 0.981021428 | 0.999946483           | 0.999770440              | 782.8      | 15       | 0.01916                      | 457179.2 | 24.47 | 2.0000  | 2.061  | 8976    | 2.0109   |
| <b>Propeller/Disc</b>        |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| Item: 107                    | Fan, Propeller/Disc.                                    | 0.989640193 | 0.999957798           | 0.999093547              | 384.1      | 4        | 0.01041                      | 841188   | 35.50 | 1.8677  | 1.954  | 2156    | 7.9405   |
|                              |   | 0.989640193 | 0.999957798           | 0.999093547              | 384.1      | 4        | 0.01041                      | 841188   | 35.50 | 2.0000  | 1.954  | 2156    | 7.9405   |
| <b>Tubeaxial</b>             |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| Item: 108                    | Fan, Tubeaxial.   | 0.989938879 | 0.999908070           | 0.999055744              | 1087.8     | 11       | 0.01011                      | 866290.9 | 7.91  | 11.4244 | 11.375 | 12047   | 8.2717   |
|                              |   | 0.989938879 | 0.999908070           | 0.999055744              | 1087.8     | 11       | 0.01011                      | 866290.9 | 7.91  | 11.0000 | 11.375 | 12047   | 8.2717   |
| <b>Vaneaxial</b>             |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| Item: 109                    | Fan, Vaneaxial.   | 0.996408668 | 1.000000000           | 1.000000000              | 141.8      | 0        | 0.00360                      | 2434823. | xxx   | xxx     | xxx    | xxx     | 0.0000   |
|                              |   | 0.996408668 | 1.000000000           | 1.000000000              | 141.8      | 0        | 0.00360                      | 2434823. | 0.00  | 0.0000  | xxx    | xxx     | 0.0000   |
| <b>Filter</b>                |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| <b>Electrical Tempest</b>    |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| Item: 113                    | Filter, Electrical Tempest.                             | 0.999898973 | 1.000000000           | 0.99903911               | 5047.9     | 0        | 0.00010                      | 86704894 | xxx   | 0.2894  | 0.289  | 3012    | 0.8417   |
|                              |   | 0.998510134 | 1.000000000           | 1.000000000              | 342.1      | 0        | 0.00149                      | 5875341. | xxx   | 0.0000  | 0.000  | 2996424 | 0.0000   |
|                              |   | 0.998510134 | 1.000000000           | 1.000000000              | 342.1      | 0        | 0.00149                      | 5875341. | 0.00  | 0.0000  | 0.000  | 2996424 | 0.0000   |
| <b>Mechanical</b>            |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| Item: 110                    | Filter, Mechanical, Air Regulator Set.                  | 0.999891630 | 1.000000000           | 0.999896927              | 4705.8     | 0        | 0.00011                      | 80829552 | xxx   | 0.2894  | 0.289  | 2808    | 0.9029   |
|                              |   | 0.999840000 | 1.000000000           | 0.99981949               | 3187.2     | 0        | 0.00016                      | 54745647 | 0.00  | 0.0000  | 0.044  | 2464    | 0.1581   |
| Item: 112                    | Filter, Mechanical, Fuel Oil.                           | 0.999271146 | 1.000000000           | 0.99910729               | 699.5      | 0        | 0.00073                      | 12014494 | 0.00  | 0.0000  | 0.486  | 5442    | 0.7820   |
| Item: 111                    | Filter, Mechanical, Lube Oil.                           | 0.999377566 | 1.000000000           | 0.999554311              | 819.1      | 0        | 0.00062                      | 14069411 | 0.00  | 1.0000  | 1.439  | 3229    | 3.9042   |
| <b>Fuse</b>                  |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| >5KV ≤15KV                   |   | 0.997969725 | 1.000000000           | 1.000000000              | 1145.4     | 0        | 0.00087                      | 10033704 | xxx   | xxx     | xxx    | xxx     | 0.0000   |
| Item: 116                    | Fuse, >5KV ≤15KV.                                       | 0.999341365 | 1.000000000           | 1.000000000              | 774.1      | 0        | 0.00066                      | 13295858 | xxx   | xxx     | xxx    | xxx     | 0.0000   |
|                              |   | 0.999341365 | 1.000000000           | 1.000000000              | 774.1      | 0        | 0.00066                      | 13295858 | 0.00  | 0.0000  | xxx    | xxx     | 0.0000   |
| <b>0-5KV</b>                 |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| Item: 115                    | Fuse, 0-5KV.  | 0.998627456 | 1.000000000           | 1.000000000              | 371.3      | 0        | 0.00137                      | 6377929. | xxx   | xxx     | xxx    | xxx     | 0.0000   |
|                              |   | 0.998627456 | 1.000000000           | 1.000000000              | 371.3      | 0        | 0.00137                      | 6377929. | 0.00  | 0.0000  | xxx    | xxx     | 0.0000   |
| <b>Gas Turbine Generator</b> |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| <b>Packaged</b>              |   |             |                       |                          |            |          |                              |          |       |         |        |         |          |
| Item: 119                    | Gas Turbine Generator, Packaged, 750KW-7MW, Continuous. | 0.647849145 | 0.988890863           | 0.990692798              | 921.5      | 400      | 0.43410                      | 20779.80 | 22.38 | 2.1583  | 2.419  | 260     | 81.531   |
|                              |   | 0.587787144 | 0.988689955           | 0.989043771              | 750.9      | 399      | 0.53139                      | 16485.05 | 21.60 | 2.1103  | 2.366  | 216     | 95.976   |
|                              |   | 0.177710554 | 0.994598022           | 0.983584136              | 167.9      | 290      | 1.72760                      | 5070.6   | 27.39 | 1.0000  | 1.225  | 75      | 143.80   |
| Item: 118                    | Gas Turbine Generator, Packaged, 750KW-7MW, Standby.    | 0.829472916 | 0.999868149           | 0.990615770              | 583.0      | 109      | 0.18696                      | 46853.7  | 6.18  | 4.0000  | 4.453  | 475     | 82.205   |

| CATEGORY              | CLASS   | Reliability | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF     | MTR    | MTM     | MDT    | MTBM   | Hrtd/Year |
|-----------------------|---|-------------|-----------------------|--------------------------|------------|----------|------------------------------|----------|--------|---------|--------|--------|-----------|
| <b>Unpackaged</b>     | Item: 121 Gas Turbine Generator, Unpackaged, 750kW-7MW, Continuous. | 0.994155201 | 0.999775158           | 0.997950995              | 170.6      | 1        | 0.00586                      | 1494384  | 336.00 | 4.5892  | 5.146  | 2512   | 17.949    |
|                       |   | 0.994155201 | 0.999775158           | 0.997950995              | 170.6      | 1        | 0.00586                      | 1494384  | 336.00 | 5.0000  | 5.146  | 2512   | 17.949    |
| <b>Gauge</b>          | Item: 122 Gauge, Fluid level.                                       | 0.999042094 | 1.000000000           | 0.99999785               | 532.2      | 0        | 0.00096                      | 9140564. | xxx    | xxx     | xxx    | xxx    | 0.0019    |
|                       |   | 0.999042094 | 1.000000000           | 0.99999785               | 532.2      | 0        | 0.00096                      | 9140564. | xxx    | xxx     | xxx    | xxx    | 0.0019    |
| <b>Heat Exchanger</b> | Item: 123 Heat Exchanger, Boiler System, Steam.                     | 0.989034610 | 0.99997303            | 0.998935596              | 634.9      | 7        | 0.01103                      | 794489.1 | 2.14   | 1.8371  | 1.838  | 1727   | 9.3242    |
|                       |   | 0.971835048 | 0.99998369            | 0.997231137              | 210.0      | 6        | 0.02857                      | 306624   | 0.50   | 29.2586 | 28.300 | 10221  | 24.255    |
| <b>Lube Oil</b>       | Item: 125 Heat Exchanger, Lube Oil.                                 | 0.996596565 | 0.99995330            | 0.999740960              | 293.3      | 1        | 0.00341                      | 2569488  | 12.00  | 6.5360  | 6.590  | 25440  | 2.2692    |
|                       |   | 0.996596565 | 0.99995330            | 0.999740960              | 293.3      | 1        | 0.00341                      | 2569488  | 12.00  | 7.0000  | 6.590  | 25440  | 2.2692    |
| <b>Water to Water</b> | Item: 124 Heat Exchanger, Water to Water.                           | 0.996130029 | 1.000000000           | 0.999861134              | 131.5      | 0        | 0.00388                      | 2259200  | xxx    | 0.0544  | 0.054  | 392    | 1.2165    |
|                       |   | 0.996130029 | 1.000000000           | 0.999861134              | 131.5      | 0        | 0.00388                      | 2259200  | 0.00   | 0.0000  | 0.054  | 392    | 1.2165    |
| <b>Heater</b>         | Item: 126 Heater, Electric, Lube/Fuel Oil or Jacket.                | 0.947826981 | 0.999984168           | 0.994164558              | 317.3      | 17       | 0.05358                      | 163483.7 | 2.59   | 1.2053  | 1.207  | 207    | 51.118    |
|                       |   | 0.947826981 | 0.999984168           | 0.994164558              | 317.3      | 17       | 0.05358                      | 163483.7 | 2.59   | 1.2053  | 1.207  | 207    | 51.118    |
| <b>Humistat</b>       | Item: 127 Humistat, Assembly.                                       | 0.984575905 | 0.99998226            | 0.99998226               | 643.3      | 10       | 0.01554                      | 563551.2 | 1.00   | 0.0000  | 0.043  | 24083  | 0.0155    |
|                       |   | 0.984575905 | 0.99998226            | 0.99998226               | 643.3      | 10       | 0.01554                      | 563551.2 | 1.00   | 0.0000  | 0.043  | 24083  | 0.0155    |
| <b>Inverters</b>      | Item: 131 Inverters, All Types.                                     | 0.995190512 | 0.99995691            | 0.99998793               | 414.8      | 2        | 0.00482                      | 1817016  | 26.00  | 5.1691  | 5.321  | 13263  | 3.5146    |
|                       |   | 0.995190512 | 0.99995691            | 0.99998793               | 414.8      | 2        | 0.00482                      | 1817016  | 26.00  | 5.1691  | 5.321  | 13263  | 3.5146    |
| <b>Meter</b>          | Item: 135 Meter, Electric.  | 0.998913484 | 0.99993988            | 0.99993981               | 1657.7     | 18       | 0.00109                      | 8058086. | 48.44  | 0.0055  | 1.182  | 195743 | 0.0529    |
|                       |   | 0.998913484 | 0.99993988            | 0.99993981               | 1657.7     | 18       | 0.00109                      | 8058086. | 48.44  | 0.0055  | 1.182  | 195743 | 0.0529    |
|                       |   | 0.999635167 | 0.99999958            | 0.99999958               | 13702.4    | 5        | 0.00036                      | 24006614 | 1.00   | 0.0000  | 0.025  | 606228 | 0.0004    |
|                       |   | 0.999635167 | 0.99999958            | 0.99999958               | 13702.4    | 5        | 0.00036                      | 24006614 | 1.00   | 0.0000  | 0.025  | 606228 | 0.0004    |

| CATEGORY                   | CLASS                                   | Reliability | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTTR   | MTTM   | MDF    | MTBM   | Hr/Yr  |
|----------------------------|---|-------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|--------|--------|--------|--------|--------|
| <b>Fuel</b>                |   | 0.946014073 | 0.999543853           | 0.999543853              | 216.2      | 12       | 0.05550                      | 157844     | 72.00  | xxx    | 72.000 | 157844 | 3.9958 |
| Item: 136                  | Meter, Fuel.                            | 0.946014073 | 0.999543853           | 0.999543853              | 216.2      | 12       | 0.05550                      | 157844     | 72.00  | 0.0000 | 72.000 | 157844 | 3.9958 |
| <b>Water</b>               |   | 0.999621152 | 0.999999870           | 0.999999697              | 2639.1     | 1        | 0.00038                      | 23118360   | 3.00   | 0.0075 | 0.013  | 43537  | 0.0027 |
| Item: 137                  | Meter, Water.                           | 0.999621152 | 0.999999870           | 0.999999697              | 2639.1     | 1        | 0.00038                      | 23118360   | 3.00   | 0.0000 | 0.013  | 43537  | 0.0027 |
| <b>Motor Generator Set</b> |   | 0.975052652 | 0.999978501           | 0.993070544              | 435.4      | 11       | 0.02526                      | 346741.0   | 7.45   | 0.8368 | 0.839  | 121    | 60.702 |
| <b>3 Phase, 400HZ</b>      |   | 0.985075131 | 0.999995491           | 0.998628032              | 202.6      | 1        | 0.00494                      | 1774344    | 8.00   | 2.8722 | 2.895  | 7782   | 3.2584 |
| Item: 144                  | Motor Generator Set, 3 Phase, 400HZ.    | 0.985075131 | 0.999995491           | 0.998628032              | 202.6      | 1        | 0.00494                      | 1774344    | 8.00   | 3.0000 | 2.895  | 7782   | 3.2584 |
| <b>3 Phase, 60HZ</b>       |   | 0.957963867 | 0.999963722           | 0.987366458              | 232.9      | 10       | 0.04295                      | 203980.8   | 7.40   | 0.8220 | 0.824  | 65     | 110.66 |
| Item: 147                  | Motor Generator Set, 3 Phase, 60HZ.     | 0.957963867 | 0.999963722           | 0.987366458              | 232.9      | 10       | 0.04295                      | 203980.8   | 7.40   | 1.0000 | 0.824  | 65     | 110.66 |
| <b>Motor Starter</b>       |   | 0.999147052 | 0.999995416           | 0.999944527              | 597.7      | 1        | 0.00085                      | 10265882   | xxx    | 0.2442 | 0.266  | 4795   | 0.4859 |
| ≤ 600V                     |   | 0.988167781 | 1.000000000           | 0.999842223              | 278.1      | 0        | 0.00183                      | 4776705.   | xxx    | 0.0814 | 0.081  | 5161   | 0.1382 |
| Item: 150                  | Motor Starter, ≤ 600V.                  | 0.988167781 | * 1.000000000         | 0.999842223              | 278.1      | 0        | 0.00183                      | * 4776705. | * 0.00 | 0.0000 | 0.081  | 5161   | 0.1382 |
| >600V                      |   | 0.996875738 | 0.999991427           | 0.999909983              | 319.6      | 1        | 0.00313                      | 2799480    | 24.00  | 0.3683 | 0.406  | 4515   | 0.7885 |
| Item: 151                  | Motor Starter, >600V.                   | 0.996875738 | 0.999991427           | 0.999909983              | 319.6      | 1        | 0.00313                      | 2799480    | 24.00  | 0.0000 | 0.406  | 4515   | 0.7885 |
| <b>Motor, Electric</b>     |   | 0.999032041 | 0.999973300           | 0.999830849              | 27880.2    | 27       | 0.00097                      | 9045589.   | 241.52 | 0.5662 | 0.921  | 13318  | 0.6058 |
| <b>DC</b>                  |   | 0.985531708 | 0.999031729           | 0.998182336              | 754.8      | 11       | 0.01457                      | 601071.2   | 582.00 | 0.4228 | 0.904  | 497    | 15.922 |
| Item: 141                  | Motor, Electric, DC.                    | 0.985531708 | 0.999031729           | 0.998182336              | 754.8      | 11       | 0.01457                      | 601071.3   | 582.00 | 0.0000 | 0.904  | 497    | 15.922 |
| <b>Induction</b>           |   | 0.981918899 | 0.999992950           | 0.999724259              | 712.5      | 13       | 0.01825                      | 480090.4   | 3.38   | 2.9576 | 2.967  | 10761  | 2.4155 |
| Item: 148                  | Motor, Electric, Induction, ≤ 600V.     | 0.988992708 | 0.999998736           | 0.999957372              | 361.4      | 4        | 0.01107                      | 791448     | 1.00   | 1.0000 | 1.336  | 31344  | 0.3734 |
| Item: 149                  | Motor, Electric, Induction, >600V.      | 0.974689985 | 0.999986993           | 0.999484292              | 351.1      | 9        | 0.02564                      | 341709.3   | 4.44   | 3.0000 | 3.311  | 6420   | 4.5176 |
| <b>Single Phase</b>        |   | 0.999860411 | 0.999999987           | 0.999882267              | 26034.5    | 1        | 0.00002                      | 44718136   | xxx    | 0.6247 | 0.625  | 53286  | 0.1028 |
| Item: 139                  | Motor, Electric, Single Phase, ≤ 5 amp. | 0.999979878 | * 1.000000000         | 0.999996192              | 25345.3    | 0        | 0.00002                      | * 43534240 | * 0.00 | 0.0000 | 0.491  | 128934 | 0.0334 |
| Item: 140                  | Motor, Electric, Single Phase, >5 amp.  | 0.988550210 | 0.999999503           | 0.999696847              | 689.3      | 1        | 0.00145                      | 6037872    | 3.00   | 1.0000 | 0.716  | 2360   | 2.6556 |

| CATEGORY                 | CLASS                                | Reliability   | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTR   | MTTM   | MDT    | MTBM   | Hrtd/Year |
|--------------------------|--------------------------------------|---------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|-------|--------|--------|--------|-----------|
| <b>Synchronous</b>       |                                      | 0.998653401   | 0.999978284           | 0.999857033              | 378.5      | 2        | 0.00135                      | 6500894.   | xxx   | 2.2088 | 2.576  | 18019  | 1.2524    |
| Item: 152                | Motor, Electric, Synchronous, ≤600V. | 0.998558656 * | 1.000000000           | 0.999777580              | 147.8      | 0        | 0.00345 *                    | 2538917. * | 0.00  | 2.0000 | 2.000  | 8992   | 1.9484    |
| Item: 153                | Motor, Electric, Synchronous, >600V. | 0.991366824   | 0.999964367           | 0.999907948              | 230.7      | 2        | 0.00867                      | 1010304    | 36.00 | 3.0000 | 4.650  | 50515  | 0.8064    |
| <b>Motor, Mechanical</b> |                                      | 0.195448823   | 0.99809717            | 0.998810724              | 1154.7     | 1885     | 1.63246                      | 5386.145   | 1.02  | 2.8441 | 2.212  | 1860   | 10.418    |
| <b>Diesel</b>            |                                      | 0.904562026   | 0.999953538           | 0.991433654              | 129.6      | 13       | 0.10030                      | 87334.15   | 4.06  | 3.2492 | 3.253  | 380    | 75.041    |
| Item: 142                | Motor, Mechanical, Diesel.           | 0.904562026   | 0.999953538           | 0.991433654              | 129.6      | 13       | 0.10030                      | 87334.2    | 4.06  | 3.0000 | 3.253  | 380    | 75.041    |
| <b>Gas</b>               |                                      | 0.161029030   | 0.999791533           | 0.999743425              | 1025.1     | 1872     | 1.82617                      | 4796.923   | 1.00  | 0.7500 | 0.941  | 3668   | 2.2476    |
| Item: 143                | Motor, Mechanical, Gas.              | 0.161029030   | 0.999791533           | 0.999743425              | 1025.1     | 1872     | 1.82617                      | 4796.9     | 1.00  | 1.0000 | 0.941  | 3668   | 2.2476    |
| <b>Pipe</b>              |                                      | 0.981888041   | 0.99994337            | 0.99991952               | 383.0      | 7        | 0.01828                      | 479265     | 2.71  | 4.0000 | 3.000  | 372762 | 0.0705    |
| <b>Flex</b>              |                                      | 0.981888041   | 0.99994337            | 0.99991952               | 383.0      | 7        | 0.01828                      | 479265     | 2.71  | 4.0000 | 3.000  | 372762 | 0.0705    |
| Item: 51                 | Pipe, Flex, Non-Reinforced, >4".     | 0.985560776   | 0.99994466            | 0.99990038               | 206.3      | 3        | 0.01454                      | 602290.2   | 3.33  | 4.0000 | 3.600  | 361374 | 0.0873    |
| Item: 53                 | Pipe, Flex, Reinforced, >4".         | 0.977618384   | 0.99994186            | 0.99994186               | 176.7      | 4        | 0.02264                      | 386996.1   | 2.25  | 0.0000 | 2.250  | 386996 | 0.0509    |
| <b>Piping</b>            |                                      | 0.999960899   | 0.99998770            | 0.999676366              | 13042.9    | 12       | 0.00004                      | 22403087   | xxx   | 7.7177 | 7.728  | 23878  | 2.8350    |
| <b>Refrigerant</b>       |                                      | 0.999954550   | 0.99999430            | 0.99990919               | 11221.0    | 6        | 0.00005                      | 19273661   | xxx   | 3.0645 | 3.199  | 352314 | 0.0785    |
| Item: 91                 | Piping, Refrigerant, <1 inch.        | 0.999925556 * | 1.000000000           | 0.99993884               | 6850.6     | 0        | 0.00007 *                    | 11766837 * | 0.00  | 4.0000 | 3.670  | 600109 | 0.0536    |
| Item: 158                | Piping, Refrigerant, <2 inch.        | 0.997181886   | 0.999996564           | 0.99986684               | 1063.0     | 3        | 0.00282                      | 3104080    | 10.67 | 1.0000 | 0.932  | 70017  | 0.1166    |
| Item: 159                | Piping, Refrigerant, >2 inch.        | 0.99822269 *  | 1.000000000           | 1.000000000              | 2869.2     | 0        | 0.00018 *                    | 49283482 * | 0.00  | 0.0000 | xxx    | xxx    | 0.0000    |
| Item: 92                 | Piping, Refrigerant, 1-3 inch.       | 0.993176045   | 0.99993747            | 0.999895362              | 438.1      | 3        | 0.00685                      | 1279328    | 8.00  | 9.0000 | 8.730  | 83434  | 0.9166    |
| <b>Water</b>             |                                      | 0.999720116   | 0.99994706            | 0.997739077              | 1821.9     | 6        | 0.00028                      | 31294258   | xxx   | xxx    | 8.008  | 3542   | 19.805    |
| Item: 154                | Piping, Water, ≤2 inch.              | 0.998834378 * | 1.000000000           | 1.000000000              | 437.3      | 0        | 0.00117 *                    | 7510917. * | 0.00  | 0.0000 | xxx    | xxx    | 0.0000    |
| Item: 93                 | Piping, Water, >12".                 | 0.938385452 * | 1.000000000           | 1.000000000              | 8.2        | 0        | 0.06253 *                    | 140094.1 * | 0.00  | 0.0000 | xxx    | xxx    | 0.0000    |
| Item: 155                | Piping, Water, >2 ≤4 inch.           | 0.979679275   | 0.999966994           | 0.999966994              | 292.3      | 6        | 0.02053                      | 426692     | 14.08 | 0.0000 | 14.083 | 426692 | 0.2891    |
| Item: 156                | Piping, Water, >4 ≤8 inch.           | 0.998103531 * | 1.000000000           | 1.000000000              | 268.7      | 0        | 0.00190 *                    | 4614729. * | 0.00  | 0.0000 | xxx    | xxx    | 0.0000    |
| Item: 157                | Piping, Water, >8 ≤12 inch.          | 0.999374866 * | 1.000000000           | 0.994961083              | 815.6      | 0        | 0.00063 *                    | 14008611 * | 0.00  | 8.0000 | 8.000  | 1588   | 44.140    |

| CATEGORY                         | CLASS   | Reliability   | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTTR  | MTTM   | MDT   | MTBM  | Hrds/Year |
|----------------------------------|---|---------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|-------|--------|-------|-------|-----------|
| <b>Pressure Control</b>          |   | 0.983091820   | 0.999995568           | 0.999938101              | 721.3      | 5        | 0.00693                      | 1263676.   | 5.60  | 3.3935 | 3.492 | 56414 | 0.5422    |
| <b>Assembly</b>                  |   | 0.983091820   | 0.999995568           | 0.999938101              | 721.3      | 5        | 0.00693                      | 1263676.   | 5.60  | 3.3935 | 3.492 | 56414 | 0.5422    |
|                                  | Item: 160 Pressure Control, Assembly.                         | 0.983091820   | 0.999995568           | 0.999938101              | 721.3      | 5        | 0.00693                      | 1263676.   | 5.60  | 3.0000 | 3.492 | 56414 | 0.5422    |
| <b>Pressure Regulator</b>        |   | 0.989163441   | 1.000000000           | 0.999993069              | 609.4      | 0        | 0.00084                      | 10467090   | xxx   | 0.5000 | 0.500 | 72138 | 0.0607    |
| <b>Hot Gas</b>                   |   | 0.989163441   | 1.000000000           | 0.999993069              | 609.4      | 0        | 0.00084                      | 10467090   | xxx   | 0.5000 | 0.500 | 72138 | 0.0607    |
|                                  | Item: 161 Pressure Regulator, Hot Gas.                        | 0.989163441 * | 1.000000000           | 0.999993069              | 609.4      | 0        | 0.00084 *                    | 10467090 * | 0.00  | 0.0000 | 0.500 | 72138 | 0.0607    |
| <b>Pump</b>                      |   | 0.983705867   | 0.99994889            | 0.999826613              | 1742.2     | 11       | 0.00631                      | 1387387.   | 7.09  | 0.4204 | 0.432 | 2494  | 1.5189    |
| <b>Centrifugal</b>               |   | 0.984206434   | 0.99995523            | 0.999903450              | 1376.8     | 8        | 0.00581                      | 1507638    | 6.75  | 0.3372 | 0.353 | 3654  | 0.8458    |
|                                  | Item: 163 Pump, Centrifugal, Integral Drive.                  | 0.982515450   | 0.999993654           | 0.999897429              | 665.5      | 5        | 0.00751                      | 1166025.   | 7.40  | 1.0000 | 0.599 | 5836  | 0.8985    |
|                                  | Item: 164 Pump, Centrifugal, wo/Drive.                        | 0.985791244   | 0.99997272            | 0.999909083              | 711.3      | 3        | 0.00422                      | 2076992    | 5.67  | 0.0000 | 0.246 | 2707  | 0.7964    |
| <b>Positive Displacement</b>     |   | 0.991821538   | 0.99992500            | 0.999537023              | 365.3      | 3        | 0.00821                      | 1066720    | 8.00  | 0.5176 | 0.526 | 1135  | 4.0557    |
|                                  | Item: 165 Pump, Positive Displacement.                        | 0.991821538   | 0.99992500            | 0.999537023              | 365.3      | 3        | 0.00821                      | 1066720    | 8.00  | 1.0000 | 0.526 | 1135  | 4.0557    |
| <b>Radiators</b>                 |   | 0.987545587   | 0.99997760            | 0.999934189              | 877.7      | 11       | 0.01253                      | 698976     | 15.55 | 0.0999 | 0.150 | 2285  | 0.5765    |
| <b>Small Tube</b>                |   | 0.987545587   | 0.99997760            | 0.999934189              | 877.7      | 11       | 0.01253                      | 698976     | 15.55 | 0.0999 | 0.150 | 2285  | 0.5765    |
|                                  | Item: 166 Radiators, Small Tube.                              | 0.987545587   | 0.99997760            | 0.999934189              | 877.7      | 11       | 0.01253                      | 698976     | 15.55 | 0.0000 | 0.150 | 2285  | 0.5765    |
| <b>Rectifiers</b>                |   | 0.985540658   | 0.99991837            | 0.988972976              | 447.5      | 2        | 0.00447                      | 1960032    | 16.00 | 3.4491 | 3.471 | 3379  | 8.9967    |
| <b>All Types</b>                 |   | 0.985540658   | 0.99991837            | 0.988972976              | 447.5      | 2        | 0.00447                      | 1960032    | 16.00 | 3.4491 | 3.471 | 3379  | 8.9967    |
|                                  | Item: 168 Rectifiers, All Types.                              | 0.985540658   | 0.99991837            | 0.988972976              | 447.5      | 2        | 0.00447                      | 1960032    | 16.00 | 3.0000 | 3.471 | 3379  | 8.9967    |
| <b>Sending Unit</b>              |   | 0.989566658   | 0.99999536            | 0.99999258               | 36914.4    | 16       | 0.00043                      | 20210622   | 9.38  | 0.0170 | 0.045 | 60956 | 0.0065    |
| <b>Air Velocity</b>              |   | 0.988667884   | 0.99998707            | 0.99997599               | 6179.6     | 7        | 0.00113                      | 7733345.   | 10.00 | 0.0156 | 0.034 | 14050 | 0.0210    |
|                                  | Item: 173 Sending Unit, Air Velocity.                         | 0.988667884   | 0.99998707            | 0.99997599               | 6179.6     | 7        | 0.00113                      | 7733345.   | 10.00 | 0.0000 | 0.034 | 14050 | 0.0210    |
| <b>Pressure</b>                  |   | 0.987916028   | 0.99997883            | 0.99997089               | 4314.2     | 9        | 0.00209                      | 4199130.   | 8.89  | 0.0208 | 0.076 | 26028 | 0.0255    |
|                                  | Item: 171 Sending Unit, Pressure.                             | 0.987916028   | 0.99997883            | 0.99997089               | 4314.2     | 9        | 0.00209                      | 4199130.   | 8.89  | 0.0000 | 0.076 | 26028 | 0.0255    |
| <b>Temperature</b>               |   | 0.989980697   | 1.000000000           | 1.000000000              | 26420.6    | 0        | 0.00002                      | 45381247   | xxx   | xxx    | xxx   | xxx   | 0.0000    |
|                                  | Item: 172 Sending Unit, Temperature.                          | 0.989980697 * | 1.000000000           | 1.000000000              | 26420.6    | 0        | 0.00002 *                    | 45381247 * | 0.00  | 0.0000 | xxx   | xxx   | 0.0000    |
| <b>Software Con. ADAS Sys.</b>   |   | 0.642221250   | 0.999854564           | 0.999658784              | 551.0      | 244      | 0.44282                      | 19782.19   | 2.88  | 0.5615 | 0.855 | 2505  | 2.9891    |
| <b>≤ 1000 Acquisition Points</b> |   | 0.777690112   | 0.99954199            | 0.99986246               | 373.9      | 94       | 0.25143                      | 34841.10   | 1.60  | 1.2558 | 1.376 | 12312 | 0.9790    |
|                                  | Item: 169 Software Con. ADAS Sys., ≤ 1000 Acquisition Points. | 0.777690112   | 0.99954199            | 0.99986246               | 373.9      | 94       | 0.25143                      | 34841.1    | 1.60  | 1.0000 | 1.376 | 12312 | 0.9790    |

| CATEGORY                           | CLASS  | Reliability | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTR    | MTTM    | MDT    | MTBM   | Frdl/Year |
|------------------------------------|--|-------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|--------|---------|--------|--------|-----------|
| <b>&gt;1000 Acquisition Points</b> |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
| Item: 170                          | Software Con. ADAS Sys., >1000 Acquisition Points. | 0.428800729 | 0.999644282           | 0.999174503              | 177.1      | 150      | 0.84676                      | 10345.28   | 3.68   | 0.4825  | 0.771  | 934    | 7.2314    |
|                                    |  | 0.428800729 | 0.999644282           | 0.999174503              | 177.1      | 150      | 0.84676                      | 10345.3    | 3.68   | 0.0000  | 0.771  | 934    | 7.2314    |
| <b>Strainer</b>                    |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
|                                    |  | 0.999943310 | 1.000000000           | 0.999916767              | 8996.1     | 0        | 0.00006                      | 15452150   | xxx    | 0.3084  | 0.308  | 3705   | 0.7291    |
| <b>Coolant</b>                     |  | 0.998861684 | 1.000000000           | 0.999333463              | 447.8      | 0        | 0.00114                      | 7691200    | xxx    | 1.6290  | 1.629  | 2444   | 5.8389    |
| Item: 177                          | Strainer, Coolant.                                 | 0.998861684 | * 1.000000000         | 0.999333463              | 447.8      | 0        | 0.00114                      | * 7691200  | * 0.00 | 2.0000  | 1.629  | 2444   | 5.8389    |
| <b>Duplex Fuel/Lube Oil</b>        |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
| Item: 180                          | Strainer, Duplex Fuel/Lube Oil.                    | 0.995679886 | 1.000000000           | 0.999861421              | 117.8      | 0        | 0.00433                      | 2023341.   | xxx    | 0.8614  | 0.861  | 6216   | 1.2140    |
|                                    |  | 0.995679886 | * 1.000000000         | 0.999861421              | 117.8      | 0        | 0.00433                      | * 2023341. | * 0.00 | 1.0000  | 0.861  | 6216   | 1.2140    |
| <b>Fuel Oil</b>                    |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
| Item: 179                          | Strainer, Fuel Oil.                                | 0.998766615 | 1.000000000           | 0.999924447              | 413.2      | 0        | 0.00123                      | 7098023.   | xxx    | 1.7094  | 1.709  | 22625  | 0.6618    |
|                                    |  | 0.998766615 | * 1.000000000         | 0.999924447              | 413.2      | 0        | 0.00123                      | * 7098023. | * 0.00 | 2.0000  | 1.709  | 22625  | 0.6618    |
| <b>Lube Oil</b>                    |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
| Item: 178                          | Strainer, Lube Oil.                                | 0.999529759 | 1.000000000           | 0.999881981              | 1084.3     | 0        | 0.00047                      | 18624376   | xxx    | 1.7380  | 1.738  | 14726  | 1.0339    |
|                                    |  | 0.999529759 | * 1.000000000         | 0.999881981              | 1084.3     | 0        | 0.00047                      | * 18624376 | * 0.00 | 2.0000  | 1.738  | 14726  | 1.0339    |
| <b>Water</b>                       |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
| Item: 175                          | Strainer, Water, ≤4 inch.                          | 0.999926442 | 1.000000000           | 0.999960363              | 6933.0     | 0        | 0.00007                      | 11908456   | xxx    | 0.1288  | 0.129  | 3249   | 0.3472    |
|                                    |  | 0.999920044 | * 1.000000000         | 0.999999893              | 6378.3     | 0        | 0.00008                      | * 10955614 | * 0.00 | 0.0000  | 0.000  | 3116   | 0.0009    |
| Item: 176                          | Strainer, Water, >4 inch.                          | 0.999081068 | * 1.000000000         | 0.999505864              | 554.7      | 0        | 0.00092                      | * 9528423. | * 0.00 | 3.0000  | 3.168  | 6411   | 4.3286    |
| <b>Switch</b>                      |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
| <b>Automatic Transfer</b>          |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
| Item: 183                          | Switch, Automatic Transfer, >600 amp., ≤600V.      | 0.993744427 | 0.999996988           | 0.999960651              | 9720.8     | 61       | 0.00628                      | 1395966.   | 4.20   | 1.5333  | 1.612  | 40959  | 0.3447    |
|                                    |  | 0.950118163 | 0.999976051           | 0.999857315              | 1074.9     | 55       | 0.05117                      | 171197.6   | 4.10   | 7.3553  | 6.490  | 45487  | 1.2499    |
| Item: 182                          | Switch, Automatic Transfer, 0-600 amp., ≤600V.     | 0.968631015 | 0.999994046           | 0.999809981              | 690.3      | 22       | 0.03187                      | 274853.5   | 1.64   | 34.0000 | 20.891 | 105941 | 1.6646    |
|                                    |  | 0.917774618 | 0.999943753           | 0.999942269              | 384.6      | 33       | 0.08580                      | 102093.8   | 5.74   | 0.0000  | 1.280  | 22165  | 0.5057    |
| <b>Disconnect</b>                  |  |             |                       |                          |            |          |                              |            |        |         |        |        |           |
| Item: 185                          | Switch, Disconnect, Enclosed, ≤600V.               | 0.999846881 | 0.999999966           | 0.999961037              | 3330.5     | 1        | 0.00015                      | 57205889   | xxx    | 1.5473  | 1.547  | 39694  | 0.3413    |
|                                    |  | 0.999394569 | * 1.000000000         | 0.999838186              | 842.1      | 0        | 0.00061                      | * 14464658 | * 0.00 | 2.0000  | 1.991  | 32214  | 0.5415    |
| Item: 187                          | Switch, Disconnect, Enclosed, >5kV.                | 0.998257804 | 0.999999801           | 0.999939288              | 573.5      | 1        | 0.00174                      | 5023755.   | 1.00   | 2.0000  | 1.510  | 24870  | 0.5318    |
|                                    |  | 0.997942528 | * 1.000000000         | 0.999867230              | 247.6      | 0        | 0.00206                      | * 4253270. | * 0.00 | 2.0000  | 2.400  | 18076  | 1.1631    |
| Item: 186                          | Switch, Disconnect, Enclosed, >600V, ≤5kV.         | 0.999408178 | * 1.000000000         | 1.000000000              | 861.5      | 0        | 0.00059                      | * 14797364 | * 0.00 | 0.0000  | 0.000  | 314444 | 0.0000    |
| Item: 65                           | Switch, Disconnect, Fused, DC, >600 amp., ≤600V.   | 0.999367257 | * 1.000000000         | 0.99987568               | 805.8      | 0        | 0.00063                      | * 13840094 | * 0.00 | 1.0000  | 0.548  | 44115  | 0.1089    |
| Item: 64                           | Switch, Disconnect, Fused, DC, 0-600 amp., ≤600V.  |             |                       |                          |            |          |                              |            |        |         |        |        |           |

| CATEGORY               | CLASS   | Reliability | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF     | MTRR   | MTTM    | MDT    | MTBM  | Hrd/Year |        |
|------------------------|---|-------------|-----------------------|--------------------------|------------|----------|------------------------------|----------|--------|---------|--------|-------|----------|--------|
| <b>Electric</b>        | Item: 184 Switch, Electric, On/Off Breaker Type, Non-knife., ≤600V.               | 0.999358198 | 0.999999927           | 0.999999780              | 3115.2     | 2        | 0.00064                      | 13644684 | 1.00   | 0.0093  | 0.014  | 63170 | 0.0019   |        |
|                        |   | 0.999358198 | 0.999999927           | 0.999999780              | 3115.2     | 2        | 0.00064                      | 13644684 | 1.00   | 0.0000  | 0.014  | 63170 | 0.0019   |        |
| <b>Float</b>           | Item: 104 Switch, Float, Electric.  | 0.997716932 | 0.999999478           | 0.999985388              | 437.5      | 1        | 0.00229                      | 3832560  | 2.00   | 0.1869  | 0.193  | 13216 | 0.1280   |        |
|                        |   | 0.997716932 | 0.999999478           | 0.999985388              | 437.5      | 1        | 0.00229                      | 3832560  | 2.00   | 0.0000  | 0.193  | 13216 | 0.1280   |        |
| <b>Manual Transfer</b> | Item: 188 Switch, Manual Transfer, ≤600 amp., ≤600V.                              | 0.999129111 | 1.000000000           | 0.999966262              | 585.4      | 0        | 0.00087                      | 10054305 | xxx    | 1.4786  | 1.479  | 43826 | 0.2955   |        |
|                        |   | 0.997919138 | 1.000000000           | 0.999952908              | 244.8      | 0        | 0.00208                      | 4205411. | *      | 0.00    | 1.0000 | 1.098 | 23313    | 0.4125 |
| <b>Oil Filled</b>      | Item: 189 Switch, Manual Transfer, >600 amp., ≤600V.                              | 0.988503402 | 1.000000000           | 0.999975663              | 340.5      | 0        | 0.00150                      | 5848994. | *      | 0.00    | 3.0000 | 2.880 | 119317   | 0.2114 |
|                        |   | 0.988241979 | 1.000000000           | 0.999998849              | 289.8      | 0        | 0.00176                      | 4978494. | xxx    | 8.0000  | 8.0000 | 8.000 | 2539032  | 0.0276 |
| <b>Static</b>          | Item: 190 Switch, Oil Filled, ≤5kV.   | 0.988241979 | 1.000000000           | 0.999998849              | 289.8      | 0        | 0.00176                      | 4978494. | *      | 0.00    | 8.0000 | 8.000 | 2539032  | 0.0276 |
|                        |   | 0.997748999 | 0.999996656           | 0.999919287              | 887.5      | 2        | 0.00225                      | 3887220  | 13.00  | 2.0390  | 2.113  | 26177 | 0.7070   |        |
| <b>Switchgear</b>      | Item: 191 Switchgear, Bare Bus, ≤600V, All Cabinets,Ckt. Bkrs. Not Included.      | 0.996326697 | 0.99999918            | 0.999739539              | 271.7      | 1        | 0.00368                      | 2380392  | 24.00  | 3.0000  | 3.584  | 13759 | 2.2816   |        |
|                        |   | 0.92336720  | 0.99998244            | 0.999994731              | 130.0      | 1        | 0.00769                      | 1138728  | 2.00   | 0.0000  | 0.078  | 14789 | 0.0462   |        |
| <b>Bare Bus</b>        | Item: 193 Switchgear, Bare Bus, >5kV, All Cabinets,Ckt. Bkrs. Not Included.       | 0.989506665 | 1.000000000           | 0.999999648              | 485.8      | 0        | 0.00105                      | 8343764. | *      | 0.00    | 0.032  | 90539 | 0.0031   |        |
|                        |   | 0.991916417 | 0.999974462           | 0.999885725              | 4558.7     | 37       | 0.00812                      | 1079291. | 27.56  | 3.4490  | 3.646  | 8800  | 3.6291   |        |
| <b>Insulated Bus</b>   | Item: 192 Switchgear, Bare Bus, >600V ≤5kV, All Cabinets,Ckt. Bkrs. Not Included. | 0.989863408 | 0.999968286           | 0.999579123              | 3239.0     | 33       | 0.01019                      | 859808.3 | 27.27  | 3.7329  | 3.993  | 9486  | 3.6869   |        |
|                        |   | 0.990554799 | 0.999992098           | 0.999455289              | 1791.3     | 17       | 0.00949                      | 923088.2 | 7.29   | 4.0000  | 4.308  | 7909  | 4.7718   |        |
| <b>Insulated Bus</b>   | Item: 194 Switchgear, Insulated Bus, ≤600V, All Cabinets,Ckt. Bkrs. Not Included. | 0.982216877 | 0.999995342           | 0.999839597              | 780.2      | 14       | 0.01794                      | 488208.8 | 2.27   | 1.0000  | 1.296  | 8079  | 1.4051   |        |
|                        |   | 0.997007968 | 0.999872746           | 0.999607036              | 667.4      | 2        | 0.00300                      | 2923296  | 372.00 | 10.0000 | 14.270 | 36314 | 3.4424   |        |
| <b>Insulated Bus</b>   | Item: 194 Switchgear, Insulated Bus, ≤600V, All Cabinets,Ckt. Bkrs. Not Included. | 0.999613608 | 0.999989619           | 0.999601929              | 1319.6     | 4        | 0.00039                      | 22666917 | xxx    | 2.9046  | 2.975  | 7473  | 3.4871   |        |
|                        |   | 0.988420947 | 1.000000000           | 0.999468794              | 322.7      | 0        | 0.00158                      | 5543247. | *      | 0.00    | 3.0000 | 3.182 | 5990     | 4.6534 |

| CATEGORY                | CLASS  | Reliability   | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTTR  | MTTM    | MDT    | MTBM   | Hr/d/Year |
|-------------------------|--|---------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|-------|---------|--------|--------|-----------|
| Item: 196               | Switchgear, Insulated Bus, >5kV, All Cabinets,Ckt. Bkrs. Not Included.       | 0.995913049   | 0.999992547           | 0.999626621              | 732.5      | 3        | 0.00410                      | 2139024    | 37.33 | 14.0000 | 14.434 | 38657  | 3.2708    |
| Item: 195               | Switchgear, Insulated Bus, >600V ≤5kV, All Cabinets,Ckt. Bkrs. Not Included. | 0.996224761   | 0.999996546           | 0.999696028              | 264.4      | 1        | 0.00378                      | 2316000    | 8.00  | 1.0000  | 0.774  | 2548   | 2.6628    |
| <b>Tank</b>             |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| <b>Day</b>              |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 198               | Tank, Day, Genset Fuel.  | 0.995965564   | 0.999991636           | 0.999971186              | 1978.9     | 8        | 0.00404                      | 2166924    | 18.13 | 0.1221  | 0.172  | 5955   | 0.2524    |
|                         |  | 0.994810377   | 0.999997030           | 0.999974756              | 384.4      | 2        | 0.00520                      | 1683600    | 5.00  | 0.3074  | 0.346  | 13688  | 0.2211    |
|                         |  | 0.994810377   | 0.999997030           | 0.999974756              | 384.4      | 2        | 0.00520                      | 1683600    | 5.00  | 0.0000  | 0.346  | 13688  | 0.2211    |
| <b>Fuel</b>             |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 197               | Tank, Fuel.  | 0.993549151   | 0.999955673           | 0.999872929              | 309.0      | 2        | 0.00647                      | 1353576    | 60.00 | 1.2584  | 1.911  | 15040  | 1.1131    |
|                         |  | 0.993549151   | 0.999955673           | 0.999872929              | 309.0      | 2        | 0.00647                      | 1353576    | 60.00 | 1.0000  | 1.911  | 15040  | 1.1131    |
| <b>Receiver</b>         |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 167               | Tank, Receiver, Air.   | 0.997280535   | 0.999997824           | 0.999996891              | 734.4      | 2        | 0.00272                      | 3216840    | 7.00  | 0.0029  | 0.010  | 3078   | 0.0272    |
|                         |  | 0.997280535   | 0.999997824           | 0.999996891              | 734.4      | 2        | 0.00272                      | 3216840    | 7.00  | 0.0000  | 0.010  | 3078   | 0.0272    |
| <b>Water</b>            |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 199               | Tank, Water.   | 0.996377265   | 0.999997993           | 0.999899539              | 551.1      | 2        | 0.00363                      | 2413680    | 0.50  | 0.1260  | 0.128  | 12221  | 0.0916    |
|                         |  | 0.996377265   | 0.999997993           | 0.999899539              | 551.1      | 2        | 0.00363                      | 2413680    | 0.50  | 0.0000  | 0.128  | 12221  | 0.0916    |
| <b>Thermostat</b>       |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 201               | Thermostat, Radiator.  | 0.998319168   | 0.999999398           | 0.99997565               | 6538.9     | 11       | 0.00168                      | 5207323.   | 3.14  | 0.7895  | 0.969  | 397782 | 0.0213    |
|                         |  | 0.998319168   | 0.999999398           | 0.99997565               | 6538.9     | 11       | 0.00168                      | 5207323.   | 3.14  | 0.7895  | 0.969  | 397782 | 0.0213    |
|                         |  | 0.998319168   | 0.999999398           | 0.99997565               | 6538.9     | 11       | 0.00168                      | 5207323.   | 3.14  | 1.0000  | 0.969  | 397782 | 0.0213    |
| <b>Transducer</b>       |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 114               | Transducer, Flow.  | 0.999978470   | 0.999999933           | 0.999998552              | 23687.4    | 42       | 0.00002                      | 40686583   | xxx   | 0.0183  | 0.019  | 13235  | 0.0127    |
|                         |  | 0.996713345   | 1.000000000           | 0.999866736              | 154.9      | 0        | 0.00329                      | 2660941.   | xxx   | 0.3600  | 0.360  | 27142  | 0.1162    |
|                         |  | 0.996713345 * | 1.000000000           | 0.999866736              | 154.9      | 0        | 0.00329 *                    | 2660941. * | 0.00  | 0.0000  | 0.360  | 27142  | 0.1162    |
| <b>Pressure</b>         |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 162               | Transducer, Pressure.  | 0.997477750   | 0.999999423           | 0.999987243              | 791.9      | 2        | 0.00253                      | 3468708    | 2.00  | 0.6983  | 0.720  | 56402  | 0.1118    |
|                         |  | 0.997477750   | 0.999999423           | 0.999987243              | 791.9      | 2        | 0.00253                      | 3468708    | 2.00  | 1.0000  | 0.720  | 56402  | 0.1118    |
| <b>Temperature</b>      |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 200               | Transducer, Temperature.   | 0.998242572   | 0.999999950           | 0.99999026               | 22740.5    | 40       | 0.00176                      | 4980177    | 0.25  | 0.0119  | 0.013  | 12848  | 0.0085    |
|                         |  | 0.998242572   | 0.999999950           | 0.99999026               | 22740.5    | 40       | 0.00176                      | 4980177    | 0.25  | 0.0000  | 0.013  | 12848  | 0.0085    |
| <b>Transformer, Dry</b> |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| <b>Air Cooled</b>       |  |               |                       |                          |            |          |                              |            |       |         |        |        |           |
| Item: 202               | Transformer, Dry, Air Cooled, ≤500kVA.                                       | 0.99953743    | 0.999995817           | 0.999971899              | 11025.1    | 19       | 0.00005                      | 18937280   | xxx   | 3.2263  | 3.693  | 131402 | 0.2462    |
|                         |  | 0.999882198   | 1.000000000           | 0.99944571               | 4329.0     | 0        | 0.00012                      | 74357512   | xxx   | 4.2724  | 4.272  | 77078  | 0.4856    |
|                         |  | 0.999775100 * | 1.000000000           | 0.999995570              | 2267.4     | 0        | 0.00022 *                    | 38946258 * | 0.00  | 4.0000  | 3.826  | 863591 | 0.0388    |

| CATEGORY                              | CLASS   | Reliability               | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF                 | MTR    | MTTM    | MDT    | MTBM    | Htd/Year |
|---------------------------------------|---|---------------------------|-----------------------|--------------------------|------------|----------|------------------------------|----------------------|--------|---------|--------|---------|----------|
| Item: 204                             | Transformer, Dry, Air Cooled, >1500kVA ≤3000kVA           | 0.999393210 * 1.000000000 | 0.999745124           | 0.99987102               | 840.2      | 0        | 0.00061 * 14432242 *         | 0.00042 * 20979011 * | 0.00   | 4.0000  | 4.206  | 16503   | 2.2327   |
| Item: 203                             | Transformer, Dry, Air Cooled, >500kVA ≤1500kVA            | 0.999582527 * 1.000000000 | 0.999987102           | 0.999987102              | 1221.4     | 0        | 0.00042 * 20979011 *         | 0.00042 * 20979011 * | 0.00   | 6.0000  | 6.000  | 465187  | 0.1130   |
| <b>Isolation</b>                      |   |                           |                       |                          |            |          |                              |                      |        |         |        |         |          |
| Item: 132                             | Transformer, Dry, Isolation, Delta Wye, <600V.            | 0.997166548               | 0.999993113           | 0.999989567              | 6696.1     | 19       | 0.00284                      | 3087252.             | 21.26  | 0.9286  | 2.519  | 241390  | 0.0914   |
|                                       |   | 0.997166548               | 0.999993113           | 0.999989567              | 6696.1     | 19       | 0.00284                      | 3087252.             | 21.26  | 1.0000  | 2.519  | 241390  | 0.0914   |
| <b>Transformer, Liquid Forced Air</b> |   |                           |                       |                          |            |          |                              |                      |        |         |        |         |          |
| Item: 206                             | Transformer, Liquid, Forced Air, ≤10,000kVA.              | 0.994797669               | 0.999950735           | 0.998990580              | 8819.2     | 46       | 0.00522                      | 1679476.             | 82.74  | 16.9047 | 17.588 | 17424   | 8.8425   |
|                                       |   | 0.989259891               | 0.999836759           | 0.996601877              | 2593.0     | 28       | 0.01080                      | 811246.2             | 132.43 | 21.1758 | 22.066 | 6494    | 29.767   |
|                                       |   | 0.992879584               | 0.999797696           | 0.990915913              | 419.8      | 3        | 0.00715                      | 1225880              | 248.00 | 23.0000 | 23.677 | 2606    | 79.576   |
| Item: 205                             | Transformer, Liquid, Forced Air, ≤5,000kVA.               | 0.987452327               | 0.999994736           | 0.999987215              | 1821.5     | 23       | 0.01263                      | 693748.2             | 3.65   | 1.0000  | 0.976  | 76345   | 0.1120   |
| Item: 207                             | Transformer, Liquid, Forced Air, >10,000kVA ≤50,000kVA.   | 0.994329760               | 0.999065253           | 0.985856760              | 351.7      | 2        | 0.00569                      | 1540524              | 1440.0 | 22.0000 | 23.203 | 1641    | 123.89   |
| <b>Non-Forced Air</b>                 |   |                           |                       |                          |            |          |                              |                      |        |         |        |         |          |
| Item: 208                             | Transformer, Liquid, Non-Forced Air, ≤3000kVA.            | 0.997113141               | 0.999998203           | 0.999985412              | 6226.1     | 18       | 0.00289                      | 3030057.             | 5.44   | 0.7600  | 0.850  | 58270   | 0.1278   |
|                                       |   | 0.998891114               | 0.999999367           | 0.999996102              | 5407.8     | 6        | 0.00111                      | 7895436              | 5.00   | 10.0000 | 8.394  | 2153301 | 0.0341   |
| Item: 241                             | Transformer, Liquid, Non-Forced Air, >10000kVA ≤50000kVA. | 0.982624792               | 0.999987813           | 0.999893406              | 627.6      | 11       | 0.01753                      | 499773.8             | 6.09   | 1.0000  | 0.648  | 6081    | 0.9338   |
| Item: 209                             | Transformer, Liquid, Non-Forced Air, >3000kVA ≤10000kVA.  | 0.994771048               | 0.999999402           | 0.999985038              | 190.7      | 1        | 0.00524                      | 1670904              | 1.00   | 3.0000  | 2.500  | 167090  | 0.1311   |
| <b>UPS</b>                            |   |                           |                       |                          |            |          |                              |                      |        |         |        |         |          |
| <b>Rotary</b>                         |   |                           |                       |                          |            |          |                              |                      |        |         |        |         |          |
| Item: 213                             | UPS, Rotary.  | 0.999078297               | 0.999998349           | 0.999951289              | 553.1      | 4        | 0.00092                      | 9499764.             | xxx    | 3.8000  | 3.688  | 75701   | 0.4267   |
|                                       |   | 0.995983397               | 1.000000000           | 0.999895500              | 126.7      | 0        | 0.00402                      | 2176564.             | xxx    | 6.1053  | 6.105  | 58424   | 0.9154   |
|                                       |   | 0.995983397 *             | 1.000000000           | 0.999895500              | 126.7      | 0        | 0.00402 *                    | 2176564.             | 0.00   | 6.0000  | 6.105  | 58424   | 0.9154   |
| <b>Small Computer Room Floor</b>      |   |                           |                       |                          |            |          |                              |                      |        |         |        |         |          |
| Item: 216                             | UPS, Small Computer Room Floor.                           | 0.990661925               | 0.999997858           | 0.999967870              | 426.4      | 4        | 0.00938                      | 933708               | 2.00   | 2.7317  | 2.667  | 82996   | 0.2815   |
|                                       |   | 0.990661925               | 0.999997858           | 0.999967870              | 426.4      | 4        | 0.00938                      | 933708               | 2.00   | 3.0000  | 2.667  | 82996   | 0.2815   |

| CATEGORY         | CLASS                               | Reliability   | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF       | MTR  | MTM    | MDT   | MTBM    | Hrd/Year |
|------------------|-------------------------------------|---------------|-----------------------|--------------------------|------------|----------|------------------------------|------------|------|--------|-------|---------|----------|
| <b>Valve</b>     |                                     | 0.999995192   | 0.999999568           | 0.99977752               | 106073.6   | 183      | 0.00000                      | 18219692   | xxx  | 0.7962 | 0.806 | 36233   | 0.1949   |
| <b>3-way</b>     |                                     | 0.999727982   | 1.000000000           | 0.999987577              | 1874.6     | 0        | 0.00027                      | 32199388   | xxx  | 0.5165 | 0.516 | 41574   | 0.1088   |
| Item: 236        | Valve, 3-way, Diverting/Sequencing. | 0.999257278 * | 1.000000000           | 0.999999501              | 686.4      | 0        | 0.00074 *                    | 11790070 * | 0.00 | 0.0000 | 0.015 | 30388   | 0.0044   |
| Item: 237        | Valve, 3-way, Mixing Control.       | 0.999570876 * | 1.000000000           | 0.999980689              | 1188.2     | 0        | 0.00043 *                    | 20409317 * | 0.00 | 1.0000 | 1.020 | 52836   | 0.1692   |
| <b>Ball</b>      |                                     | 0.999807822   | 0.999999957           | 0.999999204              | 2653.5     | 2        | 0.00019                      | 45578400   | xxx  | 0.1577 | 0.164 | 205708  | 0.0070   |
| Item: 217        | Valve, Ball, N.C.                   | 0.999516658 * | 1.000000000           | 0.999981106              | 1054.9     | 0        | 0.00048 *                    | 18119435 * | 0.00 | 0.0000 | 0.192 | 101548  | 0.0166   |
| Item: 218        | Valve, Ball, N.O.                   | 0.998749718   | 0.999999929           | 0.999999929              | 1598.6     | 2        | 0.00125                      | 7002036    | 0.50 | 0.0000 | 0.045 | 636549  | 0.0006   |
| <b>Butterfly</b> |                                     | 0.998692271   | 0.999999513           | 0.999995506              | 17576.2    | 23       | 0.00131                      | 6694253.   | 3.26 | 0.5539 | 0.609 | 135416  | 0.0394   |
| Item: 219        | Valve, Butterfly, N.C.              | 0.991788585   | 0.999996931           | 0.999990199              | 2789.5     | 23       | 0.00825                      | 1062421.   | 3.26 | 1.0000 | 1.288 | 131375  | 0.0859   |
| Item: 220        | Valve, Butterfly, N.O.              | 0.999965510 * | 1.000000000           | 0.999996507              | 14786.8    | 0        | 0.00003 *                    | 25398456 * | 0.00 | 0.0000 | 0.476 | 136206  | 0.0306   |
| <b>Check</b>     |                                     | 0.999742108   | 0.999999971           | 0.999980199              | 3877.1     | 1        | 0.00026                      | 33963360   | 1.00 | 0.9136 | 0.914 | 46146   | 0.1735   |
| Item: 221        | Valve, Check.                       | 0.999742108   | 0.999999971           | 0.999980199              | 3877.1     | 1        | 0.00026                      | 33963360   | 1.00 | 1.0000 | 0.914 | 46146   | 0.1735   |
| <b>Control</b>   |                                     | 0.999937125   | 0.999999943           | 0.999996490              | 15904.0    | 1        | 0.00006                      | 13931940   | 8.00 | 0.1091 | 0.111 | 31599   | 0.0307   |
| Item: 223        | Valve, Control, N.C.                | 0.999922211   | 0.999999929           | 0.999997478              | 12854.8    | 1        | 0.00008                      | 11260780   | 8.00 | 0.0000 | 0.080 | 31864   | 0.0221   |
| Item: 224        | Valve, Control, N.O.                | 0.999832761 * | 1.000000000           | 0.999992325              | 3049.3     | 0        | 0.00017 *                    | 52375670 * | 0.00 | 0.0000 | 0.234 | 30528   | 0.0672   |
| <b>Expansion</b> |                                     | 0.999742991   | 1.000000000           | 1.000000000              | 1984.1     | 0        | 0.00026                      | 34080094   | xxx  | xxx    | xxx   | xxx     | 0.0000   |
| Item: 105        | Valve, Expansion.                   | 0.999742991 * | 1.000000000           | 1.000000000              | 1984.1     | 0        | 0.00026 *                    | 34080094 * | 0.00 | 0.0000 | xxx   | xxx     | 0.0000   |
| <b>Gate</b>      |                                     | 0.999827547   | 0.999999888           | 0.999999642              | 17394.5    | 3        | 0.00017                      | 50792032   | 5.67 | 0.8333 | 1.135 | 3174502 | 0.0031   |
| Item: 225        | Valve, Gate, N.C.                   | 0.999421886   | 0.999999934           | 0.999998647              | 1729.3     | 1        | 0.00058                      | 15148344   | 1.00 | 1.0000 | 0.603 | 445540  | 0.0119   |
| Item: 226        | Valve, Gate, N.O.                   | 0.999872337   | 0.999999883           | 0.99999752               | 15665.3    | 2        | 0.00013                      | 68613876   | 8.00 | 2.0000 | 2.429 | 9801982 | 0.0022   |
| <b>Globe</b>     |                                     | 0.999980570   | 1.000000000           | 0.999921533              | 26248.0    | 0        | 0.00002                      | 45084720   | xxx  | 0.9954 | 0.995 | 12685   | 0.6874   |
| Item: 227        | Valve, Globe, N.C.                  | 0.999975654 * | 1.000000000           | 0.999901776              | 20947.4    | 0        | 0.00002 *                    | 35980272 * | 0.00 | 1.0000 | 0.997 | 10149   | 0.8604   |
| Item: 228        | Valve, Globe, N.O.                  | 0.999903788 * | 1.000000000           | 0.999999612              | 5300.5     | 0        | 0.00010 *                    | 91044470 * | 0.00 | 0.0000 | 0.400 | 1031837 | 0.0034   |
| <b>Plug</b>      |                                     | 0.990331504   | 0.999997992           | 0.999997984              | 15233.3    | 148      | 0.00972                      | 901648.3   | 1.81 | 0.0476 | 1.592 | 789609  | 0.0177   |
| Item: 232        | Valve, Plug, N.C.                   | 0.986191497   | 0.999997832           | 0.999997819              | 8845.9     | 123      | 0.01390                      | 630001.6   | 1.37 | 0.0000 | 1.174 | 538126  | 0.0191   |
| Item: 233        | Valve, Plug, N.O.                   | 0.996093704   | 0.999998213           | 0.999998213              | 6387.4     | 25       | 0.00391                      | 2238150.   | 4.00 | 0.0000 | 4.000 | 2238151 | 0.0157   |

| CATEGORY                  | CLASS                              | Reliability   | Inherent Availability | Operational Availability | Unit Years | Failures | Failure Rate (Failures/Year) | MTBF     | MTR    | MTTM   | MDT   | MTBM   | Hrds/Year |
|---------------------------|------------------------------------|---------------|-----------------------|--------------------------|------------|----------|------------------------------|----------|--------|--------|-------|--------|-----------|
| <b>Reducing</b>           |                                    | 0.998490771   | 1.000000000           | 0.999972616              | 337.7      | 0        | 0.00151                      | 5799905. | xxx    | 0.4939 | 0.494 | 18036  | 0.2399    |
| Item: 234                 | Valve, Reducing, Makeup Water.     | 0.998490771 * | 1.000000000           | 0.999972616              | 337.7      | 0        | 0.00151 *                    | 5799905. | * 0.00 | 0.0000 | 0.494 | 18036  | 0.2399    |
| <b>Relief</b>             |                                    | 0.998671145   | 0.999996966           | 0.999994763              | 752.0      | 1        | 0.00133                      | 6587760  | 2.00   | 0.1796 | 0.190 | 36196  | 0.0459    |
| Item: 235                 | Valve, Relief.                     | 0.998671145   | 0.999996966           | 0.999994763              | 752.0      | 1        | 0.00133                      | 6587760  | 2.00   | 0.0000 | 0.190 | 36196  | 0.0459    |
| <b>Suction</b>            |                                    | 0.998214603   | 0.999985521           | 0.999994094              | 2238.4     | 4        | 0.00179                      | 4902090  | 7.25   | 0.5358 | 0.698 | 118123 | 0.0517    |
| Item: 181                 | Valve, Suction.                    | 0.998214603   | 0.999985521           | 0.999994094              | 2238.4     | 4        | 0.00179                      | 4902090  | 7.25   | 1.0000 | 0.698 | 118123 | 0.0517    |
| <b>Valve Operator</b>     |                                    | 0.992808232   | 0.999991177           | 0.999971677              | 9975.4     | 72       | 0.00722                      | 1213674  | 10.71  | 1.0564 | 1.469 | 51860  | 0.2481    |
| <b>Electric</b>           |                                    | 0.990159307   | 0.999979209           | 0.999934083              | 3640.2     | 36       | 0.00989                      | 885794   | 18.42  | 0.9823 | 1.400 | 21245  | 0.5774    |
| Item: 229                 | Valve Operator, Electric.          | 0.990159307   | 0.999979209           | 0.999934083              | 3640.2     | 36       | 0.00989                      | 885794   | 18.42  | 1.0000 | 1.400 | 21245  | 0.5774    |
| <b>Hydraulic</b>          |                                    | 0.915817948   | 0.999969884           | 0.999601804              | 68.2       | 6        | 0.08794                      | 99616    | 3.00   | 2.1569 | 2.204 | 5534   | 3.4882    |
| Item: 230                 | Valve Operator, Hydraulic.         | 0.915817948   | 0.999969884           | 0.999601804              | 68.2       | 6        | 0.08794                      | 99616    | 3.00   | 2.0000 | 2.204 | 5534   | 3.4882    |
| <b>Pneumatic</b>          |                                    | 0.995224402   | 0.999998361           | 0.99997541               | 6266.9     | 30       | 0.00479                      | 1829941. | 3.00   | 0.9783 | 1.776 | 722345 | 0.0215    |
| Item: 231                 | Valve Operator, Pneumatic.         | 0.995224402   | 0.999998361           | 0.99997541               | 6266.9     | 30       | 0.00479                      | 1829941. | 3.00   | 1.0000 | 1.776 | 722345 | 0.0215    |
| <b>Voltage Regulator</b>  |                                    | 0.964377637   | 0.999690405           | 0.999644857              | 358.4      | 13       | 0.03627                      | 241506.4 | 74.77  | 0.3333 | 2.523 | 7103   | 3.1110    |
| <b>Static</b>             |                                    | 0.964377637   | 0.999690405           | 0.999644857              | 358.4      | 13       | 0.03627                      | 241506.4 | 74.77  | 0.3333 | 2.523 | 7103   | 3.1110    |
| Item: 238                 | Voltage Regulator, Static.         | 0.964377637   | 0.999690405           | 0.999644857              | 358.4      | 13       | 0.03627                      | 241506.5 | 74.77  | 0.0000 | 2.523 | 7103   | 3.1110    |
| <b>Water Cooling Coil</b> |                                    | 0.999577258   | 0.99999879            | 0.999993176              | 4730.0     | 2        | 0.00042                      | 20717496 | 2.50   | 0.2558 | 0.260 | 38084  | 0.0598    |
| <b>Fan Coil Unit</b>      |                                    | 0.999577258   | 0.99999879            | 0.999993176              | 4730.0     | 2        | 0.00042                      | 20717496 | 2.50   | 0.2558 | 0.260 | 38084  | 0.0598    |
| Item: 239                 | Water Cooling Coil, Fan Coil Unit. | 0.999577258   | 0.99999879            | 0.999993176              | 4730.0     | 2        | 0.00042                      | 20717496 | 2.50   | 0.0000 | 0.260 | 38084  | 0.0598    |

\* Time truncated, chi squared, 60% single-side confidence interval